out of the water and have greater fighting qualities, they offer more sport to the fisherman than does the largemouth. Obviously further experimentation with bass hybrids is needed and a desirable strain of hybrids developed. However, these voracious feeders may be too easily overfished (Birdsong and Yerger, 1967; Childers, 1967; Childers and Bennett, 1961; Hubbs, C. L., 1920; Hubbs, Carl, 1955; Hubbs and Hubbs, 1931; Hubbs and Hubbs, 1932A; Hubbs and Hubbs, 1932B; Hubbs and Hubbs, 1933; Hutchins, 1969; Krumholz, 1950; Lagler and Steinmetz, Jr., 1957; Luce, 1937; Moenkhaus, 1911; Natural History Survey, 1968; Ricker, 1948; Thompson, 1935; West and Hester, 1966; *see* also p. 120).

Percidae: Since 1950 there has been sustained interest in natural hybrids, and in the artificial hybridization between many species of Percidae. Much valuable information has been accumulated. A large number of artificial hybrids have been produced, some of which were thought to be impossible a few years ago. In 1959 Clark Hubbs (50) wrote that Strawn and he had concluded from their experiments that "any hybrid combination can be made between any two species of darter" (Distler, 1968; Hubbs, 1959; Hubbs and Laritz, 1961A and 1961B; Hubbs and Strawn, 1957A and 1957B; Whitehead and Wheeler, 1966; *see* also p. 120).

Part VI

Preserved Fish Collections and Numbers of Fishes Examined

Fortunately there exists a large number of preserved fishes, the majority of which are deposited in the following collections:

Institution housing collection	*Abbreviation of institution collection*	*Years when bulk of material was collected*	*Principal collectors*	*Approximate number of fishes examined by me*
California Academy of Sciences*	CAS	1870–1900	Philip H. Kirsch Seth E. Meek C. Kendall U. S. Fish Commission	500
Chicago Natural History Museum	CNHM	1860–1900	Charles H. Gilbert Seth E. Meek A. J. Woolman J. W. Milner	650
Cincinnati Society of Natural History	CSNH	1860–1900	Charles Dury James A. Henshall Josua Lindall Charles H. Gilbert	500
Marietta College	CM	1925–1935	H. R. Eggleston Edward Warner	100
Oberlin College Museum	OCM	1880–1895	L. M. McCormick Philip H. Kirsch	400
Ohio State Museum	OSM	1920–1938	James S. Hine Robert B. Foster Edward L. Wickliff Milton B. Trautman	9,500
Ohio State University†	OSU	1939–1969	Edward L. Wickliff Edward C. Kinney, Jr. Ted Cavender	67,000
Ohio State University Museum of Zoology	OSUM	1970–1980	Mary A. Trautman Milton B. Trautman	145,000
Stanford Natural History Museum	SNHM	1870–1900	Charles H. Gilbert Philip H. Kirsch Seth E. Meek U. S. Fish Commission	300
University of Akron	UA	1925–1939	Walter C. Kraatz	300
University of Michigan Museum of Zoology	UMMZ	1920–1950	Walter Koelz J. Hilary Deason Carl L. Hubbs Milton B. Trautman	10,500
United States National Museum	USNM	1850–1901	J. W. Milner Spencer F. Baird U. S. Fish Commission	3,500

* The CAS Collections of Ohio fishes have been transferred to the UMMZ collections.

† The Ohio State University collection has been presented to the Ohio Historical Society and was merged with the Ohio State University Museum of Zoology collection at Columbus in 1970.

Survey records indicate that in addition to the 93,250 preserved specimens mentioned above, I also identified between 50,000 and 60,000 preserved specimens belonging to other institutions and to private individuals. After identifying these specimens, they were returned to their owners or dis-

carded at the owners' request. Many thousands of specimens from the Wayne, Ashland, and other county and stream surveys were reluctantly discarded because of lack of permanent storage space, time and money necessary to properly catalog and permanently preserve them. Many thousands of fishes, collected by Edward L. Wickliff during the 1920–25 surveys, had to be discarded because of too long preservation in formalin.

During the 1925–50 period I made more than 2,000 collections, collecting in more than 1250 of the 1420± townships.* While collecting I normally released more than 90% of the catch, often saving none of some species, one or a few individuals of other species, and saving larger series only of those species needed for special study. The survey records show that during the 25-year period as many as 15,000 individuals were released during a 3-hour collecting period in one locality, and a total of between 400,000 and 600,000 fishes were captured, identified and returned to the water.

I also examined many thousands of Lake Erie fishes, while they were in the fish boats or in the fish houses, and Ohio River fishes in the nets and live boxes of the river commercial fisherman. In addition many hundreds were examined which were caught by sport fishermen in all parts of the state.

I have incorporated likewise in this report a relatively few locality records of fishes which I did not identify myself but which were adequately described to me by others. These records included only those species which could not be confused with other species, such as the paddlefishes, large muskellunges, and blue catfishes and alligator gars too large to belong to other species.

During the early years many specimens, then considered as belonging to a single species, were identified upon the spot and returned to the water or if preserved were soon discarded. Later the supposed single species were found to be a complex of two or more species. When this situation was realized, those distribution records of such complexes without specimens were discarded whenever doubt existed as to their specific identity.

During a final check up of all distributional records, those were discarded which did not fit into the distributional pattern for their species if they were not substantiated by specimens. This procedure was considered necessary despite the high probability that most of these records were of correctly identified strays.

* The number of Ohio townships decreased as some townships were incorporated into municipalities.

Methods by Which Fishes and Data Were Collected

The fishes upon which this report is based were collected primarily with the aid of Common Sense seines of 4′ and 6′ (1 and 2 m) in length, and bag seines of 15′ and 20′ (4.6 and 6.1 m) in length, the latter containing a long bag in their centers. Thousands of fishes were captured with the aid of gill, trammel, fyke and trap nets, and trawls, trot lines and angling. Hundreds were taken after having been stunned or killed by excessive amounts of domestic, industrial and soil pollutants; others, dying or dead were picked up along Lake Erie beaches.

The majority were taken during the warmer months and in the daylight hours. Representative samples were taken in the winter and at night.

The following data were usually secured at the time the collection was made: exact locality, such as name of stream, pond or other waters, the stream system and drainage in which it belonged, and the county and townships (section when possible); water conditions, including degree of turbidity, amounts and types of pollutants evident; present water level, and estimate of level during the normal low periods and the height during flood crests, the latter determined by observing the debris in the bank vegetation; an estimation of widths and depths of waters during normal conditions in summer; gradient, whether high, moderate or low; types of bottom and percentage of each type; absence of aquatic vegetation, or amounts of each kind if present; kinds of land vegetation bordering the waters such as an elm-ash-maple, or willow-pioneer weed, or sycamore-elm association; type of valley and flood plain, whether narrow or wide; fishing gear used; names of collectors; time of day; the day, month and year; pertinent remarks such as life history; habitat and behavior data, and color descriptions of living fishes.

In the 1840–1950 period, recorded collections were made at more than 2,500 localities, *see* "Distribution of Collections" map (map IX). Only a single collection was made in about 40% of the localities, and two or more were made upon different days or years in the remaining 60%. Altogether more than 6,000 recorded collections were made at the 2,500 stations, of which fewer than 300 collections were made prior to 1900; fewer than 50 between 1901–19; more than 2,900 between 1920–38; more than 2,000 between 1939–50. At least one species of fish was recorded at each collecting station, except for about 35 where the waters were so polluted at the time as to be apparently devoid of fish life.

At each of approximately 800 stations a period of two hours or less was spent in investigations; more than two hours were spent at each remaining station.

Years 1955 to 1980. More than 1,000 collecting stations were investigated during this period, some during several dozen days by many individuals and/or organizations and for several hours per day. It is impossible to estimate how many part or entire

MAP IX. Distribution of collections made in Ohio between 1840 and 1955. Each dot represents a locality from which one to several hundred collections were made

MAP X. Distribution of collections made since 1955. Each triangle represents a locality from which one to several dozen collections were made

day collections were made but the total number was obviously more than 2,000.

Areas Thoroughly Investigated and Some Results

County collections: Before 1951, the number of collecting stations per county ranged from 15 (Harrison County) to 64 (Ottawa County), with a county average of slightly more than 29. More than 32 separate collections were made in each county. Counties containing fewer than 20 collecting stations had so few because, like Highland, Medina, Shelby and Warren, they were adjacent to counties which had been thoroughly investigated and it was assumed that their fish faunas were comparatively well known; and/or like Harrison or Cuyahoga their faunas had become pauperized and aberrant because of excessive pollution and because so few suitable collecting sites remained; and/or watershed counties like Crawford, Huron, Morrow, Seneca and Wyandot because their waters lacked a wide diversity of habitats. Greater emphasis was placed upon a stream system as a unit than upon political boundaries.

Ottawa County: Since 1918 many persons and agencies, including faculty and students of Ohio State University, and members of the Ohio Department of Natural Resources and of the U.S. Fish and Wildlife Service, have investigated its waters. A county total of 92 species and four additional subspecies of fishes have been recorded. In an area of about 9 square miles surrounding South Bass Island (Langlois, 1949: 1–57) a total of 80 species and two additional subspecies were recorded during the 1939–53 period, of which 30 species were captured chiefly in the gear of the commercial fishermen, these including such species as silver lamprey, lake sturgeon, cisco and whitefish; 45 species might be captured annually with experimental gear, hand seines and trawls and included minnows, darters, sunfishes, bullheads, trout-perch, and young of the deeper water species; 25 species were so few in numbers and/or so difficult to capture as to be taken upon fewer than eight days, such as the black redhorse and spoonhead sculpin; several species apparently had become extirpated after 1945 or were so reduced in numbers as to have been impossible to capture, such as the pugnose shiner; others like the alewife and orangespotted sunfish invaded the area after 1939.

Since 1951 many collections have been made annually in Ottawa County, and especially in the vicinity of the Bass Islands by faculty and students of the Stone Laboratory. Three exotic species have been added, making a total of 95 species for the county. Of these 18 species have not been recorded since 1955 and several others have decreased greatly in abundance.

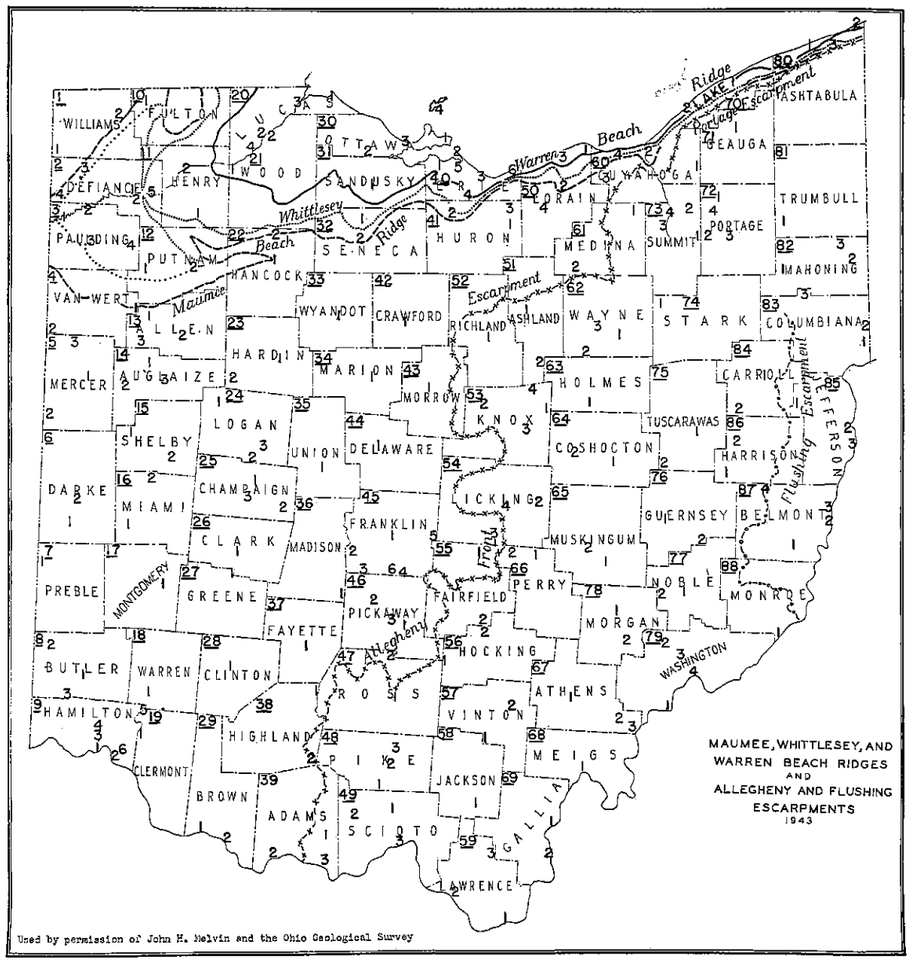
Auglaize County: The majority of the collections were made after 1920, first by Edward L. Wickliff, later principally by Clarence Clark (1942: 1–165) and myself. This county was selected partly because it contained remnants of till- and lake-plain, prairie and Black Swamp types of streams. A total of 63 species and two additional subspecies were recorded. Since 1951 only one species, the exotic striped bass, has been added, thereby increasing the total to 64 species.

Scioto County and the lower Scioto River: Before 1951, 97 species and an additional subspecies were recorded for the county. Between October 1, 1939 and September 30, 1940 members of the Ohio Department of Natural Resources conducted daily fyke and trap-net operations in a 2-mile (3-km) stretch of the Scioto River in the northern part of the county. Frequent collecting with hand seines and other gear was also done. A total of 75 species and an additional subspecies were recorded from the 2-mile (3-km) stretch of river. By 1977 there were recorded 104 species of fishes.

Scioto River drainage: No other stream drainage in Ohio has been so thoroughly investigated during the past 100 years as has this one. Although much attention had been given the Scioto River prior to 1950, a considerably increased amount has been given since. Between the years 1960 and 1965 the Ohio Division of Natural Resources, through granting funds, made it possible for several students and others to assist me in the investigations of central Ohio streams (known as COSS). As many as 50 days a year were spent in collecting and in field studies. A comparison between the present and past distribution and abundance of fishes was thus made possible. Various studies were also made of individual species. To date, 125 species have been recorded from this drainage.

Big Darby Creek: This stream rises in the gently rolling hills of Logan County and flows southward into Pickaway County, a distance of more than 75 miles (121 km), to enter the Scioto River a mile above Circleville. It is a free-flowing stream, remaining unimpounded by large dams. There has been comparatively little drastic channelization.

Because of the research and teaching possibilities of this stream, a 1/4-mile (0.4-km) stream section was designated in 1925 as an intensive study area. This section is about 1/2 mile (0.8 km) south of Fox, in Jackson Township, Pickaway County and immediately above the State Route 104 bridge. Throughout the 1925–50 period more than 125 days were spent by others and me investigating this section. Collections were made during every month of the year, the majority in April, May, September and October. By 1951 this short stream area had yielded 81 species of fishes of which 19 were collected on fewer than 4 days and were considered to be strays.



Used by permission of John H. Melvin and the Ohio Geological Survey

MAP XI. Principal ridges and escarpments, and list of numbered counties, villages and other localities mentioned in the literature or near which important collections were made

Map XI. Principal Ridges and Escarpments, and List of Numbered Counties, Cities, Villages and Other Localities Mentioned in the Literature or Near Which Important Collections Were Made

A Amsterdam, *85*-1*; Antwerp, *3*-1; Apple Creek, *62*-1; Armstrongs Mills, *87*-1; Ashland, *51*-1; Ashtabula, *80*-1; Athens, *67*-1; Auglaize, *13*-1; Aurora, *72*-1; Avon Lake, *50*-1.

B Bellaire, *87*-2; Belpre, *79*-1; Berlin Center, *82*-1; Beverly and Waterford, *79*-2; Blue Creek, *39*-1; Bridgeport, *87*-3; Brinkhaven, *53*-1; Brunersburg, *2*-1; Buckeye Lake, *54*-1; Buckland, *14*-1; Bucyrus, *42*-1.

C Caldwell, *77*-1; Cambridge, *76*-1; Canal Fulton, *74*-1; Carrollton, *84*-1; Castalia and Venice, *40*-1; Cecil, *3*-2; Cedar Point, *40*-2; Celina, *5*-1; Chagrin Falls, *60*-1; Chardon, *71*-1; Chesapeake, *59*-1; Chillicothe, *47*-1; Cincinnati, *9*-1; Circleville, *46*-1; Clarksfield, *41*-1; Cleveland, *60*-2; Clifton, *27*-1; Cloverdale, *12*-1; Columbus, *45*-1; Coney Island Resort, *9*-2; Conneaut, *80*-2; Coolville, *67*-2; Coopersville, *48*-1; Coshocton, *64*-1; Cuyahoga Falls, *73*-1.

D Darbyville, *46*-2; Dayton, *17*-1; Defiance, *2*-2; Delaware, *44*-1; Delphos, *4*-1.

E Edgerton, *1*-1; Elmwood, *9*-3; Elyria, *50*-2.

F Fairport and Painesville, *70*-1; Farmer, *3*-3; Fayette, *10*-1; Findlay, *22*-1; Flushing, *87*-4; Fly, *88*-1; Fort Jefferson, *6*-1; Fort Loramie, *15*-1; Fort Recovery, *5*-2; Fort Seneca, *32*-1; Fox, *46*-3; Fredericktown, *53*-2; Fredericktown, (St. Clair), *83*-1; Freeport, *86*-1; Fremont, *31*-1.

G Gallipolis, *69*-1; Georgesville, *45*-2; Glenford, *66*-1; Gnadenhutten, *75*-1; Grand Rapids, *21*-1; Greenfield, *38*-1; Greenville, *6*-2.

H Handen, *57*-1; Hamilton, *8*-1; Hamler, *11*-1; Hanover, *54*-2; Harrisburg, *45*-3; Hawkins (now Ira), *73*-3; Hebron, *54*-3; Hicksville, *2*-4; Higginsport, *29*-1; Hinckley, *61*-1; Hockingport, *67*-3; Howard, *53*-3; Hudson, *73*-2; Huron, *40*-3.

I Independence, *2*-5; Ira (formerly Hawkins), *73*-3; Ironton, *59*-2.

J Jelloway, *53*-4.

K Kent, *72*-2; Kenton, *23*-1; Killbuck, *63*-1; Kings Creek, *25*-1; Kings Mills, *18*-1; Kingsville, *80*-3.

L Lakeside, *30*-1; Lakeview and Russels Point, *24*-1; Laureiville, *56*-1; Leesville, *84*-2; Lima, *13*-2; Little Cedar Point, *20*-1; Lockbourne, *45*-4; Lockland, *9*-4; Lodi, *61*-2; Lorain, *50*-3; Loudonville, *51*-2; Loveland, *9*-5; Lowell, *79*-3; Lucasville, *49*-1; Ludlow Falls, *16*-1.

M Manchester, *39*-2; Mansfield, *52*-1; Marietta, *79*-4; Marion, *34*-1; Marysville, *35*-1; Maumee, *20*-2; McConnelsville, *78*-1; Mechanicsburg, *25*-2; Milan, *40*-4; Milford, *19*-1; Millersport, *55*-1; Mingo Junction, *85*-2; Mount Gilead, *43*-1; Mount Sterling, *36*-1; Monroeville, *41*-2.

N Napoleon, *11*-2; Neagley, *83*-2; Nellie, *64*-2; Newark, *54*-4; Newcomerstown, *75*-2; New Paris, *7*-1; Newton Falls, *81*-1.

O Oak Harbor, *30*-2; Oak Hill, *58*-1; Oakwood, *3*-4; Oberlin, *50*-4; Olive Green, *77*-2; Olmstead Falls, *60*-3; Ottawa, *12*-2; Otway, *49*-2; Oxford, *8*-2.

P Painesville and Fairport, *70*-1; Paulding, *3*-3; Peninsula, *73*-4; Perrysburg, *21*-2; Philo P. O. (Taylorsville), *65*-1; Piketon, *48*-2; Piqua, *16*-2; Poland, *82*-2; Pomeroy, *68*-1; Port Clinton, *30*-3; Portsmouth, *49*-3; Put-in-Bay, *30*-4.

R Raccoon Island, *69*-2; Ravenna, *72*-3; Redbank, *9*-6; Reynoldsburg, *45*-5; Ripley, *29*-2; Rockbridge, *56*-2; Rockford, *5*-3; Rocky River, *60*-4; Rome (Stout P. O.), *39*-3; Ross P. O. (Venice), *8*-3; Roundhead, *23*-2; Russels Point and Lakeview, *24*-1.

S Salem, *83*-3; Sandusky, *40*-5; Senecaville, *76*-2; Shadeville, *45*-6; Shreve, *62*-2; Sidney, *15*-2; Sinking Springs, *38*-2; Spencerville, *13*-3; Springfield, *26*-1; St. Clair (Fredericktown), *83*-1; Steubenville, *85*-3; St. Marys, *14*-2; Stockport, *78*-2; Stout P. O. (Rome), *39*-3; Streetsboro, *72*-4; Sugar Grove, *55*-2.

T Tappan, *86*-2; Taylorsville (Philo P. O.), *65*-1; Thornport, *66*-2; Tiffin, *32*-2; Toledo, *20*-3.

U Upper Sandusky, *33*-1; Urbana, *25*-3.

V Van Buren, *22*-2; Venice (Ross P. O.), *8*-3; Venice and Castalia, *40*-1; Vermilion, *40*-6.

W Wakeman, *41*-1; Wapakoneta, *14*-3; Washington, C. H. *37*-1; Waterford and Beverly, *79*-2; Waterloo, *59*-3; Waterville, *20*-4; Waverly, *48*-3; West Liberty, *24*-2; West Unity, *1*-2; Wilmington, *28*-1; Willoughby, *70*-2; Willshire, *4*-2; Wooster, *62*-3.

Y Yellow Bud, *47*-2; Youngstown, *82*-3.

Z Zaleski, *57*-2; Zanesfield, *24*-3; Zanesville, *65*-2.

* The italicized number is the underscored number in the upper left hand quarter of the county which it represents. Following that is the number representing the city, village or other locality.

Since 1955 Big Darby Creek, and especially the study area, has been ever increasingly investigated by members of many organizations, ichthyologists and students from within and outside Ohio. No stream system in the state has been more thoroughly investigated. Faculty and students of Ohio State University utilize it regularly for investigative purposes as do those from other universities such as John Carroll, Bowling Green State and Ohio Wesleyan. To date, 92 species of fishes have been recorded from the study area of which 15 have not been collected since 1951 and 13 are considered to be strays. An additional 8 species, not recorded in the study section, have been taken elsewhere in Big Darby, giving a total of 100 species for the system.

Olentangy River: This southward flowing stream of central Ohio has several small cities and the northern half of Columbus within its watershed. Its confluence with the Scioto River is in the center of Columbus. Because of its proximity to Ohio Wesleyan and Ohio State universities, considerable research of its fauna and flora has been conducted during the past century. Despite the large number of people living along its banks and within its watershed, it contains a goodly fish population. The stream is much fished by people of all ages.

The Olentangy River compares favorably with Big Darby Creek in the length and size of its watershed. However, there are striking differences in the composition of the fish species. The paddlefish, buffalofishes and other large river species have not been recorded, presumably because of dams situated in the Scioto River a short distance below the confluence of the Olentangy, these dams preventing vernal migrations upstream. Apparently because of dams, human population density, and a more northern location in Ohio, only 71 species have been recorded for the Olentangy, in comparison with 100 species recorded in Big Darby Creek.

Salt Creek: This stream system drains portions of Hocking, Vinton, Jackson and Ross counties in southcentral Ohio, entering the Scioto River in western Ross County. It has been regularly investigated since 1920 and the northern branch was thoroughly studied between 1972–74 by Andrew White, Bruce McLean and associates. To date, 84 species have been reported from the system.

Franklin County: In 1899 and 1900 E. B. Williamson and R. C. Osburn investigated its waters. After 1920 much additional collecting was done by Edward L. Wickliff, several fishery workers and me. A total of 91 species had been recorded, of which, after 1920, ten were considered to have become extirpated and ten to be strays. By 1977 the recorded number of species was 100.

Pike County: Robert B. Foster and I collected a total of 95 species in this county between 1925–34. Many collections have been made since by others and me. At present the recorded number of species is 102.

Wayne County: Its waters were investigated by Ralph V. Bangham and his students, principally in 1935–45. A total of 61 species and an additional subspecies were obtained. By 1977 there were recorded 64 species of fishes.

Ashland County: Mary A. Trautman (*née* Mary Auten) and her students collected fishes during the 1935–40 period, obtaining 63 species and an additional subspecies. By 1977 there were recorded 68 species of fishes.

Lake Erie and tributaries from Lorain County eastward to the Pennsylvania border: This area has been investigated at intervals since J. P. Kirtland began his studies of the zoology of Ohio about 1835. Since then personnel from federal and state organizations, universities and private individuals have studied and observed its fish fauna. Since 1971 Andrew White and associates have conducted intensive studies of the area, which continues (White et al., 1975). To date, 106 species and an additional 5 subspecies have been recorded for the area.

Ohio River: Since 1792 the states of Kentucky and later West Virginia have claimed ownership to all of the Ohio River to its present northern shoreline, despite impoundings which later flooded a considerable portion of land originally belonging to the state of Ohio. Recently the United States Supreme Court ruled that the northern boundary of the Ohio River is to be the 1792 low water mark, at which time Kentucky became a state. This returns to Ohio that portion which consists of 80 to 100 feet (24–30m) southward from the present Ohio shoreline. The ruling gives to the state of Ohio jurisdiction over that portion and also fish protection including our migrating fishes which spawn and summer in Ohio streams.

Columbiana, Defiance and Lucas counties: While residing at Ann Arbor, Michigan, between 1934 and 1938 I, assisted by students and Louis W. and the late Bernard R. Campbell, of Toledo, conducted investigations of many Ohio streams, principally in Columbiana (68 species recorded before 1950; 72 after), Defiance (74 species recorded before 1950; the county has been intensely investigated at times since 1887; *see* Trautman and Gartman [1974]; 76 species recorded after 1951) and Lucas (95 species recorded before 1950; 104 after).

Blacklick Creek: After 1935 Edward L. Wickliff conducted a series of investigations on this central Ohio stream. At least 40 species could be recorded annually.

Other streams: Between 1925–45 I periodically investigated the West Branch of Beaver Creek in Columbiana County, Sunfish Creek in Pike County, Auglaize River in Auglaize County, and several prairie- and till-plain streams, primarily to observe smallmouth blackbass production and changes in abundance of the fish fauna caused by changing ecological conditions.

Comparisons between Various Waters

Before 1951 a total of 160 species and 12 additional subspecies were recorded for all Ohio waters, of which a total of 122 species and seven additional subspecies were listed as occurring, or as having occurred at some time during the 1750–1950 period, in the Lake Erie drainage of Ohio, and 141 species and three additional subspecies in the Ohio River drainage.

By 1980 a grand total of 166 species and 13 additional subspecies had been recorded for all Ohio waters. The increase of six species and one subspecies since 1957 was the result of the introduction of exotic species, inadvertent omission of a species from the first edition, elevation from subspecific to specific rank and recognition of an undescribed species.

Before 1951 the Ohio waters of Lake Erie and its connecting bays and harbors (omitting flowing waters) yielded a total of 93 species and six additional subspecies, of which 30 are classified as strays from streams. These strays included such typical stream species as the creek chub and striped shiner. By 1980, 98 species and six additional subspecies had been recorded for the Ohio waters of Lake Erie and its connecting bays and harbors.

Before 1951 the Maumee River system contained a total of 93 species and two additional subspecies. By 1980, 103 species and two additional subspecies had been recorded. Since 1900 the rapidly increasing rates of turbidity and siltation presumably caused the extirpation of at least six species, drastic reduction in numbers of 27 species and/or the endangering of 19 additional species, all native.

Before 1951 the Ohio River, without its tributaries, yielded a total of 93 species and an additional subspecies. By 1980, 103 species and an additional subspecies, of which about 30 were present during droughts or in winter, and some of which were strays, had been recorded.

Before 1951 the Muskingum River and tributaries yielded 106 species and two subspecies. By 1980, 120 species and a subspecies had been recorded.

The above indicate that:

Each county, carefully investigated, contained more than 60 species of fishes. Counties situated along the divide between the two drainages contained the smallest number of species. Counties bordering Lake Erie and the Ohio River contained the largest number of species.

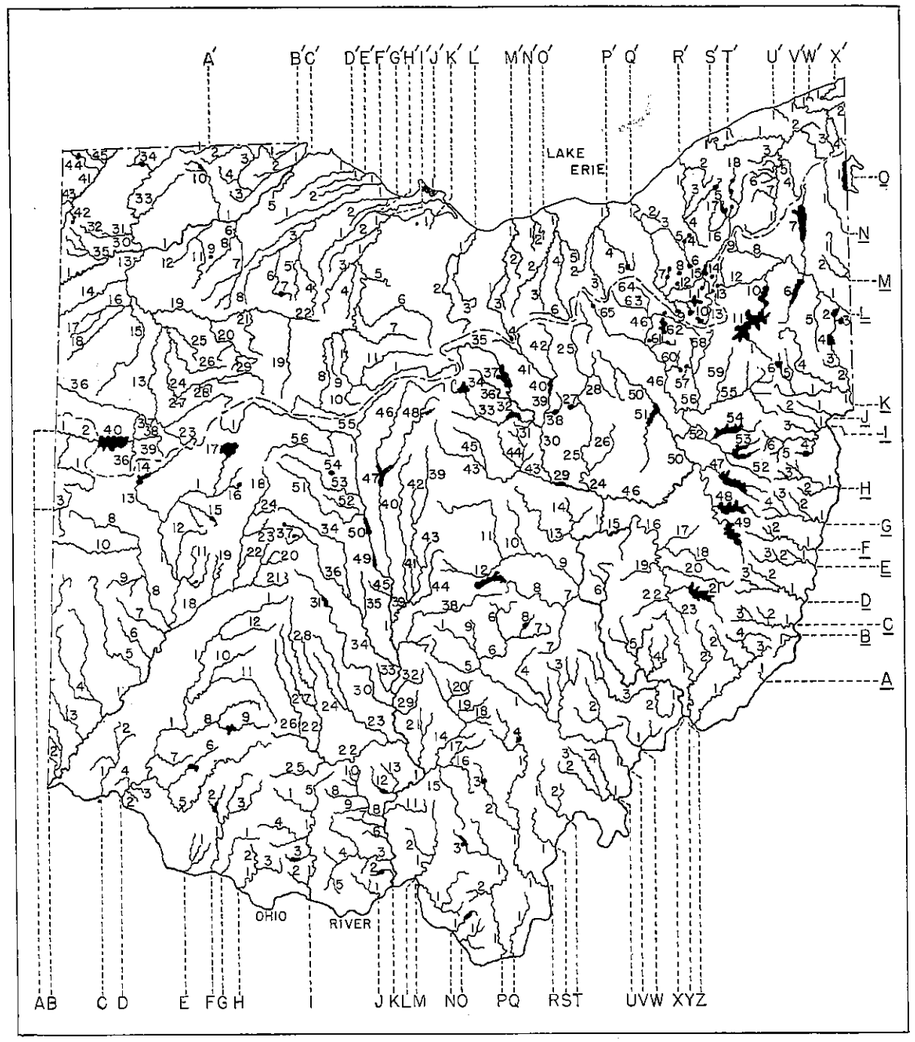
Short sections, and entire stream systems, in the Ohio drainage contained larger numbers of species than did similar waters in the Lake Erie drainage, provided that they were not heavily polluted. A larger number of species was recorded for the Ohio drainage than for the Lake Erie drainage.

Factors Influencing Fish Distribution and Abundance

To understand fish distribution and abundance it is necessary to realize that each species has its own specialized complex of many ecological niches or habitats, the sum total of which comprises its environment. Wherever its environmental conditions prevail, a fish species under normal conditions can successfully repel all other fish species (including close competitors) from at least part of its specialized environment.

The numbers of a species are usually controlled by the amount of available environment. This environment, in part or in its entirety, may fluctuate greatly from year to year, or from one series of years to another and this, coupled with the high offspring potentials of most fish species, may result in spectacular increases in abundance of a species in a single year, or during two or more consecutive years; *see* Tippecanoe darter.

It is because species (including subspecies) are so restricted to their particular set of environmental conditions that they cannot follow the popular



MAP XII. Names of streams mentioned in the literature or from which important collections have been made

Map XII

Ohio River Tributaries

A 1—Wabash R.; 2—Beaver Cr.; 3—Mississinawa R.

B 1—Great Miami R.; 2—Whitewater R.; 3—Indian Cr.; 4—Seven Mile Cr. (right) and Four Mile Cr. (left); 5—Twin Cr.; 6—Bear Cr.; 7—Wolf Cr.; 8—Stillwater R.; 9—Ludlow Cr.; 10—Greenville Cr.; 11—Honey Cr. (below and right), Indian Cr. (left) and Silver Lake (below); 12—Lost Cr.; 13—Loramie Cr.; 14—Loramie Res.; 15—Mosquito Cr. and Kiser Lake; 16—Bokengehalas Cr. and Silver Lake; 17—Indian Lake; 18—Mad R.; 19—Donnels Cr.; 20—Buck Cr. (left); 21—Beaver Cr.; 22—Cedar Run; 23—Kings Cr. (above); 24—Macocheek Cr. (below)

C 1—Mill Cr.; 2—East Br. (below)

D 1—Little Miami R.; 2—Cluff Cr. (above); 3—McCullough Cr. (left); 4—Duck Cr.; 5—East Fork; 6—Stonelick Cr. and Stonelick Lake; 7—O'Bannon Cr.; 8—Todds Fork; 9—Cowan Cr. and Cowan Lake; 10—Caesars Cr.; 11—Andersons Fork; 12—Massies Cr.

E 1—Bull Skin Cr.

F 1—Whiteoak Cr.; 2—Sterling Run and Grant Lake; 3—East Fork

G 1—Straight Cr.

H 1—Eagle Cr.; 2—West Fork; 3—East Fork

I 1—Ohio Brush Cr.; 2—Beasley Fork; 3—Lick Fork and Adams Lake; 4—Little West Fork; 5—Bakers Fork

J 1—Turkey Cr.

K 1—Scioto R.; 2—Pond Cr. and Roosevelt Lake; 3—Scioto Brush Cr.; 4—South Fork; 5—Churn Cr.; 6—Bear Cr. (below); 7—Camp Cr. (below); 8—Sunfish Cr.; 9—Chenoweths Fork; 10—Morgans Fork (below); 11—Beaver Cr.; 12—Peepee Cr. and Lake White; 13—Crooked Cr.; 14—Salt Cr.; 15—Little Salt Cr.; 16—Pigeon Cr. (below); 17—Middle Br.; 18—Queer Cr.; 19—Pine Cr.; 20—Laurel Run; 21—Walnut Cr. (right); 22—Paint Cr.; 23—North Fork; 24—Compton Cr. (right); 25—Rocky Fork; 26—Rattlesnake Cr. (right); 27—Sugar Cr. (between); 28—East Fork (below); 29—Kinnikinnick Cr.; 30—Deer Cr.; 31—Madison Lake; 32—Scipio Cr.; 33—Yellow Bud Cr. (left); 34—Big Darby Cr.; 35—Hellbranch Run (left); 36—Little Darby Cr.; 37—Brush Lake (upper) and Baker Lake (lower); 38—Little Walnut Cr.; 39—Big Walnut Cr.; 40—Alum Cr. (right); 41—Masons Run (below); 42—Little Walnut Cr. (below); 43—Rocky Fork (below); 44—Blacklick Cr.; 45—Scioto Big Run (below); 46—Olentangy R.; 47—Delaware Res.; 48—Whetstone Cr. and Mt. Gilead lakes (right); 49—Griggs Res.; 50—O'Shaughnessy Res.; 51—Mill Cr.; 52—Blues Cr. (below); 53—Bokes Cr.; 54—Richwood Lake (below); 55—Little Scioto R. (right); 56—Rush Cr.

L 1—Little Scioto R.; 2—Rocky Fork

M 1—Pine Cr.

N 1—Storms Cr. and Vesuvius Lake

O 1—Ice Cr.

P 1—Symmes Cr.; 2—Johns Cr.; 3—Black Fork and Lake Jackson

Q 1—Indian Guyon Cr.

R 1—Raccoon Cr.; 2—Little Raccoon Cr.; 3—Lake Alma; 4—Lake Hope

S 1—Campaign Cr.

T 1—Leading Cr.; 2—Little Leading Cr.

U 1—Shade Cr.; 2—West Br.; 3—Middle Br.; 4—East Br.

V 1—Hocking R.; 2—Federal Cr.; 3—Sunday Cr.; 4—Monday Cr.; 5—Clear Cr.; 6—Rush Cr.; 7—Little Rush Cr.; 8—Clouse Lake; 9—Pleasant Run

W 1—Little Hocking Cr.

X 1—Muskingum R.; 2—South Br. Wolf Cr.; 3—West Br. Wolf Cr.; 4—Olive Green (right) and Little Olive (left) crs.; 5—Meigs Fork; 6—Salt Cr.; 7—Moxahala Cr.; 8—Jonathan Cr.; 9—Licking R.; 10—Rocky Fork; 11—North Cr. (left) and Dyes Cr. (right); 12—South Fork and Buckeye Lake (below); 13—Wakatomika Cr.; 14—Little Wakatomika Cr.; 15—Wills Cr. Res.; 16—Wills Cr.; 17—Sugartree Fork; 18—Salt Fork; 19—Crooked Cr.; 20—Leatherwood Cr. (below); 21—Seneca Cr. and Senecaville Res.; 22—Buffalo Fork; 23—Buffalo Cr.; 24—Walhonding R. (below); 25—Killbuck Cr.; 26—Doughty Cr. (right); 27—Shreve Cr. and Beaver Lake (below); 28—Apple Cr. (right); 29—Mohawk Res.; 30—Mohican R.; 31—Pine Run (above); 32—Pleasant Hill Res. (below); 33—Clear Fork; 34—Clear Fork Res. (left); 35—Black Fork (below); 36—Rocky Fork (right); 37—Charles Mill Res.; 38—Odell Lake (above); 39—Lake Fork (right); 40—Mohicanville Res.; 41—Jerome Fork; 42—Muddy Fork; 43—Kokosing R.; 44—Big (right) and Little (left) Jelloway crs.; 45—North Br. (right); 46—Tuscarawas R.; 47—Little Stillwater Cr. and Tappan Res. (below); 48—Brushy Fork and Clendening Res.; 49—Big Stillwater Cr. and Piedmont Res. (left); 50—Sugar Cr.; 51—Beach City Res. and South Br.; 52—Conotton Cr.; 53—Leesville Res.; 54—Atwood Res.; 55—Sandy Cr.; 56—Nimishillen Cr. (right); 57—Myers Lake (above); 58—Middle Br. (right); 59—Little Sandy Cr.; 60—Sippo Cr. (right) and Lake (below); 61—Nimisila Cr. (below) and Comet Lake (right), Luna Lake (left); 62—Portage lakes (left); 63—Wolf Cr. (below); 64—Schocalog Run (right); 65—Chippewa Cr. (left) and Lake

Y 1—Duck Cr.; 2—East Fork

Z 1—Little Muskingum R.; 2—Clear Fork (right); 3—Witten Fork; 4—Cranenest Fork

A 1—Jims Run near Fly, Ohio
B 1—Opossum Cr.
C 1—Sunfish Cr.; —Piney Cr.; 3—Bakers Fork (right)
D 1—Captina Cr.; 2—Bend Fork; 3—North Fork (below)
E 1—McMahon Cr.; 2—Little McMahon Cr. (right); 3—Brush Cr. (right)
F 1—Wheeling Cr.; 2—Campbells Cr.
G 1—Short Cr.; 2—Piney Fork; 3—North Fork (left); 4—Middle Fork (below)
H 1—Cross Cr.; 2—McIntyre Cr.; 3—Salem Cr. (right)
I 1—Big Yellow Cr.; 2—North Fork (below); 3—Brushy Fork; 4—Town Fork and Jefferson Lake; 5—Elklick Run; 6—Elkhorn Cr. (left)
J 1—Little Yellow Cr.
K 1—Little Beaver Cr.; 2—North Fork; 3—Bull Cr. (right); 4—Middle Fork; 5—Cold run (right); 6—West Fork and Guilford Lake (right)
L 1—Mahoning R.; 2—Yellow Cr. and Hamilton Lake (right); 3—Burgess Lake (left); 4—Pine Lake (right); 5—Mill Cr.; 6—Meander Cr. and Res.; 7—Mosquito Cr. and Res.; 8—Eagle Cr.; 9—Silver Cr. (right); 10—Milton Lake (right); 11—Berlin Res.; 12—West Br.; 13—Crystal Lake (above)
M 1—Big Yankee Cr.; 2—Little Yankee Cr. (both of Little Deer System)
N 1—Pymatuning Cr.
O 1—Pymatuning Res.

Lake Erie Tributaries

A′ 1—Bear Cr.
B′ 1—Ottawa R.; 2—Ten Mile Cr.; 3—Prairie Ditch (below and connects with Swan Cr.)
C′ 1—Maumee R.; 2—Swan Cr. (below); 3—South Br. (below); 4—West Fork (below); 5—Grassy Cr. (above); 6—Beaver Cr. (right); 7—Yellow Cr. (below) and Cut-off Ditch (right); 8—West Br.; 9—Hamler Pond (below); 10—Bad Cr. (right) and Delta Lake (above); 11—Turkeyfoot Cr.; 12—School Creek; 13—Auglaize R. (right); 14—Flat Rock Cr.; 15—Little Auglaize R.; 16—Prairie Cr.; 17—Hagerman Cr. (below); 18—Hoaglin Cr. (below); 19—Blanchard R.; 20—Riley Cr. and tribs.; 21—Ottawa Cr. (right); 22—The Outlet (below); 23—Pusheta Cr.; 24—Ottawa R. (below); 25—Plum Cr. (left); 26—Sugar Cr. (below); 27—Little Ottawa R. (between); 28—Lost Cr. (above); 29—Big and Little Hog crs. (below); 30—Tiffin R. (right); 31—Mud Cr.; 32—Lost Cr. (below); 33—Brush Cr. (right); 34—Mill Cr. and Harrison Lake (below); 35—Gordon Cr. and branches (left); 36—St. Mary's R.; 37—Six Mile Cr. (between); 38—East Br. (below); 39—Clear Cr. (right); 40—Lake St. Marys; 41—St. Joseph R.; 42—Lehmans and Little lakes; 43—Fish Cr. (below); 44—Nettle Cr. and Nettle Lake; 45—West Br. (below)
D′ 1—Crane Cr.
E′ 1—Turtle Cr.
F′ 1—Toussaint Cr.; 2—Packard Cr. (right)
G′ 1—Portage R.; 2—Nine Mile Cr. (right); 3—Middle Br. (below); 4—East Br.; 5—South Br. (right); 6—Rocky Fork Cr.; 7—Van Buren Lake; 8—Needles Cr. (right)
H′ 1—Big Muddy Cr.
I′ 1—Sandusky R.; 2—Muskellunge Cr. (below); 3—Wolf Cr. (below); 4—East Br.; 5—Sugar Cr.; 6—Honey Cr.; 7—Sycamore Cr.; 8—Tymochtee Cr.; 9—Little Tymochtee Cr. (above); 10—Little Sandusky R. (right); 11—Broken Sword Cr.
J′ 1—West, Middle and East Harbors
K′ 1—Cold Cr. (right) and Miller Blue Hole (left)
L′ 1—Huron R.; 2—West Br.; 3—East Br. (above)
M′ 1—Vermilion R.; 2—East Fork (right); 3—East Br. (right); 4—Savannah lakes
N′ 1—Beaver Cr.; 2—East Br. (right)
O′ 1—Black R.; 2—West Br.; 3—Wellington Cr.; 4—East Br.; 5—Willow Cr.; 6—West Fork (below)
P′ 1—Rocky R.; 2—Plum Run (right); 3—West Br.; 4—East Br.; 5—Hinkley Lake
Q′ 1—Cuyahoga R.; 2—Mill Cr.; 3—Tinkers Cr. (below); 4—Geauga Lake (above); 5—Aurora Pond (below); 6—Stewart Pond (left); 7—Mud Br. (right) and Wyoga (lower) and Mud (upper) lakes; 8—Crystal Lake (below); 9—Springfield Lake (above); 10—Fritch Lake (left); 11—Mogadore Res. (below); 12—Silver Lake (left); 13—Congress Lake Outlet (left) and Congress Lake (lowest), Muzzy Lake (middle) and Sandy Lake (upper); 14—Brady Lake (below); 15—Rockwell and Pippen lakes (right, and as one); 16—Bridge Cr.; 17—Lake Punderson and Bradley Pond (both to the right, Bradley Pond the farther); 18—Outlet Br. (below) and Alderman Pond (lower) and Aquila Lake (upper)
R′ 1—Chagrin R.; 2—East Br.; 3—Griswold Cr. (below); 4—Aurora Br. (left); 5—Bass Lake (above)
S′ 1—Grand R.; 2—Mill Cr. (below); 3—Trumbull Cr. (below); 4—Rock Cr.; 5—Crooked and Mud crs. (left and across the Grand River); 6—Hoskins and Indian crs. (right); 7—Phelps Cr. (below)
T′ 1—Arcola Cr.
U′ 1—Indian Cr.
V′ 1—Ashtabula R.; 2—Ashtabula Cr. (above); 3—West Br.; 4—East Br. (above)
W′ 1—Creek near Kingsville
X′ 1—Conneaut Cr.

conception that any fish species may be expected to occur (or can be successfully stocked) wherever there is water. An examination of the distribution maps verifies this; *see* the striking distributional patterns of the central mottled sculpin, redbelly and blacknose daces.

An analysis of ecological data was begun in 1940, and has continued as more data were collected. It is obvious from this analysis that escarpments, lake- and till-plains, unglaciated plateau and other physiographic features exerted a profound influence upon fish distribution and abundance, and that there was a correlation between physiography and stream gradients.

After studying the gradients of a few central Ohio streams, the importance of stream gradients to fish distribution was realized, so in 1941, assisted by George Borman, the plotting of all streams except the smallest tributaries was undertaken. U.S. topographical maps were used to plot gradients in feet per stream mile, by dividing the distance in stream miles between two contour lines into the numbers of feet of elevation between these contour lines.

In 1942 I published a paper relative to the correlation of stream gradients with fish distribution and abundance, suggesting that under average conditions, the absence or presence and abundance of a fish species in a given stream section was largely governed by the speed of flow, and that speed of flow, through its ability to erode, scour, dig and deposit various materials, determined to a large degree: (1) the number of riffles per stream mile, their depths, widths, and types of bottoms; (2) number of pools per stream mile, their depths, widths, the presence or absence of currents, and types of bottoms; (3) amount of silt deposited during various water levels; (4) amount and kinds of bank undercutting and resultant tree root exposure; (5) absence, or presence and abundance of macro- and micro-vegetation; (6) absence, or presence and abundance of backwaters, oxbows, sloughs and overflow ponds (Trautman, 1942: 211-23).

In addition to the actual gradient, the speed of flow is sometimes affected by the depth of water since within limits the rate of flow increases as the depth increases. Because of the effects of various rates of flow, water depths and stream widths upon fish distribution and abundance, it becomes necessary to establish ratings for five stream sizes as follows:

Average Stream Widths*		Average Riffle Depths		Low		Moderate		High	
Feet	Meters	Feet	Meters	Feet/Mile	Meters/Kilometer	Feet/Mile	Meters/Kilometer	Feet/Mile	Meters/Kilometer
1.0′- 15.0′	03.m- 4.7m	0.3′- 3.0′	0.1m-0.9m	1.0′-10.0′	0.20m-1.9m	12.0′-20.0′	2.3m-3.8m	25.0′+	4.8m+
16.0′- 30.0′	4.8m- 9.2m	0.5′- 3.0′	0.2m-0.9m	1.0′- 6.0′	0.20m-1.1m	7.0′-18.0′	1.3m-3.4m	20.0′+	3.8m+
31.0′- 45.0′	9.3m-13.8m	1.0′- 3.0′	0.3m-0.9m	1.0′- 5.0′	0.20m-1.0m	6.0′-10.0′	1.1m-1.9m	12.0′+	2.3m+
46′-100.0′	13.9m-30.6m	1.5′- 5.0′	0.5m-1.5m	0.5′- 4.0′	0.10m-0.8m	5.0′- 8.0′	1.0m-1.5m	9.0′+	1.7m+
101.0′+	30.7m+	1.5′-10.0′	0.5m-3.0m	0.1′- 1.0′	0.02m-0.2m	2.0′- 4.0′	0.4m-0.8m	5.0′+	1.0m+

* Stream sizes were determined by striking an average when the stream was at normal summer level.

Other factors affecting fish distribution and abundance:

(1) Physiography and the types of bedrocks and soils: for an example, *see* Trautman (1942: 219–22) concerning lamprey distribution east of the Flushing Escarpment.

(2) Degree and availability of fertility in soils: streams draining fertile soils usually contained faster growing and/or larger fish populations than did those streams draining soils of low fertility.

(3) Soil, domestic and industrial pollutants: below normal fish populations occurred when detrimental pollutants were present, even though stream gradient and other factors were favorable.

(4) Season of year: the absence or presence and abundance of fish species in a given stream section varied according to the seasons, because most of the Ohio fish species are migratory to some extent. Such species, and especially the adults, moved from lower to higher gradients (and usually from larger to smaller streams) with the increase of water temperature in late winter or spring; later, in late spring or summer, the adults and many young began drifting downstream to winter in lower (or at least as low)

gradients. Because of this annual movement into smaller streams and higher gradients some species as the creek chub and smallmouth blackbass were far more numerous in winter in the Ohio River than they were in that stream in summer.

(5) Population pressure from competitors: an example is the smallmouth blackbass which wintered in larger numbers in gradients of less than 5.0′ (1.5 m) per mile (1.6 km) wherever the spotted blackbass was absent than it did in similar gradients where the latter species was present.

The Distribution Maps

Note: Future locality records for each species can be marked on their respective distribution maps and, since these records will be inserted in pencil or in ink, will readily show any changes in distributional patterns, new county and new drainage records, which have been obtained since 1950. Especially interesting will be the records of such invading species as the orangespotted sunfish and white perch, and by using different symbols for subsequent years a graphic record of range extension and speed of invasion will be had.

The symbols on the distribution maps indicate rather accurately the localities where one or more individuals of a species were recorded on one or more days.

Many symbols closely clustered usually denote a center of abundance.

Relative abundance and distribution of many species show a correlation with such physiographic features as escarpments, lake- and till-plains, unglaciated plateaus, large or small lakes, and large or small streams.

Changes in abundance of some species during part or all of the 1850–1950 period are shown by the use of different symbols for the various periods.

Degree of subspecific intergradation throughout sections of the state is demonstrated by the use of various symbols.

The distribution maps fail to portray accurately the relative abundance of a species because each symbol has the same numerical value and may either represent one, hundreds, or thousands of individuals.

The maps do not indicate seasonal changes in abundance of the more migratory species, such as the creek chub which spawns in spring in the smaller creeks and brooks and winters chiefly in larger waters including the Ohio River.

The maps portray rather accurately the distributional patterns for the various species as they existed during the 1920–50 period, but do not indicate the vast changes in distributional patterns of many species prior to 1900, because of the comparatively few numbers of early preserved specimens and literature records. An example is the redbelly dace which unquestionably was more widespread in its Ohio distribution prior to 1900 than it has been since, because habitat conditions for it were more widespread during the early years. As a general rule, those species least tolerant to turbid waters, other pollutants, silt-covered bottoms, ditching and dredging have become more restricted in, or were extirpated from, their Ohio ranges, whereas those species most tolerant to such conditions have become more widespread and have recently invaded areas not previously occupied since 1750.

For further details as to which records have been accepted for use in the distribution maps, *see* "Preserved fish collections and numbers of fishes examined." *See* map X for collections since 1955.

Insert Maps

Each Ohio distribution map has with it a small insert map which shows the approximate present and/or original range in North America of the species or subspecies indicated on the larger map. The range of monotypic species is presented in black. When a species is divided into subspecies the range of the subspecies under discussion is in black whereas the ranges of other subspecies are outlined. In such cases the combined black and outlined areas constitute the entire range of the species in that portion of North America which is shown on the map.

These ranges are generalized, and because there are sections of North America where relatively little is known concerning the distribution of fishes, the limits of range in such sections must be indefinite to a greater or lesser degree. As a general rule the farther the limit of range is from Ohio the greater is the possibility of inaccuracy. This is especially true of northern Canada and Mexico.

The same factors which have caused recent changes in the distributional patterns of many fish species in Ohio have likewise caused drastic recent changes in part or all of the range of some species. Some native species are extending their ranges in one or more directions. In others their ranges are becoming smaller, and in the case of the harelip sucker it may have become extinct.

Some species or subspecies are rather uniformly distributed over much or all of their range; others have large unoccupied areas within their range caused by a lack or a destruction of their habitat.

A few species occur only in isolated colonies which are sometimes separated from each other by considerable distances.

Many native game fishes and other species have been widely introduced into many areas outside of their original or recent range. Only in a few instances have attempts been made to indicate on the insert maps where these introductions were made but mention of these introductions usually was referred to in the legends accompanying the maps. The legends also give other facts essential to an understanding of the ranges.

In order to have these ranges as accurate as possible I have made use of the literature and of the information accumulated by me and many coworkers, especially Reeve M. Bailey, Carl L. Hubbs, Clark Hubbs (Texas), George A. Moore (Oklahoma and general), Royal D. Suttkus (Gulf States), W. Ralph Taylor (catfishes), and Edward S. Thomas.

The Illustrations

With few exceptions there is an outline drawing representing each fish species and subspecies, or a drawing of both sexes of those species in which sexual dimorphism is marked. Exceptions are those species or subspecies which are so similar in general appearance that a drawing of them would be duplication. In addition, there are many illustrations containing anatomical drawings of some part or parts of a fish.

How the Illustrations Were Made

There were between 20 and 40 different counts and measurements taken of ten to 50 individuals of each species or subspecies, except for those species in which fewer than ten individuals were available. Counts and measurements were usually made with the aid of magnification and accuracies within half a millimeter were attempted upon such body parts as length of eye and snout. Particular care was given measurements which were of special taxonomic importance. The specimens usually ranged in size and age from medium- or large-sized young to large, old adults, with the mean frequently about the size of the average adult. After all counts and measurements had been taken the mean value of each was obtained, and that specimen whose counts and measurements came closest to all the means was selected for drawing. Proportional dividers were used to transfer measurements of the specimen to that of the drawing. The drawings from which the reproductions were made were with few exceptions between 12.0″ (30.5 cm) and 14.0″ (35.6 cm) in total length.

Color descriptions and chromatophore patterns were recorded when possible from living fishes, or from dead fishes as soon after their death as practical. The fishes were then preserved in a formalin solution consisting of one part commercial formalin to 7–10 parts of water. A few weeks after preservation in formalin, another description of the then-faded colors and chromatophore patterns was taken, after which the specimens were transferred (after washing 48 hours in water) into a 70% solution of alcohol and distilled water, in which solution they remained permanently. A third set of descriptions was taken, usually within a year, after the specimens had been placed in the alcohol solution. When necessary, separate descriptions were taken of different age groups and/or sexes of the same species. Later, those colors and chromatophore patterns most persistent and indicative of the species were stippled in the drawings. I made all counts, measurements and color descriptions.

After the specimen to be drawn was selected, Mrs. E. R. Weeks or I sketched in its outlines and squamation after which I gave the drawing a thorough examination, modifying it when necessary. Mrs. Weeks assisted with those illustrations on which her initials, E. R. W., appear. All of the stippling was done by me. No conscious attempt was made to include highlights in eyes or on the body, yet the patterns of such species as the Tippecanoe darter give the illusion of having highlights.

Some may consider the lack of colors in the illustrations a handicap, and so it is in those rather few species whose colors in life are taxonomically reliable. However, coloration is of little value in

many species, and in some it hides those characters which are taxonomically the most important. In addition a colored plate usually portrays only one sex, or a color phase of one sex during one period of the year, ignoring the three to six quite different color phases of the other sex, or age groups during various periods of the year.

Instructions upon How to Use the Illustrations

The fish drawings are actually diagrammatic illustrations of the species, or of one or both sexes of the species, because all of the counts, measurements and chromatophore patterns are *average* for their species. All measurements of curved surfaces, such as the snout measurement, are actual measurements and are not foreshortened as they frequently are in photographs, paintings and artistic drawings. Therefore, the average length of eye or other body length may be obtained from the drawings by accurately measuring those body parts with dividers, after which the measured body part may be divided into any other body part, thereby obtaining the average proportions between these two parts.

To Identify a Specimen:

(1) Determine the family to which it belongs. If you are not sure, use the "Key to Families of Ohio Fishes."

(2) Leaf through the pages containing the drawings and text for that family, comparing your specimen with the drawings of every species in the family until the one most like your specimen is found.

(3) Use the species analysis given under that species, checking each statement under *Characters*, including both those under *General* and *Specific* (and *Subspecific*).

(4) If the above characters agree with your specimen, check all statements under *Differs*. These statements stress the trenchant characters separating this species from others most closely resembling it, or which superficially resemble it. This section usually exposes errors made previously.

(5) The section on *Most like* and *Superficially like* emphasizes those species which must be eliminated.

(6) Coloration often aids in verifying the identification, and especially in those species in which coloration may be of taxonomic significance.

(7) *Lengths* and *weights* indicate growth rates, and may aid identification. They may disclose a misidentification, especially if your specimen is considerably larger than the maximum length and/or weight given for the species. An example is a fish 4.0″ (10 cm) in length which you identified as a Tippecanoe darter, but whose maximum length is given as only 1.8″ (4.6 cm).

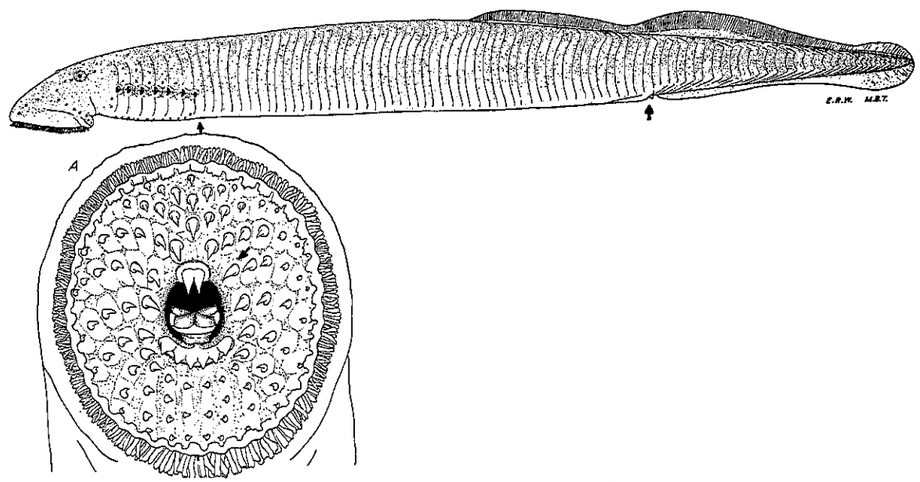
(8) The section on *Hybridizes* is of especial importance when difficulty is had in satisfactorily relegating a specimen to a given species, especially when your specimen appears to fit into no species description satisfactorily but appears to fit partially two or more species. When this occurs your specimen may be a hybrid. This section gives the hybrid combinations recorded from Ohio waters. The chapter on "Natural Hybrids," pp. 119–26, will also be helpful.

Identification, Distribution and Habitat of the 166 Species and 13 Additional Subspecies of Fishes

SILVER LAMPREY

Ichthyomyzon unicuspis Hubbs and Trautman

Fig. 1



Upper fig.: Lake Erie, Ottawa County, O. 253 mm TL, 10.0″ TL.*
April 20, 1940. OSUM 3014.†
Adult female.

Anterior arrow points to the first counted myomere after the last gill opening; posterior arrow points to the last counted myomere before the anus; all myomeres including, and between, these two are counted.

Fig. A: view of mouth; arrow points to one of the 1-pronged (unicuspid) teeth of the circumoral series; also note teeth radiating from the center.

Identification

Adult characters: Dorsal fin not divided. Lateral teeth of circumoral series sharp, long, and with only 1 point or prong, fig. A. Myomeres usually 50–53, rarely to 56, upper figure. Jawless mouth (sucking disc) may be expanded wider than body width. Parasitic on fishes.

Differs: Sea, American brook and least brook lampreys have dorsal divded into 2 fins. Northern brook lamprey has the outer teeth of the radiating series too small to be readily seen, or are hidden by skin. Mountain brook and Ohio lampreys have some or all lateral teeth 2-pointed (bicuspid) and the myomere count is usually more than 55.

Most like: Ohio lamprey.

Ammocoetes differ from adults: Lack teeth. Eyes

* TL. = Total Length; SL. = Standard Length.

† In January, 1956 the trustees of The Ohio Historical Society accepted as a gift from the trustees of The Ohio State University the fish collections of the University, then housed at the Franz Theodore Stone Laboratory at Put-in-Bay, Ohio. They have been removed from the Stone Laboratory and are now in The Ohio State Museum, where they are being integrated with the fish collection there. They will be available to qualified persons for study by 1957 after which all specimens having collection numbers preceded by OSU or OSM will be at The Ohio State Museum at Columbus.