

A History of the Study of Fishes in Indiana

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Introduction

Fishes have provided a wide variety of research material bearing on taxonomy, evolution, distribution, life history, general ecology, and the analysis of populations. Studies made in Indiana have contributed significantly to all of these subjects since the early history of ichthyology in the United States. In fact, Indiana University was a center of ichthyological interest in the years between 1875 and 1925. The tradition has been maintained, and there has been an unbroken chain of biologists interested in fishes from the days of David Starr Jordan to the present. These men have concentrated on basic biological problems, and the results of their researches have had far-reaching effects on the development of ichthyology and fishery biology.

As in most other fields of biological inquiry, the first studies were directed toward taxonomy and anatomy. The work of the present day is built upon a fine foundation laid by the early naturalists in these fields. Concurrent with the descriptive studies, research on fishes received a stimulus from another quarter. Commercial and sport fishermen alike were aware that fish populations fluctuated considerably from time to time. Large variations in the catch demonstrated this fact beyond any question. Also, great differences were found in the productivity, species composition, and the size of fishes which were caught in different places. The questions which were raised by these observations required explanation, especially since a great economic importance was attached to them. Knowledge was needed about the nutrition, physiology, diseases, behavior, age, growth, and population characteristics of fishes in order to utilize this resource intelligently. The work has become a fascinating field of scientific endeavor, and it is being prosecuted vigorously throughout the country.

The Earliest Records

The first records of the fishes of Indiana coincided with the entrance of the state into the Union. There were only a few colonies of people, scattered principally along the Ohio River, when the first constitutional convention was held at Corydon in 1816. In 1820 the capital was moved to Indianapolis, and Samuel Rafinesque's "*Ichthyologia Ohiensis*" appeared the same year. Rafinesque's untoward adventures have been recorded elsewhere, and it is not the province of this paper to repeat them. Suffice it to say, that he took a trip down the Ohio Valley in 1818, a year before he was appointed to a professorship at Transylvania University

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in Lexington, Kentucky. His excursion into Indiana was at the Falls of the Ohio River near Jeffersonville where he hastily described about a hundred new species. In typical fashion Rafinesque preserved no type specimens, and ichthyologists were left to wonder what he actually saw. In later years David Starr Jordan revisited the site, and he was able to save much of Rafinesque's work for posterity by comparing his collection with Rafinesque's descriptions. On the same trip Rafinesque went as far west as Illinois and visited the Wabash River on the way. This accounts for the references to Wabash River species which are found in his famous paper.

Rafinesque was a visitor to New Harmony on the Wabash River in southwestern Indiana after Robert Owen from New Lanark, Scotland, purchased the settlement from a religious group, the Rappites, in 1824. The famous "Boatload of Knowledge" from Pittsburgh in 1826 brought a group of distinguished scientists to participate in the well-known but unsuccessful social experiment. Included among them were Thomas Say, the Father of American Zoology, who will always be remembered for his studies on the shells and insects of the region, and the great French ichthyologist, C. A. LeSueur. LeSueur had done much exploratory work in the eastern United States and Canada before coming to New Harmony. With this background and further work in the Middle West he wrote his great book, "American Ichthyology. Or, Natural History of the Fishes of North America: with Coloured Figures from Drawings Executed in Nature," which was published in New Harmony in 1827. The "Histoire Naturelle des Poissons" by Cuvier and Valenciennes referred briefly to Indiana fishes in 1833. They did no collecting in this country but relied on information gathered by LeSueur.

Later on as the country became more settled, the interest in natural history grew. The contributions of physicians were among the most important of the early period. Jared P. Kirtland, who made valuable discoveries in Ohio, studied some of the Indiana tributaries of the Ohio River, and reported his findings in 1841 in the *Boston Journal of Natural History*. Another physician, J. T. Plummer, made collections around his home in Richmond, and the list of fishes which he found was printed in the 1851 volume of the *Proceedings of the Boston Society of Natural History*.

The famous naturalist and paleontologist, Edward Drinker Cope, visited Indiana in the 1870's. He was especially interested in the cave blindfish, *Amblyopsis spelaeus*, and visited Wyandotte Cave near Corydon in southern Indiana in order to see the species in its native habitat. The 1872 volume of the *Annual Reports of the Geological Survey of Indiana* carried his article, "Life in Wyandotte Cave."

Jordan's Day

A great surge of interest in fishes accompanied the arrival of David Starr Jordan in the state. He had spent two years of teaching since receiving his M. S. degree at Cornell, one at Lombard College at Galesburg, Illinois and the other at the Appleton Collegiate Institute, a preparatory school in Appleton, Wisconsin. After the latter appoint-

ment he joined the faculty of Shortridge High School in 1874 and a year later became Professor of Biology and Dean of Science at Butler University, a position which he held until 1879.

Botany, ornithology, and geology had claimed his attention in his collegiate years, and his field of specialty was undecided. During a summer with Louis Agassiz at his summer school on Penikese Island off the coast of Massachusetts, Jordan was given the project of collecting and identifying the fishes of the region. This must have made a considerable impression on him because he continued work along these lines at Appleton.

In Indianapolis he and Herbert E. Copeland, a colleague from Cornell, began to study fishes in earnest. It was quickly apparent that the dean of North American ichthyology was at work. Jordan could hardly wait to get started on his life's work, and one of his first papers was "Genera to be looked for in Indiana." This and two papers on the cosco (*Leucichthys artedi*) of Lake Tippecanoe appeared in 1875. He and Copeland began three sets of investigations; the life history of certain species of darters, the identification of the fishes described from the Falls of the Ohio by Rafinesque, and a catalogue of the freshwater fishes of the United States. The latter project indicated the broad scope of the work which he intended to carry on during his life. In addition, the two collaborators collected 69 species around Indianapolis. No laggard about publication, Jordan appended the list to a comprehensive paper, "Partial Synopsis of the Fishes of Upper Georgia with Supplementary Papers on Fishes of Tennessee, Kentucky, and Indiana," in the 1877 *Annals of the New York Lyceum of Natural History*. He acknowledges that the fish were collected by Professor H. E. Copeland and himself, but it was not until 1882 that the same list appeared under joint authorship in the *Reports of the Geological Survey of Ohio*. Three other papers concerning Indiana fishes also appeared in Jordan's name in 1877.

Jordan's interests were too broad for Indiana's fishes to occupy his full attention. After writing a catalogue of the fishes of Indiana in 1877, he compiled a catalogue for Illinois in 1878, and one for Ohio in 1882. His restless search for new species continued as long as he lived. In 1876 he explored the streams of Georgia with Charles Gilbert, who became a life-long associate and a brilliant ichthyologist in his own right. He again went south in 1877 and 1878, and this time Gilbert, A. W. Brayton, and Barton Warren Evermann accompanied him. These trips were made on foot and one cannot help but admire the persistence and devotion of these men to their work. Several papers on taxonomy grew out of these trips. One of the best was published as a *Bulletin of the U. S. National Museum* in 1878 with Alembert W. Brayton, "On the Distribution of the Fishes of the Allegheny Region of South Carolina, Georgia, and Tennessee with Descriptions of New or Little Known Species."

During this time Jordan became acquainted with the curators of the National Museum where he visited frequently. With financial help from the Museum he was able to visit every major river basin in the

United States by 1890. He knew the taxonomy of fishes better than any man of his day and perhaps of the present day also. At least no one has had the courage to tackle a revision of "The Fishes of North and Middle America" which began in the days in Indianapolis with Copeland, was continued with Gilbert as the "Synopsis of the Fishes of North America" in 1882, and brought to a conclusion with Evermann in 1900.

Jordan joined the Indiana University faculty as Professor of Natural History in 1879, and quickly became recognized as an outstanding teacher. One of Jordan's greatest attributes lay in his ability to attract superior men to his fold and bring them to full flower. Quite naturally these men became interested in fishes. Evermann and Gilbert have already been mentioned. Evermann distinguished himself with the U. S. Fish Commission and later as Curator of the Division of Fisheries of the U. S. National Museum and as Director of the Museum of the California Academy of Sciences from 1914 until his death. Charles H. Gilbert received his original indoctrination in ichthyology on Indiana fishes before following Jordan to Stanford University where his work on Hawaiian fishes and the salmon and trout of the West Coast became recognized the world over. Joseph Swain, a mathematician, fell under Jordan's spell and he described a new species of darter from southern Indiana. Later Swain became president of Indiana University from 1893 to 1902 and left Indiana to become president of Swarthmore College in Pennsylvania. Oliver P. Jenkins, Amos Butler, Albert B. Ulrey, Stephen A. Forbes, and the great paleontologist Oliver P. Hay all worked on Indiana fishes in Jordan's time. These men received at least the A. M. degree from Indiana University and most of them were awarded the Ph.D. degree. Hay ultimately published, "The Lampreys and Fishes of Indiana" in the 1894 *Report of the Indiana Department of Geology and Natural Resources*.

Indiana is the birthplace of another distinguished ichthyologist, John Otterbein Snyder. His early education was received in the state and he attended Indiana University for a year. Snyder completed an A. M. degree at Stanford in 1899 and went on to become the head of the Zoology Department at that University from 1925 to 1932. He also served the U. S. Fish Commission, the U. S. National Museum, and the California State Fish and Game Commission. He was the Director of the Bureau of Fisheries Laboratory at Woods Hole, Massachusetts for many years.

Eigenmann's Day

Carl H. Eigenmann was one of Jordan's favorite students who took over ichthyological work at Indiana University after Jordan left the presidency of the University in 1891 to become president of Stanford. Eigenmann was head of the Zoology Department from 1891 to 1925, and the first Dean of the Graduate School from 1908 to 1925. His Bachelor's, Master's, and Doctor's degrees were all obtained from Indiana University between 1886 and 1889.

In 1886 he went to California to take a job in the public schools of Santa Paula. He failed to arrive in time to get the position and con-

tinued on to San Diego where he married Rosa Smith, another of Jordan's students, who was an avid naturalist. The couple then travelled to Harvard and spent two years working on the South American fish collection. They returned to San Diego, and Eigenmann became Curator of Fishes in the Museum of the San Diego Society of Natural History. During this time the two published papers as joint authors, and throughout their life together the wife and husband worked closely on many scientific enterprises. Eigenmann made extensive explorations of the marine and freshwater fauna of the western United States while he was in the west, and in 1892 collected fishes along the line of the Canadian Pacific Railway for the British Museum.

Eigenmann is chiefly known for two great pieces of work, studies on the cave vertebrates and the taxonomy of South American fishes. The latter work was his first love and he published continuously on the subject throughout his career. He became acquainted with the tropical fauna by visiting the major eastern museums which had accumulated collections from various expeditions to South America. He rapidly became an expert on the region. His first publication on these forms was in 1888 and dealt with the catfishes, and by 1891 he had produced, "A Catalogue of the Fresh-water Fishes of South America" in collaboration with his wife. This work was intended to be a companion-piece to Jordan and Evermann's, "Fishes of North and Middle America," but circumstances prevented its completion in the form in which it was originally conceived.

Over the years he initiated several South American expeditions, some of which he accompanied and others which were managed by his colleagues. He worked over 20 years on preserved specimens before he was able to see the fish in their natural color. The early expeditions were financed by the Carnegie Museum at Pittsburgh, of which he was Curator of Ichthyology from 1909 to 1918. Indiana men who went on these trips were W. J. Moenkhaus, who will be mentioned later, John Nathan Pearson, now at Butler University, John Haseman, living at Linton, Indiana, and the late William Ray Allen who was head of the Zoology Department at the University of Kentucky. It is difficult to single out an individual piece of this phase of Eigenmann's work which was superior to the rest, but his name is probably most intimately associated with the characids and the catfishes.

Eigenmann's contributions to the local fish fauna began with, "A Catalogue of the Fishes of Bean Blossom Creek, Monroe County, Indiana" in 1886 with M. W. Fordice. This collection is famous because 40 species were found in a single mile of stream. "The Fishes of Indiana" by Eigenmann and C. H. Beeson was the most comprehensive of his work on the state's fauna. It appeared in the 1893 volume of these *Proceedings*.

Shortly before this time, he became attracted to the cave vertebrates, and he recognized that the cave environment was favorable to demonstrate evolutionary change. The caves of the United States and Cuba were combed for examples of blind vertebrates and 40 papers were written on the subject. The most active period of this research was

done between 1898 and 1903. The studies of Eigenmann and his students were summarized in a synoptic paper, "The Cave Vertebrates of America, a Study of Degenerative Evolution" published in 1909 by the Carnegie Institution of Washington.

The opportunities offered by the cave fauna stimulated others to work in this field. Fernandus Payne should be mentioned especially in this connection. Payne performed experiments on the reactions of blindfish to light and determined that they obtained their food by the sense of touch. As one of the early directors of the Biological Station, Chairman of the Zoology Department, and Dean of the Graduate School, he fostered and preserved the interest in fishes and aquatic life at Indiana University. It was due to his efforts that the work was expanded in the 1940's in order to be of more service to the state.

The story of Eigenmann is intimately associated with the founding of the Indiana University Biological Station at Wawasee (Turkey) Lake in 1895, and its ultimate location at Winona Lake near Warsaw in 1899. Eigenmann's objective in founding the Station was to stimulate research on evolutionary problems. The lakes in northern Indiana were ideal for collecting material in large quantity for studies on variation. The most significant work on variation in fishes was done by W. J. Moenkhaus. He published two classical papers in this field between 1894 and 1898, using the logperch (*Percina caprodes*) and johnny darter (*Etheostoma nigrum*) as his material. Two of these papers can be found in volumes 11 and 13 of these *Proceedings*. He was among the first to attempt to distinguish different populations of the same species on a statistical basis. Moenkhaus also went on an expedition to South America where he collected fish for Eigenmann and spent a year as Assistant Director of the State Museum, São Paulo, Brazil. His other important work dealt with one of the first attempts at hybridization of fishes using two species of salt water cyprinodonts. Later he had a distinguished record as a physiologist in the Indiana University Medical School.

Eigenmann was not the only Jordan protégé working on fishes in Indiana during this period. Seth E. Meek received the Ph.D. degree at Indiana and later became Curator of Zoology at the Field Museum of Natural History in Chicago. While he was assistant curator, he compiled a "List of Fishes Known to Occur in the Waters of Indiana for the 1908 *Biennial Report of the Commissioner of Fisheries and Game*. This was an illustrated popular article, but added no new information about the state's fauna. However, Meek and Samuel F. Hildebrand made a fine contribution to the ichthyology of northern Indiana in their 1910 paper, "A Synoptic List of the Fishes Known to Occur Within Fifty Miles of Chicago." This was based on an extensive series of collections and was the first publication on the fishes of northwestern Indiana. Hildebrand was a native Hoosier who received the A. B. degree at the Indiana State Normal School and made great contributions in systematic ichthyology in Central America. He became director of the U. S. Fisheries Laboratory at Beaufort, North Carolina, and was a distinguished ichthyologist with the Bureau of Fisheries for many years. Both Meek and Hildebrand became experts on the fishes of Central

America. One of their best pieces of work was a joint effort, on, "The Marine Fishes of Panama," published by the Field Museum.

Evermann and Howard Walton Clark were hard at work at Lake Maxinkuckee near Culver, Indiana. The aim of this project was to make a complete ecological study of a typical glacial lake, and most certainly this objective was accomplished. It now stands as one of the most complete ecological surveys ever conducted. It was only natural that the investigation should be done in Indiana since both Evermann and Clark were native sons. The work was begun under the sponsorship of the U. S. Fish Commission in 1899 and the last observations were made in 1908. The Commission lacked funds to publish the results, but finally in 1920 the Indiana Department of Conservation brought out "Lake Maxinkuckee, a Physical and Biological Survey." Many men collaborated in the survey. The list of people associated with the project reads like a "Who's Who" of American limnology. Among them was a plankton expert, Chauncey Juday, another son of Indiana who was a teacher in the Evansville schools at the time. His further history with Edward Birge, of Wisconsin, is one of the highlights in the development in limnology in the United States.

Willis S. Blatchley is best known as an entomologist, but he found the fishes too interesting to leave alone. One of his first major contacts with fishes was as a collector for Philip H. Kirsch who was sent to explore the Maumee and Eel River Basins of Indiana in 1892 by Evermann while he was an assistant to the U. S. Fish Commission. This work was very carefully done, and is the best reference material on northern Indiana prior to the contributions of the Biological Station. The results were published by Kirsch in the 1894 *Bulletin of the U. S. Fish Commission*.

Blatchley's position as state geologist from 1894 to 1911 gave him the privilege of compiling the annual reports, and they were filled with valuable natural history. The best of the fish papers was, "The Lakes of Northern Indiana and their Associated Marl Deposits," with G. H. Ashley in 1900. The paper contained lists of species from many lakes. In some cases the lists were copied from other publications without the courtesy of reference, but many represented original collections made by Blatchley himself. Blatchley worked on fishes off and on for many years, and in his later life he published a book, "The Fishes of Indiana" in 1938. Unfortunately the book contributed very little beyond what was known in the early 1900's.

The Later Years

Beginning in the 1920's work was begun by Will Scott, a student of Eigenmann's, which contributed directly to conservation problems. Scott was interested in all aspects of the aquatic community. He studied the morphometry and sedimentation of northern Indiana lakes, plankton, bottom fauna, and the food of fishes. Scott was responsible for the first cooperative arrangement between the Zoology Department and the Department of Conservation, a relationship which later became known as the Indiana Lake and Stream Survey. With small financial

help it was possible to make surveys of the lakes and streams of northern Indiana as well as concentrated studies on problems of particular interest. The Biological Station, of which Scott was Director from 1924 to 1937, was used as a base of operations during this time.

From these studies emerged a series of publications titled, "Investigations of Indiana Lakes and Streams." The first issue appeared in 1928 and the journal has continued to the present. The wide variety of interests shared by Indiana aquatic biologists in these later years can be found in the 45 articles comprising the four volumes published to date. This is one of the first technical journals on aquatic life to be published by any state, and its inception was the direct result of Scott's initiative and vision.

Scott was an extraordinary teacher. He will long be remembered as a teacher of beginning zoology courses, and he was particularly effective in preparing graduate students for their careers. Ralph Hile did his doctorate research on the age and growth of several species by interpreting the marks on the scales at a time when this kind of work was just beginning in this country. This type of study has since become standard procedure in solving many practical and theoretical problems. Hile joined the U. S. Fish and Wildlife Service and was assigned to study the fishes of northern Wisconsin where he continued and expanded his life history work. His studies on the rock bass introduced several new techniques into the analysis of age and growth data, and information which he collected on the cisco made valuable contributions to the interpretation of subspeciation in the herrings. His later work has been on the analysis of populations of Great Lakes fishes with particular emphasis on fluctuations in abundance.

James Wilding performed experiments for his doctorate thesis on the oxygen threshold of three species, a subject which is important in defining the minimal respiratory requirements in unfavorable situations such as pollution. He also entered the U. S. Fish and Wildlife Service for a few years and is now engaged in radiological work at the Radiological Laboratory of the U. S. Air Force at Austin, Texas. Herman P. Wright analyzed the snail fauna of northern Indiana and determined the migration pathways of these animals into the area after the retreat of the Wisconsin glacier. Although not related to fishes directly, this research was a fundamental contribution to the question of immediate post-glacial redistribution of animals. The pathways used by snails have been confirmed for the fishes, also. Wright died soon after completing his thesis.

Seven students studied for the Master's Degree with Scott. Two of them, John Black of Northeast Missouri State Teachers College, and James Leach of Ohio State University, continued their interest in fishes and subsequently received the doctorate at other institutions. Black collaborated with Carl L. Hubbs on several papers on the taxonomy of minnows, darters, and suckers. Leach has worked on the lamprey for many years, stressing their anatomy and physiology.

Following Scott's premature death in 1937, William E. Ricker came to the University in 1939 and took over the directorship of the Biological

Station and the Lake and Stream Survey. The Station had ceased to function as an undergraduate teaching unit at the end of the summer of 1937, but it became the summer headquarters of the Survey. Stronger ties with the Conservation Department and increased financial support allowed an expanded program, and in 1945 and 1946 Louis A. Krumholz and the writer joined the group. This association lasted until 1950 when Ricker left to become editor of the Fisheries Research Board of Canada and Krumholz joined the Oak Ridge National Laboratories.

Ricker obtained his doctorate at the University of Toronto and worked with the Pacific Salmon Commission and the Fisheries Research Board of Canada before coming to Indiana University. While with the Commission he was associated with the Cultus Lake investigations which are already famous for the thoroughness with which the salmon populations were charted as they moved to and from the lake. This experience stimulated an interest in the vital statistics of fish populations which he has followed ever since. "Further Notes on Fishing Mortality and Effort" in the 1944 volume of *Copeia* was the result of several years work on the general problem, and was followed in 1948 by a more general paper, "Methods of Estimating the Vital Statistics of Fish Populations," published in the *Indiana University Publications, Science Series*. These researches and others accelerated the work on population dynamics, and Ricker's place in this development was recognized in 1956 when he was invited to give the Baldi Lectures at the International Congress of Limnology in Finland.

The application of these fundamental researches has been widespread. In our own state this work created doubt about wisdom of seasonal regulations restricting the catch of panfish. As a result, seasonal restrictions were removed, and the move started a trend which has spread widely over the country. This is only one example of the practical applications associated with the work of the Lake and Stream Survey. The group worked closely with the Conservation Department and gave advice and information about many critical problems confronting the Division of Fish and Game.

Ricker's students include Wendell L. Johnson and John Gottschalk of the U. S. Fish and Wildlife Service in Washington, D. C., Donald C. Scott at the University of Georgia, Donald E. Wohlschlag at Stanford University, and the writer. All of these students have continued their interest in fishes and are now engaged in research or administration concerned with the production and utilization of fish populations.

David G. Frey came to Indiana University in 1950 and took over the responsibilities of Ricker. The Lake and Stream Survey continued actively until 1953 when the Department of Conservation withdrew its financial support. Funds from other sources have provided the means of continuing aquatic research in the state, but on a much more limited scale. Keith V. Slack recently completed a doctorate thesis which has a bearing on stream fish production, and several other graduate students are presently engaged in advanced degree problems.

There has been some research on fishes at other colleges and universities of the state. Hurst Shoemaker published a study on the distribu-

tion of fishes in Wayne County in 1942, while he was an instructor at Earlham College. Paul S. Stokely and Clarence E. Dineen at the University of Notre Dame have been working on the osteology and growth of fishes. Raymond M. Cable and his associates at Purdue University have studied the parasites of fishes for many years. The Department of Conservation now employs Harold McReynolds who is in charge of a project concerned with the fishes of the Muskatatuck River drainage in southeastern Indiana.

The Fish Collection

Jordan's fish collection was destroyed by fire in 1883 when lightning struck the Science Building at Indiana University. Jordan was in Europe at the time on one of the "Indiana Summer Tramps." As soon as he returned, he gathered the nucleus of a new collection around Woods Hole, Massachusetts, with the cooperation of the U. S. Fish Commission. The following winter he collected in Florida and Cuba, and the collection began to take shape once again. After this experience Jordan took precautions against another loss. He saved three series of species from his collections, and sent the first to the U. S. National Museum, the second to either Indiana or Stanford, and the third to a museum in Europe.

Eigenmann added an unusually rich collection of South American fishes to the collection, but after his death there was little interest in it. In order to place it where it would be used, the collection was sold to the California Academy of Sciences, and the money was used to acquire books and journals for the Biology Library. Lately, specimens of the North American freshwater species have been transferred from the California Academy to the Fish Division of the University of Michigan Museum of Zoology.

An extensive collection was made by the writer during work on the distribution of the state's fishes. For some time it was in storage due to lack of space, but a special room has been set aside for it in the newly constructed Jordan Hall of Biology which was occupied in 1955. The collection has now been arranged and is available for reference by interested persons.

A Comment

No bibliography of publications dealing with fishes by Indiana authors has been included. The task would be great indeed since Eigenmann alone had 225 titles to his credit and Jordan was very prolific during his years in Indiana. An almost complete bibliography on the taxonomy and distribution of Indiana fishes can be found in a paper written by the writer in 1945, "Distribution of the Fishes of Indiana," in the *Investigations of Indiana Lakes and Streams*.

Also, it has not been possible to include all the persons who have contributed to the rich literature on fishes stemming from Indiana. This sketch was intended to describe the main lines of work during the last 80 years and their omission is no reflection on the importance of their contributions.

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