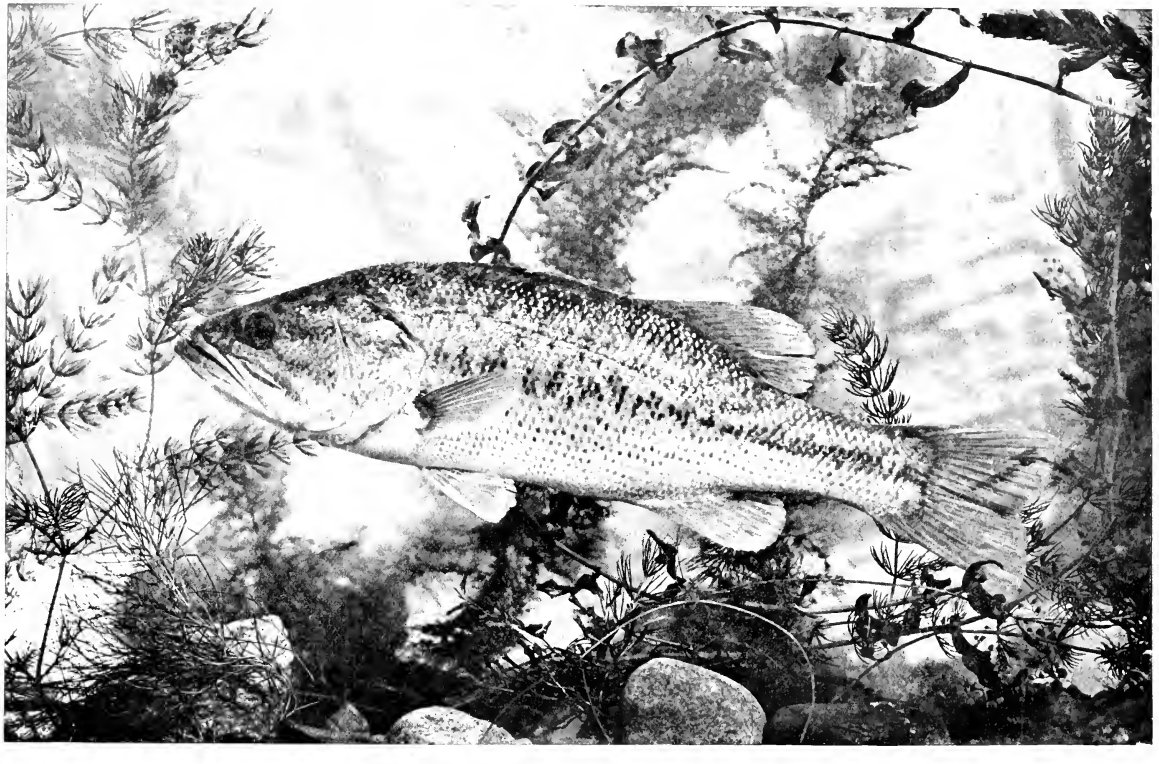

LARGE-MOUTH BLACK BASS (*Micropterus salmoides*)

Photographed at Lake Maxinkuckee, Indiana, by A. Radcliffe Dugmore for Jordan and Evermann's "American Food and Game Fishes," published by Doubleday, Page and Company.

THE DEPARTMENT OF CONSERVATION
STATE OF INDIANA

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LAKE MAXINKUCKEE

A PHYSICAL AND BIOLOGICAL SURVEY

BY

BARTON WARREN EVERMANN, A. M., PH. D.
Director of the Museum of the California Academy of Sciences

AND

HOWARD WALTON CLARK, A. B., A. M.
Scientific Assistant U. S. Bureau of Fisheries
Biological Station, Fairport, Iowa

VOLUME I

PUBLISHED BY
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Foreword

The Department of Conservation presents this monograph to the public in the belief that it is a notable addition to the scientific works of the present day. It is especially valuable because Maxinkuckee is typical of thousands of lakes in the glaciated regions of North America. It will be invaluable to future students because here are authentically reported numerous species and conditions which are rapidly disappearing because of the increased use of all available lakes for summer resorts and their destruction by drainage.

The actual work of investigation was financed by the U. S. Bureau of Fisheries. Although they spent thirteen years of work and much money, when the report was finally complete an insufficient printing fund prevented publishing.

When The Department of Conservation was inaugurated, April 1, 1919, the question of printing the Maxinkuckee report was placed before the Conservation Commission. The great scientific value of the work, the unquestioned authenticity, and the fact that the lake is in Indiana led the Commission to approve of its publication.

The illustrations used in this monograph have come from various sources. The halftones showing Lake Maxinkuckee scenery (except that of Shady Point, which is from a photograph by Mr. Clark), were supplied by the Culver Military Academy. Most of the text-figures of fishes are chiefly from Jordan and Evermann's "Fishes of North and Middle America"; the others, as well as the three figures of frogs, were furnished by the United States Bureau of Fisheries. The Bureau of Fisheries very kindly supplied electros for all these text-figures. The halftone plates of the large-mouth black bass, small-mouth black bass, rock bass, bluegill, red-eared sunfish and yellow perch, are from photographs of live fishes in the water, taken at Lake Maxinkuckee by A. Radcliffe Dugmore for use in Jordan and Evermann's "American Food and Game Fishes," published by Doubleday, Page & Company. For the colored plates of thirty-three species of fishes we are indebted to Dr. Stephen A. Forbes, Director of the Illinois State Natural History Survey.

The Conservation Commission wishes to express to these various gentlemen and institutions its appreciation of the courtesies

which they have so generously extended. Their kindly co-operation has added materially to the attractiveness and value of this report.

To Dr. Evermann, Mr. Clark and their collaborators is due praise and honor for the work. It is truly a scientific classic and without peer in its field.

RICHARD LIEBER.
Director, The Department of Conservation.

April 7, 1920.

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LAKE MAXINKUCKEE

A Physical and Biological Survey

By Barton Warren Evermann, A. M., Ph. D.,
Director of the Museum of the California Academy of Sciences.
and
Howard Walton Clark, B. S., A. M.,
Scientific Assistant, U. S. Bureau of Fisheries Biological Station,
Fairport, Iowa.

Introduction

Though the United States Fish Commission (now the Bureau of Fisheries) was organized in 1871, it was not until 1888 that any definite attempt was made to study either the biological or physical characters of any of the streams and lakes of the United States. In that year and the two or three years following, a beginning was made toward working out the distribution of the species of fishes in the streams of certain regions, and some little attention was given to the larger crustaceans and to water temperatures. Beginning with 1891, one or more field parties from the Division of Scientific Inquiry of the Commission have been in the field, usually for a brief period each summer. These parties usually gathered data for each stream examined, upon the following points: character of country through which the stream flows; the volume of water which it carries; general character of the water as to clearness and purity, and its temperature; the fishes, crustaceans, mollusks, reptiles, batrachians and other animals inhabiting the stream or found about it, and the abundance, distribution and habits of each; also, the species of aquatic plants, their distribution, abundance, and relation to the fishes of the same waters. The primary and immediate objects of these investigations were to determine what fishes each stream already contains and whether the conditions, physical and biological, are favorable for the introduction of other species. Since 1890 investigations of this kind have been carried on in a number of States, among which may be mentioned California, Oregon, Washington, Idaho, Montana, Wyoming, North Dakota, South Dakota, Missouri, Arkansas, Iowa, Minnesota, Texas, Florida, Tennessee, New York,

Maine, New Hampshire, Vermont, and perhaps others. As many of these investigations were made in response to resolutions of Congress calling upon the Commission to determine the desirability of establishing fish-cultural stations in certain States, it can be seen that a wide area had to be covered and that the investigations were necessarily hurried and incomplete except for the specific purpose in view. Occasionally, however, it was possible to confine the season's investigations for a longer period to a limited area, and more thorough work resulted; as, for example, upon the Redfish Lakes in Idaho in 1895 and 1896, the Connecticut Lakes in 1904, and the Rangeley Lakes and Sebago Lake in Maine in 1905-1913.

The need of exact knowledge of the physical and biological conditions obtaining in the various types of lakes and streams became increasingly evident. In the direct interest of fish culture, there was great need of more complete knowledge of the habits not only of our most common food fishes, but also of the animals and plants associated with them, and of the physical and biological conditions under which they thrive.

Not until 1899, however, was any such work undertaken under really favorable conditions. It was in that year decided to select a small lake and make such a study of it as might serve as a model for the investigation of all similar lakes.

There are, in the upper Mississippi Valley, particularly in Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota and Iowa, many thousand lakes of glacial origin. With scarcely an exception, these lakes teem with food and game fishes of the finest quality, besides many other species of greater or less importance. Many of these lakes are inhabited also by a large number of species of turtles, batrachians, mollusks and crustaceans, some of which are already used for food or otherwise utilized by man. They are the home also of many other species of aquatic animals and many species of aquatic plants which are known to serve an important purpose in the economy of the lakes in their relation to food fishes, and of still many other species whose status we do not yet know.

The value of exact knowledge concerning this type of lake and the inhabitants thereof is appreciated by all biologists and fish-culturists and can scarcely be overestimated.

In making selection of a particular lake for study along these lines it was important that the lake chosen should meet certain essential conditions. It must not be too large; it must be sufficiently compact to enable any or all parts to be reached readily from a central station; there should be no inlets or connecting

waters of a size great enough to complicate the problems; in other words, the conditions should be bunched and the environmental unit should be a fairly homogeneous one; furthermore, the lake should be one where there are fishing and angling interests and which would afford a field for fish-cultural studies and operations.

Lake Maxinkuckee, in northern Indiana, was believed to meet all these conditions. It was assumed to be typical of the class of small glacial lakes. It was selected for study primarily because of these facts. Its accessibility and the fact that the field expenses there would be exceptionally small were also factors in determining the selection.

Scope of investigations:—In planning the investigations to be made, it was desirable to make them as comprehensive as possible, that the report, when published, would be really a monograph of the lake. Among the more important purposes to be considered were the following:

1. To gain a fairly good understanding of the physical and biological conditions obtaining in a typical glacial lake. Accurate knowledge of *one* lake of a type enables a study of other lakes of that type to be made more readily and easily.

2. To study carefully and fully the habits of as many species of animals and plants of the lake as time permitted. This field is practically inexhaustible and the opportunities infinite. The writers know of no place where one can study more problems of interest to fish-culture and general biology than at Lake Maxinkuckee. This is because of the unusual abundance of aquatic animals and plants in that lake. There are now known from Lake Maxinkuckee 64 species of fishes, 9 species of turtles, 18 species of batrachians, about a dozen species of crustaceans, more than 130 species of mollosks, and more than 100 species of aquatic plants. Each of these groups is represented by a greater number of species than is known from any other lake of similar or even considerably greater size in the world; and most of the species are each very abundant as to individuals.

3. To study carefully the physical and biological conditions under which the more important of these species thrive.

In short, Lake Maxinkuckee was utilized as a biological station where scores of interesting problems were studied and where many more problems can be studied more effectively than at any other lake with which the writers are acquainted.

In the spring of 1899 the senior author submitted to the Honorable George M. Bowers, then United States Commissioner of Fish and Fisheries, a memorandum setting forth reasons why an

investigation of this kind should be made in the interest of fish culture and the biology of freshwater fishes. Mr. Bowers approved the recommendation and ordered the investigation to be entered upon in the summer following.

The actual study of Lake Maxinkuckee by the U. S. Fish Commission was begun in 1899. On July 5 of that year a station was established at the Duenweg cottage (known now as Shady Point) on the west side of the lake at the base of Long Point and in front of the Arlington flag station of the Vandalia Railroad. The party consisted of the following: Dr. Barton Warren Evermann of the U. S. Fish Commission, in charge; Dr. Josiah T. Scovell, teacher of biology, Terre Haute, Ind., high school, botany; Thomas Large, teacher of science, Evansville, Ind., high school, hydrography; Chancey Juday, teacher of biology, Evansville, Ind., high school, plankton; and T. Bronté Evermann, student Cornell University, general assistant. During a portion of the season, H. Walton Clark of Fort Wayne, Ind., and Harry Warren of Evansville, Ind., were present as volunteer assistants.

The field work of 1899 was carried on from July 5 to September 5, though certain lines were continued until October 18, and during the time from then until July, 1900, temperature and various other meteorological observations, as well as notes on the appearance and behavior of the water birds, fishes, etc., were recorded by S. S. Chadwick, then resident on Long Point.

On July 1, 1900, the work was resumed by a regular field party consisting of the following: Dr. Evermann, in charge; Dr. Scovell, botany and general assistant; Leonard Young, teacher of biology, Evansville, Ind., high school, plankton; Wm. F. Hill, U. S. Fish Commission, surveyor; T. Bronté Evermann, assistant to surveyor and draughtsman; Millard Knowlton of Sims, Ind., general assistant; Robert G. Gillum, professor of physics and chemistry, Indiana State Normal School, physics and chemistry; H. Walton Clark, botany. Regular investigations along a number of lines were carried on until about the middle of September. Dr. Evermann remained at the lake until December 12, and Mr. Clark continued the investigations continuously through the entire winter of 1900-1901 and to July 11, 1901.

In 1902, Dr. Evermann was again at the lake from June 19 to July 4, and again in 1904 most of the time from October 22 to November 11. Mr. Clark was there in 1904 from October 17 to November 29 and again from December 1 to January 5 following, and Dr. Scovell from November 23 to 26. In 1906, Mr. Clark carried on observations from July 19 to November 25, and Dr. C.

B. Wilson of Westfield, Mass., studied the parasites of the fishes of the lake during the summer.

In 1907, Dr. Evermann was again at the lake from August 3 to 8 and from September 7 to November 6, and Mr. Clark from September 12 to November 6.

In 1908, Mr. Clark was at the lake from August 19 to September 11, Dr. Wilson from August 19 to September 7, Donald Earll of Washington, D. C., from August 19 to September 4, and Dr. Evermann from September 6 to 10. In 1909, Mr. Clark and Dr. Wilson carried on work from July 21 to 28, on August 1 and 2, and from August 31 to September 13. In 1910, Dr. Evermann was at the lake September 27 to 29, and October 1, 2 and 6; and from October 31 to November 4 in 1912. In 1913, Dr. Evermann was at the lake from September 2 to October 20, and Mr. Clark from September 9 to November 9.

In addition to the observations made by the above named investigators, a great many observations were made and recorded by Mr. Chadwick, particularly in the winters from 1898 to 1914.

It will be observed from the foregoing that more or less field work was done in each month, but that most of it was done in the summer and fall months. The longest continuous period of observation was that from June 19, 1900, to July 11, 1901. The longest continuous period by any one observer was that covered by Mr. Clark from August 27, 1900, to July 11, 1901. During the winter of 1900-1901, Mr. Clark spent the entire time alone at the lake devoting all his time to field observations. Practically the only other winter observations we have are those communicated to us by Mr. Chadwick.

Perhaps the most satisfactory records are those for the fall months, September and October, as those months have been covered, in part at least, in more different years. The spring records are most incomplete and unsatisfactory, practically the only observations for those months being those made by Mr. Clark in 1901. It is much to be regretted that a more thorough study of the lake could not have been made in those important months.

While our studies of the lake have been quite unevenly distributed throughout the year, while many observations have not been verified as often as might be desired, and while many phases of lake study have barely been touched, and others not at all, nevertheless, it is hoped that the studies have added materially to our knowledge and understanding of the physics and biology of small glacial lakes, such as are found so abundantly in the upper Mississippi Valley states.

It is regretted that the publication of this report has been so long delayed. Much of it was written in the winter of 1901-1902, but before it could be completed other duties so engrossed the attention of the senior author as to render its completion at that time impossible. This, however, has not been wholly without compensating advantages, in that opportunity occurred from time to time to revisit the lake and make new observations, verify former ones, or to study phases previously neglected. As a result, it is now possible to write on some of the problems more fully and with greater confidence, and to make the report somewhat more comprehensive. It also enables us to omit certain discussions and conclusions which later observations failed fully to support.

There still remains a multitude of problems which should receive further study and which the writers would like very much to consider, but they feel the report should not be longer delayed.

Even so, they feel that more is probably known of Lake Maxinkuckee, particularly of its biology, than of any other lake in the world.

It may be thought by some that the scope of the report is too broad, that subjects are included which do not bear any relation to fish-culture. Such is not the case. There is probably not a species of animal or plant in or about the lake that does not bear some relation, more or less important, to the fish-life of the lake. The truth of this impresses itself more and more evidently upon one as he becomes more and more fully acquainted with the relations and inter-relations of the multitude of species of animals and plants in and about the lake, and their dependence and interdependence among and upon each other. The field naturalist is constantly observing facts and phenomena, climatic and biologic, which impress upon him the great principle of the dependence of the varied forms of organic life upon climatic conditions and of the inter-dependence of the various species among themselves and upon each other. One who has never made any special study of these problems in the field may find it difficult to discover the relations or to appreciate their significance. That is to be expected. Some of the relations and the significance of others may not always be evident even to him who has given them consideration; but he feels that all available facts are worth recording and that the relations and the meaning thereof will in time appear.

Acknowledgments:—To mention the names of all those from whom the writers have received assistance in their study of Lake Maxinkuckee would be impossible. Nearly every cottager about the lake, and scores of the anglers who visit the lake from time

to time, have extended courtesies in various ways, such as giving information regarding their angling experiences at the lake, permitting their catch to be measured and weighed, and furnishing fish to be examined for a study of their food or parasites. Similar favors have been shown by a number of persons who come to the lake in the fall to hunt ducks. We are under special obligation to Mr. S. S. Chadwick, formerly of Long Point, Lake Maxinkuckee, now of Ithaca, Mich., Mr. George E. Farrington and other officials of the Vandalia Railroad, and Captain Eisenhard of the Culver Military Academy, for assistance of various kinds.

To the Lake Maxinkuckee Association, particularly to its sometime secretary, Mr. W. T. Wilson of Logansport, we are indebted for courtesies of many kinds. Mention should be made also of the late Colonel A. F. Fleet, for many years Commandant of the Culver Military Academy; Colonel L. R. Gignilliat, the present Commandant of that flourishing institution; of Mr. Brownell of Peru; Mr. Clement Vonnegut of Indianapolis; and Mr. J. H. Vajen of Indianapolis; also of Judge A. C. Capron and Colonel Daniel McDonald of Plymouth. All these gentlemen rendered us real service for which we desire to express grateful appreciation.

To Mr. Chadwick we are indebted for the air and water temperature records from October 18, 1899, to June, 1900, and for other briefer periods, also for a vast amount of useful information regarding the fishes, birds and mammals, and regarding weather conditions. Mr. Chadwick's long and intimate acquaintance with the lake, keen powers of observation, and skill as hunter and fisherman, enabled him to supply us with much valuable data which could have been secured from no other source.

To Mr. Farrington we are indebted for material assistance in enabling the Bureau to keep the lake stocked with bass and wall-eyed pike.

To these gentlemen and to all others who co-operated so effectively with us in our work we take this opportunity to express, not only for ourselves but for the Bureau of Fisheries, grateful appreciation.

Special Localities often referred to in Various Chapters of this Report

In the chapters which follow frequent references are made to various particular localities or places about the lake. In order that these references may be readily understood, the locations of the places referred to are here definitely described:

Arlington Hotel:—On the west side of the lake at the base of the east side of Long Point, and within a few yards of the Arlington railroad station.

Assembly grounds:—On the west side of the lake about 1,000 to 2,000 feet north of the Outlet. These grounds are across the railroad from the lake and are high and sparsely wooded.

Bardsley cottage:—On the northeast shore of Lost Lake in the west of Green's woods. Known also as Sunset cottage.

Birch swamp:—On west side of railroad near Walley's, about a mile south of Arlington.

Chadwick house:—Near the end of Long Point on the west side of the lake.

Culver Academy grounds:—On the north side of the lake near the east side, fronting on the west part of Aubeenaubee Bay.

Culver Creek:—Entering the lake at Aubeenaubee Bay in the east part of the Academy grounds.

Delong:—On Tippecanoe River, 3 miles south of Lake Maxinkuckee.

Drained lake:—About 2½ miles west of the Outlet.

Edwards' boathouse:—On the east side, at the mouth of Aubeenaubee Creek.

Farrar's woods:—A heavy forest of many acres along the south end of the lake from Murray's east to the neighborhood of Overmyer's brook. This wood consists chiefly of oaks, hickories, elms, willows, poplars, sassafras, and dense underbrush. It is fully described elsewhere.

Fish Commission station:—The Shady Point (formerly the Duenweg) cottage on the west side of the lake in front of the Arlington railroad station and adjacent to the Arlington hotel. (See plate 34.)

Gravelpit:—Just west of the railroad on the west side of the lake, 600 to 1,800 feet south of the Arlington station.

Green boathouse:—On the lake shore at the west edge of the Norris Inlet marsh—the large marsh at the head of the lake.

Green's marsh:—Sometimes called Green's flat, a tract of about 11 acres of low, marshy ground, on the west side of Long Point, between it and the railroad and just south of Outlet Bay. This marsh is covered with a rich growth of blue-joint grass (*Calamagrostis canadensis*), sedges (Carex), a large clump of buttonbush (*Cephalanthus occidentalis*), low willows (*Salix bebbiana*), and a little Cornus. During times of high water this marsh becomes flooded so that a boat can be rowed about over it. In dry weather it can be walked over.

Green's woods:—Between Lake Maxinkuckee and Lost Lake.

Hawk's marsh:—At the southwest border of the town of Culver, or just west of the Assembly grounds. The marsh comprises 3 or 4 acres. It is a sphagnum bog with a dense thicket of poison sumac, mountain holly, winter holly, chokeberry, and the like. In the middle of the marsh is a small pond around which are cranberries, pitcher plants, high bush huckleberries, leather leaf, marsh rosemary, cotton grass, etc.

Ice-houses:—On the west side of the lake at Outlet Bay and north of the Outlet about 500 feet.

Indiana boathouse:—On the east side about half a mile north of the Maxinkuckee road.

Indianapolis pier:—On the east side about 2500 feet south of the mouth of Aubeenaubee Creek.

Jenks' cottage:—East side of Long Point near the McSheehy cottage.

Lakeview Hotel:—On the north shore of the lake about 1,000 feet east of the Culver railroad station.

Lapaz Junction, 18 miles north of Culver.

McOuat cottage:—On east side of lake north of the Indianapolis pier.

McSheehy cottage:—East side of Long Point near the tip.

Murray's:—A small farm bordering the southwest part of the lake, south of the Gravelpit.

Norris pier:—At the southeast corner of the lake about 1,200 feet from Norris Inlet.

Outlet:—At the base of the north side of Long Point. It is crossed at its beginning by a concrete bridge on the public highway and also by the Vandalia Railroad a few feet further down. Sometimes referred to as the Thoroughfare.

Outlet marsh:—The low, marshy ground along the Outlet between the railroad bridge and the upper end of Lost Lake. This marsh is mostly under water and is covered with a rank growth of bluejoint grass, sedges and cattails. It is a favorite resort for bitterns, rails, long-billed marsh wrens, and red-winged blackbirds.

Outlet stream:—The stream connecting Lost Lake with the Tippecanoe River; sometimes called Outlet Creek.

Overmyer's woods:—On the south shore of the lake between Farrar's woods and Norris Inlet. This has the same general character as Farrar's woods, except that much of it is on higher ground in which there is a good deal of clay.

Palmer house:—On the north shore just west of the Academy grounds.

Scovell cottage:—On the east side of Long Point.

Shady Point:—In front of the Arlington station and adjacent to the Arlington hotel grounds. This was formerly known as the Duenweg cottage and was occupied by the U. S. Fish Commission party in 1899-1901. (See plate 34.)

Tamarack swamp:—About two miles west of the Assembly grounds.

Thoroughfare:—The Outlet or stream connecting the two lakes.

Vajen's cottage:—On northeast side of lake.

Walley's woods:—Just west of the railroad and bordering Outlet Creek, about a mile southwest of the lake.

Walter Knapp cottage:—East side of Long Point just north of the Scovell cottage.

Winfield's cottage:—On the west side of the lake north of the Outlet.

PHYSICAL FEATURES

Location:—Lake Maxinkuckee is situated in about 41° 12′ north latitude, and 86° 24′ west longitude, in northern Indiana, on the Terre Haute and Logansport Railroad (Vandalia Line). It is 34 miles south of South Bend, Indiana, 94 miles southeast of Chicago, 32 miles north of Logansport, 121 miles north of Indianapolis and 149 miles north of Terre Haute. It is easily reached by the Pennsylvania Line from any of the places above mentioned. It lies wholly in Union Township in the southwest corner of Marshall County; the distance westward to the Starke County line being 2.25 miles, and to the Fulton County line on the south, but 1 mile.

The Vandalia Railroad runs north and south along the west shore of the lake. Near the north end of the west side of the lake is the town of Culver, with a population of about 1,500, which is the principal railroad station for Lake Maxinkuckee. One mile south from Culver is a flag station called Arlington. On the east side of the lake, and about a half mile back from it, is the little village of Maxinkuckee with a population of about 100. Near the middle of the north shore are the buildings and grounds of the Culver Military Academy, a flourishing institution.

Elevation above sea-level:—The surface of the lake at the average stage of water, is 734.5 feet above sea-level of the Gulf of Mexico at Biloxi, Miss., 150 feet above Lake Michigan, and 130 feet below the summit of the divide between Lake Michigan and the Wabash drainage. It is 15 feet above Tippecanoe River 4 miles south, into which it drains, and 75 feet above English Lake 20 miles west. The lake itself, therefore, is situated on a south and west slope.

Size, form, etc.:—Lake Maxinkuckee lies in a north and south direction and its greatest length is 2.6 miles. The maximum width from east to west is 1.6 miles. The lake covers parts of sections 15, 16, 21, 28, 32, and 34 north, range 1 east of the second principal meridian, and has a total area of 1,854 acres. The average length of the shore line is 7.3 miles. The distance around the lake by the road which goes around it at some distance from the shore, is about 12 miles.

The form of the lake, as may be seen from the map, is quite regular. The major axis lies in an approximately north and south direction, but about one-quarter east of the middle of the lake. The longest line from east to west is about the same distance north of the middle of the lake. In the north half of the lake the east and west shore lines are approximately parallel, but in the south half they converge considerably, and that part of the lake is much narrower than the north half.

There are not many bays or indentations of importance. At the northeast corner of the lake is Aubeenaubee Bay, the most pronounced of any. On the east the shore-line sweeps eastward in a long regular curve, making a long but narrow bay. At the south end, as already stated, the lake narrows greatly, producing a considerable bay extending somewhat toward the southeast. Near the middle of the west side is a point of land known as Long Point, projecting into the lake toward the northeast. This is the most pronounced and conspicuous irregularity in the shore-line of the lake. The north line of Long Point runs approximately east and west and at the Outlet the shore-line turns to the northward again, resulting in a considerable indentation known as Outlet Bay.

Character of the surrounding country:—The country surrounding Lake Maxinkuckee lies wholly in the glacial region of Indiana. The lake is near the southwestern angle of the Saginaw Moraine, and deep borings in the adjacent soil indicate that at its greatest depth it does not reach the bottom of the drift. The topographic features are somewhat varied, as shown on the accompanying map. There are numerous small hills with gentle slopes, and among them are a good many kettle-holes, some of considerable depth, and with more or less water during wet seasons, while others are less deep and fairly dry. While the surface irregularities are considerable, they are, as a rule, not abrupt. The highest land anywhere about the lake is a hill just east of the village of Maxinkuckee about one-half mile from the lake. Its elevation above the surface of the lake is 136 feet.

Soil:—It is desirable to give some consideration to the character of the various kinds of soils of the region about the lake; for the soil determines in some measure many of the physical and biological factors which influence the lake more or less directly, such as the topography of the country, the flora, fauna, clearness and purity of the water, and the lake bed.

The Lake Maxinkuckee region is highly favored in that it contains many kinds of soils, which the glaciers brought down and deposited about the lake. Speaking broadly, it may be said that the soil about Lake Maxinkuckee is composed chiefly of sand. There are a few isolated areas of clay, usually of small extent, and even they usually have a considerable proportion of sand mixed with the clay. The west and south sides of the lake are more sandy than the east and north. Long Point is a high sand ridge underlain with gravel, and is continued out into the lake a considerable distance beyond the shore in a long sandbar in shallow water. In some places, at the southeast corner of the lake, there is considerable gravel and clay mixed with the sand, and at a few places on the north and east sides, and one place at the southwest corner, there are a good many boulders of moderate size. There are only six places about the lake where there is any marsh; two of these are on the north end, two on the south, and one each on the east and west. The west one of those on the north is in the vicinity of the Morris boathouse and is of small extent, the other is on Aubeenaubee Bay at the northeast corner of the lake. This is of considerable extent, but the western part of it has been filled in by the improvements at the Culver Academy grounds. The marshy tract on the east side lies about the mouth of Aubeenaubee Creek and extends eastward to near the head of that creek. At the southeast corner of the lake is the largest and lowest area of marsh; this lies along Norris Inlet, and several acres are entirely too marshy to permit walking over. Near the middle of the south end is another small area of low ground which at times is under water. The remaining patch of marsh is on the south of Outlet Bay and west of Long Point. This is known as Green's marsh and is in the shape of a narrow strip on the northwest side of Long Point, widening to the westward and covering several acres just south of the Outlet.

The soils of the catchment basin of Lake Maxinkuckee have been classified by the United States Bureau of Soils[1] as Miami

[1] Soil Survey of Marshall County, Indiana, by Frank Bennett and Charles W. Ely, Field Operations of the Bureau of Soils, 1904, pp. 689-706, with map.

gravelly sandy loam, Marshall sandy loam, Miami sand, Miami clay loam, and muck.

The first of these, as described by Bennett and Ely, is usually a light or dark brown sandy loam, containing a high percentage of gravel and, frequently, small glacial boulders. The subsoil is a gravelly or sandy clay with numerous small stones scattered through it. This is the type of soil found bordering lakes or old lake basins as a chain of rounded knolls or hills, which are generally composed of stratified and unstratified sands, clays and gravels. There is a large area of this soil, the largest in the county according to Bennett and Ely, on the east side of Lake Maxinkuckee. It borders the lake from the mouth of Culver Inlet on the north to the mouth of Aubeenaubee Creek near the middle of the east side, and extends east and southeast from the lake about 1½ miles or to the head of Aubeenaubee Creek.

The Marshall sandy loam borders the lake from the mouth of Aubeenaubee Creek south to Norris Inlet, thence across the south end and up the west side to Arlington station. There is also a small area between the mouth of Culver Inlet and the Academy grounds. This type of soil usually presents a rolling topography and generally occurs in irregular ridges composed of rounded knolls. The soil in the intervening depressions is a heavy black sandy loam. On the rounded knolls the soil is often quite gravelly. Granite boulders often occur scattered over the knolls and ridges.

The entire north end of the lake and all of the west side south to beyond the Gravelpit is Miami sand. A narrow tongue of the same runs southward along the lake shore to the extreme southern end. The town of Culver and the entire region for some distance to the northwest is of this character. The surface to a depth of about 9 inches is a slightly loamy grayish or yellowish sand of medium texture, while the subsoil is a yellow or orange-colored sand of about the same texture. In the depressions the soil is more loamy, much darker, and extends to a greater depth. The Miami sand presents a very rolling topography and much of it resembles sand dunes in form and appearance. In all probability a large portion was formerly old sand dunes on which plants obtained a foothold and checked the action of the wind. Some of it is even now shifted about by the winds. This soil has been, and still is, a more important factor than any other in determining the character of the lake.

Miami clay loam is found near the lake in only one place, namely, in a narrow ridge across the south end of the lake and

some rods back from it. This is a yellowish white loam, almost white when dry, but dark gray when damp, composed of about equal parts of sand and silt. There is usually some gravel scattered through this soil or left on the surface by erosion.

Muck is found only in a few places about the lake and in limited areas along the creeks. The largest area is that about the lower course of Norris Inlet. The low ground along the Outlet between Outlet Bay and Lost Lake (including Green's marsh), a narrow strip on either side of the creek below Lost Lake, and a similar narrow strip along the lower part of Aubeenaubee Creek, are of muck. There is also a small amount about the mouth of Culver Inlet, and west of the lake about a mile is a large area.

This soil usually represents deposits of partly decayed organic matter, and occurs in low, wet places, commonly known as "marshes". The muck is usually several feet deep and is black or brownish-black in color. It has much to do in determining the character of the water and the vegetation of the parts of the lake where it occurs.

The relation of the soils of the country surrounding the lake to the lake itself is an intimate one. In the first place the kind and amount of soluble salts in the soil will determine the mineral character of the water. In certain places there appears to be considerable iron in the soil. This is particularly noticeable at the Gravelpit where large masses of post-glacial conglomerate are found resulting from the cementing of pebbles together. There is a smaller area of similar material on the east side. There is also some lime in the soil and no doubt much is leached out and carried into the water of the lake from which it is again removed by the various mollusks, and by certain plants. The water of the springs and flowing wells also contains considerable iron and lime.

Erosion:—Not a great amount of eroding is now going on about the lake. Although heavy and frequent rains occur, the soil is sufficiently sandy to take up most of the water readily and the run off is not great. Most of the abrupt slopes are still covered fairly well with vegetation. A few hills or ridges, especially along roadsides, are rather deeply grooved and channeled, but the eroded material is largely deposited before reaching the lake. The fall in the inlets is so slight that comparatively little detritus reaches the lake and the deltas and sandbars formed at their mouths are insignificant. The largest delta is at the mouth of Overmyer's Creek at the south end of the lake where a hilly region, chiefly of Miami clay loam, near the lake, has long been cleared and is most eroded.

Tributary streams:—Lake Maxinkuckee is a body of water in which the physical and biological conditions are bunched; the lake is only of moderate size and regular in form; its catchment basin is quite limited, it being hardly more than three times as large as the area of the lake itself, and there are no important connecting streams or other waters which complicate the conditions. The streams flowing into the lake are few in number and inconsiderable in size. There are only three deserving any special description; these are known as Culver Creek, Aubeenaubee Creek, and Norris Inlet.

Culver Creek:—This creek enters Aubeenaubee Bay at the northeast corner of the lake. It rises in a small marsh about 2 miles from the lake, and pursues a winding course in a general southwesterly direction, entering the lake in the eastern part of the Culver Military Academy grounds. Just before entering the Academy grounds, this creek turns abruptly to the west, and, after flowing a few rods in that direction, turns southward to enter the lake. At the first bend mentioned, the stream, on August 21, 1900, was about 4 feet wide, and with a maximum depth of three feet, though the average depth was not more than two feet. From this point it increases in width and depth through the Academy grounds where the banks have been improved by sodding. Much marsh gas comes up when the bottom is disturbed. There is everywhere an abundance of aquatic vegetation, chiefly *Philotria canadensis, Ceratophyllum demersum* and *Potamogeton.* An effort is made by the Academy authorities to keep the lower portion of this creek free of vegetation by dredging it out with rakes (as explained elsewhere).

Aubeenaubee Creek, named for the Pottawattomie chief who at one time owned the land on the east side of the lake, rises in a small marsh some two miles east of the lake. This creek flows through a low level meadow or prairie region. It averages about four feet wide and from a few inches to a foot in depth with occasional deeper holes. The bed in the upper part of its course is usually of fairly compact sand with some admixture of muck, and its banks are sodded and rather firm. In the lower portion of its course, the shores are more marshy, the banks less stable, and the bed has an increasingly larger percentage of muck. Throughout most of its length this creek is overhung by bushes and briars and is full of sticks and brush. It enters the lake at the Edwards boathouse near the middle of the east side of the lake, or 3½ rods south of section line No. 28.

Norris Inlet has its sources in some small springs southeast of the lake and about two miles distant. It flows in a northwesterly direction and enters the lake through the marsh at the southeast corner. Though this creek does not carry much, if any, more water than either of the others just described, it is usually spoken of as "the inlet". The upper part of this creek flows through fields and other cleared land, and the banks are usually well defined and sodded. The marsh about the Norris Inlet is about 80 rods wide and ½ mile long, and is a flat, level, quaking bog full of holes. The lower portion of the creek is through a wet marsh with an abundance of marsh-grass and sedges but with scarcely any woody vegetation except a few bushes of *Decodon verticillata*, scattered low clumps of pussy-willow, and an occasional button bush *(Cephalanthus)*. There is but little vegetation in the upper part of this stream, but the lower part is well filled with hornwort *(Ceratophyllum)*, milfoil *(Myriophyllum verticillatum)*, spatterdock *(Nymphaea advena)*, and various species of duckweeds.

Overmyer's Brook:—A few rods west from the mouth of Norris Inlet is a small brook about a mile long which usually contains some water. This may be called Overmyer's Brook or Creek. Besides this there is a very small brook a few rods long near the southwest corner, another small one coming from the Peebles' flowing well on the northeast part of the lake, and two or three very small streams from flowing wells at the north end.

The total volume of water carried into the lake by these various little streams cannot be conveniently nor accurately determined; but from observations and experiments made at various times, the total daily flow during July and August, 1900, probably did not exceed 400 gallons per minute.

Flowing wells:—There are on the immediate shores of the lake more than 100 wells, of which about 50 are flowing wells, i.e., wells in which the water rises above the surface of the ground without being pumped. With the exception of one or two recently dug along the south shore, these wells are all located on the east and north sides of the lake. Beginning just north of Norris Inlet, flowing wells have been secured at irregular intervals all along the east shore and across the north end, the last one being at the Vandalia Railroad station at Culver. These wells vary greatly in depth; some are only 27 to 30 feet deep, while others are as much as 138 feet deep. The depths of all were not learned, but the majority seem to be between 50 and 80 feet. In driving these wells it often happened that flowing water could be obtained at a certain depth, and, by going deeper, a stronger flow would

be secured. The deep wells seem to have the strongest flow, though this is not invariably the case; indeed, the "Wise well" at the Maxinkuckee road is said to be 110 feet deep and flows only a trifle over one gallon per minute, while the Sheerin well on the north side is only 38 feet deep, flows 50 gallons per minute, and is the strongest well about the lake. The flow of the different wells ranges from three-tenths of a gallon to 50 gallons per minute, and the total flow of all is about 400 gallons per minute. In some the water barely rises to the surface of the ground, while in others it will rise from 10 to 18 feet above.

The temperature of the water as it leaves the pipes is usually 52° F., the variation being from 51.5° to 54.5°. This variation is probably due chiefly to the length of pipe on or above ground, and to the difference in rapidity of flow. The coldest of all the flowing wells is the one at the cottage of Mrs. Judge A. R. Heller, on the east side. This well is 103 feet deep, flows 25 gallons per minute, and has a temperature of 51.5°. The warmest is that of Otto Stechhan, also on the east side, flowing only two-thirds of a gallon per minute and with a temperature of 54.5°. The water in several of the pump wells is colder than in any of the flowing wells, the coldest being that at the cottage of Judge John Mitchell on the east side, the depth being 36 feet and the temperature 50.5°. All the wells about the lake were examined August 25 and 26, 1900, and the temperatures and volumes given were obtained on those dates.

List of Wells on Shore of Lake Maxinkuckee

The following table gives the most important facts about the wells in the vicinity of the shore of the lake. The temperatures were taken with a Queen & Company's protected thermometer, and the volume determined by noting the time required to fill a bucket holding 2.5 gallons. Several tests were usually made at each well for temperature and for volume. The work began at the well of H. R. Norris, at the southeast corner of the lake, and proceeded northward. The temperatures and depths of the pump wells as well as those of the flowing wells, were recorded.

The list is as of August, 1919. In order that the table may be useful in various ways we have given a complete list of all the lots on the shore of the lake whether there is thereon a flowing well or not. In column 1, we have numbered the lots consecutively beginning with the Vandalia Railroad land at the Culver station and proceeding around the lake on the north side, then south, then west, thence north to the starting point. In column 2, we give the

owner of each lot; in 3, the frontage; in 4, whether there is a cottage or not; in 5, the depth of the well; in 6, the size of pipe; in 7, the flow in gallons per minute, if it is a flowing well; and in 8, the temperature of the water of the well.

It is difficult to prepare a table of this kind that will remain accurate very long. Lots are changing hands, new wells are being driven, old wells deepened, pipes changed, etc., etc. It is believed, however, that this list will be found useful and interesting. For much of the data we are under obligations to the Culver Military Academy.

No	Owner	Front Feet	Cottage	Well Depth feet	Size of pipe, in inches	Number of gallons per minute	Temperature of water, degrees Fahr
1	Vandalia Railroad	2,500	No	67	2	73	54
2	Lakeview Hotel	1,000	Hotel	65	2		53
3	Ed. Morris	243	No		2	06	52
4	S. P. Sheerin	313	Yes	38	4	50	53 5
5	Carrie B. Waldorf	100	Yes	65	2		
6	Albert F. Schad	50	Yes	65	2		
7	Fred Thompson	50	Yes	65	2		
8	Helen Albrecht	50	Yes	65	2	3 53	53
9	Adolph Herz	50	Yes		1½	7 5	52
10	Palmer House	187	Hotel	65	2¼	3	53
11					1	Pump	52 5
12	L. H. Scheurman	65		60		Pump	52 5
13				65			52
14	Wm. F. Kuhn and Oscar D. Bohlen	50	Yes		2 5	3 35	52
15						Pump	53
16	Theophilus Gonzelman			45	1	4 41	52
17				65	2		52
18	Culver Military Academy	4,500		65	3	40	52
19				65	3	40	52
20				65	3	40	53
21					2	3	54
22					2	3	
23					2	3	
24					2	3	
25	(Woodcraft reservation)			64	2	1	
26	E. R. Culver	124	Yes		2		
27	Culver-Bell		Yes (2)		2		
28	Laura Culver	245	Yes		2		
29	Mary L. Forman	50	No				
30	George Vonnegut	100	Yes		2 5	1 01	54
31	Bernard Vonnegut	110	Yes				52
32	Clement Vonnegut	100	Yes	65	3		52 5
33	Mueller Inv. Co	100	Yes		2		
34	Maude F. Wolfe	110	Yes		2		
35	Mary Y. and Josephine Robinson	68	Yes		3		
36	Lillian Ketchum	92	Yes				
37	Lillian Deming (Brownell)	214	Yes	65	2		
38	J. W. Smith	400	Bayview Hotel	104	2		
39	George E. Miller	93	Yes		2		
40	M. M. Milliken	70	Yes	107	2		
41	Wm. E. Wheeler	30	Yes	103	2 5	8 33	52 5
42			Yes			Pump	53
43	Gideon W. Blane	156	Yes				

No.	Owner	Front Feet	Cottage	Well Depth feet	Size of pipe, in inches	Number of gallons per minute	Temperature of water, degrees Fahr.
44	Anna R. Heller	272	Yes	103	2	25	51 5
45	D. W. and E. Marmon	173	Yes	104	2	5 55	52
46			Yes	104	2	1 22	52 5
47						21 43	52
48	Elizabeth Marmon	115					
49	Charles C. Perry	410	Yes	70	2		
50	H. R. Bliss			105	2	6	52 5
51	Elizabeth B. Crawford	190	Yes	65	2		
52	John H. Vajen				2	24 17	52
53	Jos. Strong			75	2	40	53
54	L. B. Martin	60	Yes		2	1 25	52
55	Worth B. Steele	50	Yes	65	2		
56	C. R. Green				2		52
57	Milton Shirk	208	Yes	70	2	10 29	52
58	Guy T. Bigley	96	"Wise well"	105	3	1 07	53
59	Peter Spangler			78	2	16 67	52
60	Mrs. S. R. A. Rector			27	2	3	53
61			Rector	Spring		3 75	53 5
62	Jennie Capron	69	Yes (2)	98	2	24 75	52
63	Clarence Carson	50	Yes				
64	Jacob Cramer	50	Yes				
65	Emma Rhodhammel	70	Yes	100	2		
66	Charles Barnaby	140	Yes	100	2		
67	A. B. Gates			110 to 115	2	1 16	53
68	Edward Hazeldine	140	Yes	100	2		
69	Mrs. C. Maus			40		Pump	51 5
70						Pump	52 5
71	R. T. Daggett					Pump	52 0
72	Dr. Charles Benepe	140	Yes	75		Pump	53 0
73	Charles E. Coffin	243	Yes	100	2		
74	Francis W. Jones (Dr. Parsons)	71	Yes	104	2		
75	Jacob V. Stimson	71	Yes	106	2		
76	Eleanor Y. Hoard	71	Yes	110	2		
77	Florence B. Halliday	71	Yes	116	2		
78	Joseph Schaff	71	Yes	120	2		
79	Magdelina Favre	212	Yes				
80	W. W. Wilson	110	Yes				
81	Alfred M. Glosbrenner	70	Yes	120	2		
82	F. M. Harwood	50	Yes	47 5		Pump	53
83	Richard A. Edwards (boathouse)	356	Yes	130	1¼		73
84				14		Pump	53
85	Ada Stuart	50	Yes				
86	John Mitchell	100	Yes	36		Pump	50 5
87	Francis A. Helm	58	Yes				
88	Harvey Bates	143	Yes				
89	Martha L. Wilson	148	Yes				
90	T. H. Wilson					Pump	52
91	Frank M. Rice	50	Yes				
92	A. J. Murdock					Pump	52 5
93	Mary J. Snider	101	Yes	48		Pump	51 5
94	W. T. Wilson		Yes			Pump	51
95	Mary Judah	107	Yes	48		Pump	51 5
96	Helen Shroyer	125	Yes	40		Pump	
97	Harry C. Adams	100	Yes			Pump	52 2
98	Rice and Vaughn	100	Yes	37		Pump	52
99	Lyman Brackett					Pump	52
100	Henry Mordhurst	52	Yes				
101	Mrs. W. E. Shedd					Pump	51 4
102	L. T. Van Schoiack			30		Pump	52

No.	Owner	Front Feet	Cottage	Well Depth feet	Size of pipe, in inches	Number of gallons per minute	Temperature of water, degrees Fahr.
103	E. B. McQuat	207	Yes				
104	Lavina Walker	454	No				
105	Sidney A. Vaughn	100	Yes				
106	Mary Van Schoiack	50	No				
107	J. D. Ferguson	125	Yes				
108	Fred Gompf	120	Yes (3)				
109	J. A. Maxwell					Pump	52
110	Walter Twiname	50	Yes				
111	Marion Ellsworth	100	Yes				52.5
112	C. D. Snoeberger	75	Yes				
113	Anna B. Bramen	50	Yes				
114	A. Curtis			40		Pump	52.5
115	W. F. Christian	100	Yes				
116	Wm. Wallace	70	Yes				
117	Pierce and Ward	75	Yes				
118	M. V. McGilliard		Yes			Pump	53
119	J. M. Dresser	50	Yes	63 5		Pump	53 6
120	Mary L. Taylor	200	Yes (3)				
121	Lavina Walker	514	No	100	2		
122	Eva Sherman	61	Yes				
123	Richard Irwin	78	Yes	100	2		
124	Otis Hann	163	Yes		2		
125	Cordelia Edwards	127	Yes				
126	Marvin T. Loudon	65	No				
127	Effie Crabb	77	Yes				
128	Chester Edwards	77	Yes				
129	Wm. Daggett					Pump	51 8
130	H. C. Chandler			37 (104)	2 (2)	0 66	53.4
131	Daniel W. Gardner	90	Yes	64 (100)	1	0 75	52 5
132	Edwin Fulton	372	Yes (3)	71.6	2	3 57	52 5
133	Jesse Heywood	200	Yes				
134	William J. Wood	143	Yes (No)	(104)			
135	Harvey R. Norris	¼ mile	Yes	66	2	1.2	53.8
136	Daniel Easterday	1,200	Yes				
137	Adolph Muessel	100	Yes				
138	Samuel Medbourn	548	Yes				
139	William Rankin	101	Yes				
140	John W. Cromley	500±	Boathouse				
141	I. & H. Faulkner	50	Boathouse				
142	Washington Overmeyer	50	Boathouse				
143	Daniel McDonald	140	Yes	60	2		
144	William Cline	50	Boathouse	60	2		52.8
145	Lewis McDonald	50	Yes				
146	Ada F. Daugherty (Col. Farrar estate) (John Murray plot:)	½ mile				Pump	51
147	Ida Walker	172	Yes			Pump	51
148	Ida Rovell	47	Yes				
149	David C. Jenkins	100	Yes				
150	James E. Hillis	45	Yes				
151	Lloyd Rovell	42	Yes				
152	Maude Abbott (end of Murray plot)	50	No				
153	Catherine Duenweg	400	Yes				
154	James Green (Wm. O'Keefe)		Yes			Pump	
155	Bardsley Cottage (Lost Lake)		Yes			Pump	
156	Schroff (Shady Point)	160	Yes			Pump	52
157	William H. Holland (Arlington)	160	No	52		Pump	52
158	George W. Barnes	100	Yes			Pump	52.1

No.	Owner	Front Feet	Cottage	Well Depth feet	Size of pipe, in inches	Number of gallons per minute	Temperature of water, degrees Fahr
159	W. C. Routh	50	Yes				
160	Cordelia C. Shafer (Scovell)	50	Yes				
161	Frank C. Murphy (Walter Knapp)						
162	Jane A. Fisher (Green's plot)	30					
163	Loretta Z. Heilman	50	Yes				
164	Charles Monninger	50	Yes	50		Pump	52
165	Henry Meyer	75	Yes				
166	Mary B. Reitemeier	25	Yes				
167	Mintie A. Holman	100	Yes				
168	Arthur H. Springer	50	Yes				
169	Frank B. Murphy (Plank)	50	Yes				
170	Fred A. Seeburger	50	Yes				
171	John J. Campbell	100	Yes				
172	Jacob W. Miller	100	Yes			Pump	52 5
173	Otto E. Hornung	37 5	Yes				
174	Webster & Folrath	37 5					
175	Keller, Florin & Retz	75	Yes				
176	Jessie Uhl and Mary Traut	75	Yes				
177	Maude C. Goldsmith	80	Yes				
178	H. J. McSheehy	80	Yes			Pump	52
179	Kathryn Duenweg	92	Yes			Pump	52
180	A. J. Shepherd	83 25	Yes				
181	Weinstein & Dahlen	55.5	Yes				
182	Edward W. Johnson	55.5	Yes				
183	Frances J. Duenweg	55.5	Yes				
184	Jane A. Fisher (Judge Slick) (Chadwick plot:)	27.75	Yes				
185	John H. Himmelberger	450	Yes				
186	Melvin T. Anderson (Chadwick)	274	Hotel	29		Pump	54
187	Isador Hessel (Chadwick)	191	Yes				
188	Charles E. Holbrunner	440	Yes				
189	C. C. Durr and George Green	50	No				
190	Maurice Winfield	1,000	Yes	36		Pump	53
191	Daniel Wolf	80	Yes			Pump	51
192	M. R. Cline	140	Yes				
193	Samuel Medbourn	130	Yes				
194	Helen M. Outland	100	Yes			2	
195	J. Freeman	100					
196	Ed. Morris	100	No				

There are a few small springs along the shores, and probably a good many in the bottom of the lake, but how much they contribute to the supply of the lake, there is no means of knowing.

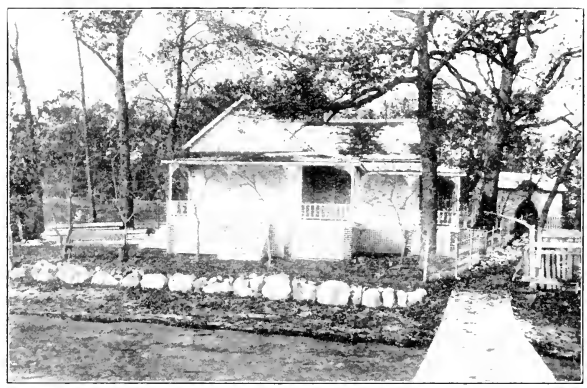
The water of the springs and wells in several cases contains a considerable amount of iron. In some wells the iron is perceptible to the taste and discolors the drain troughs. The water in all contains some lime, the well-water being about three times as hard as that of the lake. In some instances boards exposed to it become coated with lime.

In addition to the wells given above, numerous others have been constructed since our observations were made. Weak flowing wells have been obtained at the McDonald cottage between Farrar's and

the south spring. Many of the wells which are not flowing have the water within a few feet of the surface.

President W. W. Parsons of the Indiana State Normal School, who has built on the east side since the census of wells was taken, has a flowing well 116 feet deep which remains at 52° the year round; now owned by Francis W. Jones.

The sum total of water entering the lake from the flowing wells actually measured, is, therefore, about 400 gallons a minute, which equals 24,000 gallons an hour or 576,000 gallons, or considerably over a half million gallons, every day of 24 hours. Add to this another 400 gallons per minute from the various tributary creeks and we have a total of 1,152,000 gallons daily. This large amount,



The Duenweg or Shady Point Cottage, used as headquarters by the investigators in 1899-1901. The Arlington station seen in the background at the right.

added to the unknown amount from under-water springs, must exercise a great influence on both the character and temperature of the lake water the year round.

The Outlet:—The outlet or thoroughfare of Lake Maxinkuckee is near the middle of the west side just north of Long Point, through a small stream which, after flowing sluggishly for about 3 rods to the west and south, enters Lost Lake. Just as the Outlet leaves the lake it is crossed by a wagon bridge, and 27 feet west of this the Vandalia Railroad bridge also crosses it. Immediately below the railroad bridge the stream turns southward and continues nearly due south through a somewhat artificial channel for 800 feet, and then through a wet marsh about 1,000 feet to Lost

Lake into which it gradually widens. The banks are low and the adjacent ground is of soft black muck over which one cannot pass, except in the driest season, without danger of miring. At the lower end the marsh along its edges is continually under water. The bed of the stream at the bridges is artificially 16 feet wide and the water about 18 inches deep in dry weather. There is usually a fairly strong current at the bridges, but below them it is barely perceptible.

Shore and Beach:—The shores of Lake Maxinkuckee are in most places several feet above the lake level; there is very little marsh ground anywhere. The beach is usually of compact sand or fine gravel; with the exception of a few rods at Norris Inlet and a few yards in 3 or 4 other places, it would be possible to drive a team and wagon entirely around the lake in shallow water without any danger of miring.

Beginning at the Outlet and proceeding southward the shore and beach may be described in detail as follows:

From the Outlet to the middle of the north side of Long Point the shore is low and continuous with Green's marsh. During extreme high water the public highway is sometimes flooded. Recently the western portion of this section has been materially modified by filling in and is now firmer ground than it was originally. The beach is of fine yellow sand, usually quite firm and free of vegetation.

Long Point rises abruptly to a maximum height of 35 feet above the lake. The distal end of this point has recently been cut down considerably but still remains several feet above the lake. The crest of Long Point from near the extreme end to the Arlington station is 20 to 35 feet above the water line. The shore is abrupt and bluff-like.

The beach along the east side of Long Point and southward to Arlington is of clean yellow sand with a considerable proportion of pebbles and fine gravel just below the water line.

Toward the south the gravel becomes rather more evident. From Arlington to the Gravelpit there is a narrow low strip extending back to the railroad west of which the shore rises abruptly to an extreme height of 40 feet, the highest point being at the Gravelpit. Opposite the Kettlehole and just south of the Gravelpit the high ground again approaches very close to the water's edge, so that we have a quite narrow beach, and the bare beach patches are not sandy, but both shore and bottom are covered by very coarse gravel, the component pebbles of the gravel being about the size of a goose's or hen's egg. There are also quite large rocks

of a granitoid nature projecting out on the narrow beach from the base of the hill.

From Murray's to Farrar's there is a rather broad and tolerably bare sandy or gravelly beach, with moderately coarse gravel in the bottom. The shore is low and level, the ice-beach being the highest ground. The next section of about 1,000 feet east of Farrar's presents a strong contrast to the preceding, the immediate shore being a low marshy woodland with a well-defined ice-beach near the water's edge. The ridge is narrow, 2 or 3 feet high, and practically cuts off a strip which otherwise would be a part of the lake. In some places there is a second, similar ice-ridge parallel to the first and some distance back of it. Both of these ice-ridges bear trees of considerable size, some of them 6 inches or more in diameter and 20 feet high. The shore is flat and mucky and full of muskrat holes. It is thickly covered in some places by the three-cornered bulrush *(Scirpus americanus)*. It is too miry to walk on between the water-line and the ice-ridge; one has to walk on the ridge in places.

Following this flat shore is a stretch of 110 feet of fine sandy beach, where a hill comes down to the shore. This is in line with a public road, and is used for a boat-landing. There is a broad beach of fine yellow sand, and a gravelly shelly bottom, bare and sandy a distance out from shore. The break in the rush patch is probably due to boats going over this region.

Then occurs a stretch of about 850 feet reaching from the end of the sandbar mentioned above to the place where the forest comes to the shore.

In general this shore is a good deal alike throughout its extent, is nearly flat, and has behind it most of the way an ice-ridge separating it from a large swamp behind; all of the shore is soft, and it extends out into the lake as a long broad cape. The apex point of the cape is sand, but both sides, especially the northern side, are tolerably black on top from a scum of decaying vegetation.

The hill which forms the border of the swamp approaches the lake, but does not reach it, so that there lies a flattish, rich, but dry and elevated plain between it and the lake. This plain is well forested. At this place the hill is cut in two by a deepish and rather wide gully with moderately steep, but well rounded sides, cut by Overmyer's Brook which enters the lake at this point and forms a large flat sharp delta of sand which projects out for a considerable distance into the lake. The delta holds a sort of lagoon, and at the northeast edge of the delta the stream and waves have combined to form a sandbar with a sharp apex and an almost

regular and equal slope on each side. The shore is quite irregular here, with sandy capes and mucky gulfs. The bottom of the northern half of this stretch is of fine sand; the southern part is a solid platform of firm black dirt.

The hill or bluff here comes down to the lake and there is a well-wooded, high slope coming down nearly to the water-line. In most places there is no beach at all, or only a very narrow one. The hill is made up of a yellowish clay full of boulders. At about the middle of the hill a torrent bed cuts somewhat into the hill and makes a small sandbar off shore. There are many quite large boulders along the water's edge. Toward the southern half of this stretch the shore becomes broader. The shore is gradual in its slope; for the northern half it has coarsish gravel out for a little way under water; farther out it is fine sand with ripple-marks. *Scirpus validus*, the common bulrush, forms a large patch 15 feet from shore and farther. Toward the southern end the bottom is filled with gravel, the pebbles of which are about the size of goose eggs.

The next stretch reaches from this place to near Norris Inlet. Back of the shore is a flat, dense willow and red osier dogwood jungle. There is a broadish beach with a very gradual slope all the way. The shore changes gradually from a flat soft fine white sand with considerable vegetable intermixture to a flat miry black or brown stretch of muck. The Scirpus, Potamogetons, cattail, etc., grow so densely in the water that the bottom can be seen only in a few places. It is quite flat and mucky and marly. There is a good deal of *Spirodela* (duckweed), dead and white, and much green algæ may usually be seen washed up on this flat miry shore. At the end of this stretch there are back of the flat beach two low, broad, flat ice-ridges, very close together and side by side.

The region about the mouth of Norris Inlet is a flat sedgy plain with a low ice-ridge near the water's edge. At the west end this ice-ridge is quite high and well-marked; at the east end nearer the creek it is less distinct.

The Inlet is tolerably narrow and deep where it enters the lake; farther up it becomes very crooked and shallow, and its bottom is full of rootstocks of the yellow pond-lily, or spatterdock, *Nymphaea advena*. It is surrounded by about 40 acres of flat, wet marsh, overgrown with sedges, reeds, cattails and various grasses, with bushes of red osier dogwood, or willow here and there. Much of it is tussocky. Near the lake it is quaky and full of holes. Along the sides of the Inlet are many lagoons. On both banks near the water's edge is a thick, narrow growth of *Decodon verti-*

cillata. This plant forms a fringe on each border some distance upstream about a quarter of a mile.

Besides the spatterdock already mentioned as growing in the bottom, the water of the Inlet contains much vegetation on its surface along the edges—the various duckweeds in great masses, and great quantities of the floating liverwort, *Riccia fluitans*. The duckweeds thrive in great abundance at the mouth of the Inlet.

From Norris Inlet to the Norris pier—about 1,000 feet—the shore, except for the last few yards, is low and boggy. The ice-ridge is pretty plainly marked for much of this distance. At Norris's the low flat country ceases and the hill slopes gently down to the water's edge. The ice-ridge stops and the beach is composed of a strip of gravelly sand. Then the ice-ridge reappears and is overgrown with tall willows and sycamores.

From the Norris pier northward the shore is low, but rises near the Indianapolis pier and continues high until Aubeenaubee Creek is reached. The beach is mostly of fine firm sand with considerable gravel in places and a number of large granite boulders sparsely scattered near shore.

At the mouth of Aubeenaubee Creek the country has been modified somewhat by dredging and straightening the stream. The stream now flows through the center of a marshy tract about 200 feet wide. This marsh is of flat black miry ground covered with a rank growth of marsh vegetation.

From Aubeenaubee Creek northward to beyond the Maxinkuckee road is a long stretch of low, level ground extending back to beyond the public highway. The hills or high ground recede gradually from the lake, leaving broad, dry greenswards of gentle slope. Just north of the Maxinkuckee road the high ground again approaches the lake and forms an abrupt bluff 20 to 50 feet high for a distance of about three-fourths of a mile, or to the southeast corner of Aubeenaubee Bay. The only considerable break in this line is the narrow canyon of Spangler Creek just south of Brownell Point. There is another small gully north of the Indiana boathouse. Throughout this entire distance the shore rises abruptly from the water line and much of it is protected by a stone breakwater. There is, consequently, no beach. In the shallow water near shore are a good many granite boulders of various sizes, and a few masses of post-glacial conglomerate. This shore is the highest and most abrupt of any about the lake; it is also the most considerable section of high shore.

At Aubeenaubee Bay the high ground recedes from the lake front and turns suddenly almost at a right angle from the lake.

There is, therefore, facing on this bay a broad area of low, almost marsh, ground. The beach is broad and of fine sand with a considerable admixture of muck which induces a rank growth of aquatic vegetation.

The eastern part of the ground at the north end of the lake is occupied by the Culver Military Academy. This ground has, of course, been greatly modified in response to the needs of this institution. The grounds are relatively level and are bordered in the rear by the usual ridge of higher ground.

West of the Academy grounds and extending to the Vandalia Railroad station at Culver, the shore is somewhat higher, especially at the Lakeview Hotel where it ascends abruptly to a height of 30 feet or more. Along this shore there is not much beach, the shore-line being for the most part artificial. There are, however, a number of short stretches of sandy beach with boulders scattered here and there.

From the railroad station at Culver southward to the Assembly grounds the shore is relatively level and elevated 5 to 15 feet above the lake. This section has undergone many modifications incident to the development of the town of Culver and the construction of the railroad which, in the main, parallels the shore. There are two or three small marshy areas, and at one place there is a small cape with lower ground between it and the higher land in the background. Beginning with the Assembly grounds and extending to the Outlet the shore rises abruptly as a sandy hill to a height of 30 feet or more, there being only a narrow strip of low ground scarcely wider than needed by the railroad. The beach along this side of the lake is usually of very fine sand with but few boulders except at the cape, and but little gravel. It has a sufficient percentage of muck and marl to support a luxuriant growth of aquatic vegetation.

The Ice-beach:—One of the most interesting phenomena at Lake Maxinkuckee is the ice-beach or ice-ridge so well-marked on many parts of the shore. In many places where the shore is low and moderately firm, an ice-beach is more or less evident. Starting at Long Point and proceeding southward the ridge is but faintly or not at all marked until in the vicinity of the Farrar cottage. There are slight evidences at the base of Long Point and also between Green's pier and Murray's and just west of Farrar's. It is probable ridges form periodically along this shore, but soon become obliterated through various agencies. Just east of Farrar's is a very definite ridge, high and narrow, and much resembling an artificial dam or towpath. It juts up against the

shore and partially cuts off what was originally part of the lake. In some places there is a second similar ridge parallel to the first and some feet back of it. Both of these ridges have growing on them trees of considerable size, some of them about 6 inches in diameter and 20 feet high. East of this the ice-ridge is for a distance old and worn away on the lake side, so that many of the trees growing on it have been more or less undermined and now lean out over the water. The commonest species of tree on the ridge is the water-beech; there is an occasional willow, soft maple, elm and kinnikinnik *(Cornus sericea)*. From this point east to Norris Inlet, an ice-ridge is more or less evident and back of it a second, and sometimes a third, older ridge appears for short reaches.

These ridges, even the last and most evident one, are usually not continuous for more than a few rods without interruption. The wearing away most often takes place on the lake side and is the result of undermining by the waves.

After passing the miry ground at the mouth of Norris Inlet some 500 feet the ice-ridge reappears and is overgrown with tall slender willows, weeds and grasses. Just before reaching the Norris pier it stops, but soon reappears again as a high broad ridge overgrown with tall willows and sycamores. The ridge then disappears and is not seen again until just south of the Indianapolis pier where it is quite pronounced and separates a small pond from the lake.

The rest of the lake shore from this point on north and around to Long Point, seems to be entirely without any ice-ridge.

HYDROGRAPHY

Depth:—In determining the depth of the lake several thousand soundings were made. The method followed in taking soundings was essentially as follows:

Two different sounding machines were used during this work. The first consisted of a brass reel with a grooved rim on which was wound piano wire of sufficient length. The circumference of the reel or wheel was just 3 feet, so that in sounding, each revolution of the wheel reeled off exactly 3 feet of wire. The sounding lead consisted of a 2½ lb. piece of lead shaped like a truncated pyramid with a cupshaped base in which was placed a small quantity of lard and beeswax for the purpose of securing samples of the bottom. In the end of the axle was placed an ordinary cyclometer which recorded the revolutions made by the wheel. The reel thus equipped was installed in the bow of a rowboat. In taking

soundings 3 people were employed,—one to row the boat, one to operate the sounding machine, and one to record the readings.

A smaller machine was sometimes used when sounding in shallow water. This consisted of a wooden reel cut out of a thoroughly seasoned piece of oak and then boiled in oil and paraffin to prevent splitting. This reel was just two feet in circumference, and on its grooved rim was wound piano wire. A similar but lighter sounding weight was used and the reel was installed in the boat in essentially the same manner as was the larger one.

Usually a sounding was taken at the end of every 15 oar strokes. An effort was made to have the same person do all the rowing. Before entering on the work he endeavored, through practice, to acquire a uniform stroke, to the end that 15-oar-stroke intervals between soundings might be approximately equal.

Quiet days with little or no breeze and with the lake surface undisturbed and smooth were selected for this work; under these conditions the drifting of the boat was reduced to a minimum and it was easy to follow a definite line. In order to do this, range signals were placed on shore; these were always visible to the rower.

Lines of soundings were run across the lake on all section, half-section and quarter-section lines, both east and west and north and south, and in a number of places lines were run at even closer distances.

In order to determine the location and extent of bars, deep holes, or other topographic features of special interest, a buoy was established on the bar or other special feature, from which radiating lines of soundings were run in sufficient number and with the soundings at sufficiently short intervals to determine the desired facts. The locations of these buoys were determined by sextant readings based on shore marks of known position.

During the winter of 1900-1901, a number of lines including several hundred soundings were run by Mr. Clark when the lake was covered with ice. The exact position of each of these soundings was determined from known shore positions by measurements on the ice.

It is believed that the care taken at all times while carrying on this work, the great number of soundings taken, and the frequent verification of questionable results, justify the belief that the hydrography of this lake has been pretty accurately determined and that the contour lines on the map showing the depths may be depended upon as showing the actual depths with reasonable accuracy.

Topography of the lake bottom:—There are many striking features in the topography of the lake bottom; in fact, it is quite diversified and the contour lines, as may be seen by an examination of the map, are very irregular both as regards direction and spacing. There are a number of low hills and plateaus with gentle slopes, others of smaller area and rising abruptly from deep water, numerous long, narrow troughs or valleys running between bars, and a number of holes where the depth over a limited area is noticeably greater than in the surrounding region. Only a few of the more salient topographic features need be described in detail.

The Deep Hole:—The greatest depth known in Lake Maxinkuckee is 89.5 feet. The locality where this sounding was gotten is known as the "Deep Hole". It is about midway on a direct line between the tip of Long Point and the J. H. Vajen cottage, a short distance north of the Maxinkuckee road. It is also on a direct line drawn from the Palmer House to Overmyer's spring at the south end of the lake. Located more precisely, its center is 3,426 feet (about 2 3 of a mile) from the end of the Maxinkuckee road, 3,140 feet (nearly 2 3 of a mile) from the end of Long Point, 4,568 feet (or about 5 6 of a mile) from the Palmer House, and 8,000 feet (or 1.5 miles) from the Overmyer spring.

This so-called "deep hole", in which the depth is 70 feet or more, is quite irregular in shape. Its greatest length lies north and south and is about 2,500 feet; about 1,000 feet of this, however, is a narrow trough (400 feet wide) of 70-foot water extending northward from the main body. The average width of the main part is between 700 and 800 feet. The total area of 70-foot water and over is close to 40 acres.

The Sugarloaf:—At the northern edge of the main body of deep water is a small area (about 100 feet long by 75 feet wide) known as the "Sugarloaf", over which the depth is but 10 feet. The sides of this little hill are very steep, the distance to 40-foot water in any direction being only 50 to 100 feet.

The Sugarloaf is on a direct line from the end of Long Point to the Indiana Boathouse and almost midway between the two points. It is also on a direct line drawn from the Maxinkuckee road to the tabernacle in the Assembly grounds; also between the Lakeview Hotel and Norris's pier; also between the depot pier at Culver and the Indianapolis pier.

The Weedpatch:—This is an east-and-west bar about 1,200 feet long and 500 feet wide, on a direct line between the Arlington Hotel and Van Schoiack's place and just midway between these

two points. A line drawn from the Palmer House to the mouth of Overmyer's brook passes over the east end of the Weedpatch; one from the Lakeview Hotel to the same point passes over the west end of it; and a line from the tip of Long Point to the Chandler cottage passes over the center of the Weedpatch.

This bar rises rather abruptly from 40-foot water, the minimum depth on the bar being about 10 feet, of which there is an area of about 4 acres.

The Weedpatch is remarkable because of the very luxuriant growth of the large-leaved pondweed, *Potamogeton amplifolius*, found there.

The Kettlehole:—This is a deep hole about 1,000 feet off the shore between Murray's and Farrar's, in the southwestern corner of the lake. Over the greater part of this portion of the lake the depth is less than 10 feet. At the Kettlehole the depth increases rather abruptly to 20 feet, 30 feet, and then to 40 feet. The area over which the depth is 20 feet or more is ovoid in shape, the major axis being about 1,000 feet, east and west, while the north and south line is about 700 feet. The area of 40-foot water is about 600 feet long (from east to west) and not much over 100 feet wide.

While the above are the only topographic features of the lake bottom which have received definite names there are several others worthy of special mention. Among deep holes are the following: In front of the Arlington Hotel, or little south of it, and about 1,200 feet off shore is an oblong area of 60-foot water, about 1,000 feet long from southwest to northeast, and about 200 feet wide. This is surrounded by much shallower water. A short distance

The Cadets of the Culver Summer Cavalry School occasionally take their horses along for the afternoon swim.

east of this are two smaller deep holes, of 50 feet and 60 feet respectively, and between them and the Deep Hole is another with a depth of 70 feet.

While that portion of the lake north of Long Point is mostly shallow, there are in it a few deeper areas. About 1,200 feet north from Long Point is a hole 35 feet deep. Just off the Assembly grounds is a small 20-foot hole; off Winfield's cottage is a 45-foot hole, while some distance farther out and 1,400 feet southeast from the Lakeview Hotel is another of about the same depth. Northeast from the Sugarloaf are 3 or 4 small areas in which the depth reaches 50 to 70 feet.

Among bars of special interest are the following: Just east of the Deep Hole and the Sugarloaf is a considerable bar rising out of deep water and extending northeast and southwest on which the minimum depth is less than 10 feet. North of it some 1,300 feet is another small bar with a depth of 20 feet.

A long, narrow bar extends north and east from Long Point for nearly 2,500 feet before the depth exceeds 10 feet, and a similar but broader bar extends west from the mouth of Aubeenaubee Creek nearly 3,000 feet before a greater depth than 10 feet is reached. On the other hand, a deep, broad trough of 30 to 50-foot water comes from a little north of west to near shore at the mouth of Aubeenaubee Creek, and a similar trough is found off the Arlington Hotel, and another off the Indiana Boathouse.

There is no deep water at the shore in Lake Maxinkuckee; the depth everywhere increases from shore so gently or gradually that there is scarcely any probability of even a small child ever getting beyond his depth when wading in the lake. There are no sudden irregularities or increases in depth; the increase in depth is so uniform and gentle that several steps would be necessary to make any appreciable difference. Small children can therefore wade about along shore with perfect safety. But beyond the 5-foot contour line the irregularities are greater and well-marked.

If the water level of the lake were lowered 10 feet, the result would be the formation of at least 3 islands (Weedpatch, Sugarloaf and the large bar east of Sugarloaf). At the same time the Kettlehole would become detached from the main lake and become a small independent lake. Another small lake would be formed north of Long Point; another would be formed off the Assembly grounds, and perhaps others would be made.

The peculiar distribution of deeps and shallows, the abundance of shallow bars and deep holes closely associated, taken together

with the favorable character of the bottom, present a combination of conditions remarkably favorable to fish life, and distributed in such a way as to make practically every part of the lake attractive to the angler.

The very gradual slope and absence of stepoffs in the shallower portion of the lake near shore which make the lake so admirable as a bathing resort is due in large measure to the waves, and especially the undertow which rolls the fine sand near the shore down to lower levels and thus produces a marked levelling action. The effect of waves upon bottom topography is quite marked and well-formed ripple marks which are formed in water to a depth of 5 feet or more are often left when the lake freezes over, where they remain until spring and can be observed to an advantage through the clear ice.

The depths at 10-foot intervals are shown by the contour lines on the map which accompanies this report. Most of the topographic features mentioned are indicated on the map.

The Lake Bottom

Soils

So far as we have been able to determine, there is no bedrock anywhere on the bottom of the lake. Several hundred tests in different parts of the lake, and the fact that wells about the lake drilled to depths of 100 to 150 feet pass through only sand, gravel and clay without reaching bedrock, indicate that the original bed of the lake was composed wholly of morainic materials, chiefly sand and gravel with a few boulders and some boulder clay. Over the greater part of the original bed has been deposited a more or less thick coating of marl and mud.

The morainic or drift material of the original bed is composed essentially of the same materials as those that make up the drift of the surrounding land.

Sand:—Along most portions of the shore, particularly on the west, north and southeast, there is considerable compact fine sand out to a depth of 2 to 6 or 8 feet.

Gravel:—On the east, and in limited stretches elsewhere, there is mixed with the sand considerable gravel . This is especially true on the north and east sides. This gravel ranges from very fine, almost sand, to rather coarse. The most conspicuous gravel areas are across the north end from the Lakeview Hotel eastward, and off the east shore, particularly near the Indiana Boathouse. There is a

little gravel along the east side of Long Point, and between the Kettlehole and the shore. The Sugarloaf appears to be made up largely of gravel. Dredging on the north and south sides of it revealed considerable gravel ranging up to the size of hen eggs. This gravel was usually not round but rough and angular. Doubtless there is much gravel in the lake bed that is not apparent, it is so mixed with or covered by sand or other fine material.

Boulders:—There are not many boulders on the lake bottom. There are a few on the north end and a few scattered ones on the east side and south end. The more or less mythical "split-rock", of which some of the older fishermen and boatmen speak, is said to be somewhere in the south end of the lake, perhaps near the Flatiron or the Weedpatch bars. Although we made frequent search for this alleged rock, and asked many people about it, we never succeeded in finding it, or, in fact, in finding but two men who claim to have seen it. It must therefore remain as one of the mysteries of Maxinkuckee.

Marl:—The most interesting and important component of the lake-bed is marl. The hard compact sandy bed usually extends out to a depth of but a few feet—on the west side from 2 to 4 feet, on the east to a somewhat greater depth. Beyond this border of hard bottom the marl begins. The depth to which it extends varies considerably. Off Long Point it is first met in water about 2 feet deep. On the north and east the depth is usually greater, and in some places is as much as 6 to 8 feet. From these depths the marl extends inward and covers practically all the lake bed. It is most evident on the bars, but is present everywhere. The thickness of the marl bed varies considerably. Along the outer edge it probably nowhere exceeds 6 or 8 feet in thickness. In deeper water and on the bars it is probably thicker. The greatest thickness determined by us was about 22 feet which was in the southern part of the lake, off the Gravelpit. The color and purity of the marl seem to vary in different parts of the lake. It appears to be composed chiefly of calcium carbonate mixed with more or less decaying vegetable matter and fine sand of aeolian origin. Samples from the surface are usually quite dark; those from deeper in the bed are much lighter in color. The color and purity are doubtless related to the amount of decaying vegetable matter present. Analyses of several examples of marl from different parts of the lake were made by Dr. Wm. A. Noyes, formerly of the Rose Polytechnic Institute, now of the University of Illinois, with the following results:

Sample No. 1, from a bar east of the Long Point bar, just south of the center of the northeast quarter of Section 28:

Calcium carbonate ($CaCO_3$)	85.02
Magnesium carbonate ($MgCO_3$)	3.85
Ferric oxide (Fe_2O_3)	0.33
Alumina (Al_2O_3)	0.12
Calcium sulphate ($CaSO_4$)	0.17
Insoluble inorganic matter (silica, etc.)	5.67
Organic matter	3.21
	98.37

Sample No. 2, taken 5 feet down in a bed in 8-foot water:

Calcium carbonate ($CaCO_3$)	85.38
Magnesium carbonate ($MgCO_3$)	3.50
Ferric oxide (Fe_2O_3)	0.33
Alumina (Al_2O_3)	0.05
Calcium sulphate ($CaSO_4$)	0.17
Insoluble inorganic matter (silica, etc.)	6.40
Organic matter	3.15
	98.98

Sample No. 3, from the surface of a marl bed in deep water off the Gravelpit:

Calcium carbonate ($CaCO_3$)	75.07
Magnesium carbonate ($MgCO_3$)	4.18
Ferric oxide (Fe_2O_3)	0.51
Alumina (Al_2O_3)	0.09
Calcium sulphate ($CaSO_4$)	0.11
Insoluble inorganic matter (silica, etc.)	15.26
Organic matter	3.65
	98.87

The last of these shows too high a percentage of magnesium carbonate and insoluble elements to render it satisfactory in cement making. The first and second samples are much purer, and would make a good cement.

The origin of marl is a question of popular interest. The marl of Lake Maxinkuckee, as well as of the other lakes of northern Indiana, is evidently a secondary deposit on the original bed of glacial drift. The water of all the wells and springs of the region contains more or less lime and is usually regarded as hard, while the water of the lake, although containing considerable calcium carbonate, is relatively soft. That certain species of animals and plants dwelling in the lake have been important, perhaps the only

important, agents in separating the lime from the water, is quite certain. Chief among these agencies are the various mollusks, especially the Unionidæ and *Vivipara contectoides*, and certain plants, such as the Charas and Potamogetons. These have the power of separating out from the water the soluble calcic compounds and converting them into insoluble compounds which constitute the basis of the marl.

The most abundant and most widely distributed mollusk in the lake is the univalve, *Vivipara contectoides*. This rather handsome and beautifully marked shell occurs throughout the lake, apparently at all depths and on all kinds of bottom, but it is most noticeable in the great windrows of dead shells that are so often seen lining the beach, particularly at low water. These mollusks evidently die by the million every year. Their shells are fragile and disintegrate rapidly. The total annual limy accumulation on the lake bottom from this source alone must be quite considerable.

Next to *Vivipara contectoides* is the species of mussel known as fat pocket-book, *Lampsilis luteola*. As set forth elsewhere in this report, this is the most abundant species of freshwater mussel in the lake. It is pretty generally distributed and is very abundant. There are several very extensive beds, particularly off Long Point and in the south end of the lake. Then there are at least 13 other species of mussels and no fewer than 30 or 40 species of gasteropods, some of them represented by myriads of individuals. Besides such of the mussels as naturally die, the muskrats make considerable onslaughts upon them, leaving their shells strewn over the bottom to decay, and millions of the gasteropods die every year, and their decaying shells go to augment the lime deposited in the bottom of the lake. And there are several species of plants which have the power of separating the lime from the water. The most notable of these are the various species of Chara, some of which are so heavily encrusted in lime that when dried out on shore they become a chalky brittle mass and are accordingly known among fish-culturists as "lime-plants". These grow in depths up to 15 or 20 feet, and most of the plants grow in thick carpets on the bottom, the older portions becoming so thickly encrusted that they are hardly recognizable.

Besides the Charas there are not fewer than 14 species of pondweed or *Potamogeton*, all of which, in varying degrees are lime gatherers. Their leaves, particularly those of *Potamogeton amplifolius, P. compressus, P. robbinsii and P. americanus*, are often encrusted with lime, the first mentioned species so heavily that the

leaf coatings often drop off as casts and are to be found lying heaped up about the bases of the plants. The so-called ditch-moss, *Philotria*, is an energetic lime gatherer; indeed, all the other submersed plants in the lake possess this same property and contribute in the aggregate in no inconsiderable degree to the amount of marl in the bottom of the lake.

In addition to the mollusks and plants there are still other organisms which play a part in the formation of marl; among these are the various species of crustaceans, particularly the crawfishes, whose shells contain calcic compounds.

The rate of deposition of lime in the lake is quite difficult to estimate. It was probably more rapid during the early life of the lake when the amount of calcium carbonate in the water was greater than it now is. Even at best the rate must be very slow, indeed. An annual deposit of one-hundredth of an inch has been estimated. A deposit of 10 feet would therefore require 12,000 years as the age of the lake. But this is scarcely more than a mere guess, and signifies very little.

The Lake Level

Stage of water:—The mean elevation of the surface of the water of Lake Maxinkuckee above sea level at Biloxi, Mississippi, is 734.5 feet. Records kept by the Office of Engineer, Maintenance of Way, of the Terre Haute and Logansport Railway Company, from October 18, 1895, to May 7, 1900, totaling about 50 observations, show that the lowest water in that period occurred on October 18, 1895, when it stood at 733.30 feet. The highest, 735.21 feet, was recorded March 13, 1899. The extreme variation was therefore 1.91 feet or 22.92 inches.

Our party began making observations on the stage of the water in the lake on August 14, 1900. On that date a three-foot rule, graduated to inches, was properly installed at the side of the wagon bridge which crosses the Outlet just as it leaves the lake. The position of this gauge was correlated with that of the upstream girder of the railroad bridge, which crosses the Outlet 27 feet below the wagon bridge. Readings were taken from time to time from that date up to October 22, 1913. The lowest water was recorded November 3, 1908, and the highest July 8, 1902.

Starting with the extreme low water of November 3, 1908, as "zero" and reducing all observations to that basis, we have the following table:

TABLE SHOWING STAGE OF WATER IN INCHES ABOVE EXTREME LOW WATER MARK IN LAKE MAXINKUCKEE.

Date	Height in inches above extreme low water mark	Remarks
1900		
August 14	20 25	
20	22 25	Lake rose 2 inches. Heavy rain yesterday
27	22 00	
September 13	19 00	
17	18 00	
21	17 50	
28	17 25	
October 10	16 75	
18	15 50	
24	14 75	
November 5	14 00	
11	14 00	
15	13.25	
17	14.25	Rained all night of the 17th. S. E. wind. Heavy rain on the 18th, day and night, with S. wind. Rain also on 19th.
25	18 75	
27	18 50	
29	19 50	
December 2	18 50	
6	18 00	
9	17 75	
11	18 00	
1901		
August 13	10 75	
1902		
January 27		Lake very low.
June 30	26 50	A good deal of rain last night. N. E. wind.
July 1	27 00	
1	27 25	
2	27 00	
2	28 00	
3	28 25	
7	27 50	Heavy and almost continuous rain for more than a week
7	28 25	
8	28 50	**Highest water yet recorded.**
17	24 50	
20	26 50	Rain
24	24 50	
27	23 50	Rain.
28	25 75	
August 14	22 50	
13	21 50	Rain.
16	21 00	
19	20 50	
24	19 50	
30	17 00	
31	19 00	Rain.
September 5	18 50	
14	19 50	
21	17 00	
22	17 00	
28	19 00	Rain four days
October 16	17 00	
20	17 25	
November 1	15 75	
30	14 00	

TABLE SHOWING STAGE OF WATER IN INCHES ABOVE EXTREME LOW WATER MARK IN LAKE MAXINKUCKEE—Continued

Date	Height in inches above extreme low water mark	Remarks
1902		
December 9	12 50	
20	17 00	
24	17 50	
1903		
February 1	15 50	
4	17 50	
14	19 50	
26	18 00	
27	19 50	
March 1	20 50	
8	21 00	
9	21 50	
14	20 00	
17	19 50	
29	16 50	
April 16	21 50	
May 1	20 50	
10	16 50	
13	15 50	
17	15 00	
20	14 50	
June 7	16 50	
29	13 50	
July 1	13 00	
2	21 00	Exceedingly heavy rains
3	21 50	
4	22 25	Heavy rains.
11	21 50	
16	20 50	
19	22 75	
August 8	19 25	
26	16 00	
September 16	23 50	Screen put in at railroad bridge, raising the lake
17	21 25	Rain for several days.
26	22 00	
October 22	22 00	
1904		
June 18	12 25	
July 4	11 25	
August 1	6 25	
October 18	8 50	
29	8 25	
31	8 25	
November 3	7 00	
12	8 50	
1906		
January 22	10 50	Recently rose 3 inches
August 20		Lake rose 1¾ inches.
October	3 50	
1907		
September 12	10 50	
21	10 20	
October 1	9 00	
3	9 50	
5	9 50	
11	9 50	

TABLE SHOWING STAGE OF WATER IN INCHES ABOVE EXTREME LOW WATER MARK IN LAKE MAXINKUCKEE—Continued.

Date	Height in inches above extreme low water mark	Remarks
1907		
October 14	8.50	
15	9.50	
24	9.50	
25	9.50	
30	9.50	
November 2	10.00	
1908		
October 1	.....	Very low.
November 3	**0.00**	**Lowest water yet recorded.**
1911		
November 18	8.50	
1913		
September 9	7.50	
21	7.00	
28	6.00	
30	6.50	
October 1	6.80	
2	7.00	
3	7.00	
4	6.50	
5	6.50	
6	6.75	
7	6.50	
8	6.75	
10	6.75	
11	7.00	
13	7.00	
14	6.75	
15	6.50	
16	6.00	
19	6.80	
20	6.50	
22	6.00	

As shown by the above table, the water was continuously and quite uniformly low during the fall of 1913. There were no rains sufficient to produce any effect on the lake. The slight variation of an inch in September and October was doubtless due to winds. A southwest wind continuing for any length of time would blow the water back from the Outlet, thus slightly lowering the water at the gauge, while a northeast wind would blow the water into Outlet Bay and slightly increase the depth at the Outlet.

It will be observed that our observations were not taken at regular intervals. They were usually taken whenever we were at the lake and occasion seemed to require; records were also made from time to time by Mr. Chadwick, especially at times of sudden change and of unusually high or low water. It is believed that

the extremes for the period from 1899 to 1914 have been recorded in the table.

Although the catchment basin of the lake is small (less than 8,000 acres) the lake is very sensitive to rains and responds promptly. Every heavy rain causes an almost immediate rise in the lake. High water will therefore be correlated with heavy continued rainfall and low water with the dry season. The early spring rains and melting snows put the lake up somewhat above the winter conditions, and the heavy rains that usually come in June and early July produce the highest water. The lake is therefore apt to be highest in June and July, after which it begins to fall until minimum low water is reached toward the last of October and early in November. As already stated the lowest water recorded was that of November 3, 1908, and the highest that of July 8, 1902, when it was 28½ inches above extreme low water. This extreme high water of 28½ inches followed three weeks of heavy and almost continuous rains. As early as June 15 the water was higher than old residents about the lake had ever seen it. It kept on rising until July 8. The ice-beach on the west and south shores was entirely covered; it was impossible to walk along the beach between Long Point and Arlington; the swamps were full of water and the low country generally flooded; nearly all the piers were under water, and a portion of the public road near the Outlet was flooded. Green's marsh was flooded so that one could go about all over it in a boat. One old resident says that the lake was equally high in June or July, 1896, and quite high in May and June, 1892.

The extreme low water of November 3, 1908, followed a rather dry summer and fall. Our records show very little rain in August, September or October of that year.

Volume of outflow:—The volume of water flowing from Lake Maxinkuckee varies greatly from time to time. As already stated, at times of high water, the depth at the bridge is 3 to 3½ feet. The current, however, is never strong, and does not vary much. The water surface in the two lakes varies synchronously and the current therefore does not vary greatly.

Measurements of the outflow were taken at various times. The results are recorded in the following table. It will be observed that the variation in number of gallons is considerable. The minimum, 1,168 gallons per minute, was recorded on September 25, 1899, at which time the average width was 15 feet, the depth 11.7 inches and the current 1.7 feet per second. This would mean an outflow of 1,681,920 gallons per day. The greatest volume of out-

flow was recorded July 8, 1902, when the width was 15 feet, the depth 42.5 inches and the current 1.4 feet per second. This indicated an outflow of 33,915 gallons per minute or 4,883,184 gallons per day.

Number of gallons flowing out of Lake Maxinkuckee as determined on various dates:

Aug.	8, 1899	4,424 gallons per minute
"	11, 1899	2,576 gallons per minute
"	27, 1899	3,347 gallons per minute
Sept.	7, 1899	2,512 gallons per minute
"	25, 1899	1,168 gallons per minute
July	1, 1902	32,288 gallons per minute
"	8, 1902	33,915 gallons per minute
Sept.	10, 1913	2,618 gallons per minute

The Outlet

Lake Maxinkuckee drains into Lost Lake through a short but very interesting little stream or thoroughfare known locally simply as "The Outlet." This stream leaves the lake at the north side of the base of Long Point or at Outlet Bay, which is on the west side about one-third the distance south of the north end of the lake. Just as it leaves the lake it is crossed by the wagon bridge on the public highway which follows the lake shore closely from the southwest corner of the lake to the Arlington station, then cuts across the base of the broad peninsula known as Long Point, and again approximating the shore along the north side of Long Point, only to leave it again immediately after crossing the Outlet. Twenty-seven feet below the wagon bridge the Outlet is crossed by the Vandalia Railroad bridge. Under and between these two bridges the stream flows nearly west, then turns southwest and south through the marsh until it finally loses itself in Lost Lake.

Under the bridges and for a few yards below, the stream has a maximum width of 16 to 20 feet and a depth varying with the stage of water in the lake. During the period of our observations it has varied from about 6 inches to something more than 3 feet. Early in July, 1902, at the time of highest water, the depth was about 3½ feet and the water rushed through with a good strong current. In September and October, 1913, the lake was quite low, only 6 inches above extreme low water mark, and the depth under the bridges was only 6 inches or less, which made it very difficult to get a row boat through.

The bed of the Outlet at the bridges is of fine sand. Formerly this bed was overgrown sparsely with certain aquatic plants,

chiefly wild celery *(Vallisneria spiralis)* and floating pond weed *(Potamogeton americanus)*, which prevented washing and gave the bed a permanent character. In August, 1913, the old wooden wagon bridge was torn down and replaced by a concrete structure. In the work incident to this change the vegetation was destroyed and the bed torn up, since which it has silted up with clean sand in which the vegetation has not yet re-established itself.

The distance that the stream pursues through the marsh below the railroad bridge and before losing itself in Lost Lake is about 1,500 feet. Through the upper part the course has been dredged and the banks are well defined; but lower down, the banks are scarcely evident, the stream widens out through the dense growth of Carex, cattail, bluejoint grass, etc., and finally loses itself completely in a large area of spatterdock at the head of Lost Lake.

The water in the Outlet is always very clear. The current does not vary much, the rate being about the same whether the water be high or low.

Lost Lake

Lost Lake, on a cursory examination, might be regarded merely as an expansion of the Outlet, but such is not the case. It is a real lake occupying a considerable hole probably of independent, though synchronous, origin with that of the large lake. There is considerable evidence to show, however, that the high sand ridge separating the two lakes and terminating in Long Point with the long shallow bar extending out into Lake Maxinkuckee from the tip of Long Point, is largely of aeolian origin, built up in part at least by the strong southwest winds.

The open part of this lake, that is, the part not obscured by rank vegetation, is about 2,500 feet long and 1,500 feet wide, the major axis or length extending northeast and southwest. On the southeast side is a high sandy hill or ridge heavily timbered over its northern half and a cultivated field at the southern end, which slopes gradually down to the lake. The shore on this side is in most places a few feet above the water and is dry and firm. There is high ground at the northwest corner of the lake and for most of the distance along the southwest side, bordered by a narrow strip of marsh but rising rather abruptly into a high sandy ridge. At the upper and lower ends are the large areas of lily-pads, etc., already mentioned.

Lost Lake is very shallow. Many soundings were taken. One line of soundings, taken every 10 oar strokes, from the Bardsley

cottage on the east side toward the north end of Hawk's house on the west side, gave the following depths in feet: $2\frac{3}{4}$, $4\frac{1}{4}$, 5, 4, $3\frac{3}{4}$, $3\frac{1}{2}$, 3, 3, $3\frac{3}{4}$, $3\frac{3}{4}$, and $1\frac{1}{2}$. The greatest depth found was 5 feet. The bottom everywhere was covered with a dense bed of Chara, patches of Potamogeton, Myriophyllum, etc., with white and yellow pond-lilies at the west end, all growing in deep mud. In most places the sounding pole could be pushed down 2 to 8 feet in soft muck.

At the lower end of the lake just where it narrows, the depth varied from 5 to 9 feet, and the bottom was more firm in some places. A little farther north and west is a considerable area over which the depth is uniformly 9 feet, which is the greatest depth found in this lake. A line run from the lower to the upper end of the lake gave 9 feet along the southwest end and 8 to 4 feet toward the northeast. Along this line there was an abundance of Chara, Myriophyllum, etc., and the bottom everywhere was of very soft muck; in fact, the bottom everywhere is of this character and in some places it is so thin as to be almost impalpable.

In front of the Bardsley cottage is a "floating island", probably a detached portion of a pond-lily patch that has floated away from shore, or possibly material that has been built up around a muskrat home.

This lake is so shallow that a lowering of the water 15 feet would convert the entire lake-bed and many acres of marsh into tillable land.

The margin of Lost Lake outlet is a wide plain bordered by a gravelly hill; then an inner margin of a broad belt of *Bidens comosa* and *B. laevis*, then sedges. Many of the sedges in the former portion are annually cut for hay, chiefly for the Calamagrostis they contain.

Outlet Creek

At the lower end of Lost Lake is another marsh similar to that at the upper end but larger, in which the outlet stream again gradually becomes definite and well defined. The upper portion may be regarded practically as a continuation of the lake, so overgrown with water-lilies, spatterdock and other water plants as to obscure its lake character as well as the channel. This marsh-lake gradually narrows, however, and finally becomes a well-defined creek, filled in places with patches of long-stemmed Ceratophyllum, Potamogeton, and some wild rice. Then the stream becomes a quite definitely defined creek with low grass-grown banks pursuing its way with many windings and turns through low grassy

meadows dotted here and there with clumps of slender black oak trees growing on little hummocks which were doubtless little islands when the whole region was a lake or river. The stream averages perhaps 5 feet wide and one to three feet deep, with occasional holes that are much deeper. The banks are low everywhere and are of rich black loam; the bed is usually of fine white sand, with a little gravel in places. The water is always very clear and pure and cold enough for rainbow and black-spotted trout.

Although the distance in a direct line from Lost Lake to the Tippecanoe River does not exceed 4 miles the sinuosities of the stream increase its length to at least 12 miles. At times of low water it is difficult to get a boat down the creek to the river but when there is moderately high water an ordinary clinker-built rowboat passes through nicely, and no more delightful trip can be taken than that through the outlet from Lake Maxinkuckee to the Tippecanoe River.

METEOROLOGY

Introduction

The remarkable development of animal and plant life in and about Lake Maxinkuckee is undoubtedly due in large measure to the unusually favorable geologic and climatic conditions of the region in which the lake is situated. The geological features are discussed elsewhere in this report; the climate may be considered here.

The cold winters and the warm summers, together with favorable winds, adequate rainfall advantageously distributed throughout the year, and the varying conditions of sunshine and clouded sky, make up an environment peculiarly favorable to the development and maintenance of an abundant and varied flora and fauna. Many correlations between certain climatic conditions, such as temperature, direction of wind, character of sky, and rains, and the habits of the fishes, turtles, ducks, coots, certain insects, etc., readily suggest themselves to any one interested in such problems and a number of them can be demonstrated. The distribution of the fishes in the lake, with reference to depth and nearness to shore, is particularly influenced by such factors as those mentioned. This fact is well understood by the experienced anglers familiar with this lake.

During the investigations at Lake Maxinkuckee considerable attention was given to meteorological conditions. Early in the work arrangements were made for making regular observations

regarding the more important meteorological phenomena, such as the temperature of the air, the direction and strength of the winds, the character of the sky, rainfall, snow, fog, frost, dew, storms, etc.

Our first records of air temperatures taken at the lake were made in November and December, 1898, by Mr. S. S. Chadwick. These records, few in number, were of the readings from an ordinary thermometer, hung about 6 feet above the surface of the lake on the north side of a house-boat on the east side of Long Point. Following these are a few records for January, February and March, 1899, also made by Mr. Chadwick.

On July 5, 1899, the recording of temperatures was regularly begun by our party and continued without serious interruption until July, 1901, since which date records have been kept for various periods from then to the end of 1913.

Sky

Along with the other weather observations kept at the lake, the condition of the sky as to clearness and cloudiness was also recorded. Generally, the condition of the sky was noted whenever temperatures of the air and water were taken, that is, three times a day. In addition to this, however, any sudden clearing off or clouding up that was observed and noted, and for each day's journal was entered a general summary of the day's weather. The state of the sky was usually written out in considerable detail; much more than would be desirable in a general report. In looking over the records it was observed that the various days could be described as clear, cloudy clearing, clouding and partly clear, and partly cloudy. These terms are generally relative. Days without the sign of a cloud are not very frequent. Days without a patch of blue sky anywhere are not very common, but more common that absolutely cloudy ones. Accordingly, by days with clear sky is meant days when clouds were relatively few, and generally speaking such days are very bright and cheerful, although absolutely clear days, so far as clouds are concerned, may be hazy or very smoky, and relatively dull, while days entirely overcast by thin clouds may be fairly bright. The terms "clearing" and "clouding" are self-explanatory. Partly cloudy and partly clear mean, of course, throughout the day the clouds and blue sky have so evenly balanced that neither greatly prevailed.

During the period from November 2, 1899, when the record begins, to September 17, 1908—with considerable gaps from time to time—the state of the sky has been observed for 1,223 days; of

these, 393 were clear, 530 cloudy, 151 clearing, 104 clouding up and 49 about evenly balanced between cloudy and clear.

In a discussion elsewhere of the conditions of the sky for various months, the conditions were given for periods of observation, so that the observations along that line could fit in well with the temperature records taken three times daily. In the present consideration they are given by days.

Taking the year extending from July 1, 1900, to June 30, 1901, the year for which the record is most complete, there are represented in the record 361 days (4 days in December having no record). Of these 361 days 79 were clear, 168 cloudy, 53 clearing, 46 clouding, and 15 partly cloudy and partly clear. Taking this year by months, the days were distributed as shown by the following table:

CONDITION OF SKY FOR 1 YEAR FROM JULY 1, 1900, TO JUNE 30, 1901

Month	Clear	Cloudy	Clearing	Clouding	Partly cloudy partly clear	Total
July 1—31, 1900	14	7	5	5		31
Aug. 1—31, 1900	9	15	3	1	3	31
Sept. 1—30, 1900	9	12	4	3	2	30
Oct. 1—31, 1900	14	11	1	2	3	31
Nov. 1—30, 1900	6	14	5	5		30
Dec. 1—27, 1900	5	16	5	1		27
Jan. 1—31, 1901	3	18	4	6		31
Feb. 1—28, 1901	6	16	5	1		28
Mar. 1—31, 1901	1	19	5	3	3	31
April 1—30, 1901	6	13	5	6		30
May 1—31, 1901	0	18	7	5	1	31
June 1—30, 1901	6	9	4	8	3	30

Although the records of no other year are full enough to make the giving of the full year satisfactory, the records of a number of months are almost complete, and those of a few months fully complete. A table for such months as have complete records is given below for the sake of comparison:

Month	Year	Clear	Cloudy	Clearing	Clouding	Partly cloudy; partly clear	Total
April	1900	14	6	6	4		30
February	1902	15	6	1	2	4	28
March	1902	11	14	6			31
April	1902	14	14	1		1	30
December	1904	5	17	4	3	2	31
October	1907	9	14	4	1	3	31

The Air

Pressure:—The data concerning air pressure at Lake Maxinkuckee were obtained by readings taken 3 times daily, at 6 a. m., noon, and 6 p. m., from a compensated aneroid barometer kept hanging on a porch of the cottage used as our laboratory. The readings were continued from July 25, 1900, to June, 1901. The average pressure during that time was 29.291 inches. The minimum pressure recorded during that period was 28.62 inches, taken at noon of March 8, 1901, and the highest pressure noted was 30.26 inches on January 3, 1901, about 6 a. m., giving a range of 1.64 inches. A self-recording instrument would in all probability have given a lower minimum, a higher maximum, and larger range. The average pressure did not vary greatly during the different months of the year. The month having the lowest average was October, with an average of 29.005, and that having the highest was February, with an average pressure of 29.583. The month having the least range was August, in which the pressure varied from 29.42 to 29.85, exhibiting a variation of .43 inch, and the month showing the greatest range was January, with a range of from 28.82 to 30.26, or 1.44 difference. The greatest change of the barometer noted within the space of 6 hours was a fall of .9 inch between noon and 6 p. m. on May 2, 1901, and the greatest change in the same direction for a single period of 24 hours was from 29.85 on the evening of September 14 to 28.88 on the evening of September 15, making a fall of .97 inch. The greatest increase of barometric pressure between two consecutive observations was from 28.91 at noon of May 21 to 29.77 at 6 p. m., a rise of .86 inch, and this was followed by an almost equal fall within the next 12 hours. It not infrequently happened, especially during the month of August, 1900, that 2 successive readings were the same, or nearly the same, and in nearly all cases where this occurred the two nearly equal or equal readings were those of noon and evening, there being usually little change during the afternoon. The period of 24 hours showing the least change was from noon August 14 to noon August 15, during which the change was only .08 inch.

In the study of the barometric readings at the lake these were plotted in a graph (the time periods being represented by abcissas and the height of the barometer in inches by ordinates) and the graph so constructed exhibited at a glance the most striking features of the barometric record. Of these the following may be noted:

The pressure for August, 1900, was remarkably uniform, the graph for this month standing in marked contrast with all the other months considered. There were no rapid or violent changes whatever. The average for the whole month is just a trifle below the average for the whole period, and the pressure for the middle third of the month is somewhat lower than that for either end. While there are no violent changes in pressure whatever there is a remarkably regular daily pulse of variations. With only two exceptions the morning reading is the highest; from this time there is a fall of about .16 inch (varying from about .09 to .2 inch) until noon, after which there is usually very slight change toward evening, after which it rises back to nearly its original morning reading. We have then for this month a rather constant daily mode. This mode is of quite frequent occurrence throughout the whole year, and there are all degrees of approximation to it and divergence from it; during the autumn, winter and early spring months its appearance is somewhat less frequent. Rather strictly interpreted, this mode occurs with the following coefficient of frequency for different months: August, 21; September, 4; October, 13; November, 5; December, 2; January, 2; February, 5; March, 4; April, 9; and May, 4.

The average height of the barometer is determined by the altitude of the place, and the great barometric changes are due to the passage of general storm centers. The small daily changes, however, are quite probably due to local conditions, and even the large changes are due to conditions which are represented on a small scale in the area immediately about the lake. Among these causes are difference in nature of the surface of areas of land and water and the presence in the atmosphere of clouds, vapor, dust, etc.

Generally speaking, the air mass over a water area is comparatively stable in relation to daily changes of temperature, while that over land areas is subject to much larger changes. We have differences somewhat analagous to differences of potential between different elements in a galvanic cell. The air above the land surfaces becomes superheated during the day and during the afternoon represents areas of low pressure, while the air mass above them becomes cooled during the night and becomes areas of high pressure during the latter part of the night.

Again taking up land surfaces in detail, these differ considerably among themselves. Large areas of sand have a greater daily amplitude of temperature than areas of loam or muck, and these more than clay, so that, continuing the analogy of the galvanic

cell, we have a greater difference of potential between areas of sand than between muck, loam or clay. No marked tendency is shown to congregate in the vicinity of the maximum.

While the morning readings appear to have a pretty distinct mode, no such feature is apparent in the other two readings, although it cannot be said that a long and diligent scrutiny might not yield some results. For the month of August they are usually close together, but rather indifferent as to position, although in a small majority of cases the evening reading is the lower and when the reverse is true the difference is usually less. On several occasions they were equal. Of 22 observations where the maximum reading was not represented by the morning, however, 15 were represented by evening readings and 7 by morning, so there is quite discernible a tendency for these readings to differentiate in this regard. It is worthy of note, too, that of these 22 observations, 7 (4 of the noon and 3 of the evening) represent strong and sudden changes in the barometer at the time, so that the departure from the mode may be explained in these cases, quite markedly when all are taken together, as a result of a sort of inertia carrying the barometer beyond its normal reading, and the advantage of the one additional abnormality in favor of the morning reading is, taken altogether, of almost equal value in explaining the abnormality there.

Air Temperatures

During the investigations at Lake Maxinkuckee considerable attention was given to air temperatures.

Beginning with July 5, 1899, the temperature readings were from a Wilder protected thermometer which had been tested by the U. S. Bureau of Standards. This thermometer, from July 5, 1899, to May 31, 1901, was hung about 10 feet above the surface of the lake on the shaded side of a cottage near the Arlington station on the west side of the lake. After May 31, 1901, it was hung about 15 feet above the surface of the lake, on the north side of the Chadwick House on Long Point.

Temperature readings were usually taken three times daily, at 6 a. m., noon, and 6 p. m. During the year 1900-1901 a set of standardized maximum and minimum thermometers was installed on the shaded side of the cottage at Arlington and readings from these are given in the appropriate accompanying tables.

The temperature observations were made and the record kept by various persons, as follows:

Period.	*Observer.*
November, 1898, to July 1, 1899	S. S. Chadwick
July 5, 1899, to September 1, 1899	T. Bronté Evermann
September 1 to October 18, 1899	Barton W. Evermann
October 18, 1899, to June 19, 1900	S. S. Chadwick
June 19 to July 15, 1900	J. T. Scovell
July 15 to December 11, 1900	Barton W. Evermann
December 11, 1900, to May 31, 1901	H. Walton Clark
December 8, 1901, to October 10, 1903	S. S. Chadwick
October 18, 1904, to January 4, 1905	H. Walton Clark
January 5, 1905, to July 22, 1906	S. S. Chadwick
July 23, 1906, to October 24, 1906	H. Walton Clark
October 25, 1906, to September 6, 1907	S. S. Chadwick
September 7, 1907, to October 31, 1907	H. Walton Clark
November 1, 1907, to August 26, 1908	S. S. Chadwick
August 27, 1908, to September 26, 1908	H. Walton Clark
September 27, 1908, to August 31, 1913	S. S. Chadwick
September 1, 1913, to October 31, 1913	Evermann and Clark
November 1, 1913, to February 1, 1914	S. S. Chadwick

JANUARY

Temperatures:—The total number of records for January is 485, as follows: 5 for 1899; 93 for 1900, 1901, 1902, 1903 and 1914 each; 12 for 1905; 3 for 1906, and 1 for 1907.

The lowest temperature recorded for this month was —12° on the 27th and again on the 28th, in 1902. The highest was 65° on January 20, 1906. The extremes for each year were as follows:

1900, –8° January 31, and 42.5° January 18; range 50.5°.
1901, –1.3° January 1, and 45° January 21; range 46.3°.
1902, –12° January 27 and 28, and 38° January 2; range 50°.
1903, –4° January 12, and 50° January 29; range 54°.
1914, 4° January 12, and 56° January 29; range 52°.

Records of temperatures at or below freezing were made as follows: In 1899, at 6 a. m. on the 8th, 29th, 30th and 31st, the only dates on which temperatures were recorded; in 1900, at 6 a. m. on the 1st to 4th, both inclusive; 8th, 9th, 11th, 12th, 13th, 16th, 17th, 21st, 22d, 23d, and 25th to 31st, both inclusive, and at 6 p. m. on the 1st, 2d, 3d, 10th to 13th, both inclusive; 16th, 20th, 23d, and 25th to 31st, both inclusive.

From this it appears that, in January, 1900, the temperature was at or below freezing on 21 days at 6 a. m., at noon on 11 days, and on 18 days at 6 p. m. The average temperature for the month is shown in a table elsewhere in this report (page 70).

In 1901, freezing temperatures were recorded at 6 a. m. on the 1st to 6th, both inclusive; 9th, 11th, 12th, 13th, 15th, 17th, 18th, 19th, and 22d to 31st, both inclusive, and 6 p. m. on the 1st, 2d, 3d, 5th, 7th, 11th, 12th, 13th, 16th to 19th, both inclusive. In

other words in January, 1901, the temperature was at or below freezing at 6 a. m. on 24 days, at noon on 17 days, and at 6 p. m. on 20 days.

In 1902, freezing temperatures were recorded at 6 a. m. on the 1st, 3d to 6th, both inclusive; 8th to 17th, both inclusive; 19th to 25th, both inclusive, and 27th to 31st, both inclusive; at noon on the 3d, 4th, 5th, 11th, 12th, 13th, 16th, 18th, 19th, 23d, 24th, 25th, and 27th to 31st, both inclusive; at 6 p. m. on the 1st to 5th, both inclusive; 10th to 16th, both inclusive, and 18th to 31st, both inclusive. The temperature was at or below freezing at 6 a. m. on 27 days, at noon on 17 days, and at 6 p. m. on 25 days.

In 1903, freezing temperatures were recorded at 6 a. m. on the 1st, 2d, 4th to 26th, 30th and 31st, at noon on the 4th to 14th, 17th, 18th, 19th, 21st to 25th, both inclusive, and 30th, at 6 p. m. on the 1st, 3d to 15th, 17th, 18th, 19th, 22d, 23d, 24th, 25th, 29th and 30th. The temperature was therefore at or below freezing on 27 days at 6 a. m., on 20 days at noon, and on 23 days at 6 p. m.

In 1905, we have records for only the first 4 days of January. On the 2d, the temperature was below freezing at noon and at 6 p. m., while on the 3d and 4th it was below freezing all day.

In 1914, at 6 a. m. on the 1st to 8th, both inclusive, 10th to 14th, both inclusive; 17th, 18th, 19th, 21st, 22d, 23d, 25th, 26th, 30th and 31st; at noon on the 1st, 4th, 6th, 10th to 13th, both inclusive; 18th, 21st to 25th, both inclusive, 30th and 31st; at 6 p. m. on 4th to 7th, both inclusive, 10th, 11th, 12th, 13th, 18th, 23d, 25th, 26th, 29th, 30th and 31st; or at or below freezing at 6 a. m. on 22 days, at noon on 15 days, and at 6 p. m. on 17 days.

The greatest daily range in January was as follows:

January 24, 1900, from 33° to 56.5°, or 23.5°.
January 2, 1901, from 1.5° to 24°, or 22.5°.
January 28, 1902, from −12° to 10°, or 22°.
January 1, 1903, from 16° to 40°, or 24°.
January 29, 1914, from 32° to 56°, or 24°.

The average temperature for the month was as follows: In 1900, 24.2° at 6 a. m., 33° at noon, and 29° at 6 p. m., or 28.7° for the day; in 1901, 23.8° at 6 a. m., 31.3° at noon, 29.2° at 6 p. m., or 28.1° for the day; in 1902, 19.3° at 6 a. m., 29.9° at noon, 24.7° at 6 p. m., or 24.6° for the day; in 1903, 22.1° at 6 a. m., 31° at noon, 27.1° at 6 p. m., or 26.7° for the day; in 1914, 29.2° at 6 a. m., 34.4° at noon, 32.8° at 6 p. m., or 32.1° for the day.

Sky:—The records show that clear and cloudy periods in January, 1901, were about equally divided, with the clear periods some-

what in excess. This month for 1901 was markedly cloudy, the sky being obscured about $\frac{3}{4}$ of the time. In 1902 it was again about equally divided as to clearness and cloudiness, with only 1 extra period in favor of cloudiness. In 1903 it was again markedly cloudy. Taking the entire period observed under consideration, there are almost twice as many cloudy days as clear ones. In 1914, the first clear day was on the 8th; the next two cloudy, the 12th very clear; 13th, 15th and 17th clear; 14th, 16th, 18th, and 31st, cloudy; no record for the other days.

Winds:—North and east winds are relatively infrequent. Winds from other directions are so evenly distributed that we cannot speak of any as a prevailing wind. Taking the period as a whole, indeed, the southwest winds are considerably in the lead of the others but a consideration of the several years shows that on some years other winds predominate, for example, the west winds in 1900 and 1901, so that a different series of years would yield somewhat different results. The southwest winds, especially those of winter and autumn are usually chilling, and frequently bring storms. Calm periods were fairly common in 1900. The January of 1901 was unusually calm, the calm periods being considerably in excess of any wind from any particular direction and, indeed, aggregating nearly $\frac{1}{3}$ of the entire month. The months of January, 1902 and 1903, were unusually boisterous, no periods of calm being recorded for either.

Snow:—Rainstorms are only occasional, 3 or 4 for the month being the usual number. Snow storms are more frequent. The unusual number of 23 were reported for 1901, but a number of these were rather light snow flurries.

In 1914, there was snowing all day on the 2d, snow and rain on the 3d and 4th, rain on the 14th, and snow all day on the 18th and 31st.

The following tables represent briefly and comprehensively the weather phenomena for January during the periods when the lake was under observation:

	Sky		Winds									Rain	Snows	Snowfall in inches
Year	Clear	Cloudy	Calm	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.			
1900	17	12	5	1	3	2	6	2	9	11	6	4	3	
1901	26	69	23	0	3	2	12	13	14	16	13	4	23	.
1902	16	17	0	1	5	0	4	2	13	1	9		5	7
1903	9	22	0	1	2	3	3	7	9	2	6	3	8	7.5
1914	14	27	.	.	.	.	.	.	1	.	.	9	14	. .

AIR TEMPERATURES FOR JANUARY, 1899

Date	6 a. m
1	0°
8	30°
29	—13
30	0
31	—9

AIR TEMPERATURES FOR JANUARY, 1900

Date	6 a. m.	Noon	6 p. m.	Average
1	0°	18°	10°	9 3°
2	12	28	15	18 3
3	10	30	22	20 6
4	22	37	37	32
5	38	44	37	39 6
6	33	40	37	36 6
7	42	44	40	42
8	22	34	30	28 6
9	25	42	42	36 3
10	35	36	32	34 3
11	30	32	31	31
12	29	31	31	30 3
13	30	33	32	31 6
14	34	38 5	34	35 5
15	34	44	40	39 3
16	32	33	32	32 3
17	31 5	36	39	35 5
18	42 5	46	44	44 1
19	40	45	49	44 6
20	35	40	32	35 6
21	21	41 5	34	32 1
22	29	43	34	35 3
23	31	43 5	32	35 5
24	33	56 5	50	46 5
25	27 5	18 5	13	19 6
26	8 5	20	13	13 8
27	13	30	32	25
28	8	8	2 5	6 1
29	0	16	18	11 3
30	10	13	3	8 6
31	—8	0	0	—2 6
Average	24 2	33 0	29 0	28 7

AIR TEMPERATURES FOR JANUARY, 1901

Date	6 a. m.	Noon	6 p. m.	Average	Maximum	Minimum
1	—1 3°	16 1°	7 9°	7 6°	16 9	1 9
2	1 5	24	17 9	14 1	24 6	1
3	6 5	23 1	23 5	17 7	27 6	5 3
4	20 8	39 9	32 1	30 9	40 1	16 5
5	25	25 2	25 8	25 3	29 9	21 5
6	25	38 9	37 9	33 9	41 2	21 5
7	34	34	32	33 3	39 2	32
8	38 9	47 9	50	45 6	51 7	31 5
9	31	33	33	32 3	39 1	30 5
10	36 2	35	33	34 7	45 8	32 1
11	31 5	34	31	32 1	33 9	30
12	26 4	33.7	27	27 3	34 3	24 1
13	24	32	31.7	29 2	33	23 5
14	36 3	42	39 8	39 3	44 7	28 3
15	30 1	44	48 2	40.8	48 5	29 1
16	34 9	36	31 9	34 2	51	31
17	20 3	20.7	18 9	19 9	28 5	18 3
18	10 1	24 1	25 1	19 8	25 6	9 1
19	13 6	19 5	24 8	19 3	27 5	13 1
20	34 7	50.5	48 5	44 5	54 9	22 9
21	45	42 7	34	40 5	47 1	33 6
22	24 8	31	32 5	29 4	34 8	21 9
23	31	35	38 3	33 7	41	27 9
24	28 5	29 3	20	25 9	41	19 8
25	18 5	23	24 8	22 1	25 3	14 5
26	24 5	26 3	27	25 8	27 5	22 6
27	29.5	28 9	24 2	27 5	30	23 9
28	20 3	28	21 5	23 2	28 1	18 2
29	11 3	22 1	23 5	18 9	25 1	5 3
30	20 5	27	15 1	20 8	29 7	15
31	3 2	24 5	21 5	17 4	27 5	3 2
Average	23 7	31 3	29 2	28 1		

AIR TEMPERATURES FOR JANUARY, 1902

Date	6 a. m.	Noon	6 p. m.	Average
1	20°	36°	32°	29 3°
2	38	35	26	33
3	10	20	20	16 6
4	12	29	26	22 3
5	10	29	30	23
6	23	38	38	33
7	33	40	36	36 3
8	30	43	34	35 6
9	29	48	38	38 3
10	29	44	32	35
11	20	26	23	23
12	19	24	20	21
13	15	22	18	18 3
14	16	33	30	26 3
15	18	34	32	28
16	29	29	20	26
17	17	36	40	31
18	35	30	28	31
19	14	30	29	24 3
20	20	40	30	30
21	28	36	29	31
22	27	35	26	29 3
23	28	31	27	28 6
24	25	32	29	28 6
25	21	28	32	27
26	36	40	27	34 3
27	—12	0	—8	—6 6
28	—12	10	0	—0 6
29	3	6	6	5
30	6	20	11	12 3
31	11	24	6	13 6
Average	19 29	29 94	24 74	24 6

AIR TEMPERATURES FOR JANUARY, 1903

Date	6 a. m.	Noon	6 p. m.	Average
1	16°	40°	32°	29 3
2	30	34	34	32 6
3	34	34	30	32 6
4	26	28	26	26 6
5	26	32	30	29 3
6	13	27	21	20 3
7	30	25	25	26.6
8	17	14	10	13 6
9	3	15	10	9 3
10	1	20	15	12
11	15	19	10	14.6
12	—4	7	1	1 3
13	2 5	18	17	12 5
14	15	25	27	22 3
15	27	37	30	31.3
16	22	40	38	33 3
17	28	24	23	25
18	11	20	18	16 3
19	15	30	20	21 6
20	16	40	35	30 3
21	28	28	22	26
22	18	32	35	28 3
23	20	27	23	23 3
24	20	28	21	23
25	22	30	28	26 6
26	30	50	40	40
27	39	47	40	42
28	38	43	45	42
29	50	46	22	39 3
30	18	22	23	21
31	28	38	39	35
Average	21 11	29 68	25 48	25 4

AIR TEMPERATURES FOR JANUARY, 1905

Date	6 a. m.	Noon	6 p. m.	Average	Maximum	Minimum
1	36°	50°	42°	42 6°	50°	35 1
2	35	28	22	28 3	16	22
3	9	19	17	15	25	9
4	9	24	21	18	28	6
5	.....	.....			23	
Average	22 5	30 3	25 5	26		

Air Temperatures for January, 1906

There are only three records for this month, all at 6 a. m., viz.: January 20, 65°; 21st, 60°; and 22d, 35°.

Air Temperatures for January, 1907

There are only two records for this month, viz.: January 19, 60° maximum, and January 20, 6° at 6 a. m.

AIR TEMPERATURES FOR JANUARY, 1914

Date	6 a. m.	Noon	6 p. m.	Range	Average
1	30°	32°	34°	4°	32 °
2	30	35	33	5	32 7
3	31	39	36	8	35 3
4	30	32	32	2	31 3
5	27	37	32	10	32
6	29	29	29	0	29
7	29	33	30	4	30 7
8	29	40	37	11	35 3
9	38	40	36	4	38
10	26	27	25	2	26
11	18	24	20	6	20 7
12	14	21	15	7	16 7
13	14 5	30	28	15 5	24 2
14	26	39	40	14	35
15	35	48	42	13	41 7
16	35	42	37	7	38
17	30	36	34	6	33 3
18	30	30	32	2	30 7
19	32	35	37	5	34 7
20	36	38	34	4	36
21	18	25	33	15	25 3
22	19 5	24	35	14 5	26 2
23	25	30	31	6	28 7
24	33	30	34	4	32 7
25	25	28	30	13	27 7
26	30	33	31	3	31 3
27	38	50	45	12	44 3
28	40	46	42	6	42 7
29	56	56	32	24	48
30	26	31	30	5	29
31	25	30	30	5	28 3
Average	29 2	34 4	32 8		32 1

AVERAGE AIR TEMPERATURES FOR JANUARY

Year	6 a. m.	Noon	6 p. m.	For the month
1900	24 2°	33 0°	29 0°	28 7°
1901	23 8	31 3	29 2	28 1
1902	19 3	29 9	24 7	24 6
1903	21 1	29 7	25 5	25 4
1914	29 2	34 4	32 8	32 1
For five years	23 5	31 7	28 2	27 8

February

The weather conditions for February during the time when this month was under observation are given in brief form in the following table:

Year	Sky		Winds									Rains	Rain-fall in inches	Snows	Snow-fall in inches
	Clear	Cloudy	Calm	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.				
1900	20	10	1	2	4	1	8	4	1	6	9	5		8	20.2
1901	34	50	28	0	4	8	7	2	11	7	19			14	
1902	20	11	0	1	7	2	2	5	5	0	6				
1903	12	17	0	0	4	0	2	6	0	1	4	7	11.5	7	

Sky:—February of 1900 was a relatively clear bright month, the records for clearness being twice those for cloudiness. That month for 1901 on the other hand was considerably more gloomy, the records for cloudiness exceeding those for clearness. 1902 was similar to 1900 in weather conditions prevailing during this month, it being a bright cheerful month, while in 1903 it was just a trifle more frequently cloudy than clear. For the whole period of the 4 years this month was under observation there is a remarkable balance between clear and cloudy periods, these being very nearly equal, the total number of clear periods being exceeded by cloudy periods by only 2.

Winds:—North winds are the least frequent, being almost rare. Northwest winds are the most prevalent not only for the greater number of years but rather markedly so for the whole period observed, being on the whole twice as frequent as any wind from any other direction but not by any means equalling the sum total of the other winds combined. Generally speaking, February is a rather blustery month, periods of calm being rare. The February of 1901, however, was unusually calm, the number of calm periods exceeding considerably that of any particular wind, and giving for the entire period a very respectable sum total of calm periods.

Storms:—Rainstorms are of rather infrequent occurrence. Snow flurries and snow storms are common, there being usually a foot of snowfall for this month.

Temperatures:—The total number of records for February is 438, as follows: 13 for 1899; 84 each for 1900, 1901, 1902, 1903, and 1914; 1 for 1905; 3 for 1906; and 1 for 1908.

The lowest temperature recorded for this month was —22° on February 18, 1905. The highest was 56° on February 8, 1900. The extremes for each year were as follows:

1900, −8° February 1 and 17, and 56° February 8; range 64°.
1901, −14.5° February 6, and 37.5° February 17; range 52°.
1902, −13° February 3, and 52° February 27; range 65°.
1903, −6° February 19, and 49° February 10; range 55°.

Temperatures at or below freezing were recorded as follows: In February, 1899, at 6 a. m. on the 1st, 2d, 7th to 15th, both inclusive; 25th and 27th, the only days on which observations were recorded: Zero weather was recorded on the 1st, 2d, and 7th to 13th, both inclusive. In 1900, on the 1st, 2d, 3d, 5th, 6th, 9th, 10th, 11th, 13th to 20th, both inclusive, and 22d to 28th, both inclusive, at 6 a. m.; on the 1st to 5th, both inclusive; 9th, 13th to 19th, both inclusive, and 24th to 28th, both inclusive, at noon; and on the 1st, 2d, 5th, 6th, 8th, 9th, 10th, 13th to 19th, both inclusive; 22d and 24th to 28th, both inclusive, at 6 p. m.

The temperature was therefore down to freezing on 23 days at 6 a. m., on 18 days at noon, and on 20 days at 6 p. m. Zero weather was recorded on the 1st, 16th, 17th, 24th and 25th.

In February, 1901, the temperature was down to freezing on every day at 6 a. m.; on the 1st to 17th, both inclusive, 19th to 24th, both inclusive, and 26th to 28th, both inclusive, at noon; and on the 1st to 24th, both inclusive; 16th, and 18th to 28th, both inclusive, at 6 p. m. The temperature was therefore at or below freezing at 6 a. m. on every day of the month, at noon on every day but the 18th and 25th, and at 6 p. m. on every day except the 15th and 17th. Zero weather was recorded on the 6th, 7th, and 21st.

In February, 1902, freezing temperature was recorded at 6 a. m. on every day except the 27th and 28th, at noon on every day except the 21st to the 28th, both inclusive, and at 6 p. m. on every day but the 23rd to the 28th, both inclusive. In this month records of zero or below at 6 a. m. were made on the 2d, 3d, 4th, 5th, 7th, 8th, 9th, 11th, 14th, 15th, 18th, 19th and 20th,—13 days in all.

In February, 1903, freezing temperatures were recorded at 6 a. m. on the 3d, 5th to 10th, both inclusive, and 13th to 26th, both inclusive; at noon on the 4th, 5th, 8th and 13th to 22d, both inclusive; at 6 p. m. on the 3d to 8th, both inclusive, and on the 28th. The temperature was at freezing or below on 21 days at 6 a. m., on 13 days at noon, and on 21 days at 6 p. m. Zero weather was recorded on the 17th, 18th, and 19th. We have no record for February, 1904, and only one for 1905, when on February 18, 22° below zero was recorded, the coldest temperature that has been noted during the period covered by these observations. In 1906, only 3 observations were recorded for this month, namely, 50°

on the 12th, 42° on the 13th, and 18° on the 14th, all at 6 a. m. The only record for February, 1908, is 1° at 6 a. m. on the 22d.

In February, 1914, freezing temperatures were recorded at 6 a. m. on all the days except the 3d and 28th; at noon on all the days except the 2d, 3d, 6th, 17th, 26th, 27th, and 28th; and at 6 p. m. on all days except the 2d, 4th, and 27th. The temperature was therefore at or below freezing on 26 days at 6 a. m., on 22 days at noon, and on 25 days at 6 p. m. Zero weather was recorded on the 8th, 9th, and 15th.

The greatest daily range was as follows:

February 17, 1900, from –8° to 18°, or 26°.
February 6, 1901, from –14.5° to 15.9°, or 30.4°.
February 22, 1902, from 4° to 44°, or 40°.
February 25, 1903, from 13° to 40°, or 27°.
February 9, 1914, from –2° to 28°, or 30°.

AIR TEMPERATURES FOR FEBRUARY, 1899

Date	6 a. m.
1	— 8°
2	—10
7	0
8	— 9
9	—20
10	—20
11	— 1
12	—15
13	— 8
14	7
15	19
25	35
27	16
Average	—1 07

AIR TEMPERATURES FOR FEBRUARY, 1900

Date	6 a. m.	Noon	6 p. m.	Average
1	— 8	12°	13°	5.6°
2	4	19	10	11
3	18	28	35	27
4	35	20	33	29.3
5	20	30	32	27.3
6	32	34	32	32.6
7	40	40	41	40.3
8	56	42	27	41.6
9	8	25	20	17.6
10	20	34	28	27.3
11	27	40	36	34.3
12	33	40	37	36.6
13	23	19	13	18.3
14	10	30	26	22
15	17	16	8	13.6
16	— 3	15	0	4
17	— 8	18	9	6.3
18	10	28	15	14.3
19	7	25	17	16.3
20	22	37	36	31.6
21	35	36	35	35.3
22	30	33	30	31
23	18	42	38	32.6
24	8	8	— 4	4
25	— 2	10	17	8.3
26	5	20	15	13.3
27	10	20	17	15.6
28	19	22	20	20.3
Average....	17.4	26.5	22.7	22

AIR TEMPERATURES FOR FEBRUARY, 1901

Date	6 a. m.	Noon	6 p. m.	Average	Maximum	Minimum
1	12 5°	23 °	15 2°	16 9°	23 9°	9 5°
2	2 5	25 5	27 3	18 7	27 5	— 1
3	29 5	31	31	30 5	31 3	25
4	26 5	28 5	27 8	27 6	29	22 2
5	12 7	23 9	14 8	17 1	23 5	12
6	—14 5	15 9	14 5	5 3	18 3	—16
7	— 4	19 1	18	11	22 9	—11 2
8	22 1	23 9	26 5	22 5	27	8
9	22 8	25 8	26	24 8	29 9	21
10	8 5	21	18 2	15 9	29 9	4
11	13 5	28	21 8	21 1	32 1	— 4
12	9 5	27	20 5	16 6	27 6	7 5
13	11 1	22 9	24 5	19 5	25 5	6
14	14 9	20 3	17 5	17 5	23 1	9 5
15	4	28 1	32 5	21 5	36	1 6
16	18 1	28 5	28	24 8	30 1	14 5
17	25	31 3	37 5	31 2	38 1	24
18	27 8	35 5	31 8	31 7	37	27
19	11 9	17 3	11 9	13 7	27 2	9 5
20	6	21 5	16 5	14 6	24	5 1
21	— 0 1	23 2	19 9	14 1	23	— 0 1
22	2 5	14 7	5 5	7 5	15	0 1
23	4	21	12 1	12 3	19 7	— 0 1
24	11 2	26 1	26 9	21 4	27 9	4
25	28	32 9	27 5	29 4	36 5	22 6
26	4 9	25 9	16 1	15 6	24 6	1 8
27	5	29	18 5	17 5	28	18
28	5	25 6	26 3	18 9	30 3	— 0 9
Average	11 3	24 8	22	19 3		

AIR TEMPERATURES FOR FEBRUARY, 1902

Date	6 a. m.	Noon	6 p. m.	Average
1	6°	22°	12°	13.3°
2	2	— 4	— 6	— 2.6
3	—13	0	— 6	— 6.6
4	—12	— 4	— 8	— 8
5	—12	9	7	1.3
6	9	21	27	19
7	— 3	13	6	5.3
8	— 6	14	0	2.6
9	0	20	13	11
10	12	31	20	21
11	0	32	18	16.6
12	3	23	23	16.3
13	9	27	13	16.3
14	— 3	27	9	11
15	— 1	27	20	15.3
16	17	27	22	24
17	19	31	21	23.6
18	— 7	27	19	13
19	— 3	27	18	14
20	0	28	19	14.3
21	7	38	25	23.3
22	4	44	28	25.3
23	23	49	37	36.3
24	26	47	36	36.3
25	25	43	35	34.3
26	25	48	40	37.6
27	39	52	44	45
28	41	40	40	40.3
Average.....	7.4	27.1	19.7	17.8

AIR TEMPERATURES FOR FEBRUARY, 1903

Date	6 a. m	Noon	6 p. m.	Average
1	39°	40°	43°	40 6
2	45	47	38	43 3
3	32	33	32	32 3
4	33	29	23	28 3
5	15	28	26	23
6	20	35	28	27 6
7	25	33	31	29 6
8	24	32	26	27 3
9	19	40	33	30 6
10	30	49	37	38 6
11	35	37	36	36
12	35	37	32	34 6
13	31	32	30	31
14	24	30	31	28 3
15	32	28	29	29 6
16	10	14	8	10 6
17	— 4	6	0	0 6
18	— 3	0	2	— 0 3
19	— 6	16	12	7 3
20	3	28	21	17 3
21	18	28	20	22
22	7	28	26	20 3
23	20	36	32	29 3
24	18	35	28	25 6
25	13	40	30	27 6
26	20	45	38	31 3
27	35	45	43	41
28	39	38	27	35.6
Average.....	21 7	31.8	27 2	26 8

AIR TEMPERATURES FOR FEBRUARY, 1914

Date	6 a. m.	Noon	6 p. m.	Average
1	14°	30°	27°	23.7°
2	30	40	38	36
3	33	46	30	36 3
4	14	32	36	27 3
5	22	30	32	28 0
6	28	34	30	30 7
7	14	20	8	14 0
8	— 2	14	0	4 0
9	— 2	28	28	18 0
10	20	24	27	23 7
11	10	20	20	16 7
12	7	14	9	10 0
13	9	11	15	10 7
14	9	24	22	18 3
15	0	15	18	11 0
16	9	20	10	13 0
17	20	38	30	29.3
18	27	32	30	29.7
19	22	30	20	24 0
20	14	31	24	23 0
21	9	28	27	21 3
22	21	22	12	18 3
23	8	14	12	11 3
24	1	26	23	16 7
25	3	28	28	19 7
26	17	34	31	27 3
27	27	43	36	35 3
28	36	41	32	36 3
Average.	14 6	27 46	23 39	21 9

AVERAGE TEMPERATURE FOR FEBRUARY

Year	6 a. m.	Noon	6 p. m.	For the month
1900	17 4°	26 5°	22 7°	22 0°
1901	11 3	24 8	22	19 3
1902	7 4	27 1	19 7	17.8
1903	21 7	31 8	27 2	26 8
1914	14 6	27 5	23 4	21 8
Average for five years..	14 5	27 6	23	21 5

March

March is prevailingly a cloudy month. Of thirty observations in 1900 as to condition of the sky, 12 showed clear and 18 cloudy; of 90 observations in 1901, 18 were clear and 72 cloudy; in 1902, 33 observations were made of which 15 recorded the sky as clear, and 18 as cloudy; while in 1903, of 41 recorded observations, 19 report the sky as clear and 22 as cloudy.

March is generally a boisterous month, with very little calm. Of 46 observations in 1900 no period of calm was observed; of the 46 winds observed nearly every direction was represented, there

being 5 winds from the north, 6 from the northeast, 5 from the east, 4 from the southeast, 4 from south, 8 from the southwest, 6 from the west and 8 from the northwest, the winds from the southwest and northwest being slightly in the majority. In 1901 the month was considerably more calm than during the preceding year. Of 91 observations 18 were calm, 1 north wind, 9 from the northeast, 3 from the east, 6 from the southeast, 13 from the south, 25 from the southwest, 2 from the west, 14 from the northwest, showing again the southwest and northwest winds slightly in the majority.

In 1902, of 33 observations, there was recorded no period of calm, 1 north wind, 8 from the northeast, none from the east, 3 from the southeast, 6 from the south, 8 from the southwest, 1 from the west and 6 from the northwest. In 1903, of 50 observations, there were 2 periods of calm, 6 north winds, 11 from the northeast, 4 from the southeast, 10 from the south, 8 from the southwest, 5 from the west and 4 from the northwest. A consideration of all these records shows that there is no especial direction from which winds come during this month; it varies from day to day and year to year.

March is generally a rather stormy month with a trifle more snow than rain. In 1900 there were 5 rainstorms, 6 snow storms with a total snowfall of about 7 inches, and 2 sleet storms. In 1901 there were 13 rainstorms. During 15 periods snow was recorded as falling but these were usually light snow flurries, the total depth of snowfall registering only about 2¼ inches. 4 fogs were recorded, 15 hazy days, one electrical storm and 1 frost. In 1902 there were 5 rainstorms and 4 slight snow storms, the total snowfall being 3 inches. 2 fogs and 1 frost were recorded. In 1903 there were 7 rainstorms, 3 snowstorms, 3 fogs and 1 frost. There was a cold snap at the end of the month during which ice was frozen on pools. The month is marked by rather sudden upward changes of temperature, one hour changes of 25 being common.

General weather conditions for March are given briefly in the following table:

Year	Sky		Winds									Rains	Snows	Snowfall in inches
	Clear	Cloudy	Calm	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.			
1900	12	18	0	5	6	5	4	4	8	6	8	5	1	7
1901	18	72	18	1	9	3	6	13	25	2	14	13	15	2¼
1902	15	18	0	1	8	0	3	6	8	1	6	5	4	3
1903	19	22	2	6	11	0	0	10	8	5	4	7	3	

Sky:—As shown by our records, March, in all the years records have been kept, has shown an excess, sometimes inconsiderable, sometimes considerable, of cloudy weather. During the years 1900, 1902 and 1903, the excess was not great, the month being pretty evenly divided as to periods of cloudiness and clearness. In the spring of 1901 this month was unusually cloudy, there being 3 times as many cloudy periods as clear ones. It is the abnormal condition of this particular spring that makes the periods of cloudiness during the 4 years studied sum up to more than twice as frequent as the clear ones.

Winds:—North, east and south winds are relatively infrequent. The winds from other directions vary from year to year in frequence, but, taken as a whole, are so evenly distributed that none can be called the prevailing wind. Most years this is rather a rude boisterous month with few periods of calm.

Storms:—Rainstorms, the first of the spring rains, and snow storms, are quite frequent.

Temperatures:—The total number of records for March is 370, as follows: 8 for 1899; 93 for 1900, 1901, 1902, and 1903.

The lowest temperature recorded was zero, on March 17, 1900. The highest was 73° on March 19, 1903. The extremes were as follows:

1900, 0° March 17, and 52° March 9; range 52°.
1901, 5.5° March 6, and 64.8° March 25; range 59.3°.
1902, 10° March 17, and 65° March 19; range 55°.
1903, 18° March 1, and 73° March 19; range 55°.

Temperatures at or below freezing were recorded as follows: In March, 1899, at 6 a.m. on the 12th, 22d, 23d, 24th, 28th, 29th and 31st. The only other record was 50° on the 11th. In 1900, March furnished freezing temperatures at 6 a.m. on the 1st to 5th, both inclusive; 7th to 10th, both inclusive; 12th, 14th to 18th, both inclusive; 20th, 21st, 22d, 24th, 25th, and 27th to 31st, both inclusive; at noon on the 1st, 5th, 6th, 12th, 14th to 17th, both inclusive; 20th, 21st, and 29th; at 6 p.m. on the 3d to 8th, both inclusive; 11th, 13th to 17th, both inclusive; 19th, 20th, 21st, 25th, 29th and 30th. The temperature was down to freezing at 6 a.m. on 25 days, at noon on 11 days, and at 6 p.m. on 19 days.

In March, 1901, freezing temperatures were recorded at 6 a.m. on the 1st, 5th, 6th, 7th, 11th, 12th, 14th, 15th, 16th, 17th, 21st, 22d, 27th, 28th, 29th and 31st; at noon on the 5th, 6th, 20th and 21st; at 6 p.m. on the 4th, 5th, 6th, 15th, 20th, 21st, 27th, and 28th. The temperature was at or below freezing on 16 days at 6 a.m., on 4 days at noon, and on 8 days at 6 p.m.

In March, 1902, freezing temperatures were recorded at 6 a. m. on the 2d to 6th both inclusive, 10th, 14th, 17th to 20th, both inclusive, and 31st; at noon on the 2d, 3d, 4th, 17th and 18th; at 6 p. m. on the 2d to 5th, both inclusive; 16th, 17th, and 18th. The temperature was at or below freezing on 12 days at 6 a. m., on 5 days at noon, and on 7 days at 6 p. m.

In March, 1903, freezing temperatures were recorded at 6 a. m. on the 1st, 2d, 3d, 13th, 21st, 22d, 24th, 25th and 29th; at noon on the 1st and 24th, and at 6 p. m. on the 1st and 24th. The temperature was therefore at or below freezing at 6 a. m. on 9 days, at noon on 2 days, and at 6 p. m. on 2 days.

For March, 1907, we have but three records, these showing that the maximum on each of the three days, March 21, 22, and 23, was 84°.

The greatest daily range for March was as follows:

March 3, 1900, from 7° to 43°, or 36°.
March 23, 1901, from 40° to 62.2°, or 22.2°.
March 26, 1902, from 40° to 60°, or 20°.
March 31, 1903, from 35° to 60°, or 25°.

AIR TEMPERATURES FOR MARCH, 1900

Date	6 a. m.	Noon	6 p. m.	Average
1	20°	23°	40°	27.6°
2	23	40	27	30
3	7	43	25	25
4	30	42	31	34.3
5	16	23	27	22
6	40	27	23	30
7	12	37	20	23
8	19	40	31	30
9	32	52	34	39.3
10	28	40	39	35.6
11	35	38	30	34.3
12	17	32	37	28.6
13	37	42	32	37
14	24	30	25	26.8
15	18	19	14	17
16	18	10	4	10.6
17	0	19	20	13
18	31	40	41	37
19	42	43	30	38.3
20	19	28	26	24.3
21	30	32	30	30.6
22	32	39	47	29.3
23	33	50	38	40.3
24	27	42	35	34.6
25	27	40	32	33
26	35	35	33	34.3
27	27	40	38	35
28	31	34	33	32.6
29	30	30	30	30
30	32	37	32	33.6
31	27	43	40	36.6
Average	25.8	35.2	30.5	30.4

AIR TEMPERATURES FOR MARCH, 1901

Date	6 a. m.	Noon	6 p. m.	Average	Maximum	Minimum
1	28 °	36 °	34.5°	32 8°	37 °	20 2°
2	34 2	38 8	35 1	36	40 6	33 8
3	38 4	51	38	42 4	53	33 4
4	33 5	41	27	33 8	4 9	31 4
5	8 5	16 9	7	10 8	23	7
6	5 5	24 5	26 4	18 8	28 6	3 1
7	26.1	40 8	36 2	34 3	42 4	21 4
8	38 1	41 8	43 7	41 2	44 5	34 4
9	36 8	35 2	34 5	35.5	45	33 9
10	34 5	42.5	39 9	38 9	47.5	31 8
11	28.1	33	33.6	31 5	35.5	27 3
12	28 2	36 3	38 5	34 3	38 9	37
13	41 6	37.5	34 7	37 9	43.5	34 2
14	30 7	35.5	33 1	33 1	37.3	30 4
15	28	35	28 5	30 5	34 9	26 6
16	19 6	39 5	35 2	31 4	40 6	17
17	31.1	53	49 5	44 5	54	30
18	39.3	66 5	62	55 9	69 3	39 3
19	47 8	57 1	49 2	51 3	58 5	44 4
20	32 5	30	26 1	29 5	53 9	25 3
21	22 9	22.9	29 5	25 1	29 5	21 9
22	25	40 1	43 1	36	47 8	21 5
23	40	62 2	49 5	50 5	65	35
24	44 5	56	52 1	50 8	58 5	43
25	46 6	64 8	50 8	54	67 3	46
26	41 9	46 1	41 1	43	47.5	40 5
27	32	36 2	32	33 4	40 3	31 7
28	30	34 5	32	32 1	37 9	29 1
29	29 9	35 2	37 9	34 3	38 1	22 9
30	33	32 5	32 8	32 7	36 5	31
31	30 1	35 1	38 2	34 4	43	29 9
Average	31 8	40 5	37 2	36 5		

AIR TEMPERATURES FOR MARCH, 1902

Date	6 a. m.	Noon	6 p. m.	Average
1	35°	36°	34°	35 0°
2	23	32	25	27 3
3	25	30	30	28 3
4	27	31	30	29 3
5	25	38	31	31 3
6	27	48	40	38 3
7	35	50	40	41 6
8	35	35	36	35 3
9	40	42	40	40 6
10	32	62	55	49 6
11	53	60	63	58 6
12	53	63	43	53
13	35	43	45	41
14	32	54	44	42 6
15	42	52	54	49 3
16	39	46	24	36 3
17	12	10	12	11 3
18	13	26	25	19 3
19	20	46	40	35 3
20	32	50	43	41 6
21	35	50	43	42 6
22	36	45	44	41 6
23	40	57	53	50
24	40	55	42	45 6
25	35	56	46	45 6
26	40	60	54	51 3
27	50	65	65	60
28	53	58	50	53 6
29	40	55	52	49
30	42	36	37	38 3
31	32	42	39	37 6
Average.....	34 8	46 2	41 3	40 7

AIR TEMPERATURES FOR MARCH, 1903

Date	6 a. m.	Noon	6 p. m.	Average
1	18°	29°	27°	24 6°
2	25	40	36	33.6
3	25	37	36	32 6
4	35	41	38	38
5	40	38	38	38 6
6	36	44	45	41 6
7	45	55	57	52.3
8	37	45	38	40
9	35	43	41	39.6
10	43	42	40	41.6
11	38	43	45	42
12	40	47	.....	43 5
*13	30	55	45	43.3
14	37	50	44	43 6
15	35	51	46	44
16	43	52	56	50.3
17	53	65	63	60 3
18	55	72	66	64.3
19	60	73	62	65
20	60	54	40	51 3
21	30	45	40	38.3
22	32	55	40	42.3
23	35	55	34	41.3
24	30	32	32	31 3
25	32	45	45	40 6
26	33	56	55	47 6
27	40	56	42	46
28	33	44	37	38
29	27	44	43	38
30	34	54	45	44 3
31	35	60	46	47
Average.....	37 1	49.1	42 6	43.4

*—The maximum for the 13th was 70°.

AVERAGE TEMPERATURES FOR MARCH

Year	6 a. m.	Noon	6 p. m	For the month
1900	25 8°	35 2°	30 5°	30 4°
1901	31 8	40 5	37 2	36 5
1902	34 8	46 2	41 3	40.7
1903	37 1	49.1	42 6	43 4
For four years.....	32 4	42 8	37 9	37.7

April

Sky:—Of 39 observations of the sky made in April, 1900, we have 24 records of clear and 15 cloudy; of 89 in 1901, 33 recorded the sky as clear, 56 as cloudy; of 31 in 1902, 15 noted clear, and 16 cloudy; and of 71 in 1903, 39 records gave clear and 32 cloudy, making a total of 111 records clear and 119 cloudy, the weather being pretty evenly divided in this particular, there being a few more cloudy periods than clear ones.

Generally, this month shows a very even balance between periods of clearness and of cloudiness, the month for 1900 showing a greater number of clear periods than cloudy, the spring of 1901 showing the reverse, and April of 1902 and 1903 being very little different. For the whole 4 years there are 8 more cloudy periods than clear ones.

Winds:—Generally speaking, calm periods are rare in April, none at all being recorded in 1900, 1902 and 1903. In 1901 it was, however, unusually calm, there being 19 periods of calm recorded. As to direction, winds are pretty equally divided; so much so that taking year after year, one cannot speak of any marked tendency toward a prevailing wind from any particular direction; the records are as follows:

Year	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
1900	6	5	8	2	6	4	5	3
1901	3	26	10	9	1	0	0	18
1902	4	5	2	2	3	5	1	8
1903	8	1	8	12	38	5	1	1

There are fewer west winds than any other, and more northeast than any other, the others being well distributed. The northeast winds generally bring cool weather and storms. It is generally a boisterous month, with but few calms.

Storms:—Both snowstorms and rainstorms are rather frequent.

As compared with other months, rain storms are usually rather infrequent; we have a record of 3 rainstorms for 1900, of 6 for 1901, of 4 for 1902. In 1903 it was unusually wet, there being 11 periods of rain recorded for April of that year. There are occasional snowstorms; we have 4 recorded for 1900, 1 for 1901, and .75 inch for 1902. There was one sleet storm in 1900. Five records of frost in 1901, and one hailstorm in 1903.

The following table shows the general weather conditions for April:

Year	Sky		Wind									Rains	Snows	Snow-fall in inches
	Clear	Cloudy	Calm	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.			
1900	24	15	0	6	5	8	2	6	4	5	3	3	4	6
1901	33	56	19	3	26	10	9	1	0	0	18	6	1	$^3/_4$
1902	15	16	0	4	5	2	2	3	5	1	8	4	4	1
1903	34	32	0	17	28	0	8	18	9	2	5	11	2	.....

Temperatures:—The total number of temperature records for April is 362, as follows: 90 for 1900, 1901, 1902 and 1903 each, and 1 each for 1907 and 1909.

The lowest temperature recorded was 18° on April 10, 1909. The lowest recorded in years of full records was 25° on April 5, 1900, and again on April 4, 1903; the highest was 88° on April 29, 1900. The extremes were as follows:

1900, 25° on April 5, and 88° on April 29; range 63°.
1901, 30.1° on April 1, and 85.1° on April 30; range 55°.
1902, 22° on April 8, and 86° on April 21; range 64°.
1903, 25° on April 4, and 75° on April 12; range 50°.

The temperature was at or below freezing as follows: In April, 1900, at 6 a.m. on the 1st, 3d, 4th, 5th and 10th to 14th, inclusive; at noon on the 11th; and at 6 p.m. on the 3d, 11th, and 13th. The temperature was freezing at 6 a.m. on 9 days, at noon on one day, and at 6 p.m. on 3 days.

In April, 1901, it was at or below freezing at 6 a.m. only on the 1st, and at no time at noon or 6 p.m.

In April, 1902, it was at or below freezing at 6 a.m. on the 1st, 2d, 3d, 4th, 7th and 8th; at noon on the 1st and 7th; and at 6 p.m. on the 1st, 7th and 8th. In this month it was down to freezing on 6 days at 6 a.m., on only 2 days at noon, and on 3 days at 6 p.m.

In April, 1903, the temperature was down to 30° at noon and 6 p.m. on the 3d; to 25° at 6 a.m., and 32° at noon and 6 p.m. on the 4th, to 28° at 6 a.m. on the 5th, and to 32° at 6 a.m. on the 23d.

In April, 1909, when only one observation was recorded, it was 18° at 6 a.m. on the 10th.

The greatest daily range was as follows:

April 26, 1900, from 46° to 77°, or 31°.
April 30, 1901, from 62.9° to 85.1°, or 22.2°.
April 21, 1902, from 48° to 86°, or 38°.
April 1, 27, and 28, 1903, from 40°, 40° and 50°, respectively, to 60°, 60° and 70°, respectively, or 20°.

AIR TEMPERATURES FOR APRIL, 1900

Date	6 a. m.	Noon	6 p. m.	Average
1	30°	55°	47°	44
2	37	42	43	40 6
3	27	44	32	34 3
4	27	55	40	40 6
5	25	60	51	45 3
6	38	70	55	54 3
7	49	75	60	61 3
8	47	60	50	52 3
9	38	57 5	37	41 1
10	26	47	40	37 6
11	29	32	30	30 3
12	30	40	34	34 6
13	30	46	32	36
14	30	60	44	44 6
15	48	78	65	63 6
16	58	60	55	59 3
17	52	60	58	56 6
18	55	60	52	55 6
19	49	69	53	57
20	43	73	60	58 6
21	53	64	60	52 3
22	58	65	51	58
23	45	76	65	62
24	51	74	60	61 6
25	45	74	60	59 6
26	46	77	56	59 6
27	51	67	65	61
28	64	80	63	69
29	60	88	65	71
30	50	67	60	59
Average	43	62 5	51 4	52 3

AIR TEMPERATURES FOR APRIL, 1901

Date	6 a. m.	Noon	6 p. m.	Average
*1	30 1°	44 2°	45 7°	40 3°
2	39	34	36	36
3	34 1	49	44 5	42.5
4	35.1	53 5	54	47.5
5	43 1	51 5	47 2	47 3
6	43 8	44 9	41	43 2
7	38 9	50	41.5	47 1
8	34	40 1	40 9	38 3
9	34	48 8	48	43 6
10	35 8	51 9	51.9	46.5
11	40.3	52 5	51.9	42.8
12	40 6	49	51 5	47.1
13	47 2	48	48 8	48
14	43 5	59 8	57 8	57
15	43 9	58 2	52	51 4
16	41 9	60 2	49 4	50 5
17	53 7	51 5	40 5	48.6
18	32 5	37 9	38	36 1
19	32 2	41 1	39	37 4
20	33 3	47 1	38 2	39 5
21	35 3	42 6	36 8	38 2
22	41 4	44 5	50 1	45 3
23	46	51 9	52 2	50
24	44	58.9	56 5	53 1
25	49 5	52	59	53 5
26	52 7	64 1	62 5	59 8
27	57 9	70 5	63 3	63 9
28	58 6	78	71	69 2
29	60 2	77 5	71 3	69.7
30	62 9	85 1	71 5	73 2
Average..	42 9	53 3	50 4	48.9

*—Maximum air temperature for the 1st was 48 4°; minimum, 26 1°.

AIR TEMPERATURES FOR APPRIL, 1902

Date	6 a. m.	Noon	6 p. m.	Average
1	32°	32°	32°	32°
2	31	35	36	34
3	28	47	40	38 3
4	30	50	42	40 6
5	36	56	50	47 3
6	45	60	50	51 6
7	32	26	25	27 6
8	22	38	36	32
9	35	58	45	46
10	35	65	60	53 3
11	48	55	50	51
12	46	45	44	45
13	35	41	39	38 3
14	36	44	42	40 6
15	38	50	45	44 3
16	42	58	52	50 6
17	42	60	56	52 6
18	48	68	56	57.3
19	47	56	50	51
20	40	68	53	53 6
21	48	86	77	70 3
22	67	80	78	75
23	42	50	48	46 6
24	38	58	64	53 3
25	50	62	70	60 6
26	50	46	50	48 6
27	50	60	62	57 3
28	56	76	65	65 6
29	54	78	66	66
30	56	62	60	59 3
Average	41 9	55 7	51 4	49 7

AIR TEMPERATURES FOR APRIL, 1903

Date	6 a. m.	Noon	6 p. m.	Average
1	40°	60°	.....	50°
2	55	70	65°	63 3
3	36	30	30	32
4	25	32	32	29 6
5	28	35	45	36
6	45	55	56	52
7	43	55	61	53
8	45	57	60	54
9	48	65	56	56 3
10	45	53	47	48 3
11	55	65	70	63 3
12	65	75	65	68 3
13	53	48	48	49 6
14	45	50	47	47 3
15	43	48	41	46
16	38	54	46	46
17	37	55	50	47 3
18	42	60	55	52 3
19	41	55	50	48 6
20	43	57	57	52 3
21	43	43	43	43
22	36	42	42	40
23	32	50	48	43 3
24	46	58	48	50 6
25	45	46	48	46 3
26	35	55	56	48 6
27	40	60	63	54 3
28	50	70	71	63 6
29	60	74	72	68 6
30	63	36	32	43 6
Average.....	44 1	53 8	51 9	49.9

AVERAGE AIR TEMPERATURES FOR APRIL

Year	6 a. m.	Noon	6 p. m.	For the month
1900	43 0°	62 5°	51 4°	52 3°
1901	42 9	53 3	50 4	48 9
1902	41 9	55 7	51 4	49 7
1903	44 1	53 8	51 9	49.9
Average for four years..	43	56 3	51 3	50.2

May

Sky:—Of 35 observations made in 1900, 21 record the sky as clear, and 14 as cloudy; of 95 in 1901, 23 record the sky as clear and 72 as cloudy; of 31 records in 1902 we have 15 clear and 16 cloudy; and of 76 records for 1903 we have 49 clear and 27 cloudy, making a total of 108 records for clear and 129 of cloudy, the cloudy periods being somewhat in excess of the clear ones.

May is generally a bright sunny month, most of the records showing a preponderance of bright days. Many of the periods marked "cloudy" in 1901, were bright and pleasant, either because of thinness of the clouds or broken rifts in them.

Winds:—As with April, this is a month of comparatively few calms, none being reported for 1900, 1902, or 1903. In 1901, for which our records are much fuller, we have recorded 15 periods of calm.

West winds were rather few; all others were pretty well distributed, those from the south being on the whole, the most abundant. For the year for which we have the fullest records we have a goodly record of periods of calm.

The following is a record of the winds for the time observed:

Year	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
1900	7	5	0	8	6	10	2	1
1901	5	31	2	12	1	3	1	16
1902	1	1	4	4	1	5	0	2
1903	8	1	8	12	38	5	1	1

Storms:—Rainstorms are frequent, just about as frequent as in April. Two rainstorms were recorded for 1900, 4 in 1901, none in 1902, and 6 in 1903.

Of other atmospheric phenomena there was one thunderstorm in 1901, and there were 2 cases of noticeably heavy dewfall. It may be observed that "dew", as commonly observed, especially on grass, is as much a biological as an atmospheric phenomenon, being the result of transpiration by herbage, although peculiar atmospheric conditions favor its manifestation.

The general weather conditions for May are shown in the following table:

Year	Sky		Wind									Rains
	Clear	Cloudy	Calm	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	
1900	21	14	0	7	5	0	8	6	10	2	1	2
1901	23	72	15	5	31	2	12	1	3	1	16	4
1902	15	16	0	1	1	4	4	1	5	0	2	0
1903	49	27	0	8	1	8	12	38	5	1	1	6

Temperatures:—The total number of temperature records for May is 310, as follows: 90 in 1900, 91 in 1901, 53 in 1902, and 76 in 1903.

The lowest temperature recorded was 30° on May 1, 1903. The highest was 93° on May 14 and again on May 16, 1900. The extremes were as follows:

1900, 35° on May 3, and 88° on May 25; range 53°.
1901, 42.5° on May 30, and 89° on May 23; range 46.5°.
1902,* 43° on May 15, and 88° on May 18; range 45°.
1903, 30° on May 1, and 90° on May 17 and 19; range 60°.

In the 4 years for which records were made the temperature in the month of May fell as low as freezing only once, which was at 6 a. m. May 1, 1903, when it stood at 30°.

The greatest daily range was as follows:

May 10, 1900, from 37° to 77°, or 40°.
May 23, 1901, from 60° to 89°, or 29°.
May 3, 1902, from 62° to 90°, or 28°.
May 10, 1903, from 54° to 83°, or 29°.

AIR TEMPERATURES FOR MAY, 1900

Date	6 a. m.	Noon	6 p. m.	Average
1	46°	80°	64°	63.3°
2	60	82	54	65.3
3	35	55	45	45
4	45	56	48	49 6
5	45	70	60	58 3
6	50	78	67	65
7	53	79	66	66
8	65	75	55	65
9	40	56	42	46
10	37	77	58	57 3
11	50	77	65	64
12	60	88	70	72 6
14†	79	93	76	82 6
15	70	90	80	80
16	76	93	72	80 3
17	50	65	60	58 3
18	56	60	51	59
19	50	63	51	54 6
20	50	67	63	60
21	46	70	60	58 6
22	50	70	64	61 3
23	61	80	74	71 6
24	61	85	76	74
25	63	88	76	75 6
26	70	85	83	79 3
27	68	80	70	72 6
28	64	80	70	71 3
29	68	78	70	72
30	70	88	80	79 3
31	70	80	70	73.3
Average	56 9	76 3	64 7	66

*No record after May 18.
†Maximum air temperature, 93°.

AIR TEMPERATURES] FOR MAY, 1901

Date	6 a. m.	Noon	6 p. m.	Average
1	62°	83 8°	80°	75 3°
2	.....	85 9	73 1	79 5
3	51.5	66	65 4	61
4	48 9	67	62 9	59 6
5	58 9	74 3	70 5	67 9
6	62	73 2	62 3	65 8
7	57 8	61 8	57 8	59 1
8	55	60 3	58 8	58
9	49 5	62	63 9	58 5
10	53 2	59.5	66	59 6
11	50 5	64 1	61 8	58 8
12	51 6	55 5	53	53 4
13	46 5	66 1	55 8	56 1
14	46 6	59 8	60 5	55 6
15	42.9	70 3	83	65 4
16	54	82 6	64 5	67
17	55.1	83 5	80 5	73
18	62 3	79 2	70 4	70 6
19	54 2	64 9	61	60
20	53 5	67 9	59	60 1
21	52 8	57 4	59 6	56 6
22	55	62	66 6	61 2
23	60	85 9	89	78 3
24	60 9	57 5	52 5	57
25	47 6	.....	51 1	49 4
26	45	51 5	47	47 8
27	46	56 9	54 9	52 6
28	52 2	65 2	62 6	60
29	43 9	57.9	54 5	52 1
30	42 5	58.9	57 9	53 1
31	45	66	68 9	60
Average.....	52 2	66 9	63 7	61

AIR TEMPERATURES FOR MAY, 1902

Date	6 a. m.	Noon	6 p. m.	Average
1	48°	63°	61°	57 3°
2	60	80	67	69
3	62	90	78	76 6
4	67	88	76	77
5	60	72	70	67 3
6	56	66	63	61 6
7	50	58	60	56
8	46	52	50	49 3
9	43	50	54	49
10	45	48	49	47 3
11	45	50	56	50 3
12	50	78	76	68
13	59	60	60	59 6
14	58	62	54	58
15	43	56	58	52 3
16	50	66	68	61 3
17	51	73	60	61 3
18	65	88	.....	76 5
Average.....	53 2	66 7	62 4	61 2

AIR TEMPERATURES FOR MAY, 1903

Date	6 a. m.	Noon	6 p. m.	Average
1	30	55°	50°	45 0°
2	37	60	58	51 6
3	43	43	40	42
4	37	60	54	50.3
5	47	68	60	58 3
6	55	70	60	61 6
7	45	65	60	56 6
8	45	70	62	59
9	55	82	65	67.3
10	54	83	60	65 6
11	62	81	68	70 3
12	60	84	73	72 3
13	64	84	60	69 3
14	50	80	64	64 6
15	57	78	63	66
16	60	84	65	69 6
17	63	90	66	73
18	65	85	74	74 6
19	66	90	70	75 3
20	70	78	65	71
21	68	78	70	72
22	66	75	70	70 3
23	68	80	78	75 3
24	70	80	68	72 3
25	65	81		73
27	70	80		75
Average.	56 6	75 5	63 5	65 4

AVERAGE TEMPERATURES FOR MAY

Year	6 a. m.	Noon	6 p. m.	For the month
1900	56 9°	76 3°	64 7°	66 0°
1901	52 2	66 9	63 7	61 0
1902	53 2	66 7	62 4	61.2
1903	56 6	75 5	63 5	65.4
Average for four years. .	54 7	71 4	63 6	63 3

JUNE

Sky and *Winds:*—We have complete records for June for only 2 years, 1900 and 1901, the records of other years being too fragmentary to tabulate. Of 36 records in 1900, 23 record the sky as clear and 13 as cloudy; of 78 for 1901 we have 33 records of clear sky and 45 of cloudy, leaving the month for 1900 with an excess of clear records and that for 1901 with a somewhat similar excess of records for cloudy. The total observations for the 2 years

are 56 clear periods and 58 cloudy, which is a remarkably even balance.

In 1900 there were 10 more observations marked "clear" than cloudy, while in 1901 cloudy periods were somewhat more frequent than clear. Taking observations for both years, we have the periods pretty evenly divided.

These observations show that, taken as a whole, the cloudy periods and clear periods are about equally divided, the clear periods being more prevalent in 1900 but less so in 1901. North and west winds are relatively infrequent; winds from other directions are so evenly balanced that none can be called the prevailing wind. This is an evenly tempered uneventful month and the minor weather phenomena such as fog, haze, electrical storms, etc., were not sufficiently marked to attract especial attention.

Rainstorms are not especially frequent during this month.

The results of our observations are given in the following table:

Year	Sky		Winds									Rains	Rainfall in inches
	Clear	Cloudy	Calm	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.		
1900	23	13	4	5	9	9	7	4	8	0	4	8	1.5
1901	33	45	17	0	8	5	16	5	16	3	11	9	.....

Temperatures:—The total number of temperature records for June is 202, as follows: 90 in 1900, 90 in 1901, 10 in 1902, and 12 in 1903.

The lowest temperature recorded was 45.5° on June 1, 1901. The highest was 95° on June 28, 1901.

The extremes were as follows:

1900, 49° on June 3 and 88° on June 16; range 39°.
1901, 45.5° on June 1 and 95° on June 28; range 49.5°.
1902,[1] 50° on June 21 and 22, and 66° on June 30; range 16°.
1903[2], 62° on June 27 and 86.2° on June 30; range 24.2°.

Our records show no freezing temperature for June. The greatest daily range was as follows:

June 9, 1900, from 54° to 80°, or 26°.
June 16, 1901, from 65° to 90°, or 25°.
June 28, 1902[1], from 56° to 61°, or 5°.
June 29 and 30, 1903[2], 72° and 73° to 85.2° and 83.2°, or 13.2°.

[1] Records for only 6 days.
[2] Records for only 4 days.

AIR TEMPERATURES FOR JUNE, 1900

Date	6 a. m.	Noon	6 p. m.	Average
1	76°	86°	73°	78 3°
2	68	65	60	64 3
3	49	66	60	58 3
4	58	75	70	67 6
5	67 5	80	73	73 5
6	68	78	68	71 3
7	66	79	70	70 3
8	68	79	60	69
9	54	80	60	64 6
10	65	80	70	71 6
11	68	79	65	70 6
12	63	77	75	71 6
13	70	81	76	75 6
14	63	80	65	69 3
15	64	75	63	67 3
16	60	88	78	75 3
17	66	82	68	71 3
18	65	80	63	69 3
19	65	76	74	71 6
20	76	74	63 5	70 5
21	63 5	69 5	67 5	66 8
22	65	68	60	64 3
23	64	82	70	72
24	68	84 5	70	70 8
25	67	84	73	74 6
26	84	85 7	76 5	82
27	71	84 7	79 5	78 4
28	68	85	79	77 3
29	76 5	79	69	74 8
30	60	68	72	66 6
Average	66 2	78 3	69	71

AIR TEMPERATURES FOR JUNE, 1901

Date	6 a. m.	Noon	6 p. m.	Average
1	45 5	66 1	64 6	58 5
2	52 2	66 1	79 5	65 9
3	57 3	79 5	81 2	72 7
4	60 1	84	82 1	75 4
5	69	65 9	73 9	69 6
6	65	72	76 5	71 2
7	52 5	56	52 9	53 8
8	46	63 9	58	56
9	55 2	78 5	77 1	70 3
10	62 1	71 3	79 6	71
11	73 8	91 5	93 5	86 3
12	70	94	75 1	79 7
13	70	89 8	80	79 9
14	73 8	91 6	82 5	82 6
15	72	82 5	80	78 2
16	65	90	83 8	79 6
17	66 1	71 5	73 5	70 4
18	62 9	83 6	73 5	73 3
19	68	85 9	79 5	77 8
20	63 9	77 1	74 9	72
21	69 9	75 8	79 3	75
22	72	87 8	87 9	82 6
23	67 8	81 9	83 3	77 7
24	73 9	90 1	85	83
25	76 1	94 5	83 8	84 8
26	74	91	88	84
27	76 5	93 4	81	83 6
28	71	95	91	86
29	76 5	88	82 5	82 3
30	79 5	94 2	92 9	88 9
Average	66 3	81 8	79 2	75 7

AIR TEMPERATURES FOR JUNE, 1902

Date	6 a. m.	Noon	6 p. m.	Range	Average
21	50°				
22	50				
23	55				
24	58				
28	56	64°	59°	5°	58 7
30	64	66	52	14	60 7
Average	55 5	63 5	55 5		59 7

AIR TEMPERATURES FOR JUNE, 1903

Date	6 a. m.	Noon	6 p. m.	Average
27	62°	75°	74	70 3
28	63 5	75	78	72 2
29	72	85 2	82 5	79 9
30	73	86 2	81	80
Average	67 6	80 4	78 9	75 6

AVERAGE AIR TEMPERATURES FOR THE MONTH OF JUNE

Year	6 a. m.	Noon	6 p. m.	For the month
1900	66 2°	78 3°	69 0°	71 0°
1901	66 3	81 8	79 2	75.7
1902	55 5	63 5	55 2	59.5
1903	67 6	80 4	78 9	75 6
Average for four years.	63 9	76	70 6	70.4

JULY

Sky:—The records for July are fairly complete for only 3 years and accordingly do not admit of the checking up and balancing which is possible where we have more years to compare. It may briefly be observed that the clear periods were somewhat in excess of the cloudy ones for the years under observation and that the south winds were somewhat more common than those from any other direction. The calm periods were surprisingly few.

Winds:—Northeast, west and northwest winds were the least frequent, the prevailing wind being from the south. Periods of calm were rather infrequent.

Storms:—Compared with other months, showers were rather frequent; of fairly complete records of 34 months, we have only six that equal or exceed that of this particular month.

Temperatures:—The total number of temperature records for July is 330, as follows: 93 in 1899, 93 in 1900, 26 in 1902, 93 in 1903, 24 in 1906, and 1 in 1910.

The lowest temperature recorded for this month was 54° on July 1, 1902; the highest was 103° on July 1, 1910. The extremes for each year were as follows:

1899, 58° on July 8 and 89° on July 21; range 31°.
1900, 60.5° on July 1 and 9, and 92° on July 4; range 31.5°.
1902[1], 54° on July 1 and 90° on July 7 and 27; range 36°.
1903, 60° on July 15 and 16, and 91° on July 3 and 4; range 31°.
1906[2] 60.5° on July 31 and 94° on July 23; range 33.5°.

Our records show no freezing temperature for July.

The greatest daily range was as follows:

July 12, 21 and 24, 1899, from 71°, 73° and 71°, respectively, to 87°, 89° and 87°, respectively, or 16°.
July 14 and 28, 1900, from 71° and 64°, respectively, to 88° and 81°, respectively, or 17°.
July 24, 1902, from 65° to 88°, or 23°.
July 2, 1903, from 68° to 88°, or 20°.
July 31, 1906[3], from 60.5° to 84°, or 23.5°.

[1] Records for only 11 days.
[2] Records for only 9 days.
[3] Records for only 9 days.

AIR TEMPERATURES FOR JULY, 1899

Date	6 a. m.	Noon	6 p. m.	Average
5	69°	73°	70°	70 6
6	65	77	77	73
7	69	80	78	75 6
8	58	70 5	68	65 5
9	65	76	76 5	72 5
10	69	80	80	76 3
11	71	83 5	81	78 5
12	71	87	86 5	81 5
13	74	86	74	78
14	70	74	73	72 3
15	69	..	77	73
16	71	77 5	74	77 1
17	66	72	70	69 3
18	66	79	80	75
19	69	83	82	78
20	74	86	85	81 6
21	73	89	84	82
22	73	87	84	81 3
23	72	87	85	81 3
24	71	87	85	81
25	71	86	80	79
26	68	83	82	77 6
27	69		78	73 5
28	69 5	76	81	75 5
29	72	77	68	72 3
30	64	74	71	69 6
31	62	75 5	75 5	71
Average..	68 9	80 2	77 9	75 6

AIR TEMPERATURES FOR JULY, 1903

Date	6 a. m.	Noon	6 p. m.	Average
1	60 5	73 0	76 5	70 0
2	68 4	86 5	85	80
3	70 5	88	86	81 5
4	85	92	85	87.3
5	81	90 5	85	85.5
6	77 3	89 5	85	83 9
7	71	86	76 5	77 8
8	60	65	67 5	67 5
9	60 5	75	70	68 5
10	64	79	76	73
11	76	80	67	77 3
12	67	64	77	69 3
13	64 5	75 5	74 5	71 5
14	71	88	85	81 3
15	78	88	84 5	83 5
16	71	71 5	79	73 8
17	71 5	78 5	71	73 6
18	67	74	76	72 3
19	72	84	78	78
20	72	87	66	75
21	62	71	75 8	72 8
22	67	83	81	77
23	72	86	85	81
24	75	70	71	72
25	67	78	76	73 6
26	67 5	75	70	69 1
27	66	74	75	71 6
28	64	81	70	74 6
29	73	82	78	77 6
30	70	82	76	76
31	70 5	86 5	79	78 6
Average	70	80 4	77 3	75 9

AIR TEMPERATURES FOR JULY, 1902

Date	6 a. m.	Noon	6 p. m.	Average
1	54	71	63	62 6
2	64	84	70	72 6
3	75	84		
7	80	90	75	81 6
9	76	82		79
18	79	81		80
21	58			
24	65	88	79	77 3
25	70	85	83	79 3
27	75	90	70	78 3
Average	69 6	83 9	73 4	76 4

AIR TEMPERATURES FOR JULY, 1903

Date	6 a. m.	Noon	6 p. m.	Average
1	73 5	80	71	77 8
2	68	88	84	80
3	75 5	91	87	84 5
4	79	91	75	81 6
5	78	83	76	78
6	73	79	81	77 6
7	73	84	82	79 6
8	75 2	90	86	83 7
9	73	87 5	88 5	83
10	75 2	85	83 2	81 1
11	70 5	82	77 5	76 6
12	70	78 5	68	72 2
13	68	78	73 5	73 2
14	63	76	68	69
15	60	71 5	68	66 5
16	60	75	74	69 6
17	68	78	69	71 6
18	63	68	73	68
19	73	73 5	73 5	73 3
20	67	75	77	73
21	71	85 5	78	77 1
22	73	76	70 5	73 1
23	72	78	72	74
24	81	83	83	82 3
25	82	86 5	83	83 8
26	72	89	77	79 3
27	67 5	78	80	75 1
28	71	91	79	83 3
29	70	81	76 5	75 8
30	65	73	68 5	68 8
31	58	65	67 5	63 8
Average	72 5	81 9	76 6	75 9

AIR TEMPERATURES FOR JULY, 1906

Date	6 a. m.	Noon	6 p. m.	Average
23	74	94	88	85 3
24	66	74	73	71
25	63 9	78 5		71 2
26	66	87 9		76 9
27	71 9	84	83	79 6
28	78	92 2	71 8	80 6
29	70	73 9	75	73
30	67	83 9	79 9	76 9
31	64 5	84	82	75 5
Average	68 6	83 6	78 9	76 9

AVERAGE TEMPERATURES FOR THE MONTH OF JULY

Year	6 a. m.	Noon	6 p. m.	For the month
1899	68 9°	80 2	77 9°	75 6°
1900	70	80 4	77 3	75 9
1902	69 6	83 9	73 4	76 4
1903	72 5	80 9	76 6	75 9
1906	68 6	83 6	78 9	76 6
Average for five years	69 9	81 8	76 8	76 1

AUGUST

Sky:—For August we have fairly complete records for only 2 years, 1900 and 1906. We have pretty full temperature records for 1902 but few records of other weather conditions.

Our records show an abundance of cloudy weather, and for the summer of 1906, a considerable excess. In many cases of cloudy weather, however, the clouds were much broken up, permitting many bright days and clear bits of sunshine.

Winds:—August is notably a month of calms and it is due to the placid untroubled surface of the lake that the plankton scum, which begins either at the end of the preceding month or the beginning of this, forms on the surface and reaches its maximum development. West winds are the least frequent; east winds the most so.

Storms:—In keeping with the prevailing calm, storms are relatively infrequent.

The following is the record in tabular form:

Year	Sky		Wind								Rain
	Cl	Cloudy	Calm	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	
1900	14	19	8	4	3	5	2	7	4	1	4	5
1906	19	48	34	5	3	12	4	5	2	2	7	3

Temperatures:—The total number of temperature records for August is 382, as follows: 93 in 1899, 93 in 1900, 23 in 1902, 74 in 1906, and 15 in 1908.

The lowest temperature recorded was 51°, on August 28, 1906; the highest was 98°, on August 2, 1906.

The extremes for each year were as follows:

1899, 58.5° on August 15 and 88.5° on August 19; range 30°.
1900, 62° on August 31 and 92.1° on August 10; range 30.1°.
1902,[1] 54° on August 23 and 90° on August 5; range 36°.
1903, 55° on August 12 and 86.5° on August 23; range 31.5°.
1906, 51° on August 28 and 98° on August 2; range 47°.
1908,[2] 62.5° on August 27 and 87.4° on August 31; range 24.9°.

Our records show no freezing temperature for August. The greatest daily range was as follows:

August 3, 1899, from 69° to 88°, or 19°.
August 19, 1900, from 70° to 91.5°, or 21.5°.
August 5, 1902, from 65° to 90°, or 25°.
August 21, 1903, from 59° to 79°, or 20°.
August 29, 1906, from 56° to 77.5°, or 21.5°.
August 28, 1908[2], from 63° to 81°, or 18°.

AIR TEMPERATURES FOR AUGUST, 1899

Date	6 a. m.	Noon	6 p. m.	Average
1	67.0°	73.5°	82.5°	74.3
2	75	82	76.5	74.5
3	69	80	88	79
4	73.5	83	80	78.8
5	70	73.5	73	72.2
6	69.5	74.5	76.5	73.5
7	64	76	70	70
8	62	72	73.5	69.2
9	65	80	71	72
10	70	82.5	80.5	77.6
11	71	87	86.5	81.5
12	72.5	83.5	76.5	77.5
13	64.5	71	68	67.8
14	62	70	74	68.6
15	58.5	75.5	76	70
16	60	75	78.5	71.2
17	65	80	81.5	68.8
18	69.5	81	81	77.2
19	71	88.5	85	81.5
20	72	80.5		76.2
21	71.5	83	77.5	77.2
22	65	79	80	74.6
23	72	80	82.5	78.2
24	67	83.5	82.5	78
25	67.5	80	81.5	76.3
26	68	82.5	82.5	77.4
27	62.5	82.5	83	76
28	70.5	84	82	78.8
29	69	75	74	72.6
30	70	83.5	83.5	79
31	72	81	82	78.3
Average	67.9	79.5	79	75.1

[1] Records for only 12 days.
[2] Records for only 5 days.

AIR TEMPERATURES FOR AUGUST, 1900

Date	6 a. m.	Noon	6 p. m.	Average	Maximum	Minimum	Range
1	65 8°	76 5	78 0°	73 1°	79 4	64 5°	14 9°
2	60 5	76	76	73 8	79	67 2	11 8
3	69	78	81 1	76	82 8	67 2	15 6
4	70 2	89 8	87	82 3	90 5	67 4	23.1
5	75	89 8	88	84 2	91	73 6	17 4
6	76 5	87 5	86 8	83 6	89 8	74	15 8
7	75	89 5	86 5	83 6	80 6	71 8	8 8
8	76	88	85 1	83	90 4	70 6	19 8
9	74 5	90 2	87 5	84	91 5	70 4	21 1
10	77 4	90 8	88.4	85 5	92.1	75 2	16 9
11	77	91	78	82	92	73 5	18.5
12	69 5	77	76 4	74 3	81 8	69.5	12 3
13	68	89 2	81	76 4	84 5	65 6	18 9
14	67 6	68.5	77	71	80	63	17
15	71	70.1	72	71	73 2	68 5	4 7
16	65.8	71	77	71 3	78 5	64 6	13 9
17	73 9	77	75	75 3	80 5	67	13 5
18	73	86 6	87	82 2	90 4	69 8	20 6
19	77	90	68 5	78 5	91.5	70	21 5
20	71 5	88 5	81	80 3	90 5	69 6	20 9
21	64 8	80 9	75 5	73 4	83 8	63 2	20 6
22	71 9	79	79	76 6	82 8	70 5	12 3
23	69 4	71	78	72 8	82	69.4	12 6
24	71 5	83	81	78 5	86	70 2	15 8
25	72	84	77 3	77 7	86 5	70 6	15 9
26	73 5	81	75 5	75 3	80 6	69 8	10 8
27	8 5	79 8	78	75 4	82 2	65 2	17
28	65 5	79	78	74 1	81 8	64 5	17 3
29	69 5	81	78	76 1	82 6	67	15 6
30	61	82 5	81	74 8	84	65	19
31	68	83	82	77 3	85 2	62	23 2
Average	70 8	81 9	80	77 5			

AIR TEMPERATURES FOR AUGUST, 1902

Date	6 a. m.	Noon	6 p. m.	Average
5	65	90		77 5
7	56	74		65
10		75		
11	56			
19	72	86	80	79 3
20	76		74	75
21	65			
22	56	66	65	62 3
23	54			
24	61	76	70	68 6
28	62	81	73	72
30		88		
Average	62 2	79 5	72 4	71 4

AIR TEMPERATURES FOR AUGUST, 1903

Date	6 a. m.	Noon	6 p. m.	Average
1	57°	70°	73°	66.6
2	64	83	69	75.3
3	72	87	70.5	77.1
4	66	73.5	75	71.5
5	68	78.5	78.5	75
6	68	74	68	70
7	55	73	67	65
8	60	76	68	68
9	62	75	68	68.5
10	60	75	75	70
11	56	70	64	63.3
12	55	67	67	63
13	60	72	70	67.3
14	61.5	74	73	69.5
15	60	68	65	64.3
16	63	75	74	70.6
17	63	75	71	69.6
18	65	81	77	74.3
19	63	64	69	65.3
20	58	75	70	67.6
21	59	79	75	71
22	67	81	78	75.3
23	69	86.5	82.5	79.6
24	73	86	85	81.3
25	76	86	72	78
26	60	71	75	68.6
27	68	78	69	71.6
28	65	75	76	72
Average	63.3	76	72.7	70.7

AIR TEMPERATURES FOR AUGUST, 1906

Date	6 a. m.	Noon	6 p. m.	Average
1	65.5	85.5	83.9[1]	77.6
2	71	88	98	85.7
3	65.9	85.5	75.9	75.8
4	72.9	91.5	72.9	79.1
5	75	87.5	71.9	78.2
6	70.9	88	69	76
7	68.8	80	73.4	74.1
8	68.5	79	83.5	77
9	70	..	..	..
10	67.5	78	76.9	74.1
11	66.4	79.5	74.9	73.6
12	59	70.1	70.1	66.4
13	59.9	75	72.5	69.1
14	65	..	..	..
15	..	..	80.9	..
16	72.5	87.8	80.5	80.3
17	71	76.5	74.1	73.9
18	68	81.8	72.6	74.1
19	75.5	..	..	..
20	....	90.5	73	81.8
21	80.5	..	..	..
22	....	89	79	84
23	..	90	84	87
24	70.5	78.5	..	74.5
25	82.5	.....	..	..
26	.....	89.5	66.5	78
27	58.9	65.9	61	61.9
28	51	66.9	65.5	61.1
29	56	77.5	75	69.5
30	61.5	68	68	65.8
31	59	..	..	..
Average	67.4	81.1	75.1	74.9

[1] Maximum for the day, 77.8°.
[2] Maximum for the day, 74°; minimum, 51.9°.
[3] Maximum for the day, 89°; minimum, 79°.

AIR TEMPERATURES FOR AUGUST, 1908

Date[1]	6 a. m.	Noon	6 p. m.	Average
27	62.5	80	76	72.8
28	63	81	76	74.3
29	69	73	75	72.3
30	70.5	83	82.1	78.5
31	73	87.4	86	82.1
Average	67.6	80.9	79	75.8

[1] Records only for the last five days of the month.

AVERAGE TEMPERATURES FOR AUGUST

Year	6 a. m.	Noon	6 p. m.	For the month
1899	67.9°	79.5	79.0°	75.1
1900	70.8	81.9	80	77.5
1902	62.2	79.5	72.4	71.4
1903	63.3	76	72.7	70.7
1906	67.4	81.1	75.1	74.9
1908	67.6	80.9	79	76
Average for six years...	66.5	79.8	76.4	74.3

SEPTEMBER

Sky:—The month of September generally contains a good proportion of fair bright days. Our table for 1900 shows a considerable excess of cloudy days, but the conditions are reversed in 1903, when, however, we have only about a third of the month represented. In 1906, the records cover only the first 19 days and are expressed in too general terms to easily adapt themselves to tabular form, but which, of the 19 days, record 16 days as "fine" or "fair weather" and 3 as cloudy or showery. The only fairly complete record for September is that of 1900. In 1902 we have scattered records covering 6 days, too fragmentary to be tabulated. In 1903 we have continuous records only from the 21st to the 30th, but as these are pretty full records they are entered.

Winds:—Calm days are frequent. In September, 1900, south winds were the most prevalent. In September, 1906, northeast winds were frequent; these are usually cold disagreeable winds.

Storms:—Rainstorms are rather frequent most years and are accompanied by cool weather. Fogs are occasional, and this is the month of the first frosts.

The following is the table for the two years:

Year	Sky		Wind									Rains
	Clear	Cloudy	Calm	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	
1900	21	31	8	3	2	2	5	10	6	1	3	13
1903	12	6	0	2	1	0	3	7	1	1	1	1

Temperatures:—The total number of temperature records for September is 452, as follows: 84 in 1899, 88 in 1900, 11 in 1902, 25 in 1903, 52 in 1906, 61 in 1907, 47 in 1908, and 84 in 1913.

The lowest temperature recorded was 37° on September 29 and 30, in 1899; the highest was 95° on September 1, 1913.

The extremes for each year were as follows:

1899, 37° on September 29 and 88° on September 2; range 51°.
1900, 37.3° on September 18 and 90.3° on September 10; range 53°.
1902,[1] 42° on September 14 and 80° on September 21; range 38°.
1906,[2] 51° on September 14 and 90° on September 12; range 39°.
1907,[3] 39° on September 25 and 86° on September 17; range 47°.
1908,[4] 50° on September 3 and 88° on September 11; range 38°.
1913, 39° on September 22 and 23, and 95° on September 1; range 56°.

[1] Records for only 6 days.
[2] Records for only 19 days.
[3] Records for only 22 days.
[4] Records for only 17 days.

Our records show no freezing temperature for September. The greatest daily range was as follows:

September 16, 1899, from 50.5° to 86°, or 35.5°.
September 5, 1900, from 59.5° to 88.8°, or 29.3°.
September 5 and 21, 1902,[1] from 51° and 60° respectively to 71° and 80° respectively, or 20°.
September 22, 1903,[2] from 56° to 76°, or 20°.
September 11, 1906,[3] from 65.5° to 88.1°, or 22.6°.
September 14, 1907,[4] from 62° to 80°, or 18°.
September 3 and 11, 1908,[5] from 50° and 64° respectively to 72° and 88° respectively, or 22°.
September 10, 1913, from 51° to 75°, or 24°.

[1] Records for only 3 days.
[2] Records for only 7 days.
[3] Records for only 16 days.
[4] Records for only 19 days.
[5] Records for only 15 days.

AIR TEMPERATURES FOR SEPTEMBER, 1899

Date	6 a. m.	Noon	6 p. m.	Average
1	73	81 5	79	77 8
2	73	88	81	81 0
3	76 8	84 7	72 4	77 9
4	59 6			
6	71 5	78 5	80	76 6
7	75	79 4	77	77
8	68	73	68	69 6
9	60	70		65
10	59 5	63	63	61 8
11	62	69 5	71	67 5
12	63	70	67 5	66 8
13	58	68	58	61 3
14	47 5	58 5	60	55 3
15	51	70	71	62
16	59 5	86	82	75 8
17	69	84 6	70	74 5
18	65	66	63 2	64 7
19	56	56 4	55 5	55 9
20	47	61 6	54	54 2
21	46 5	68	66	60 1
22	57	72	59	62 6
23	55 6	61	65 5	60 7
24	62	71 6	59	64 2
25	49 5	55	51	51 8
26	44	54 5	48	48 8
27	42	60 2	60	54
28	55	57	50	54
29	37	46 5	41	41 5
30	37	47 5	39	41 1
Average	58	67 9	63 5	63 1

AIR TEMPERATURES FOR SEPTEMBER, 1900

Date	6 a. m.	Noon	6 p. m.	Average	Maximum	Minimum
1	71 8°	85 0°	74 0°	76 9°	85 0°	71 8°
2	71	82	75	76	82 5	71
3	70	76 5	71 5	72 6	78	67 5
4	61	76 2	75	70 7	79	59 8
5	64 2	87	84 5	78 5	88 8	59 5
6	74	88	75	79	88	73
7	66	73	75	71 3	77	63
8	64 5		78 8	71 6	82 9	63
9	71	85 2	74	76 7	86	66
10	69 5	88 2	77	78 2	90 3	69 5
11	73	87 5	79	79 8	88 6	71 5
12	63	71 5	67 8	67 4	78	58 5
13	58 5	74	73	68 5	77 3	53
14	62 2	79	76 5	72 5	80 6	60 5
15	62	81 9	80	74 6	85 5	61 5
16	53 6	57 6	55	55 4	71 6	53 5
17	45		52	47 5	57	44 5
18	38 5	63	64	55 1	66	37 5
19	57	58 8	69 4	58 7	61 6	55
20	62 5	74 5	71	69 3	77	60 5
21	52	62 2	61 5	60 2	70	51
22	51 5	68	63 5	61 6	70	48 6
23	55	72 7	65	64 2	75	54
24	56 5	72 5	63 5	64 1	76	51
25	71	87 5	83	80 5	88 8	70 5
26	70	75 9	66 5	70 8	80 5	65 5
27	58 5	60 5	58 7	59 2	64 5	58
28	56	65	67 5	62 8	69 5	55 2
29	59	61 5	57	59 1	66 2	55
30	50 5	62 8	63 1	58 8	63 1	44
Average	61 3	74 2	69 7	68 1		

AIR TEMPERATURES FOR SEPTEMBER, 1902

Date	6 a. m.	Noon	6 p. m.	Average
5	51°	71°		61°
13	43			
14	42			
21	60	80	72°	70.6
23	66			
28	60	64	60	61 3
Average	53 7	71 7	66	64.3

AIR TEMPERATURES FOR SEPTEMBER, 1903

Date	6 a. m.	Noon	6 p. m.	Average
21	55.5°		60°	57.7°
22	56	76°	64	65.3
23	59			
24	50			
25	46	70		58
26	60	78	60	66
27	46	50	46	47
28	44	65	59	56
29	56	70	65	60
30	60	71	68	66.3
Average	53.3	67.1	60.2	59.5

AIR TEMPERATURES FOR SEPTEMBER, 1906

Date	6 a. m.	Noon	6 p. m.	Average
1	51°	73°	71.5°	65.2°
2	71.1	71	66	69.4
3	62.5	70	65	65.8
4	59.5		73	66.3
5	56.2	75	68	66.4
6	62	79	70	70.3
7	63.9	80.9	73.9	72.9
8		80.5	72	76.3
9	69	81	75	75
10	63		67	65
11	65.5	88.1	74.9	76.2
12	66	90	69	71.7
13	67.5	68	69	68.2
14	51	58.6	63.1	57.6
15	52	69	59.8	60.3
16	61	77	70	69.3
17	63	83	74	73.3
18	66	83.5	82	77.2
19	70			
Average	62.2	76.7	70.2	69.3

AIR TEMPERATURES FOR SEPTEMBER, 1907

Date	6 a. m.	Noon	6 p. m.	Average
7			63°	
8	62°	69	69	66.7°
9	68	68	61	65.7
10	55	57	56.5	56.2
11	52	66	64	60.7
12	56.5	75	79.5	70.3
13	62	79	73	71.3
14	62	80		71
17	73	86	72	77
18	68	70	79	72.3
19	72	85	79	78.7
20	72	78	73	74.3
21	56.9	70	64	63.6
22	47	60	59	55.3
23	55		65	60
24	58	63	54	58.3
25	39	51	49	46.3
26	43	58	58	53
27	52	51	57	53.3
28	58	61	58	59
29	54	55	55	54.7
30	51		54	52.5
Average	58	67.5	63.9	62.9

AIR TEMPERATURES FOR SEPTEMBER, 1908

Date	6 a. m.	Noon	6 p. m.	Average
1	74°	75°		74.5°
2	63.5	70.5	60°	64.7
3	50	72	66.5	62.8
4	58.1	75	67	66.7
5	61		80	70.5
6	69	77	66	70.7
7	54	70	69.5	64.5
8	59			
9	62.5	79.5	80	74
10	65.5	82.8	78	75.4
11	64	88		76
12	69	83.5		76.8
13	68	83	77.9	76.3
14	65	78	75	72.7
15	67	73	75	71.7
16	60	78	79	72.3
17[1]	66	81	78	75
Average	63.3	77.8	73.2	71.5

[1] At 6 a. m. on the 28th the air was 47°, and the maximum for that day was 92°.

AIR TEMPERATURES FOR SEPTEMBER, 1913

Date	6 a. m.	Noon	6 p. m.	Average
1	....	95	....	
2	....	94	....	
3	....	93	81	87 0
4	65		79	72
5	64	76	79	73
6	67	86	87	80
7	73	87	76	78 7
8	69	76	71	72
9	53	73	68	64 7
10	51	75	74	66 7
11	58	81	69	69 3
12	60	67	62	63
13	49	65	63	59
14	50	69	64	61
15	49	65	63	59
16	63	69	70	67 3
17	67	67	62	65 3
18	55	65	60	60
19	51	71	67	63
20	62	54	49	55
21	44	49	43	52
22	39	49	47	45
23	39	60	62	53.7
24	56	78	70	68
25	55	76	72	67 7
26	50	52	53	51 7
27	41	60	60	53.7
28	48	66	60	58
29	61	70	67	66
30	59	73	63	65
Average	55 3	71	65 8	64 1

AVERAGE AIR TEMPERATURES FOR SEPTEMBER

Year	6 a. m.	Noon	6 p. m.	For the month
1899	58 0	67 9	63 5	63 1
1900	61.3	74.2	69.7	68 1
1902	53.7	71 7	66	64 3
1903	53 3	67.1	60 2	59 5
1906	62.2	76.7	70 2	69 3
1907	58	67 5	63 9	62 9
1908	63.3	77 8	73 2	71 5
1913	55.3	71	65 8	64 1
Average for eight years.	58.1	71 7	66 6	65 1

October

Sky:—The records are fairly complete for October in the years 1899, 1900, 1903 and 1913. We have also a fragmentary record for 1902 which is too incomplete to tabulate.

October is singularly blest with bright, sunny days, the clear periods having outnumbered the cloudy periods every year observations were taken, and in the sum total of our records exceeding the cloudy periods by nearly 50 per cent.

Winds:—It is also a month of calm, the number of calm periods generally exceeding that of any other month. October is made up largely of pleasant hazy Indian summer days. When the calms are broken it is usually by pleasant southeast or southerly winds, winds from the north, northeast, west and northwest being the least frequent.

Storms:—Storms are not frequent, and such rains as fall are usually gentle drizzles such as weight down the loosened leaves and bring them to earth. Fogs are common in low places, especially in the morning. There are few records of frost, probably on account of the fogs.

The following table gives the general weather features:

Year	Sky		Winds									Rains
	Clear	Cloudy	Calm	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	
1899	8	5	4	4	1	2	3	6	2	1	2	6
1900	46	32	27	1	6	10	19	10	3	2	5	9
1903	22	20	8	2	0	2	3	9	14	3	0	3

Temperatures:—The total number of temperature records for October is 507, as follows: 88 in 1899, 93 in 1900, 27 in 1902, 24 in 1903, 42 in 1904, 45 in 1906, 93 in 1907, 1 in 1908, 1 in 1912, and 93 in 1913.

The lowest temperature recorded was 28.5° on October 11, 1906; the highest was 84° on October 5, 1900.

The extremes for each year were as follows:

1899, 36° on October 1 and 82° on October 15; range 46°.
1900, 33.7° on October 17 and 85° on October 5; range 51.3°.
1902,[1] 33° on October 29 and 93° on October 26; range 60°.
1903,[2] 46° on October 10 and 80° on October 3; range 34°.
1904,[3] 30° on October 28 and 72° on October 18 and 19; range 42°.
1906, 28.5° on October 11 and 68° on October 17; range 39.5°.
1907, 33° on October 19 and 78° on October 2; range 45°.
1913, 30° on October 21 and 31 and 83° on October 10; range 53°.

[1] Records for only 11 days.
[2] Records for only 8 days.
[3] Records for only 14 days.

Freezing temperatures were recorded as follows: In 1899, 1900, 1903, and 1907, none; in 1904, October 27, 32° and October 28, 30°; in 1906, October 10, 28.9° and October 11, 28.5°; in 1913, October 21, 30°, October 22, 32°, and October 31, 30°.

The greatest daily range was as follows:

October 15, 1899, from 60.5° to 82°, or 21.5°.
October 4, 1900, from 62.5° to 84.5°, or 22°.
October 26, 1902,[1] from 63° to 93°, or 30°.
October 10, 1903,[2] from 46° to 64°, or 18°.
October 28, 1904,[3] from 30° to 51°, or 21°.
October 20, 1906[4] from 42° to 63.8°, or 21.8°.
October 19 and 22, 1907, from 33° and 40° respectively to 54° and 61° respectively, or 21°.
October 9, 1913, from 50° to 77°, or 27°.

AIR TEMPERATURES FOR OCTOBER, 1899

Date	6 a. m.	Noon	6 p. m.	Average
1	36°	53	54.5	47.8
2	49	60	59	56
3	50	71.5	66.5	62.6
4	50	65	59	58
5	48	61.6	56	55.2
6	45	62.5	58	55.1
7	47	61.5	55	54.5
8	44.5	55	53.2	50.6
9	42.5	64	63	56.5
10	58	75.2	63	65.4
11	59.5	61.5	63	61.3
12	60.5	69	67	65.5
13	64	72	77	71
14	65.5	75	69	69.8
15	60.5	82	76	72.8
16	64	78.8	60	67.6
17	50	52	52	51.3
18	44			
19				60
20				46
21				44
22	49	65		57
23	59	78	67	68
24	57	75	65	66
25	57	77	62	65.3
26	56	73	59	62.6
27	54		53	53.5
28	51		51	51
29	43	56	50	49.6
30	38	57	54	49.6
31	42	59	43.5	48.2
Average	51.6	66.4	59.8	58.1

[1] Records for only 11 days.
[2] Records for only 8 days.
[3] Records for only 14 days.
[4] Records for only 14 days.

AIR TEMPERATURES FOR OCTOBER, 1900

Date	6 a. m.	Noon	6 p. m.	Average	Maximum	Minimum
1	54.3°	67.0°	66.0°	62.4°	69.0°	53.6°
2	58.5	77	73	69.5	78.5	58.5
3	62.5	81.5	72.5	72.1	83	62.2
4	62.5	83.5	76.9	74.3	84.5	62.5
5	67	84	79.8	76.9	85	64.9
6	65	79.5	74	72.8	84.8	63
7	58	56.5	53.5	59.3	72.5	52.8
8	50.8	57.5	51.5	53.3	59.8	50.2
9	40.5	59.5	54	51.3	61	39.4
10	44	61.5	60.5	55.3	62.4	41.5
11	49	62	62	57.7	64.5	46.5
12	51.9	64	61.1	59	65	51.3
13	54.2	63.9	63.3	60.5	67.2	51.7
14	48.7	67.5	61.9	59.4	70.6	46.5
15	48.9	70.1	68	62.3	73.4	47.2
16	55.3	55	51.8	54	62	47.3
17	35	54.5	52.5	47.3	58.4	33.7
18	38.1	64	58	53.4	67.1	37.4
19	46.3	60	59.5	55.3	63	46
20	48	67	61.9	59	68.5	47.6
21	61.1	65.1	66.6	64.3	69.5	54.4
22	65.8	69.2	65.2	66.7	70	60.3
23	57.9	65.3	61.5	61.6	66.4	57
24	43.7	64.5	62.5	56.9	66.2	47.5
25	55.3	70	66.2	63.8	72.5	55.1
26	59.3	76.3	59.9	65.2	77.5	58.3
27	47.3	64	61.8	57.7	67.7	46.2
28	53.9	69.5	67	63.8	73.2	51.2
29	61.5	71.3	69.5	67.4	74.7	61.1
30	62.7	68	65	65.2	71.7	62.3
31	61	71.5	70.1	67.5	75	61
Average	53.8	67.4	63.8	61.5		

AIR TEMPERATURES FOR OCTOBER, 1902

Date	6 a. m.	Noon	6 p. m.	Average
16	48°			
19	53	65°	55°	57.6°
20	43	59	53	51.3
21	43	58	54	51.6
22	50	68	65	61
23	58	70	65	64.3
24	60	75	70	68.3
25	60	73	64	65
26	63	93	63	73
29	33			
31			55	
Average	51.1	70.1	60.4	61.6

AIR TEMPERATURES FOR OCTOBER, 1903

Date	6 a. m.	Noon	6 p. m.	Average
1	66°	74°	67	69
2	61	73	68	67.3
3	65	80	76	73.6
4	64	76	70	70
5	67	69	66	67.3
6	66	70	68	66
7	66	68	61	65
10	46	64	60	56.6
Average	62.6	71.7	67	67.1

AIR TEMPERATURES FOR OCTOBER, 1904

Date	6 a. m.	Noon	6 p. m.	Average
18	55°	72	66	64.3
19	53	72	66	63.6
20	50	50	47	49
21	43	47	43	44.3
22	39	46	40	41.6
23	33	50	44.6	42.5
24	46	57.5	52.5	52
25	40	43.5	42	41.8
26	37	50	43	43.3
27	32	42	40	38
28	30	51	48	43
29	38.2	60	53.9	50.7
30	40	53	50.5	47.8
31	37	58	53.9	49.6
Average	40.9	53.7	49.3	48

AIR TEMPERATURES FOR OCTOBER, 1906

Date	6 a. m.	Noon	6 p. m.	Average
5			51 0°	
9	39 0°			
10			28 5	
11	28 5	40 0°	33.5	34 0°
12	34 9	51 8	49.8	45.5
13	53	65	60 5	59 5
14	44	65	58	56.5
15	47 8	63 7	57 8	56.4
16	50	62	61.5	57 8
17	54	68	62 1	61 4
18	56	64 9	62 8	61 2
19	48 8	62 8	57 5	56.4
20	42	63 8	52	52.6
21	43	61	59	54.3
22	50	55	54 5	53.2
23	56 6	56	56.9	56.2
24	59	56	49	54.7
27	46	37 5	37	40 2
28	32 5	31 5	32	32
29	30 5	41	43.5	38 3
30	38 5	49 5	36	41.3
31	28	37 6	37 2	34.2
Average	44 2	54 3	49.5	49.8

[1]Minimum for the 11th, 28 5°.
[2]Minimum for the 17th, 44°.

AIR TEMPERATURES FOR OCTOBER, 1907

Date	6 a. m.	Noon	6 p. m.	Average
1	50	69	65	61 3
2	60	78	71	69 7
3	67	74	60	70
4	57	63	57	59
5	48	63	56	55 7
6	49	69	64	60 7
7	62	66	57	61 7
8	42	53	50	48 3
9	47	61	54	54
10	42	61	60	54 3
11	41	50	43	44 7
12	38	44	43	41 7
13	39	46	46	43 7
14	36	55	52	47 7
15	44	58	54	49 3
16	52	61	58	57
17	54	69	63	62 7
18	47	49	44	46 7
19	33	51	54	46
20	47	48	43	46
21	36	53	48	45 7
22	40	61	60	53 7
23	45	51	46	48 3
24	37	56	53	48 7
25	46	55	44	48 3
26	36	44	42	40 7
27	44	45	39	42 7
28	36	41	38	38 3
29	38	45	45	42 7
30	43	46	47	45
31	42	57	52	50
Average	45 1	56 2	52	51 1

AIR TEMPERATURES FOR OCTOBER, 1913

Date	6 a. m.	Noon	6 p. m.	Average
1	54°	66°	64°	61 3°
2	52	63	58	57 7
3	43	64	64	57
4	50	74	66	63 3
5	56	70	64	63 3
6	62	76	69	69
7	61	81	68	70
8	61	77	69	69
9	60	77	71	69 3
10	63	83	78	74 7
11	49	56	51	52
12	47	63	55	55
13	46	62	59	55 7
14	51	72	66	63
15	55	72	58	61 7
16	54	60	59	57 7
17	59	63	52	58
18	43	50	48	47
19	42	53	47	47 3
20	40	43	38	40 3
21	30	34	36	33 3
22	32	39	39	36 7
23	39	45	43	42 3
24	45	54	50	49 7
25	40	51	49	46 7
26	37	58	49	48
27	43	44	43	43 3
28	40	46	44	43 3
29	40	50	35	41 7
30	34	40	37	37
31	39	39	32	33 7
Average	47	58 9	53 6	53 2

AVERAGE AIR TEMPERATURES FOR OCTOBER

Year	6 a. m.	Noon	6 p. m.	For the month
1899	51 6°	66 4	59 8°	58 1°
1900	53 8	67 4	63 8	61 5
1902	51 1	70 1	60 4	61 6
1903	62 6	71 7	67	67 1
1904	40 9	53 7	49 3	48
1906	44 2	54 3	49 5	49 8
1907	45 1	56 2	52	51 1
1913	47	58 9	53 6	51 1
Average for eight years	49 5	62 3	56 9	56 3

NOVEMBER

Sky:—Unlike October, November is prevaiently a cloudy month, there being more cloudy periods than clear for every year for which we have a record, the cloudy periods for the entire time exceeding the clear by nearly 50 per cent.

Air:—Calm periods are still frequent, east winds are the least frequent, but the others are pretty well distributed.

Storms:—Storms, both rain and snow are common. It is usually a foggy month, the fogs generally being dissipated during the day but forming again during the night. Eleven fogs were observed during this month in 1900. Frosts are very frequent, 13 having been recorded for November in 1900. It is the month in which the pools first freeze over.

There are fairly full records for November for four years, which are given in the following table:

Year	Sky			Winds								Rains	Frosts	Snows	Snow-fall in inches	Fog
	Clear	Cloudy	Calm	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.					
1899	6	10	1	3	10	2	12	5	2	2	1					
1900	35	52	24	2	8	0	12	5	15	18	7	14	13	10	3	11
1902	3	6	0	2	2	0	2	3	2	1	1	5		2	5 5	
1904	28	43	16	14	1	1	5	11	6	5	6	9		7		5

Temperatures:—The total number of temperature records for November is 402, as follows:

Three in 1898, 90 in 1899, 90 in 1900, 52 in 1902, 90 in 1904, 3 in 1906, 3 in 1902, 1 in 1910, 3 in 1912, and 67 in 1913.

The lowest temperature recorded was 5° on November 26, 1898. The highest was 70° on November 1, 1900, and again on November 2, 1902, and November 20, 1913.

The extremes for each year were as follows:

1899, 30° on November 4 and 61° on November 17; range 31°.
1900, 15.9 on November 16 and 70° on November 1; range 54.1°.
1902,[1] 22° on November 28 and 70° on November 2; range 48°.
1904, 19° on November 27 and 64° on November 3; range 45°.
1913,[2] 20° on November 11 and 70° on November 20; range 50°.

Records of temperatures at or below freezing were made as follows: In 1898, at 6 a. m. November 24, 26 and 27 (the only rec-

[1] Records for only 17 days.
[2] Records for only 24 days.

ords for that month in 1898); in 1899, at 6 a.m. on November 4, 5, 12, 26, 27 and 28, none at noon or 6 p.m.; in 1900, at 6 a.m. on November 8, 12, 14, 15, 16, 23, 26, 27, 29 and 30, at noon on November 14, 15, 16 and 29, at 6 p.m. on November 8, 13, 14, 15, 28 and 29. In other words, there were 10 days in November, 1900, when the temperature fell to or below freezing. In 1902 it was below freezing at 6 a.m. on November 25, 27, 28, 29 and 30; at noon on no day, at 6 p.m. on November 29. In 1904 it was at or below freezing at 6 a.m. on November 6, 11, 12, 13, 15, 16, 26, 27, 28 and 30, at noon on November 26, 27, 29 and 30. There were, therefore, 10 days in November, 1904, when the temperature fell to or below freezing. In 1907, our only records are for November 18 and 27 when the temperature was 20° and 30° respectively, at 6 a.m. Our only record for 1910 is for 6 a.m. November 6, when it was 20°. In 1912 we have only 3 records, all taken at 6 a.m., viz., November 1, 37°, November 2, 25°, and November 3, 25°. In 1913, the temperature fell to or below freezing at 6 a.m. on November 1, 9, 10, 11, and 12; at noon on November 9; and at 6 p.m. on November 8, 9, and 11.

The greatest daily range was as follows:

November 9, 1899, from 40° to 59.5°, or 19.5°.
November 22, 1900, from 36° to 67°, or 31°.
November 28, 1902,[1] from 22° to 38°, or 16°.
November 18, 1904, from 34° to 64°, or 30°.
November 12, 1913,[2] from 32° to 52°, or 20°.

Air Temperatures for November, 1898

We have only three records for this month, viz.: November 24, 20°; 26th, 5°; 27th, 20°, all at 6 a.m.

[1] Records for only 17 days.
[2] Records for only 24 days.

AIR TEMPERATURES FOR NOVEMBER, 1899

Date	6 a. m.	Noon	6 p. m.	Average
1	40°	48.5°	44°	44.1
2	34	40	36	37
3	34	38	34	35.1
4	30	40	37	35.6
5	27	44.5	42	37.8
6	33	44	42	39.6
7	37	56	48	43.6
8	40	56	45	47
9	40	59.5	50	49.8
10	43	55	57.5	51.8
11	43	53	40	45.3
12	32	42	38	37.3
13	33	51	50	44.6
14	48	51	48	49
15	46	48	46	46.6
16	47	56	54	52.3
17	49	61	55	55
18	56	57	50	54.3
19	42	56	50	49.3
20	42	61	51	51.3
21	49	59	54	54
22	51	55	50	52
23	41	41	42	41.3
24	38	41	40	39
25	38	41	36	38.3
26	32	46	36	38
27	32	42	36	36.6
28	32	50	56	46
29	36	43	42	37.3
30	40	56	52.5	47.5
Average	39.5	49.7	45.4	44.6

AIR TEMPERATURES FOR NOVEMBER, 1900

Date	6 a. m.	Noon	6 p. m.	Average	Maximum	Minimum
1	51.8°	51.5°	50.0°	51.1°	70.0°	49.7°
2	37.2	55.1	52.3	48.2	56.8	36.5
3	37.9	60.5	53.4	50.6	61.3	36
4	45.3	64.1	58.9	56.1	66.3	44.8
5	38.8	57	51	48.9	58.2	37
6	33	48.5		40.8	52	32
7	36	47.5	42.5	42	49	31.7
8	29.6	34.5	30.8	31.6	37.5	29.2
9	32.2	38.1	37.6	35.9	41.4	27.8
10	33.5	34.9	36.8	35.1	36.8	27.9
11	33.9	39.6	36	36.5	41.8	33
12	28.2	42.8	41	37.3	45	28.2
13	37.3	39	27.8	34.7	45.7	26.8
14	16.5	28.6	27.5	24.2	30.2	16
15	27	30	27.5	28.2	32.5	16
16	19.5	31.5	34	28.3	34.5	15.9
17	34.1	42	48.5	41.5	49.1	30.3
18	32	52.3	55.5	53.3	56.1	42.1
19	55	57.5	57.7	56.7	60.5	55
20	59.4	67	61.2	62.5	64	55
21	42.6	38.4	37.2	39.4	62	35.5
22	41	63	61	55	67	36
23	29.5	38.5	40	36	43.2	28.6
24	38	38.5	37.5	38	40.1	36.5
25	33.8	33.5	32.7	33.3	35	32.1
26	28.3	40.1	34.8	34.4	42.1	26.9
27	28.3	44.3	46.8	39.8	49.9	26.1
28	32.5	35	31.1	32.9	39	31.3
29	29.1	30.3	29.1	29.5	31.5	27.8
30	27.3	44	42.9	38.1	47	24
Average	35.6	44.3	44.2	40.7		

AIR TEMPERATURES FOR NOVEMBER, 1902

Date	6 a. m.	Noon	6 p. m.	Average
1	56°	67°	61°	62°
2	66	70	65	67
4			57	
5	55			
7	38	50	42	43.3
10	40	52	48	46.6
11	60	67	62	63
12	60	69	60	63
13	61	70	64	65
14	63	68	56	62.3
15	45	48	45	46
16	45	45	44	44.6
21	60	68	61	63
24	48			
25	30	44		37
26	40	40	40	40
27	30	34	30	31.3
28	22	38	33	31
29	30	40	32	34
30	30	40		35
Average	46.3	53.5	50	49.1

AIR TEMPERATURES FOR NOVEMBER, 1904

Date	6 a. m.	Noon	6 p. m.	Average	Maximum	Minimum
1	40.0°	62.0°	57.0°	53.0°		
2	43	64	54	53.6		
3	43	64	56	54.3		
4	40.5	61	52	51.2		
5	41.9	48	42	43.9		
6	32	42	41	39		
7	35	52.2	49	45.4		
8	36	40.2	40.1	38.8		
9	36	40	40	38.6		
10	35.5	39	33	35.8		
11	27.8	40	35.9	31.2		21.5
12	25	40	36.2	33.7		23.5
13	30	38.4	34.9	34.4		27
14	34	39	36	36.3		33.2
15	29.9	48.8	42.6	39		29.2
16	31	52	45	42.6	56.5°	30.5
17	38.1	53	50.5	47.2	57	33.9
18	36	58	52	48.6	64	34
19	45	63.2	56	54.7	64	
20	51	45.5	42	46.2	57	42
21	30	49	43	40.6	50.1	
22	35.5	52	41	42.8	54	
23	38	55	48.5	47.2		
24	40	42	38	40	49	38
25	35	38	34	35.6	46	33
26	24	28.2	27	26.4	35	23
27	19	27	25	23.6	42	18.5
28	25	34	33.8	30.9	35.4	22
29	37		25	31		34
30	19.5	33	25	25.8		
Average	34.4	46.2	41.2	40.4		

AIR TEMPERATURES FOR NOVEMBER, 1906

Date	6 a. m.	Noon	6 p. m.	Average
1	31.5°	44.9°	41.8°	39.7°
2	32.1	48.6	46.1	42.2
3	42	53	41.6	45.5
4	40.5		43.9	42.2
5	38	61.1	49	49.3
6	39			
7	55			
8	42	54	51	49
9	46.5	46.5	39	44
10	34	44	37	38.3
11	36	39.9	34	36.6
12	29.5	35.1	29.2	31.2
13	28	32.5	32.5	29.5
14	27.9	41	36.9	35.2
15	30	40	35	35
16	32.5	42.5	46.5	34.4
17	50.5	46.5	43	46.6
18	43	42.1		42.5
19	31.5	36.5	35.5	34.5
20	34	33.9		33.9
21	41.5		30	35.8
23	34			
Average	37.2	43.7	39.2	39.2

Air Temperatures for November, 1909

Our only records for this month are: November 18, 20°, and November 27, 30°, both at 6 a. m. Maximum for November 27, 45°.

Air Temperatures for November, 1910

The only record for this month is that of 20° at 6 a. m. on the 6th.

Air Temperatures for November, 1912

There are only three records for this month, all at 6 a. m., viz., 37° on the first, 25° on the second, and 25° on the third.

AIR TEMPERATURES FOR NOVEMBER, 1913

Date	6 a. m.	Noon	6 p. m.	Average
1	25°	42°	.....	.....
8	.....	32	.....	.....
9	29	28	25°	27.3°
10	27	.....	.....	.....
11	20	34	32	28.7
12	32	52	52	45.3
13	55	56	46	52.3
14	42	45	45	44
15	38	37	36	37
16	38	43	40	40.3
17	42	52	53	49
18	54	60	62	58.7
19	60	64	62	62
20	65	70	60	65
21	59	65	67	63.7
22	58	69	65	64
23	40	44	43	42.3
24	34	38	40	37.3
25	33	45	48	42
26	42	46	49	45.7
27	45	46	48	46.3
28	48	56	60	54.7
29	54	60	58	57.3
30	57	60	58	58.3
Average.....	43.3	49.7	49.9	48.6

AVERAGE AIR TEMPERATURES FOR NOVEMBER

Year	6 a. m.	Noon	6 p. m.	For the month
1899	39.5°	49.7°	45.4°	44.6°
1900	35.6	44.3	42.2	40.7
1902	46.3	53.5	50	49.1
1904	34.4	46.2	41.2	40.4
1913	43.3	49.7	49.9	47.3
Average for five years..	39.8	48.7	45.7	44.5

DECEMBER

Sky:—We have an unusually full record for December, covering the month for 1899, 1900, 1902, 1904, 1913, and a good part of 1901.

December is generally a cloudy month, our observations for every year except 1899 showing more cloudy periods than clear, the excess of cloudy periods usually being considerable.

Winds:—Periods of calm are generally frequent, the weather being as a usual thing pretty well settled and steady. North winds are the least common, those from the southeast the most frequent.

Winds from other directions are common and pretty evenly distributed.

Storms:—Rainstorms are generally pretty frequent, but not so much so as snowstorms. We have a record of 2 sleet storms in 1904, and of several fogs.

The various elements of weather are exhibited in the following table:

Year	Sky		Wind									Rains	Rain-fall in inches	Snows	Snow-fall in inches	Fogs
	Clear	Cloudy	Calm	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.					
1899	19	11	1	1	1	3	11	1	8	8	6	4	.....	6	4	1
1900	28	63	24	0	6	4	13	5	13	10	10	5	....	9	1⅛	5
1901	12	17	0	1	1	0	4	4	6	4	7	3	3	4	1	.....
1902	8	19	0	0	3	1	4	3	12	1	3	6	.....	3	14	.....
1904	32	59	20	4	6	15	5	11	10	13	3	4	.....	11	....	.....
1913	17	19	...	...	1	...	...	...	...	...	1	3	.....	4	1	.....

Temperatures:—The total number of temperature records for December is 528, as follows: 4 in 1898, 93 in 1899, 83 in 1900, 72 in 1901, 88 in 1902, 93 in 1904, 2 in 1907, and 93 in 1913.

The lowest temperature recorded was –13° on December 19, 1901; the highest was 54° on December 18, 1901.

The extremes for each year were as follows:

1899, –1° on December 31 and 54° on December 8; range 55°.
1900, 10.4° on December 29, and 50.1° on December 22; range 39.7°.
1901,[1] –13° on December 19 and 54° on December 18; range 67°.
1902, 4° on December 9 and 47° on December 1; range 43°.
1904, 3° on December 29 and 55° on December 23; range 52°.
1913, 17° on December 7 and 62° on December 3; range 45°.

Records of temperatures at or below freezing are as follows: In 1898 at 6 a. m., December 7, 8, 9 and 14 (the only records made for that month in 1898). In 1899 at 6 a. m. on December 4, 5, 6, 8, 12, 13, 15, 16, 19, 20, 21, 22, 24, 25, 26, 27, 28, 29, 30 and 31; at noon on December 5, 12, 13, 14, 15, 16, 24, 25, 26, 27, 28, 29, 30 and 31; at 6 p. m. on December 3, 4, 5, 6, 12, 13, 14, 15, 16, 19, 20, 24, 25, 26, 27, 28, 29, 30 and 31. The temperature was at or below freezing at 6 a. m. on 21 days, at noon on 14 days, and at 6 p. m. on 19 days. In 1900 it was at or below freezing at 6 a. m. on December 2, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 19, 20, 21, 24, 28, 29, 30, and 31; at noon on December 9, 10, 11, 13, 14, 15, 16,

[1] Records for only 24 days.

24, 28, 29, and 31; at 6 p. m. on December 9, 10, 11, 13, 14, 15, 28, 29, and 31. Thus the temperature in December, 1900, was at or below freezing at 6 a. m. on 19 days, at noon on 11 days, and at 6 p. m. on 9 days. In 1901, observations began on the eighth and records at or below freezing were made at 6 a. m. on the 9th, 10th, 11th, 12th, 14th to 24th, both inclusive, and 28th and 31st, both inclusive; at noon on the 14th to 21st, both inclusive, and 29th and 31st; at 6 p. m. on the 9th to 12th, both inclusive, 13th to 23d, both inclusive, 25th, and 27th to 31st, both inclusive.

In 1902 freezing temperatures were recorded at 6 a. m. on the 1st, 2d, 4th, 6th to 9th, both inclusive; 12th to 19th, both inclusive; 23d, and 25th to 31st, both inclusive; at noon on the 4th, 7th to 9th, both inclusive; 11th to 14th, both inclusive; 16th, 17th, 18th, and 24th to 31st, both inclusive; at 6 p. m. on the 4th, 7th, 8th, 9th, 11th to 14th, both inclusive; 16th to 18th, both inclusive, and 24th to 31st, both inclusive. It will thus be noted that in this month the temperature was at or below freezing at 6 a. m. on 23 days, at noon on 19 days, and at 6 p. m. on 19 days. In 1904 freezing temperatures were recorded at 6 a. m. on the 1st to 22d, both inclusive; 24th, 25th, 26th, 28th, 29th and 30th; at noon on the 1st to 6th, both inclusive; 9th to 21st, both inclusive; 24th, 25th, 28th, 29th and 30th; at 6 p. m. on the 1st to 21st, both inclusive; 24th, 25th, 27th, 28th and 29th; from which it is seen that in December, 1904, the temperature was down to freezing at 6 a. m. on 28 days, at noon on 24 days, and at 6 p. m. on 26 days. In 1913, the temperature was at or below freezing at 6 a. m. on December 8, 15, 19, 20, 21, 22, 23, 27, 28, 29, 30 and 31; at noon on December 7, 29, 30 and 31; and at 6 p. m. on December 7, 8, 18, 21, 25, 26, 28, 29, 30 and 31.

The greatest daily range was as follows:

December 8, 1899, from 29° to 54°, or 25°.
December 12, 1900, from 14° to 35.3°, or 21.3°.
December 18, 1901, from –13° to 54°, or 67°.
December 9, 1902, from 4° to 23°, or 19°.
December 13, 1913, from 34° to 54°, or 20°.

Air Temperatures for December, 1898

For this month there are only 4 records of air temperatures, all at 6 a. m., viz.: 16° on the seventh, 5° on the eighth, 10° on the ninth, and 5° on the fourteenth.

AIR TEMPERATURES FOR DECEMBER, 1899

Date	6 a. m.	Noon	6 p. m.	Average
1	40°	46°	37.5°	41.1°
2	38.5	44	38	40.1
3	36	38	31	35
4	24	33	25	27.3
5	9	27	23	19.6
6	19	43	32	31.3
7	37	46	34	39
8	29	54	38	37
9	36	41	40	39
10	46	50	48	42
11	48	53	50	50.3
12	30	30	30	30
13	20	30	20	25
14	25	27.5	24	25.5
15	7	17.5	10	11.5
16	14	22	25	20.3
17	39	46	44	43
18	39	44	48	43.6
19	28.5	32.5	30	30.3
20	22	45	30	32.3
21	26	46	38	36.6
22	26	42	38	35.3
23	34	40	35	36.3
24	30	26	20	25.3
25	5	16	12	11
26	4.5	20	20	14.8
27	9	20	13	14
28	5	18	15	12.6
29	3	14	7	8
30	0	11	0	3.6
31	— 1	17	10	8.6
Average	23.5	33.5	27.9	28.2

AIR TEMPERATURES FOR DECEMBER, 1900

Date	6 a. m.	Noon	6 p. m.	Average	Maximum	Minimum
1	36.1°	39.7°	40 0°	38.6°	42 0°	34 1°
2	29.8	40	45.7	38.5	48.5	28
3	34.2	41	39.6	38 3	48 5	33
4	36.1	36	35.7	35.9	38.7	34.9
5	34.5	35.5	35	35.2	37	33.9
6	27.5	40	41.9	36.5	43.9	27
7	37.9	37.5	35.6	37	39.1	35
8	30.8	35.3	33.8	33.3	37.2	30
9	28.7	24.4	21.3	24.8	37.2	20.6
10	16	25.8	24.5	22.1	27.5	13
11	20.3	26	22.5	22.9	27.7	19.9
12	14	35.3	34.6	28	39.2	13.3
13	29.8	32	25.1	29	36.2	24
14	15.9	20	24	16.6	24.5	14.8
15	20.6	26	25.5	24	26.5	19.3
16	20.5	27.5	32.5	26.8	32.6	19.4
17	35	42.1	40.5	39.2	43	31
18	36.8	39.9	38.8	38.5	43.9	33.4
19	26.8	42	35.7	34.8	45	23.9
20	23.1	34.3	33	30.1	37.4	21.4
21	29.8	43.5	41.5	38.3	45.4	28
22	38.2	49	49	45.4	50.1	37.2
23	43.3	36.7	32.2	37.4	49.5	32
24	26.3	30.5	.....	28.4	32	26
28	28.6	28.1	22.2	26.3	33.8	13.4
29	11.1	30.1	25.8	22.3	30.8	10.4
30	29.3	33	32.5	31.6	33.9	20 9
31	30.5	31.5	20.8	27.6	34.5	19 4
Average	28.3	34.4	31.8	31.7	.....	.....

AIR TEMPERATURES FOR DECEMBER, 1901

Date	6 a. m.	Noon	6 p. m.	Average
8	40°	48°	36°	41 3°
9	30	34	28	30 6
10	26	34	24	28
11	27	40	32	33
12	28	46	38	36 6
13	48	54	32	44 6
14	7	0	— 7	0
15	—12	— 2	— 4	— 6
16	— 5	9	8	4
17	— 5	10	8	4 3
18	— 3	8	5	3 3
19[1]	— 9	8	8	2 3
20	— 8	0	— 5	— 4.3
21	— 8	13	10	5
22	18	35	31	28
23	31	36	32	33
24	32	38	35	35
25	34	37	32	34 3
26	33	36	34	34.3
27	33	36	32	33 6
28	30	34	32	32
29	30	31	29	30
30	28	34	32	31 3
31	27	32	27	28 6
Average.....	18 8	27.1	22	22.6

[1]—Minimum, —13°.

AIR TEMPERATURES FOR DECEMBER, 1902

Date	6 a. m.	Noon	6 p. m	Average
1	30°	47°	40°	39
2	30	40	41	37
3	40	40	38	39.3
4	28	30	30	29.3
6	29	34	39	34
7	23	19.5	18	20
8	7	18	12	23
9	4	23	25	17.3
10	35	37.5	35	35.8
11	34	32	30	32
12	28	28	27	27.6
13	22	22	23	22.3
14	12	26	28	22
15	28	38	36	34
16	32	28	26	28.6
17	20	32	29	27
18	22	32	32	28.6
19	32	41	38	37
20	37	41	39	39
21	38	40	37	38.3
22	37	38	35	36.6
23	30			
24	37	18	12	22.3
25	9	12	8	10.6
26	10	16	15	13.6
27	14	22	16	17.3
28	14	30	27	23.6
29	25	29	26	26.6
30	8	20	13	13.6
31	11	31	26	22.6
Average.....	24.2	29.8	27.6	27.5

AIR TEMPERATURES FOR DECEMBER, 1904

Date	6 a. m.	Noon	6 p. m.	Average	Maximum	Minimum
1	22°	32°	30°	28°	.....	.....
2	29	26	23	26	32°	9°
3	22	25.2	23	23.4	28	21
4	22	30	25	25.6	34	17.5
5	23	32	29	28	37.5	21.5
6	19	30.5	30	28.5	36	16.1
7	24	33	31	29.3	37	23
8	26	36	32	31.3	40	26
9	26.8	25	22	24.6	32	22
10	19	25	26	23.3	30	19
11	20.5	26	24	23.5	36	19
12	23	27.2	20.5	23.5	33.2	20
13	9	20	17	15.3	24.5	4.2
14	9	20	16	15	20	7.5
15	7	20	16	14.3	22	14.5
16	11	22	21	18	30	10
17	22	27.5	20	23.1	29.5	18.3
18	20.5	29.9	30	26.8	31.5	12
19	22	23	17	21.6	31	15.1
20	27	28	21	25.3	33	13.9
21	11.9	26	23	20.3	30	8
22	28	43	44	38.3	50	20.1
23	50	54	36	46 6	55	36
24	28	26	24	26	37.2	24
25	25	28	28	27	29	23.9
26	30	36	39.8	35.2	41	27.5
27	36	38	10	28	47	29
28	7.8	10	7	8.2	10	6
29	8	21	23	.....	30	3
30	17.6	25	41	37	42.9	23
31	34.3	36	48	41.3	50	35.2
Average	21.9	28 4	25.7	25.2	.....	.....

Air Temperatures for December, 1907

Only two records: December 7, 42°, and December 8, 52°, both at noon.

AIR TEMPERATURES FOR DECEMBER, 1913

Date	6 a. m.	Noon	6 p. m.	Range	Average
1	56°	57°	56°	1°	56.3°
2	53	58	57	5	56
3	56	62	60	6	59.3
4	45	50	42	8	45.7
5	35	45	43	10	41
6	42	50	47	8	46.3
7	34	22	17	17	24.3
8	27	38	26	12	30.3
9	35	40	37	5	37.3
10	35	45	35	10	38.3
11	35	46	39	11	40
12	39	50	48	11	45.7
13	34	54	41	20	43
14	36	52	40	16	42.7
15	30	40	38	10	36
16	38	46	36	10	40
17	38	40	37	3	38.3
18	36	42	31	11	36.3
19	26	43	34	17	34.3
20	32	38	34	6	34.7
21	28	38	30	10	32
22	22	33	36	14	30.3
23	32	36	35	4	34.3
24	36	39	36	3	37
25	33	36	31	5	33.3
26	34	37	30	7	33.7
27	30	33	35	5	32.7
28	28	34	30	6	30.7
29	30	31	30	1	30.3
30	30	30	29	1	29.7
31	29	31	32	3	30.7
Average.....	35.3	41.8	37.1	.....	38.1

AVERAGE AIR TEMPERATURES FOR DECEMBER

Year	6 a. m.	Noon	6 p. m.	For the month
1899	23.5°	33.5°	27.9°	28.2°
1900	28.3	34.4	31.8	31.7
1901	18.8	27.1	22	22.6
1902	24.2	29.8	27.6	27.5
1904	21.9	28.4	25.7	25.2
1913	35.3	41.8	37.1	38
Average for six years . .	25.4	32.5	28.7	28.8

THE WINDS

Introduction

Of the more obvious relations of the winds to the lake, little need be said. Their effect upon the lake surface is evident to every one. Their effect upon the plankton-scum, the calm days allowing the minute organizations to ascend to the surface and the more windy days keeping them churned up with the upper layers of the water, and the effect upon the temperature of the water of different depths—the calm days allowing the surface layers to heat gradually downward while the windy days mix up waters of different temperatures and break up definite stratification—are effects more keenly appreciated by students of these special problems. It is due to the winds, also, that we have more or less fine sand of a peculiar sort in the bottom, this having been blown in from the neighboring hills.

It is doubtless due to the winds that the lake owes the presence and peculiarities of its plankton, many of the organisms constituting the plankton being carried to the lake by winds, a fact which accounts for the worldwide distribution of some of the species.

In the matter of keeping records, no instruments were used, and the manner of recording the observations varied somewhat from time to time and with different observers. At the beginning of the work, and for some time after the practice of taking the temperatures of air and water three times a day had been established, only a general weather record for the day was made; such as, for a certain date, "northeast wind, changing to southeast, and rain" or "wind changing to north"; "clear"; "first pleasant day of spring, though snowing"; "has been cold with east wind all week," etc. Later on, although the general observations were continued, the habit was formed of observing and recording along with the temperature observations, the condition of the sky and the direction of the wind. In summing up results and arriving at conclusions, both the journal and the periodic observations have been consulted and taken into consideration. In the absence of instruments of precision which give in definite units the force and direction of the wind, the general method which gives in general terms the prevailing "atmosphere" of the day is about as good as any, and is certainly in any case indispensible in giving data for a just estimate of the weather. It has the defect of taking into consideration only the more remarkable and striking weather

phenomena, leaving the gentler or less obvious processes pass by unobserved. The method of periodical observations on the other hand is likely to present weather as a series of disconnected events, to ignore even important intervening phenomena, and to force into prominence unimportant and insignificant details.

Moreover, so far as minor weather events are concerned, the position of the observer in regard to the lake is of importance. In the sheltered location of the cottage just below Arlington, where many of the observations were made, it would be difficult to appreciate the force and keenness of west and northwest winds, though the position of elevated vanes would show well enough in which direction the wind was blowing; on the other hand, the slightest northeast, east, south or southeast wind would be immediately manifest. At Long Point, on the other hand, where many of the observations were taken, one was protected and kept from a full realization of the force of southeast and southerly winds. Even with instruments which gave unbiased records, a wind on the leeward side of the lake would give somewhat different effects than the same wind after it had passed to the windward side and had been tempered by the water surface; a dry wind taking up some moisture and a hot wind losing some of its heat.

As a basis for the wind record, where only the journal method was used, this has been of necessity the basis for calculation. Where three daily observations were made, these have been used for the basis, but have been so modified by the journal records that the number of records for each month is exceedingly variable; winds shown by the journal as having occurred between observation periods have been counted in, while on the other hand when the records show the same wind to have continued throughout several periods of observation the records have been fused into one count so that the number of observations for any one month is usually more or fewer than 93, generally fewer.

A prominent feature of Maxinkuckee weather is the frequent occurrence of light, fitful breezes that last for only a short time and die away, winds that do not belong to the general weather of the country but are purely local phenomena. That such should be the case could naturally be expected from the nature of the country, for we have closely juxtaposed on a small scale as high a "difference of potential", to use an electrical phrase, as could well be imagined: a lake of considerable depth and withal spring-fed, so that the mass of water does not heat up like shallow ponds, but remains comparatively cool, and, not a great way to the west,

barren stretches of wind-blown sand which on hot days overheat the layers of air above them just as the tendency of the lake is to keep the air above lower than the surrounding air.

Severe wind-storms, however, are rare, and tornadoes almost unknown. In the record of August 19, 1900, occurs the entry: "Warm this morning but a breeze came up about 2 p. m. from south, then changed to north and about 3 p. m. heavy rain came up from the north with strong wind, thunder and lightning, changing more or less to all points of the compass and continuing until about 7 p. m. Brilliant lightning in the south until late at night; lake the roughest I have seen it: steamers had difficulty making landings, excursionists got drenched, one small sailboat capsized—two boys—no damage. During p. m. temperature fell from 91.5° to 68.5°, a drop of 23°." Again in the journal record of September 11, 1900, occurs the note: "Cloudy; barometer fell rapidly during morning; strong southwest wind began about 9 a. m. and continued until 8 or 9 p. m. Severest wind known here for many years; several trees blown down; lake very rough, rain followed the wind at night." A pretty severe windstorm occurred early in the summer of 1908 and blew down the large ice-houses on the west side of the lake. This appears to have been an unusually strong wind; none of the dwelling houses in the immediate vicinity, however, was injured and the destruction of the ice-houses was due to their being empty at the time and offering much surface and little resistance to the wind.

On July 8, 1913, there was a very severe storm soon after noon from the northwest, a small tornado, lasting 30 minutes. It began as a severe windstorm, the wind being full of cutting sand. It did trifling damage to some buildings and a great deal to forests, the woodlands around the lake being strewn with fallen timber—many trees being uprooted, and many twisted off from 10 to 20 feet above the ground. The storm was accompanied by some rain, and by thunder and lightning, the lightning striking one or more trees on Long Point. A few miles north of the lake there was at the same time a severe hail-storm which cut the corn into ribbons.

On the other hand, though local calms are frequent, periods of widespread calm when the entire surface of the lake lies like an unruffled mirror, are rather rare; and pretty rough conditions when the lake is covered with white-caps and it is very unpleasant, though not especially dangerous, to be out on the lake with a rowboat, are not rare, particularly during the spring and autumn.

Character of various winds:—Everybody has pretty definite notions concerning the character of different winds, and associates the north and northwest winds with storm and cold; east winds with raw, disagreeable weather; south winds with balmy, pleasant weather, etc. An attempt was made by collecting data concerning each wind with the accompanying weather, to get more precisely at the character of each wind. The same associations were not found together nearly so uniformly as expected; it is only the general and long continued, persistent winds that have deep-seated influence on the weather. The light local surface winds are more or less characterless.

Calms:—These are generally associated with pleasant weather, although there are not infrequent instances where they are noted during cloudy and sprinkling or rainy weather. Calm may be associated with exceedingly cold weather, and in some cases the cold of calm fogs is rather depressing. Generally during the winter, calm weather is much to be preferred to wind from any direction whatever. In the hot, sultry days of midsummer, however, which are fortunately rather few, the calms are very oppressive, and light winds from almost any direction are welcomed as a relief.

During the summer the calms are usually associated with fine, hazy mornings. During the autumn and spring they are usually associated with low fogs on the marshes and certain parts of the lake and with heavy frosts. The heavy hoar-frosts which are at times such a striking feature of the region, in which the various trees are surrounded by a halo of long needle-like white crystals standing at right angles to the trunk and branches, are formed only during periods of almost perfect calm, and are quickly blown off by the first breeze that springs up. Calms are generally characteristic of the mornings and evenings of fine days during settled weather, and on only rather rare occasions do they persist throughout the entire day. It is rather unusual for the winds to die down to a calm during the middle of the day.

North winds are relatively infrequent at the lake. The lighter winds may be associated with either clear or cloudy sky. The stronger winds, especially in summer, are usually though not always accompanied by clouds, and frequently storms. During late autumn and winter and early spring, they are usually characterized as "raw, cold, and disagreeable," especially when accompanied by dampness, drizzle or rain.

Northeast winds:—Some of the lighter northeast winds, even as late as October and November, are recorded as warm and pleasant, and accompanied by bright, clear weather. These, however, are exceptional cases, and generally speaking, are among the most disagreeable winds at the lake. Northeast winds are usually raw, cold and disagreeable, and are noteworthy for their persistency, usually lasting from one to several days when well under way, and during the colder season often accompanied by cutting sleet. They often bring heavy snowstorms. In April and May they frequently bring disagreeable and persistent drizzles.

East winds are relatively infrequent at the lake and are almost always associated with cloudy skies, and during the winter are often accompanied by a heavy fall of snow. Most of those occurring during the summer are simply noted without any special characterization; those mentioned during winter records are usually noted as "cold, stormy, disagreeable." Winds from the southeast are among the most common about the lake; however, they rarely attain to the dignity of winds, and are almost always referred to in the notes as "breezes"—light, brisk or stiff, as the case may be, but very rarely winds. They are, indeed, the next thing to a calm, and, in the fairest and best sorts of weather, if it is not actually calm in the morning the calm is usually replaced by a light southeast breeze. They are usually characteristic of fine mornings. They are less frequent in the evening and not common at noon. Rarely they persist through the day. The stronger breezes or winds from the southeast may be accompanied by clouds or rains in summer or by snow in winter, but this is rather exceptional. Usually they are more pleasant than winds from any other direction. One noted December 18, 1900, is characterized as a "cold, penetrating raw wind" and one of March 12 is mentioned as having "become almost a gale, cold, raw and disagreeable"; but these are highly unusual cases.

South winds are much like southeast winds in character, but are not so common. They are generally gentle breezes and when they rise to the dignity of strong winds, are frequently accompanied by mild sprinkles or in extreme cases by thunder, lightning and heavy showers of rain. It is doubtless on account of the gentleness of the south and southeastern breezes that the great majority of the duckweeds of the lake find their harbor in that portion of the lake, only a few, being the progeny of individuals driven out at rare intervals by southern storms, finding harbor in other portions of the shore behind sheltering rushes.

Southwest winds:—The southwest wind from our point of observation was always a land wind, and the fact that it always came from stretches of solid earth, whispering through grasses, rustling through leaves, or roaring through trees, made it impossible to mete out to it the same measure of judgment as is given to the other winds above mentioned which came across stretches of water. It is frequently mentioned in the notes as noisy, or howling, and was associated with the moaning or roaring winds which presage the coming of winter. This, however, was merely accidental, and from the opposite side of the lake would apply with still greater

Cutter Drill, Culver Summer Naval School. Lake Maxinkuckee covers an area of 1,854 acres, which is ample for Naval drills, and yet small enough for safe supervision.

force to northwest winds. Disregarding the point of observation, however, southwest winds have certain pretty constant characteristics. They are generally a good deal stronger than those from the southeast or south, and in the notes taken at the time of observation are usually referred to as "winds" instead of breezes—light, brisk or strong, as the case may be. They are frequently associated with clouds and rain, often with heavy storms. They are not limited to any particular time of day but are liable to spring up at any time. They do not have the persistency of the northeast winds and usually do not last much more than a half day or day.

They are generally more prevalent during the colder seasons than during the summer, but even in the winter are not often referred to as being particularly raw, cold or disagreeable.

West winds:—These are relatively infrequent at the lake and are much more prevalent during the winter than in summer. They are usually moderately strong winds. They are not generally of great duration, though they occasionally last from 12 to 18 or 24 hours, and they are not especially associated with any particular time of day. They are often associated with clouds and storms, and in the winter, with snow. In cold weather they are often raw and searching.

Northwest winds are rather frequent at the lake and vary greatly in strength, sometimes being light breezes but more often rather brisk to strong winds. They are rather infrequent in the morning but usually spring up some time during the day. When strong winds they are usually markedly disagreeable and are often associated with clouds and rain or snow. In the winter they are cold and chilling but not so persistent and depressing as winds from the northeast.

Relative duration and frequency of winds:—The direction of the wind during the summer of 1899 was observed 223 times, morning, noon and night, as follows: Easterly 90, southerly 47, northerly 34, westerly 31, calm 21. During the summer of 1900 the result of 200 observations was as follows: Southerly 66, easterly 60, westerly 31, northerly 22, calm 21. During the summer of 1903 the result of 172 observations was as follows: Easterly 59, westerly 45, northerly 32, southerly 21, calm 15.

Summary of 595 observations during three summers, 1899, 1900 and 1903 as follows:

Easterly winds	209
Southerly winds	134
Westerly winds	107
Northerly winds	88
Calm	57
Total	595

Observations so far made show that the easterly winds prevail during the summer at Lake Maxinkuckee.

Winds for a year:—In order to get data for the winds of an entire year, the period extending from July 1, 1900, to June 30, 1901, was chosen, this being the period during which the fullest records were kept. The tables will explain themselves:

Month	Calms					North					Northeast					East					Southeast				
	Morning	Noon	Evening	All day	Total	Morning	Noon	Evening	All day	Total	Morning	Noon	Evening	All day	Total	Morning	Noon	Evening	All day	Total	Morning	Noon	Evening	All day	Total
July, 1900	0	1	3	1	5	2	0	2	0	4	2	0	0	0	2	3	1	1	0	5	6	3	1	3	13
August, 1900	2	1	1	3	7	0	0	4	2	6	3	0	1	1	5	2	0	0	2	4	1	0	0	0	1
September, 1900	1	1	1	3	6	0	0	1	1	2	2	1	0	0	3	2	0	0	0	2	4	0	0	1	5
October, 1900	3	1	7	9	20	0	0	0	0	0	1	2	2	1	6	3	2	3	1	9	7	3	2	3	15
November, 1900	6	1	6	10	23	0	1	1	0	2	1	3	0	2	5	0	0	0	0	0	4	3	3	0	10
December, 1900	4	1	5	5	15	0	0	0	1	1	2	0	1	1	4	1	2	1	0	4	8	2	3	2	15
January, 1901	6	0	3	7	16	0	1	0	0	1	2	1	1	0	4	1	1	1	0	3	4	6	3	0	13
February, 1901	10	2	6	6	24	0	0	0	0	0	0	1	1	1	3	2	1	1	2	6	2	4	1	0	7
March, 1901	7	3	1	4	15	3	1	1	0	5	3	3	3	0	9	0	0	0	2	2	2	3	3	0	8
April, 1901	7	3	6	4	20	0	3	1	0	4	4	7	7	4	22	2	0	1	3	6	4	1	1	3	9
May, 1901	7	2	5	2	16	2	3	3	0	8	5	5	5	6	21	0	2	0	0	2	4	1	1	3	9
June, 1901	7	2	11	0	20	0	1	0	0	1	5	3	3	1	12	2	2	1	0	5	4	4	6	2	16
Total	60	18	55	54	187	7	10	13	4	34	30	25	24	17	96	18	11	9	10	48	50	30	24	17	121

Month	South					Southwest					West					Northwest				
	Morning	Noon	Evening	All day	Total	Morning	Noon	Evening	All day	Total	Morning	Noon	Evening	All day	Total	Morning	Noon	Evening	All day	Total
July, 1900	5	0	5	6	16	3	4	3	0	10	2	1	0	0	3	0	3	0	0	3
August, 1900	4	0	0	6	10	2	1	0	0	3	1	0	0	0	1	2	1	2	0	5
September, 1900	1	1	2	2	6	3	2	3	1	9	2	2	0	0	4	2	0	1	0	3
October, 1900	1	4	1	4	10	0	1	1	0	2	1	1	0	0	2	2	1	0	2	5
November, 1900	1	2	0	3	6	8	4	1	1	14	5	6	3	1	15	2	5	2	0	9
December, 1900	1	3	1	0	5	3	4	5	1	13	3	3	3	1	10	3	8	4	1	16
January, 1901	5	4	3	0	12	4	3	8	0	15	2	1	9	2	14	4	6	4	1	15
February, 1901	1	1	0	0	2	6	5	2	0	13	1	4	3	2	10	4	4	7	2	17
March, 1901	2	1	6	3	12	7	7	4	4	22	1	1	1	1	4	2	1	6	3	12
April, 1901	1	0	0	0	1	0	1	0	0	1	0	0	0	0	0	5	5	5	1	16
May, 1901	0	0	0	0	0	0	2	1	0	3	1	0	0	0	1	3	1	4	2	10
June, 1901	1	1	1	0	3	7	6	3	1	17	0	1	1	0	2	3	5	5	0	13
Total	23	17	19	24	83	43	40	31	8	122	19	20	20	7	66	32	40	40	12	124

TABLE OF WINDS FROM JULY 1, 1900, TO JUNE 30, 1901

Month	Calms	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Total
July, 1900	5	4	2	5	13	16	10	3	3	61
August, 1900	7	6	5	4	1	10	3	1	5	42
September, 1900	6	2	3	2	5	6	9	4	3	40
October, 1900	20	0	6	9	15	10	2	2	5	69
November, 1900	23	2	5	0	10	6	14	15	9	84
December, 1900	15	1	4	4	15	5	13	10	16	83
January, 1901	16	1	4	3	13	12	15	14	15	93
February, 1901	24	0	3	6	7	2	13	10	17	82
March, 1901	15	5	9	2	8	12	22	4	12	89
April, 1901	20	4	22	6	9	1	1	0	16	79
May, 1901	16	8	21	2	9	0	3	1	10	70
June, 1901	20	1	12	5	16	3	17	2	13	89
Total	187	34	96	48	121	83	122	66	124	881
Per Cent	21.2	3.8	10.8	5.4	13.7	9.4	13.7	7.5	13.7	.....

RAIN

The number of rains observed from July 1, 1899, to September 15, 1909, is 277. This number is of little significance, however, as there are numerous gaps or periods during which the weather at the lake was not under observation.

Taking the year from July 1, 1900, to June 30, 1901, the year for which we have a complete set of observations, the following is the record of rains at the lake: July, 7; August, 5; September, 9; October, 5; November, 8; December, 3; January, 3; February, 0; March, 10; April, 10; May, 11; June, 9; total, 80. From this it appears that May is the most showery month, and February the least.

Of these rains, 40 are marked as "rains", 31 as "sprinkles", and 5 as "drizzles", the character of the 4 others not being designated.

Twenty are reported as occurring during the forenoon, 25 in the afternoon, and 25 during the night. The 10 others are continuations of other showers, or parts interrupted by brief periods of calm. None of the rains recorded for this year was continuous for 24 hours but each usually more or less fitful.

Among the especially heavy rains was one from the southwest on July 24, from 10 a.m. till noon, and again from 4 to 9 p.m., very hard from 5 to 6 p.m. and from 7 to 8 p.m. This storm raised the lake 2.5 inches. Outside of the particular year under discussion there is a record (Oct. 27, 1899,) of a continuous rain of "all day and all night, 36 hours, raised the lake 5 inches"; and another on Dec. 11, of the same year of a rain 24 hours.

There is another record of a severe thunder-storm on July 1,

1903, during which at least 3 inches of rain fell, raising the lake $8\frac{1}{4}$ inches.

In July of the same year there was a severe rainstorm with a total fall of fully 2 inches.

Again on August 27, 1903, there was a heavy fall of rain during the night which caused the lake to rise about $2\frac{1}{2}$ inches. Rain was abundant during this season so that the level of the lake was higher than usual. On May 11, it rained 5 inches in 12 hours and on January 22, 1906, it is recorded that it "has been raining for a week but that the lake is 18 inches below high water mark, although it has raised 3 inches."

We have few data in regard to the directions from which storms come. Of 35 records one storm is recorded as having occurred during calm weather, 5 storms came from the north, 1 from the northeast, 3 from the east, 6 from the southeast, 3 from the south, 10 from the southwest, 2 from the west, and 4 from the northwest.

The following is a table of the rainfall in inches at Logansport for the year 1902:

January	1.00	July	4.84
February	1.10	August	2.55
March	2.64	September	5.02
April	2.13	October	2.37
May	4.27	November	3.92
June	10.54	December	3.48

This makes a total of 43.86 inches of rainfall for the year.

As Logansport is only 32 miles distant from Lake Maxinkuckee the rainfall at the two places is probably approximately the same.

FROST

Economically considered, one of the most important questions concerning any particular region is the average date of the last killing frost of spring and the first of autumn. This question is of importance not only to the farmer and gardener but also to the lover of flower-beds and house-plants as well, and it has a direct and important bearing upon the aquatic life of a region such as Lake Maxinkuckee.

Taking the weather records for the whole period under observation, the number of frosts recorded is not many, there having been only 99 noted. This is largely due to the fact that it is only the first and last killing frosts that are of especial importance or interest to people in general, and also to the fact that a frost is not

an especially attention-arresting phenomenon like a rain or a thunder shower, and is likely to be overlooked, especially in the dead of winter in snowy weather.

In considering frosts, especially first and last frosts, it is necessary to distinguish between local and general frosts, or to be specific, as to locality; for there is a remarkable difference between closely neighboring areas in regard to susceptibility to frost. The low, flat, extensive peaty or mucky plains, and various sphagnous bogs, such as Hawk's marsh, usually have their early fall frosts from three weeks to a month before the upland, and quite possibly the tender, succulent herbage that they produce is much more susceptible to the effect of light frosts than the firmer growths of more solid soil. Certain plants such as cucumber vines, touch-me-not, fireweed, etc., often succumb and turn black at the touch of a frost so light as to escape ordinary observation. The upland, just about the lake, is especially favored by its freedom from killing frosts in late spring and early autumn, and peaches and other delicate orchard fruits, where planted and properly cared for, do exceedingly well.

The first autumnal frost noted about the lake in 1900 was on October 17; the first in 1901 was November 23, the first in 1902 was September 14. In 1904, the first record was October 23, but the lake had not been under observation for some time and there were quite certainly frosts much before this. In 1906, a frost was reported on August 28, but this was in the flat lowlands back from the lake. The lake was under constant observation at the time, and no frost, nor sign of any, was observed at the lake until Ocotber 29. In 1907, again when the lake was under constant observation, the first frost was reported for the region on September 25, but none was actually seen at the lake until October 10. The first frost in the fall of 1913 was noted on the morning of September 23, killing sweet potato vines and other delicate vegetation.

Of the late frosts of spring there are fewer records. In the spring of 1901, for which we have complete records, the last frost occurred April 20. In 1903 there is a record of a frost on May 2.

In the winter of 1900-1901, for which we have complete records, 39 frosts were observed; 1 for October; 7 for November; 11 for December; 7 for January; 3 for February; 3 for March, and 7 for April. Frosts were liable to occur any clear, calm night during the winter. In addition to the ordinary frost known everywhere, several modifications were common about the lake. Vapors arising from airholes in the ice were often congealed at the edge

of the airhole in the form of long plume-like or feathery objects. Indeed, on one occasion after Lost Lake had entirely frozen over, a dense steam arose from the surface of the ice and much of it congealed in the shape of long, feathery crystals.

Hoar-frost, which is frequent in all locations where there are large, exposed bodies of water such as near Lake Michigan and the Mississippi River, is of rather frequent occurrence at Lake Maxinkuckee and occasionally appears in great beauty, coating trees thickly and entirely with long, needle-shaped crystals almost an inch long. The rising sun melts the bases of the crystals first and the awakening morning breezes stirring among the bejewelled branches shake the frost crystals down in great multitudes, reducing the tree in a moment from one of the most magnificent spectacles to one quite commonplace, but producing for the moment a cataract of sparkling crystals as indescribably splendid as it is evanescent.

Frosts affect the life of the lake in various ways and through various channels. One of the first and very interesting effects is that of a decided change in the methods of the anglers. During late summer and early fall grasshoppers constitute the principal and most popular bait used by the anglers. As the season advances grasshoppers gain in popularity so long as readily obtainable. It is only when the first frosts have come and chilled the grasshoppers so that they can no longer be easily found that the anglers abandon their use and turn to other lures.

Then, again, the early frosts kill down the patches of delicate vegetation such as touch-me-nots, *Eleocharis interstincta*, etc., and affect the *Scirpus* and other aquatic plants that extend above the surface of the water thus killing or driving away the various insects that live upon or frequent such plants. The same frosts act in the same way on the marsh vegetation along the shore and the trees and shrubs which overhang the banks. The quantity of insect life living upon, in, or with this vegetation and which falls into the lake with the falling leaves or on account of the chill, or which is driven away every year, is enormous.

SNOW

Introduction

Our record of snowstorms, extending from March, 1899, to February 1, 1914, with important omissions for some years, makes mention of 194 snowstorms, varying in all degrees of intensity from

light flurries to blinding storms. The earliest snow recorded in any year was that of October 10, 1906, and the latest, at the ending of winter, was a light snow, sufficient, however, to whiten roofs, of May 4, 1907. The last snow of the winter of 1898-1899 was on March 31; the snowy period of the winter of 1899-1900 was from November 2 to April 12; that of 1900-1901 from November 7 to April 21. Records for the fall of 1901 are incomplete, the first snow recorded being on December 9, and the latest of the spring of 1902 on April 12. The first snow of the winter of 1902-3 was November 26, and the latest April 3. The record for the winter of 1904-1905 is incomplete; the earliest snow in the fall was on November 8, but there are no records for the following spring. For the autumn of 1905 an especially heavy snow occurred November 25. In the fall of 1906 a very heavy snow began October 10, and continued until 10 inches fell. This is the earliest and most noteworthy snowfall shown by our records. The latest snow in the spring of 1907, as already stated, was on May 4. The winter of 1906-1907 is, therefore, noteworthy in that it had both the earliest and the latest snowfall in the years covered by our records.

The first snow in the fall of 1913 came on the night of October 21; the next on the evening of October 29. It snowed again on November 8 and 10, a total of 12 inches falling, and drifting considerably, but all disappearing by the 18th. No more fell until December 7 when it snowed all day. On the 20th about one inch fell, and on the 22d there was snow and rain. On January 2, 1914, it snowed all day but melted as rapidly. Snow fell on the 3d and 4th and again all day on the 31st, when the first sleighing was possible.

Depth of snow:—Most of the snowstorms recorded were rather light flurries, with less than ½ inch of snowfall. Records of 1, 2, and 3 inches of snowfall are fairly frequent. There are 2 records of 4 inches each, one each of 5½, 6, and 7 inches, 2 of 10 inches, and one of the maximum snowfall of 18 inches, which was recorded for March 5 and 6, 1899.

Direction of snowstorms:—Record of the direction from which the heavier snowstorms came was kept. Of such a record for 33 storms, 5 came from the north, 7 from the northeast, 3 from the east, 2 from the southeast, 1 from the south, 5 from the southwest, 1 from the west and 9 from the northwest, thus showing the northwest to be the prevailing direction from which snows come, the northeast being a rather close second. The northeast storms hang on longer, and the snows they bring are generally sup-

posed to stay on longer, most likely because the snowstorms from that direction are more persistent and heavier.

Forms of snow:—One of the most common forms of snow at the lake is that of firm, white, little pellets like minute snowballs, a sort of form somewhat intermediate between genuine snow and sleet, and coming down with considerable force and directness; this may harden at times into genuine icy cutting sleet. This pellet snow contains more water and less enmeshed air than the feathery flakes, and it packs more tightly, an inch of it being equivalent to 2 or 3 inches of the lighter snow. The feathery flakes are common, especially in little snow flurries. The loose flakes, sometimes adhering in large masses, are the common forms in the great snowstorms which result in the deeper snows.

The following is the record of the snows for the winter of 1900-1901, the year for which there is a complete set of observations. The first snow of the winter, as given above, was on the night of November 7, when a rain, which began at 8 o'clock in the evening, changed into snow. It snowed the next night nearly all night giving a total snowfall of 3 inches. From this time on, snowstorms were of frequent occurrence, there being 11 in November, 9 in December, 16 in January, 13 in February, 11 in March and 2 in April. The last well-marked storm, that of April, was unusually unseasonable; the hazel and many other plants were fully in bloom, and the tender verdure of spring, just beginning to put forth, was covered $\frac{3}{4}$ of an inch with fluffy, sticky snow. No harm to vegetation was caused, however, as the weather was fairly warm and the snow soon melted off. The early snow of October 10, 1906, was still more unseasonable and striking in its effects, though not so much damage resulted as would have been the result of a single light frost. It had snowed heavily during the night and continued until 10 a. m., part of the time the snow coming down in remarkably large masses composed of adhering flakes. It took the birds entirely by surprise. A flock of tree swallows twittered musically from the snowclad telephone wires, and crickets were chirping underneath the snow. The houseflies, which were still present in considerable abundance out of doors, settled thickly on the window screens of the hotel, and the yellow-rumped warblers, then migrating, alighted on the screens and ate the flies. At one time there were 3 of the warblers on a window screen at the same time. About all the unoccupied cottages around the lake these warblers took refuge on the porches underneath the roof as if semi-domesticated. The golden-crowned kinglets, like the warblers, took refuge

in porches, and late dragon-flies flew about over the snow. The evening of the day closed in dark and snowy, and it snowed pretty hard all night, leaving 10 inches of snow on a level on undisturbed places. The snow settled thickly on the leaves of poplar trees, which were still green, and the weight in many instances broke off the boughs.

Relation of snow to the lake:—During the parts of early winter before the ground is covered with snow, a considerable amount of sand from the dry, barren sand hills about the lake is driven on to the ice and subsequently finds its way to the lake bottom. A covering of snow over the surrounding country of course puts a stop to this process.

A still more marked effect is that produced by a thick blanket of snow upon the ice of the lake. Among the most striking of the phenomena of the ice is its expanding and contracting on the clear, warm days and cold nights of winter; great cracks opening in certain places by the contracting of the ice, and the ice being heaved up in others, because of the expansion, until it forms high rooflike ridges. All these movements are accompanied by sharp cracking and booming like the firing of distant cannon. These movements are the cause of the shoving up of the ice-beach, and are said to have been quite striking during the winter of 1899-1900. They were well under way during the winter of 1900-1901 when a heavy blanket of snow covered the ice, the great weight of the snow weighing heavily on the ice, and by protecting it from alternate contractions and expansions, put a stop to its movements.

FOG

General fogs are rather uncommon about the lake; they are very local in their nature and are confined to certain localities for the greater part. The dry, sandy soil, so common in the higher ground, warms up readily during the day and is unfavorable to the formation of fog. On the other hand, the extensive level, peaty tracts lying in the country west of the lake are especially favorable to the formation of fogs; so are Green's marsh and the marsh at the north end of Lost Lake, Inlet marsh, and the region along the outlet. Lost Lake, which warms up more readily on account of its shallowness, and also cools more readily at night, is more favorable to the formation of fogs than Lake Maxinkuckee, and when small, local fogs are formed on the lake they are usually formed over stretches of shallow water, such as Aubeenaubee or Outlet bay. The fogs of the flat, peaty plains are generally very chilly and de-

pressing. How many fogs one would record in any given length of time would depend much upon the point of observation. Those herein recorded were observed from Long Point, and of these many were seen at a greater or less distance. Fogs are almost or entirely absent during the summer, most common through the autumn and spring months and in early winter. One of the conditions necessary for their formation is a calm or very little movement of air, as winds blow forming fogs away. During the year between July 1, 1900, and June 30, 1901, twenty-nine fogs were observed, distributed according to months as follows: July, 0; August, 1; September, 2; October, 8; November, 3; December, 5; January, 1; February, 0; March, 4; April, 1; May, 4; June, 0. From October, 1899, to August, 1906, a period in which there are considerable gaps in observation, there is a total record of 59 fogs.

The appearance and behavior of the fogs vary somewhat. Usually they are low, heavy blankets of uniform density covering limited areas, the form in which fogs are generally known, but sometimes on the lake they assume the form of tall, vertical columns which glide over the water in a peculiar, ghostly fashion. Usually the fogs form in the evening or some time during the night, and remain until morning, imperceptibly dissipating in the heat of the morning sun. Sometimes they condense on sticks, grass and other objects, or uniting to form drops, fall to the earth as a sort of rain. On December 3, 1900, a fog was noted rising from the lake, passing gradually into the far-off sky and assuming the form of immense and imposing thunderheads, the passage from fog to cloud being complete. This transition from fog to cloud was subsequently frequently seen on the upper Cumberland but never on so magnificent a scale.

Among the most noteworthy fogs observed about the lake may be mentioned the following:

Some time in December, 1896, when a thin ice extended out a considerable distance from shore, there appeared an extremely dense fog on the lake which, according to Mr. S. S. Chadwick, was the heaviest fog he has ever seen here. A large flock of wild geese was on the lake and were unable to leave on account of the fog. A party went out after the geese and, becoming bewildered in the fog, had great difficulty finding a place to land.

On October 18, 1900, a heavy fog set in about 8 o'clock and continued until about 10 the next day. A steamer got lost on the lake and did not get in until 2 or 3 o'clock the next morning.

DEW

As might be expected dews are so frequent in the mornings of the warmer portion of the year that their absence rather than their presence is generally commented upon. Yet the dews of the uplands immediately about the lake are not drenching and quickly dry up in the mornings so that one can walk about without getting wet almost any morning after 8 or 9 o'clock. The dews of the mucky or peaty lowlands are much heavier and more persistent.

It may be worth while to remark here that much that is generally taken for dew, such as the sparkling drops at the tips of spears of grass, is not condensed vapor, but water of transpiration which has passed through plants and has not evaporated from the leaves as it exuded. This might be termed organic dew, and is particularly noticeable on the leaves of strawberries, muskmelons, etc., where it is found in prominent drops at the water-pores of the leaves. This "dew" is always abundant at times when evaporation is checked in the atmosphere surrounding rapidly growing plants.

Dew proper is common on all calm nights during the summer. The dews first become noticeable about the end of April and continue until freezing weather. When fogs appear on the land they usually leave a good deal of moisture on the herbage.

WATER TEMPERATURES

Temperature of the surface of the lake:—Considerable time and attention were devoted to a study of the temperature of the lake water. Regular observations regarding the temperature of the water at the lake surface were begun July 5, 1899, and continued daily, practically without interruption, to July 1, 1901. An observation station was established at the pier in front of the cottage now known as Shady Point, on the west side of the lake at the base of Long Point, and at that time occupied by the Fish Commission party. A copper-jacketed Wilder protected thermometer was used. Observations were made and temperatures recorded three times daily—at 6 a. m., noon, and 6 p. m. In getting temperatures, the thermometer was placed in water to a depth of a foot to 18 inches. When there was ice a hole was cut, through which the thermometer was lowered into the water beneath.

From July 5 to October 19, the observations were made and recorded by a member of the Fish Commission party. From October 19, 1899, to June 25, 1900, the readings were taken and

recorded by Mr. S. S. Chadwick. Up to April 5, 1900, the temperatures were taken at the Chadwick houseboat on the east side of Long Point; after April 5 they were taken on the north end of Long Point in the south side of Outlet Bay, but sometimes at the wagon bridge across the Outlet. From June 25, 1900, to June 30, 1901, the temperatures were again taken at the pier in front of the Shady Point cottage, and usually by Mr. Clark.

Besides these regular observations, a large number of miscellaneous records were made; a few in November and December, 1898, and at various odd times since 1901, by Mr. Chadwick; and a large number by the present writers during the various times when one or both of them have been at the lake since 1901. And many more were taken in various places in the lake during the regular investigations of 1899-1901.

In addition to the surface temperature observations at the regular station, many other records were made in various parts of the lake, particularly in connection with the seining and other collecting operations, and in connection with the serial temperature work. Surface temperatures were also taken as a part of the plankton studies. Since July 1, 1901, surface temperatures have been recorded at intervals by Mr. Chadwick, also by Dr. Scovell, and by the present writers when any of them happened to be at the lake. The total number of water surface temperature readings taken and recorded exceeds 10,000. Most of these are given in the tables on pages 160 to 215.

It was felt that the large amount of attention given to temperature observations was justified because of the very intimate relation which the temperature of the water bears to aquatic animal and plant life.

It was desired to learn the relation between temperature and the feeding, breeding, and other habits, and the distribution of the different species of fishes, turtles and other animals in the lake, also of the various species of aquatic plants. It is believed that a number of interesting and important correlations have been established.

The details of the records may now be considered.

For the month of January, there are 5 records for 1899, 93 for 1900, 93 for 1901, and 12 for 1905.

As might be expected, there is but slight variation in January in the temperature of the water at the surface of the lake. The temperature of the air is at, below, or near, freezing during most of the days of the month, and, as the water-surface temperature,

until it reaches the freezing point, varies directly with that of the air, the water temperature will usually be close to freezing.

In January, 1899, only 5 records were made (on the 1st, 8th, 29th, 30th, and 31st), all of which were 32°. These were all taken through the ice. In 1900, the variation was from 32° to 38° at 6 a. m., from 32° to 40° at noon, and from 32° to 39° at 6 p. m. The lowest daily average was 32°, the highest was 39°, and the average for the month was 33.8°, the average for the air for the same period being 28.6°.

In 1901, the variation was from 33° to 39.5° at 6 a. m., from 34° to 41° at noon, and from 33.5° to 40.6° at 6 p. m. The lowest daily average was 33.7°, the highest was 42°, and the average for the month was 36°, the average for the air for the same period being 27.9°.

In 1905, records were made only on the first 4 days of January. The variation was from 32° to 34° at 6 a. m., from 32° to 34.9° at noon, and from 32° to 34.8° at 6 p. m. The lowest daily average was 32°, the highest was 34.3°, and the average for the 4 days was 33.8°.

Any discussion or interpretation of these January water temperatures is difficult. Any consideration given them must be in connection with the air temperatures. The observations in 1899 and 1900 were before the regular beginning of our work and were made by a volunteer observer whose records must be regarded as only approximately accurate. On all the days (9 in number) covered by records in January of those two years, the air was at or below freezing, and on most of the days the water temperature was taken through the ice. This will account for the large number of records of 32° or slightly above. In January, 1901, the air was at or below freezing on 24 days. The water temperatures were taken perhaps with somewhat greater care. It is interesting and significant to note, however, the close approximation of the averages for the Januarys of the 2 years, 33.8° in 1900 and 36° in 1901.

Notwithstanding the almost freezing temperature of the water near shore in January and other winter months, it was interesting to observe that various species of small fishes such as grayback minnows, straw-colored minnows, and skipjacks, gathered up in large schools under the ice in shallow water, particularly on bright sunny days. This phenomenon is considered more fully elsewhere.

In February, 1899, only 7 records were made, on the 1st, 2d, 7th, 10th, 13th, 15th and 27th, on each of which dates the air was

below freezing. All these were 32° except that on the 27th when it was 36°. In 1900, the record is complete for the month. The variation was from 32° to 35° at 6 a. m., 32° to 34° at noon, and 32° to 34.5° at 6 p. m., the lowest daily average for the air during the same period being 22.6°.

In 1901, the record is also complete for the month. The variation was from 32.5° to 35.5° at 6 a. m., from 32° to 34.5° at noon, and from 32.9° to 34° at 6 p. m. The lowest daily average was 32.5°, the highest 34.3°, and the average for the month was 33.1°, that of the air for the same period being 19.3°.

For March, 1899, the only record is for the 11th when the water was 33.5°. In 1900, the record is complete. The variation was from 33° to 37° at 6 a. m., from 33° to 37.5° at noon, and from 33° to 38.5° at 6 p. m. The lowest daily average was 33.1° on the 17th, the highest 37.5° on the 31st, and the average for the month was 35.4°, that for the air in the same period being 30.1°. The record for March, 1901, is complete. The variation was from 32.3° to 39.8° at 6 a. m., from 33° to 49° at noon, and from 32.9° to 43.4° at 6 p. m. The lowest daily average was 33° on the 1st and 3d, the highest 42.4° on the 29th, and the average for the month was 36.4°, that for the air in the same period being exactly the same, 36.4°. The average for March of the 2 years was 35.9°, that of the air 33.25°.

For the month of April, the record is complete for 1900 and 1901. In 1900, the variation was from 39° to 67° at 6 a. m., from 44° to 67° at noon, and from 45° to 67.5° at 6 p. m. The lowest daily average was 42.6° on the 1st, the highest 67.1° on the 30th, and the average for the month was 49.8°, that for the air in the same period being 52.3°. In 1901, the variation was from 36° to 60.1° at 6 a. m., from 38.5° to 65.5° at noon, and from 39° to 69.8° at 6 p. m. The lowest daily average was 38.6°, the highest 64°, and the average for the month was 47.9°, that for the air in the same period 48.9°. The average for April of the 2 years was 48.8°, that for the air, 50.6°.

For the month of May, the record is approximately complete for 1900 and 1901. In 1900, the variation was from 56° to 72.5° at 6 a. m., from 57° to 74° at noon, and from 57° to 71° at 6 p. m. The lowest daily average was 57° on the 10th, the highest 73.3° on the 30th, and the average for the month was 64.74°, that for the air being 66°. In 1901, the variation was from 51.9° to 66° at 6 a. m., from 50.5° to 70.1° at noon, and from 51.1° to 68° at 6 p. m. The lowest daily average was 52.8°, on the 2d, the highest

68.4°, on the 18th, and the average for the month was 60.93°, that for the air being 61°.

For the month of June, the record is complete for 1900 and 1901. In 1900 the variation was from 70° to 78° at 6 a. m., from 71° to 78° at noon, and from 71° to 78° at 6 p. m. The lowest daily average was 71° on the 4th, the highest 77° on the 26th and 28th, and the average for the month was 74.6°, that for the air being 71°. In 1901, the variation was from 58° to 79.2° at 6 a. m., from 64.5° to 86.2° at noon, and from 62.9° to 84.6° at 6 p. m. The lowest daily average was 61.8°, on the 1st, the highest 83.2° on the 28th, and the average for the month was 74.11°, that for the air being 75.7°.

For the month of July, there are complete records for 1899, 1900, and 1903, and partial records for 1906.

In 1899, the variation was from 70° to 79° at 6 a. m., from 75° to 88.5° at noon, and from 73.5° to 85.5° at 6 p. m. The lowest daily average was 74.1° on the 9th and 10th, the highest 84.2° on the 23d, and the average for the month was 78.2°, that for the air being 75.6°.

In 1900, the variation was from 71° to 80° at 6 a. m., from 72° to 83° at noon, and from 75° to 82° at 6 p. m. The lowest daily average was 74.6° on the 1st, the highest 80.3° on the 5th, and the average for the month was 78.4°, that for the air being 75.9°.

In 1903, the variation was from 71° to 81.5° at 6 a. m., from 73° to 87° at noon, and from 71° to 87.5° at 6 p. m. The lowest daily average was 73.1° on the 1st and 2d, the highest 83.3° on the 9th and 11th, and the average for the month was 77.86°, that for the air being 75.9°.

The records for July, 1906, cover only the last 7 days of the month. The variation was from 62.5° to 75° at 6 a. m., from 72.5° to 82° at noon, and from 73° to 83.3° at 6 p. m. The lowest daily average was 67.5° on the 25th, the highest 74.5° on the 26th, and the average for 6 days 74.3°, that for the air being 76.9°.

For the month of August, the records are nearly complete for 1899, 1900, 1903, and 1906.

In 1899, the variation was from 67° to 77.5° at 6 a. m., from 77° to 84.5° at noon, and from 75° to 84.5° at 6 p. m. The lowest daily average was 74.5° on the 9th and 15th, the highest was 82° on the 27th, and the average for the month was 78.4°, that for the air being 75.1°. In 1900, the variation was from 74° to 79.4° at 6 a. m., from 72.1° to 83.6° at noon, and from 78° to 83.6° at 6

p. m. The lowest daily average was 75.4° on the 15th, the highest 81.7° on the 22d, and the average for the month was 79.7°, that for the air being 77.5°. In 1903, the variation was from 68° to 77.1° at 6 a. m., from 71° to 78.5° at noon, and from 70.5° to 78° at 6 p. m. The lowest daily average was 70° on the 15th, the highest 76° on the 5th, and the average for the month was 73.8°, that for the air being 70.7°. In 1906, the variation was from 67° to 76.4° at 6 a. m., from 71° to 85° at noon, and from 72° to 84.5° at 6 p. m. The lowest daily average was 72.5° on the 30th, the highest was 81.3° on the 26th, and the average for the month was 76.2°, that for the air being 74.9°.

There are 14 records for the last 5 days of August, 1908. The variation was from 65° to 72.9° at 6 a. m., from 70.5° to 81° at noon, and from 73.5° to 80° at 6 p. m. The lowest daily average was 69° on the 27th, the highest was 77° on the 30th, and the average for the 5 days was 73.2°, that for the air being 75.8°.

For the month of September, the records are practically complete for 1899 and 1900, and there are partial records for 1906, 1907, 1908, and 1913. In 1899, the variation was from 54.8° to 80° at 6 a. m., from 60° to 84.2° at noon, and from 56° to 81.2° at 6 p. m. The lowest daily average was 56.9° on the 30th, the highest was 81.3° on the 3d, and the average for the month was 68.1°, that for the air being 63.1°. In 1900, the variation was from 59.3° to 77.5° at 6 a. m., from 65.5° to 83° at noon, and from 66.5° to 81° at 6 p. m. The lowest daily average was 65.6° on the 28th, the highest was 80.5° on the 1st, and the average for the month was 72.4°, that for the air being 68.1°. For September, 1906, the record is nearly complete for the first 18 days. The variation was from 60° to 76° at 6 a. m., from 67° to 80° at noon, and from 67° to 80° at 6 p. m. The lowest daily average was 65.1° on the 14th, the highest was 75.1° on the 11th, and the average for the 18 days was 71.2°, that for the air being 69.3°. For September, 1907, the record is partial for the 13th, 14th, 23d, and 30th, and complete for the 19th to 29th both inclusive. The variation was from 57° to 70° at 6 a. m., from 60° to 71° at noon, and from 59° to 73° at 6 p. m. The lowest daily average was 59.7° on the 29th, the highest was 72.2° on the 19th, and the average for all the records was 64.5°, that for the air being 62.9°. For September, 1908, the record is practically complete for the first 17 days. The variation was from 61.5° to 75° at 6 a. m., from 72° to 81° at noon, and from 70° to 78° at 6 p. m. The lowest daily average was 67.8°, on the 3d and 7th, the highest was 76° on the 12th, and

the average for the month was 72.2°, that for the air being 71.5°. For 1913, there is only one record, which is 62° at 6 a. m. on the 13th.

For October, there are nearly complete records for 1899, 1900, 1907 and 1913, and partial records for 1904 and 1906. In 1899, the variation was from 48.5° to 60.5° at 6 a. m., from 58° to 70.5° at noon, and from 55° to 65° at 6 p. m. The lowest daily average was 53° on the 21st, the highest was 65.3° on the 15th, and the average for the month was 59.5°, that for the air being 58.1°.

In 1900, the variation was from 54° to 69.8° at 6 a. m., from 62° to 73.5° at noon, and from 60° to 71° at 6 p. m. The lowest daily average was 59.3° on the 20th, the highest was 71° on the 6th, and the average for the month was 64.4°, that of the air being 61.5°.

For 1904, there are records only for the last three days of the month, when the morning range was from 47.9° to 50.2°, the noon range from 53° to 58°, and the evening range from 52.8° to 53.5°; the lowest daily average was 50.5° on the 29th, the highest 53.6° on the 31st, and the average for the 3 days 52.5°, the average for the air being 48°. For 1906, there is one record for the 5th (57° at 6 p. m.), one for the 10th (47° at 6 p. m.), and nearly complete records for the 11th to 24th both inclusive. The variation was from 44.5° to 59° at 6 a. m., from 52° to 65° at noon, and from 49.5° to 62.5° at 6 p. m. The lowest daily average was 43.3° on the 28th, the highest was 62° on the 19th, and the average for the 14 days was 53°, that of the air being 49.8°. For 1907, the variation was from 43° to 63° at 6 a. m., from 45° to 65° at noon, and from 46° to 65° at 6 p. m. The lowest daily average was 49° on the 27th and 30th, the highest was 64.3° on the 4th, and the average for the month was 54.8°, that of the air being 51.1°. In 1913, the variation was from 43° to 65° at 6 a. m., from 45° to 70° at noon, and from 44° to 68° at 6 p. m. The lowest daily average was 44.7 on the 31st, the highest was 67.3° on the 9th. The average for the month was 54.9° at 6 a. m., 58.2° at noon, 57.6° at 6 p. m., or 56.7° daily average, that of the air being 53.2°.

For November, there are 3 records for 1898 (40° on the 24th, 35° on the 26th, and 34° on the 27th, all at 6 a. m.), nearly complete records for 1899, 1900, and 1904, and 3 for 1906 (43.5°, 44.5°, and 43.5° on the 16th). In 1899, the variation was from 42° to 54° at 6 a. m., from 42° to 56° at noon, and from 43° to 52° at 6 p. m. The lowest daily average was 43° on the 29th, the highest was 55° on the 1st, and the average for the month was 47.6°,

that for the air being 44.6°. In 1900, the variation was from 32.9° to 59.8° at 6 a. m., from 39.6° to 63.8° at noon, and from 39.3° to 60.5° at 6 p. m. The lowest daily average was 38.7° on the 30th, the highest was 62.6° on the 3d, and the average for the month was 47.6°, that of the air being 40.7°. In 1904, the variation was from 37.5° to 51.5° at 6 a. m., from 38.5° to 53.9° at noon, and from 38° to 53° at 6 p. m. The lowest daily average was 38.5° on the 27th, the highest was 53° on the 4th, and the average for the month was 45.4°, that of the air being 40.4°.

In 1906, the variation was from 35.5° to 53.5° at 6 a. m., from 37° to 53.2° at noon, and from 37.2° to 50° at 6 p. m. The lowest daily average was 36.2° on the 20th, the highest was 48.8° on the 1st, and the average for the month was 44.6°, that of the air being 39.2°.

For December, there are 3 records for 1898 (32° at 6 a. m. on the 7th, 9th and 14th) and nearly complete records for 1899, 1900 and 1904. In 1899, the variation was from 32° to 46° at 6 a. m., from 32° to 48° at noon, and from 32° to 47° at 6 p. m. The lowest daily average was 32° on the 16th, 29th, 30th, and 31st, the highest was 47° on the 11th, and the average for the month was 37.2°, that of the air being 28.2°. In 1900, the variation was from 32° to 40.9° at 6 a. m., from 32° to 42° at noon, and from 32° to 42.6° at 6 p. m. The lowest daily average was 32° on the 14th, the highest was 41.5° on the 1st, and the average for the month was 36.8°, that of the air being 31.7°. In 1904, the variation was from 32° to 37° at 6 a. m., from 32° to 37.8° at noon, and from 32° to 36.5° at 6 p. m. The lowest daily average was 32° on the 10th, 12th, 13th, 15th, and 16th, the highest was 36.1° on the 2d, and the average for the month was 33.8°, that of the air being 25.2°.

In the following tables are given the detailed records of the water temperature observations:

Water Temperature Tables

WATER TEMPERATURES FOR JANUARY, 1900

Date	6 a. m.	Noon	6 p. m.	Average
1	32°	32°	32°	32°
2	32	32	32	32
3	32	32	32	32
4	32	32	32	32
5	32	32	33	32.3
6	33	33	33	33
7	34	34	34	34
8	34	35	35	34.6
9	33	33	33	33
10	33	33	33	33
11	33	33	33	33
12	33	34	33	33.3
13	33	33	33	33
14	33	33	33	33
15	33	34	34.5	33.8
16	35	35	35	35
17	34	34	35	34
18	35	35	35.5	35.1
19	35	35	35	35
20	35	35	35	35
21	35	35	35.5	35.1
22	35	35.5	36.5	35.6
23	36	37	37.5	36.8
24	38	40	39	39
25	37	36	35	36
26	34.5	34	34	34.1
27	33.5	33	33	33.1
28	33	32	32	32.3
29	32	32	32	32
30	32	32	32	32
31	32	32	32	32
Average	33.7	33.8	33.9	33.8

WATER TEMPERATURES FOR JANUARY, 1904

Date	6 a. m.	Noon	6 p. m.	Average
1	33 6	34 1	33 5	33 7
2	33 2	34	34	33 7
3	33 5	34 5	33 9	33 9
4	33	34 7	34 3	34
5	33 5	35 1	34 8	34 4
6	34	35	34 8	34 6
7	34 1	35	34 8	34 6
8	34 5	34 9	34 2	34 5
9	34	35	34	34 3
10	34	34 5	35	34 5
11	35 2	35 8	35 5	35 5
12	35 1	36	35 9	35 5
13	36	36 9	37	36 6
14	37	38 9	38 5	38 1
15	37 9	40 1	38 2	38 7
16	36 8	38 5	38 5	37 1
17	38 1		38 1	38 1
18	37 9	38 7	38 2	38 2
19	37	38 5	37 3	37 6
20	37 3	39	39 5	38 6
21	37	37 1	37 9	37 3
22	38 1	41	39	39 7
23	39 5	40	40 6	40
24	39 1	38 8	38 1	38 6
25	37 6	38 2	38	37 9
26	37 2	37 3	36 1	36 8
27	36 8	37	36 5	36 7
28	36	36 9	37 5	36 8
29	35 5	35 9	36 1	35 8
30	34 9	35 2	35 7	35 2
31	34 5	35	34 5	34 6
Average	35 4	36 7	36 8	36 4

WATER TEMPERATURES FOR JANUARY, 1905

Date	6 a. m.	Noon	6 p. m.	Average
1	33 5	34 9	34 5	34 3
2	34	34 5	32	33 5
3	34	34 8	34 8	34 4
4	32	32	32	32
Average	33.4	34 1	33 3	33 6

WATER TEMPERATURES FOR FEBRUARY, 1899

Date	6 a. m.
1	32°
2	32
7	32
10	33
13	32
15	32
25	32
27	32
Average	32.7

WATER TEMPERATURES FOR FEBRUARY, 1900

Date	6 a. m.	Noon	6 p. m.	Average
1	32°	32°	32°	32°
2	32	32	32	32
3	32	32	32.5	32.1
4	32.5	32.5	32.5	32.5
5	32	32	32	32
6	32	32.5	33	32.5
7	33	33	33.5	33.1
8	33.5	34	34	33.8
9	33	33	33	33
10	33	33	33	33
11	32.5	33	33	32.8
12	33	33	33	33
13	33	32.5	32	32.5
14	32	32	32	32
15	32	32	32	32
16	32	32	32	32
17	32	32	32	32
18	32	32	32	32
19	32	32	32	32
20	32	33	33	32.6
21	33.5	34	34.5	34
22	35	34	34.5	34.5
23	34	34	35	34.3
24	34	33	32	33
25	32	32	32	32
26	32	32	32	32
27	32	32	32	32
28	32	33	33	32.6
Average	32.6	32.6	32.7	32.7

WATER TEMPERATURES FOR FEBRUARY, 1901

Date	6 a. m.	Noon	6 p. m.	Average
1	34°	34 1°	33 5	33 8
2	33 3			
3	35 5	33 5	34	34 3
4	32 8	33 8	33 5	33
5	33 8	34	34	33 9
6	33 3	34 5	33 4	33 7
7	33 2	33 8	33 1	33 3
8	33	33 5	33	33 1
9	32 5	32	33	32 5
10	32 5	33	33 1	32 8
11	33 2	33 1	33 1	33 1
12	32 5	32 9	33	32 8
13	33	33	33 5	33 1
14	32 9	32 9	33 1	32 9
15	32 9	33 5	33 3	33 2
16	33	33 5	33 2	33 2
17	33 1	33 2	33	33 1
18	33	33 2	33 2	33 1
19	33	33 7	33 3	33 3
20	33	33 4	32 9	33 1
21	32 8	33 5	33 2	33 1
22	33 2	33	32 9	33
23	33	33 2	33	33
24	32 9	33 1	32 9	32 9
25	33	33	33	33
26	32 5	33	32 9	32 7
27	32 5	33 1	32 9	32 7
28	33	33	32 9	32 9
Average	32 7	33 3	33 2	33 1

WATER TEMPERATURES FOR MARCH, 1900

Date	6 a. m.	Noon	6 p. m.	Average
1	33°	34.5°	34°	33.8°
2	34	34.5	34	34.1
3	34	34	34.5	34.1
4	34	34	34	34
5	34	34	34	34
6	34.5	35	35	34.8
7	35	35	35	35
8	35	35.5	35.5	35.3
9	35.5	36	36	35.8
10	36	36	36	36
11	36	36	36	36
12	35	35	35	35
13	36	36	36.5	36.1
14	36	36	36.5	36.1
15	35	35	35	35
16	35	35	34	34.6
17	33.5	33	33	33.1
18	33.5	34	34	33.8
19	35	35	36	35.3
20	36	36	36	36
21	36	36	36.5	36.1
22	36	36.5	37	36.5
23	36	37	37	36.6
24	37	37	37.5	37.1
25	36.5	36	36	36.1
26	36	36	36	36
27	36	36.5	36	36.1
28	36	36	36.5	36.1
29	36	36	36.5	36.1
30	37	37.5	36.5	37
31	37	37	38.5	37.5
Average.	35.3	35.5	35.6	35.5

WATER TEMPERATURES FOR MARCH, 1901

Date	6 a. m.	Noon	6 p. m.	Average
1	33°	33°	33°	33
2	32.8	33.3	33	33.1
3	32.6	33	33.1	33
4	33.5	33.8	33.5	33.6
5	33.1	33.6	33.6	33.1
6	33	33.9	33.9	33.6
7	33	33.9	33.1	33.3
8	32.9	33.4	32.9	33
9	33.2	33.2	33.8	33.4
10	32.3	33.8	33.8	33.3
11	33.9	33	34.8	33.9
12	35.1	34.3	34.5	34.6
13	34.3	35.3	34.5	34.7
14	35	34.9	34.9	34.9
15	33.8	34.9	34.6	34.1
16	35.4	36	34.5	35.3
17	35.2	37	38	36.7
18	36.9	37.1	37.8	37.2
19	34.8	38.5	39.5	37.6
20	37.9	38	37.5	37.8
21	37	40.9	38.9	38.9
22	37.9	44.9	43.4	42
23	38.1	45.6	41.5	41.7
24	36.3	39.5	39.6	38.4
25	35	49	42	42
26	39.6	41.4	40.1	40.7
27	38.9	41.2	40.3	40.1
28	37.4	41	40.5	37.6
29	39.8	44.7	42.7	42.4
30	37.5	38.3	37.7	37.8
31	37.1	40.1	41	39.4
Average	35.4	37.4	36.9	37.5

WATER TEMPERATURES FOR APRIL, 1900

Date	6 a. m.	Noon	6 p. m.	Average
1	39°	44°	45°	42.6°
2	44	44.5	46	44.8
3	45	45.5	45	45.1
4	46	47	47.5	46.8
5	47	48	48	47.6
6	48	49	49.5	48.8
7	48	49	49.5	48.8
8	49	49	50	49.3
9	50	50.5	50	50.1
10	48	48.5	48	48.1
11	48	48	47.5	47.8
12	47	47.5	46	46.8
13	47	47	46	46.6
14	44	45	46	45
15	45.5	46	46.5	46
16	46	46.5	48	46.8
17	48	48.5	48	48.1
18	48	48	48	48
19	48	48.5	49	48.5
20	48	48	49	48.3
21	50	50	51	50.3
22	50	51	51	50.6
23	50	51.5	51	50.8
24	51	51.5	52	51.5
25	50	51	51	50.6
26	50	50	54	51.3
27	56	54	54	55.3
28	54	58	64	58.6
29	60	66	66	64
30	67	67	67.5	67.1
Average	49.1	49.9	50.5	49.8

WATER TEMPERATURES FOR APRIL, 1901

Date	6 a. m.	Noon	6 p. m.	Average
1	36°	46.2°	45.5	42.5
2	38.5	38.5	39	38.6
3	38	44	43.9	41.6
4	40	50	47.9	45.9
5	42.5	45.5	45.5	44.5
6	44	43.9	43.5	44.1
7	42.1	47.6	45.6	45.1
8	40.5	48	45.5	44.6
9	40.8	48.9	47.9	45.9
10	41.9	50.5	49.9	47.4
11	42.5	53.5	50.9	49.9
12	43.9	46.7	48.7	48.4
13	45.3	46.3	47.5	46.7
14	43.4	49.3	47.2	46.6
15	44.5	48.6	48.5	47.2
16	44.5	51.1	49.6	48.4
17	52.3	47.5	46.5	48.8
18	42.5	46.5	46	45
19	41	48.1	45	44.7
20	41.5	48.3	46.9	45.6
21	42.4	45.5	43.7	43.9
22	43.5	44.5	47.3	45.1
23	45.5	47.1	49	47.2
24	46	52.1	51.7	49.9
25	46.8	55.5	51.5	51.3
26	47.5	59	57	54.5
27	51.5	57.1	61.8	56.8
28	52	59	64.9	58.6
29	56.8	65.5	69.8	64
30	60.1	55.5	56.7	57.4
Average.....	44.6	49.7	49.5	47.9

WATER TEMPERATURES FOR MAY, 1900

Date	6 a. m.	Noon	6 p. m.	Average
1	60°	62°	61°	61°
2	56	58	60	58
3	58.5	58	59	58.5
4	60	60.5	60	60.1
5	60	61	60	60.3
6	59	60.5	60	59.8
7	59	60	61	60
8	59.5	60	59	59.5
9	58	58	57.5	57.8
10	57	57	57	57
11	58	60	60	59.3
12	62	64	65	63.6
14	66	69	69	68
15	69	71	70	70
16	71	73	70	71.3
17	63	64	63.5	63.5
18	62	62	62	62
19	62	62.5	62	62.1
20	61	60	60	60.3
21	59	60	60	59.6
22	60	61	62	61
23	61	65	70	65.3
24	68	70	71	69.6
25	70	71	73	71.3
26	72	73	74	73
27	72	73	73.5	72.8
28	72	72.5	73	72.5
29	72	72.5	73	72.5
30	72	74	74	73.3
31	72.5	73	73	72.8
Average	63.71	65.41	65.08	64.74

WATER TEMPERATURES FOR MAY, 1901

Date	6 a. m.	Noon	6 p. m.	Average
1	57 5°	58 3°	54 5	56 8
2		50 5	55	52 8
3	51 9	68 2	65 3	61 8
4	56 9	67	62 3	62 1
5	58 9	65 1	65 3	63 1
6	60 1	68	63.6	63.9
7	61	63 6	62	62 2
8	60 4	62.1	62 6	61 7
9	60 1	64 5	64 1	62 9
10	61 9	63 9	64 9	63 6
11	60 9	64 1	61 8	62 3
12	56	59	59 5	58 2
13	55 5	61 8	60	59 1
14	55	61 3	63 5	59 9
15	57 1	61 8	68	62
16	61 5	68 5	66 3	65 4
17	63 1	70	71	68
18	66	70 1	69	68 4
19	63	65 2		64 1
20	58 5	65	63 5	62 3
21	58	60 5	61	59 8
22	59	62 5	63 8	61 8
23	59 5	67 1	65 5	64
24	61 5	65 4	63 2	63 4
25	55		56 9	56
26	55	57	51 1	54 4
27	55	57 9	56 5	57 8
28	55	59	59 5	61 2
29	55	57 8	57	56 6
30	53 1	59 5	58 9	57 2
31	55 5	62 9	63 9	60 8
Average..	58 23	62 92	61 98	60 93

WATER TEMPERATURES FOR JUNE, 1900

Date	6 a. m.	Noon	6 p. m.	Average
1	73°	74°	73 5°	73 5°
2	72 5	72	72	72 1
3	71.5	72	71	71 5
4	70	71	72	71
5	71 5	72	74	72 5
6	73 5	74	73 5	73 6
7	73 5	74	76	74 1
8	76	76 5	77	76 5
9	76	76	77	76 3
10	76	76 5	75	75 8
11	74	74 5	73 5	74
12	74	75	77	75
13	76	76 5	77	76 5
14	76	77	77 5	76 8
15	77	77	76	76 6
16	75 5	77	77	76 5
17	75 5	76 5	76	76
18	75	76 5	77	76 1
19	73	76	76	75
20	70	72	72	71 3
21	71	73 2	72	73
22	70	72	70	70 6
23	71	74	73	72 6
24	72	78	75	75
25	72	78	75	75
26	78	78	75	77
27	73	77 5	78	76 1
28	75	78	78	77
29	75	78	76	76.3
30	68	78	77	74.3
Average	73 21	75 32	74 9	74 6

WATER TEMPERATURES FOR JUNE, 1901

Date	6 a. m.	Noon	6 p. m.	Average
1	58	64 5	63	61 8
2	58 1	65 5	65 5	63
3	60 5	69	68 9	66 1
4	63 3	71	68 8	67 7
5	65	66	68 9	66 6
6	64 5	68 3	68 8	67 2
7	62 6	64 8	62 9	63 4
8	58 9	66 8	63 9	63 2
9	57	68 5	70	65 2
10	65	69 6	70 2	68 3
11	66	74 5	70 5	70 3
12	67	80	75	74
13	70 9	78	74 2	71 4
14	72 1	80 9	80	77 7
15	75	78 2	78	77 1
16	70 5	80 5	80	77
17	74	78 1	75 5	75 9
18	70 1	79	75 5	74 9
19	72	80	78	76 7
20	73	77 5	73 5	74 7
21	74 3	76 4	78	76 2
22	74 8	82	80 9	79 2
23	73 9	81	81	78 6
24	76 2	83 5	82	80 6
25	77 9	83 2	81 3	80 8
26	77	84 5	83 9	81 8
27	78 5	75	84 6	79 4
28	79 2	85 7	84 6	83 2
29	78 8	86 2	82 3	82 8
30	78	85 9	81 3	82 7
Average	73 07	74 13	75 13	74 11

WATER TEMPERATURES FOR JUNE, 1903

Date	6 a. m.	Noon	6 p. m.	Average
27	65	76	75	72
28	70	77	75	74
29	71	73 2	72	72
30	72	75 2	75	74
Average	69 5	75 4	74 3	73

WATER TEMPERATURES FOR JULY, 1899

Date	6 a. m.	Noon	6 p. m.	Average
5	73 5°	75	77°	75 1°
6	73 5	80	77	76 8
7	72 5	77	75 5	75
8	72	77	73 5	74 1
9	70	77	77	74 6
10	72	76 5	74	74 1
11	72 5	77 5	77	75 6
12	74 5	80 5	79	78
13	77	79 5	75 5	77 3
14	75	77	77	76 3
15	74		76	75
16	75	77 5	76	76 1
17	75	79	78	77 3
18	74	79	77	76 6
19	74	79	78	77
20	76	81	78	78 3
21	75	82	83	80
22	79	86	85	83 3
23	79	88 5	85	84 2
24	78	86	85 5	83 2
25	79	85 5	82	82 6
26	78	84	80	81 6
27	78		83	80 5
28	78 5	82	83	81 2
29	78	81 5	79 5	79 6
30	77	82 5	80	79 8
31	75	82 5	80	79 2
Average	75 3	80 5	78 9	78 25

WATER TEMPERATURES FOR JULY, 1910

Date	6 a. m.	Noon	6 p. m.	Average
1	71	76	77	74 6
2	73	80	80	77 6
3	75	79	78 3	77 4
4	78	82	80	80
5	78	83	80	80 3
6	78	81	80	79 6
7	71	82	80	77 6
8	77 5	77	75 5	76 6
9	73	78	77	76
10	71	77	76	74 6
11	73	77 5	77	75 8
12	77	72	78	75 6
13	71	78	77	75 3
14	71	79	78	76
15	75	81	79	78 3
16	75	77	77	76 3
17	74 5	77	76	75 5
18	72	79	78	76 3
19	75	79	78	77 3
20	75	80	75	76 6
21	73	80	80	77 6
22	75	80	82	79
23	78	81	80 5	79 8
24	81	78	78	78 6
25	75	80	79 5	78 1
26	75	80	79	78
27	73	80	78	77
28	75	80	78	77 6
29	73 5	79	78	77 5
30	75	80 5	79	78 3
31	76	80	78	78
Average	74 6	79	78 3	78 1

WATER TEMPERATURES FOR JULY, 1903

Date	6 a. m.	Noon	6 p. m.	Average
1	71.5°	77°	71°	73.1°
2	71	73	75.5	73.1
3	74	77	78	71.3
4	76	79	78	77.6
5	78	80	80	79.3
6	77	83.5	84.5	81.6
7	78.5	86.5	81.5	82.1
8	79	87	81.5	82.5
9	79	83.5	87.5	83.3
10	80.5	85	85	83
11	81.5	84.5	84.5	83.3
12	81	84	81	82
13	78.5	81.5	78.5	79.5
14	78	80	78.5	78.8
15	74	77.5	78	76.5
16	75.5	79	79	77.8
17	75	78	75	76
18	73	73.5	74.5	73.6
19	73.5	74	74	77.8
20	72	75	75	74
21	72	75	73.5	73.5
22	72	75.5	75.5	74.3
23	72	79	77	76
24	75	81	80	78.6
25	78	78	77.5	77.8
26	76	79	78.5	76.8
27	76	81.5	81.5	79.6
28	77	80	78	78.3
29	72	80	78.5	76.8
30	76	78	77.5	77.1
31	71	77	75	74.3
Average	75.6	79.4	78.5	77.8

WATER TEMPERATURES FOR JULY, 1906

Date	6 a. m.	Noon	6 p. m.	Average
25	62.5°	72.5		67.5°
26	75	75.5	73°	74.5
27	68.5	76.8	77.9	74.4
28	70	77.9	74	74
29	68.1	74	80	74
30	63.5	82	82.5	76
31			83.5	
Average	67.9	76.4	78.5	74.3

WATER TEMPERATURES FOR AUGUST, 1899

Date	6 a. m.	Noon	6 p. m.	Average
1	74°	78°	78°	76 6
2	76 5	82	80	79 5
3	76	80	79	78 3
4	75 5	84 5	81	80 3
5	77 5	78 5	78	78
6	71 5	82 5	80	78
7	72 5	80	80	77 5
8	73	77	77	75 6
9	71	77 5	75	74 5
10	73	79	76 5	76 2
11	73 5	81 5	80	78 3
12	74 5	80	78 5	77 6
13	70	80	75	75
14	67	80	77	74 6
15	67	80	76 5	74 5
16	70	80	80	76 6
17	73	81	80	78
18	73 5	79	78	76 8
19	76	84	78	79 3
20	76	78 5		77 2
21	75	82 5	77	78 2
22	75	82	80 5	79 2
23	75	82	82	79 6
24	75	80	78 5	77 8
25	74	83 5	80 5	79 3
26	75	81 5	82 5	79 3
27	77	86	83	82
28	70 5	84	82	81
29	75 5	84	84 5	81 3
30	75	84	82	80 5
31	77	81 5	81 5	80
Average	73 7	81 1	79 4	78 4

WATER TEMPERATURES FOR AUGUST, 1900

Date	6 a. m.	Noon	6 p. m.	Average
1	74°	81	81.5°	78.8
2	76.5		78	77.2
3	75	79	80.3	78.1
4	76	80.8	78.5	78.4
5	77.4	81	81	79.8
6	79	83.5	79.8	80.8
7	79.2	81.8	81.8	81
8	78.8	83	81	80.9
9	79.4	83	82	81.4
10	78.9	83.5	80	80.8
11	79	83.6	80.5	81
12	78.3	81	81.5	80.2
13	78	82	80.5	80.1
14	79	79	79	79
15	76.2	72.1	78	75.4
16	75.7	77	80	77.5
17	75.5	80	79.2	78.2
18	76	80.5	79	78.5
19	78.5	83.5	78.5	80.4
20	77	81	79	79
21	76.2	83.5	83.6	81.1
22	78.2	84	83	81.7
23	78.9	80	82	80.3
24	77.5	82.5	81.5	80.5
25	77.2		79	78.1
26	76	79.5	81.5	79
27	76.5	80	79.5	78.6
28	76.5	82	81.8	80.1
29	78	83.5	81.5	81
30	76	83	83	80.6
31	78	83.5	83	81.5
Average	77.2	81.3	80.6	79.7

WATER TEMPERATURES FOR AUGUST, 1903

Date	6 a. m.	Noon	6 p. m.	Average
1	70°	71°	71°	70 6°
2	72	77	75	74 6
3	77 1	74	78	75 3
4	73 5	75	77	75 1
5	74 5	78 5	75	76
6	73 5	76	74	74 5
7	70	72	71	71
8	72 5	76 5	74	74 3
9	74	75	75	74 6
10	71	75	75	73 6
11	72	74	74	73 3
12	68	72	74	71 3
13	71	74	74	73
14	69	76	76	73 6
15	68 5	71	70 5	70
16	68	75	74 5	72 5
17	70	76	75	73 6
18	73	78	76	75 6
19	73	74	72 5	73 1
20	70	76	75	73 6
21	71	74	77	74
22	71	74	74	73
23	72	75 5	73 5	77
24	73	78	74 5	75 1
25	73 5	78	76	75 8
26	72	77	77 5	75 5
27	73	76	75	74 6
28	73	76	75	74 6
Average	71 7	75 2	74 6	73.8

WATER TEMPERATURES FOR AUGUST, 1906

Date	6 a. m.	Noon	6 p. m.	Average
1	71.5	77.5	84.5	77.8
2	76.4	81	78.9	78.8
3	71.9	77	78.9	75.9
4	73.9	78	79	77
5	73.5	78.1	77.5	76.4
6	73	81.9	77.8	77.6
7	73.1	75.4	77	75.2
8	73	82.2	84	79.7
9	73.9		83.5	78.7
10	73.9	75.5	81.5	77
11	72	83	79	78
12	68.8	75.1	76.5	73.5
13	69	73.8	75.9	72.9
14	75			
15	71	76	72.5	73.2
16	72.5	77	81	76.8
17	74	79	77.5	76.8
18	72.5	77	78	75.8
20		79.5	78	78.8
21	74.5			
22			80	
23		80	80.8	80.4
24	75.5	80		77.8
25	74.8		81	77.9
26		85	77.5	81.3
27	70	73.5	73.5	72.3
28	68.5	74.1	76	72.9
29	70	73.5	79	74.2
30	74.5	71	72	72.5
31	67			67
Average	72.5	77.7	78.5	76.2

WATER TEMPERATURES FOR AUGUST, 1908

Date	6 a. m.	Noon	6 p. m.	Average
27	65.0	73.0		69.0
28	65	74	74.0	74.1
29	69	70.5	73.5	71
30	70	81	80	77
31	72.9	78.5	79	76.8
Average	68.4	75.4	76.6	73.2

Records only for the last five days of the month.

WATER TEMPERATURES FOR SEPTEMBER, 1899

Date	6 a. m.	Noon	6 p. m.	Average
1	77°	82.5°	81.2°	80.2°
2	76.2	82.8	80	79.6
3	80	84.2	79.8	81.3
4	73.8			
6	72.5	82	79.5	78
7	73.5	79.2	78.5	77
8	75	79	75	76.3
9	67	68		67.5
10	67	69	69.5	68.5
11	69.5	77	74	73.5
12	69	77	71	72.3
13	66	75	70	71
14	57	72.5	68.5	66
15	64	73	69.5	68.8
16	64	74.5	72	70.1
17	66	76	70.8	70.9
18	62	70.5		66.2
19	63.1	64	63.5	63.5
20	61.5	68.5	65	65
21	61.5	71	67	66.5
22	62	69	66	65.6
23	63	65.5	67	65.1
24	64	66	65	65
25	61	66	63.5	63.5
26	57.5	65.5	61	61.3
27	57	63	62	60.6
28	55	61.5	60	58.8
29	56	62	57	58.3
30	54.8	60	56	56.9
Average	65.6	71.6	68.9	68.1

WATER TEMPERATURES FOR SEPTEMBER, 1900

Date	6 a. m.	Noon	6 p. m.	Average
1	77.5°	83°	81°	80.5°
2	76	81.2	77.2	78.1
3	76	80.5	79	78.5
4	75	81	81	79
5	75	80.5	77.5	77.3
6	76	79.5	77.5	77.6
7	75	78	78	77
8	75.5		80.3	77.6
9	76.5	81.2	78.6	78.7
10	75.1	80	77	77.3
11	75.8	79	76.3	77
12	72.9	72.5	76.1	73.8
13	72	79	78	76.3
14	72.1	79	72.7	74.6
15	68.8	77	74.9	73.5
16	70.1	71.1	71.8	71
17	68	..	67	67.5
18	59.3	73	71.9	67.7
19	65	65.5	69.9	66.8
20	65	71	67	67.6
21	63.5	70	67.5	67
22	63.5	71	69.5	68
23	64	70.2	67.8	67.3
24	62.8	68.5	69	66.7
25	67	75.2	71.8	71.3
26	62	69.9	69	66.9
27	66	67.3	66.5	66.6
28	61.9	68	67	65.6
29	66	67.5	67.5	67
30	63.5	71	69.5	68
Average	69.6	74.6	73.2	72.4

WATER TEMPERATURES FOR SEPTEMBER, 1906

Date	6 a. m.	Noon	6 p. m.	Average
1	64	73°	70.9°	69.3°
2	66	68	69	67.7
3	67	72.5	70.1	69.9
4	69		69.5	69.3
5	63	69	71	67.7
6	66.1	71	73	70
7	71	73	75	73
8		73	75	74
9	71.3	75	76	74.1
10	76	..	74	75
11	71	80	75.2	75.4
12	72	76.8	76	74.9
13		78.2	70	74.1
14	60	67.2	68	65.1
15		67	67	67
16	65	70.9	72	69.3
17	..		73	..
18	68.5	74.9	80	74.5
Average	67.8	72.6	72.4	71.2

WATER TEMPERATURES FOR SEPTEMBER, 1907

Date	6 a. m.	Noon	6 p. m.	Average
13		70°	69	
14	67			
19	70	74	72 5	72 2
20	70	73	73	72
21	67	72 5	70	69 8
22	62	70	70	67 3
23	65		66	65 5
24	61	66	63	63 3
25	58	62	62	60 7
26	60	62	63	61 7
27	61	61	61	61
28	61	62	62	61 7
29	60	60	59	59 7
30	57		62	59 5
Average	63	66 6	65 6	64 5

WATER TEMPERATURES FOR SEPTEMBER, 1908

Date	6 a. m.	Noon	6 p. m.	Average
1	75°	75°		75°
2	71 3	73 5	70 5	71 8
3	61 5	72	70	67 8
4	65	72	70	69
5	67		75	71
6	71	78	70	73
7	64		71 5	67 8
8	66			
9	66 5	73 5	75	71 7
10	69	76 5	75 4	73 6
11		77		
12	71	81		76
13	73	76	78	75 7
14	71	74	73	72 7
15	68 5	72	73	71 2
16	66 5	73 8	76	72 1
17		74	75	74 5
Average	68	74 1	73 3	72 2

WATER TEMPERATURES FOR OCTOBER, 1899

Date	6 a. m.	Noon	6 p. m.	Average
1	48.5°	59.5°	56°	54.6°
2	52.5	61	59	57.5
3	52	63.5	60.5	58.6
4	55	61.5	61	59.1
5	55	61.2	60	58.7
6	54	62	62	59
7	54	63.5	61	59.5
8	52.5	64	61	59.1
9	58	64.5	60	60.8
10	54.5	62	60	58.8
11	58.5	60	60	59.5
12	58.5	65	62	61.5
13	60	64	64	62.6
14	60	68	65	64.3
15	60.5	70.5	65	65.3
16	59.8	67	61	62.5
17	58.5	58.5	57	58
18	58			
22	50	58		54
23	60	66	60	62
24	60	66	60	62
25	60	62		61
26	55	64	60	59.6
27	56		57	56.5
28	57		57	57
29	56	59	59	58
30	53	59	56	56
31	52	60	55	55.6
Average	56	62.8	59.9	59.3

WATER TEMPERATURES FOR OCTOBER, 1900

Date	6 a. m.	Noon	6 p. m.	Average
1	63 5	70	68	67 2
2	62 5	71	68	67 2
3	64 5	72 5	68 9	68 6
4	65	73 2	69	69 1
5	64 9	72	70 1	69
6	67	73 5	71	70 5
7	67 5	68 5	66 8	67 6
8	65	69 5	67	67 7
9	62 5	69 5	66 5	66 2
10	69 8	68 5	67	68 4
11	62	68 5	66 9	65 8
12	65 5	66 5	65	66
13	60	65 5	64	63 2
14	62	68	66 9	65 6
15	62 3	69 3	65 5	65 7
16	61 5	65	60	62 2
17	57 6	64 8	61	61 1
18	57 2	65 5	63	61 9
19	54 5	63 6	61 2	59 8
20	54	63	61	59 3
21	61 8	62	61 9	61 9
22	60 1	62 5	63	61 9
23	58 9	63 9	61 2	61 3
24	58 1	63 5	65	62 2
25	58	64 7	63	61 9
26	58 8	64	61 5	61 1
27	58 5	66 1	64	62 9
28	57 5	64	62 8	61 1
29	60 1	65	61 7	62 3
30	61 5	65 2	62 5	63 1
31	59 9	64 9	63 9	62 9
Average	61 4	66 9	64 8	64 1

WATER TEMPERATURES FOR OCTOBER, 1904

Date	6 a. m.	Noon	6 p. m.	Average
28			52 8	
29	47 9°	53°		50 5°
30	50 2	54	53 5	52 6
31	50	58	52 9	53 6
Average	49 4	55	53 1	52 5

WATER TEMPERATURES FOR OCTOBER, 1906

Date	6 a. m.	Noon	6 p. m.	Average
5			57°	
10			47	
11	44 5	53 5°	49 5	49 2°
12	47 2	52	52	50 4
13	55	55		55
14	51	55 8	55 5	54 1
15	51 6	55 5	56 7	54 6
16	51 8		57	54 8
17	51 5	58	58	55 8
18	56	58	61	58 3
19	58 5	65	62 5	62
20	51 9	63 3	53	56 1
21	56	59	60	58 3
22	56 3	57 6	56	56 6
23	59	60 5	58	59 2
24	57 5		50	53 8
27	49 5	47	45 5	47 3
28	44	43	42 8	43 3
29	41 1	50	44 5	45 2
30	46	47 5	45	46 1
31	42	52	48 5	47 5
Average	51 1	54 9	53 1	53

WATER TEMPERATURES FOR OCTOBER, 1907

Date	6 a. m.	Noon	6 p. m.	Average
1	57°	61°	63	60 3
2	60	65	64	63
3	62	64	63	63
4	63	65	65	64 3
5	59	63	63	61 7
6	59	62	63	61 3
7	59	62	60	60 3
8	54	59	61	58
9	57	58	58	57 7
10	54	57	58	56 3
11	54	57	55	55 3
12	52	53	53	52 7
13	60	52	53	51 7
14	51	54	54	53
15	55	55	55	55
16	55	55	56	55 3
17	54	57	58	56 3
18	54	56	56	55 3
19	50	54	55	53
20	53	54	53	53 3
21	51	55	54	53 3
22	51	55	56	54
23	52	55	53	53 3
24	51	53	54	52 7
25	50	53	50	51
26	50	49	50	49 7
27	49	50	48	49
28	46	46	47	46 3
29	43	45	46	44 7
30	49	49	49	49
31	48	50	51	49 3
Average	53 3	55 6	55 6	54 8

WATER TEMPERATURES FOR OCTOBER, 1913

Date	6 a. m.	Noon	6 p. m.	Average
1	61	66°	66	64 3°
2	60		62	61
3	56	65	64	61 7
4	60	65	65	63 3
5	60	64	64	62 7
6	62	65	65	64
7	62	67	67	65 3
8	62	67	67	65 3
9	64	70	68	67 3
10	65	69	67	67
11	61	63	61	61 7
12	57	58	50	55
13	56	61	62	59 7
14	57	62	61	60
15	56	63	62	60 3
16	59	62	62	61
17	60	62	52	58
18	56	56	56	56
19	51	59	55	55
20	51	52	48	50 3
21	45	46	46	45 7
22	50	46	50	48 7
23	48	52	50	50
24	51	54	54	53
25	48	55	54	52 3
26	50	54	55	53
27	50	51	50	50 3
28	47	49	50	48 7
29	49	50	46	48 3
30	45	45	45	45
31	43	47	44	44 7
Average	54 9	58 2	57	56 7

WATER TEMPERATURES FOR NOVEMBER, 1899

Date	6 a. m.	Noon	6 p. m.	Average
1	54°	56°		55
2	45	48	46	46 3
3	45	44	43	44
4	42	42	47	43 6
5	44	52 5	50	48 3
6	47	51	48	48 6
7	48	50	49	49
8	50		50	50
9	48	52	50	50
10	48	50.5	50.5	49 6
11	50	53	50	51
12	46	48	46	46 6
13	42	50	49	47
14	46	49	48	47 6
15	48	50	49	49
16	48	51	50	49 6
17	47	50	52	49 6
18	50	51	50	50.3
19	48	51	50	49.6
20	47	51	47	48 3
21	46	49	50	48 3
22	50	51	50	50 3
23	47 5	45	45	45 8
24	45	46	45	45 3
25	43	47	45	45
26	42	47	44	44 3
27	43	46	44	44 3
28	43	47	44	44 6
29	42	44	43	43
30	42	46	47 5	45 1
Average	46 2	48 9	47 6	47 6

WATER TEMPERATURES FOR NOVEMBER, 1900

Date	6 a. m.	Noon	6 p. m.	Average
1	59 8°	59°	58 3°	59°
2	57	63 8	60 5	60 4
3	56 3	63 5	58 1	62 6
4	51 1	62	59 5	57 5
5	55 3	61	57 5	57 9
6	52	55		53 5
7	49 5	56	54	53 2
8	50	55	51 2	55 1
9	50	51 3	52 5	51 3
10	45 5	45 8	47 8	46 4
11	48 9	51 5	49 9	50 1
12	46 5	49 7	50 5	48 9
13	44 5	49 8	45 9	46 7
14	42	45 8	45 5	57 8
15	42 8	47	45	44 9
16	38 9	42 9	41	40 9
17	38 5	40	42 1	40 2
18	44 9	47	47 5	46 5
19	48 2	49 5	46 2	48
20	48 9	50	42	47
21	45 8	47 2	45 6	46 2
22	43 1	47 5	46 5	45 7
23	43 5	45 1	44 5	44 4
24	43	43	43	43
25	39	39 6	39 3	49 3
26	35 9	40 5	40	38 8
27	38	41 8	42 8	40 9
28	40 3	41 5	41 5	41 1
29	41 1	41 8	41 7	41 5
30	32 9	41 9	42	38 7
Average	45 8	49 2	47 7	47 6

WATER TEMPERATURES FOR NOVEMBER, 1904

Date	6 a. m.	Noon	6 p. m.	Average
1	50°	52 5	53°	54 8
2	50	53	53	52
3	50.5	53 9	52 9	52 4
4	51 5	53 5	54	53
5	49 9	50 2	49 2	49 8
6	42 2	48 5	47 9	46 2
7	47 8	48 2	50 5	48 8
8	47 9	48 3	45 1	47 1
9	43 9	43 9	47 5	45 1
10	47 5	44 7	44	46 3
11	42	41 8	43	42 3
12	40 3	43	43 3	42 2
13	42	44	42 9	43 3
14	41 8	43	43 5	42 8
15	41 3	42	44 8	42 7
16	42 5	44 5	47 5	41 5
17	43 9	45 3	45	44 7
18	44	45 5	46 7	42 9
19	44 9	46	47	49 9
20	46	47	45 5	46 2
21	43 6	45 5	45 5	44 9
22	43	46	45 2	44 7
23	43.5	44	44 8	44 1
24	43 5	44 2	44 5	44 1
25	42	43	42 5	42 5
26	39 8	39 9	40	39 9
27	37.5	38 5	39 5	38 5
28	43	39	38	40
29	39			
Average	44 3	45 6	45 9	45 4

WATER TEMPERATURES FOR NOVEMBER, 1906

Date	6 a. m.	Noon	6 p. m.	Average
1	45.5	50.5	50°	48.8
2	45	45	50	46.6
3	48	51	45	48
4	45.2		46	45.6
5	47	52.5	46.5	48.6
6	43			
7	53.5			
8	45	49	48.6	47.5
9	47.5	48	46	47.1
10	41.5	53.2	44.5	46.4
11	45.2	48.9		
12	42.5	45.1	45	44.2
13	41.8	43	42	42.2
14	41	46.6	44.5	44
15	43			
16	43.5	44.5	43.5	43.8
17	43.5		40	41.1
18	45	45.5		45.2
19	42.5	37.5	37.2	39
20	35.5	37		36.2
21	39.5		39	39.2
23	43.5			
Average	42.9	46.5	44.5	44.6

WATER TEMPERATURES FOR DECEMBER, 1899

Date	6 a. m.	Noon	6 p. m.	Average
1	44°	46°	45	44 3
2	42	46	43	43 6
3	42	43	42	42 3
4	41	42	37	40
5	35	39	38	37 3
6	38	44	39	39 3
7	37	40	38 5	38 5
8	38	42	40	40
9	40	40	40	40
10	44	42	42 6	42 6
11	46	48	47	47
12	40	40	40	40
13	40	38	35	37 6
14	35	36	36	35 6
15	36	36	36	36
16	32	32	32	32
17	32	35	37	34 6
18	34	39	38	37
19	38	38	38	38
20	36	36	36	35
21	34 5	37	38	36 5
22	37	38	38	37 6
23	34	36	34	34 6
24	34	34	33	33 6
25	32	34	33	[illegible]
26	33	34	34	[illegible]
27	32	34	32	[illegible]
28	32	34	32	[illegible]
29	32	32	32	[illegible]
30	32	32	32	[illegible]
31	32	32	32	[illegible]
Average	36 6	37 9	37	[illegible]

WATER TEMPERATURES FOR DECEMBER, 1900

Date	6 a. m.	Noon	6 p. m.	Average
1	39.9°	42°	42.6°	41.5°
2	38.9	40.9	41.5	40.4
3	40	41.2	42	41.1
4	40.9	41.3	41	41.1
5	40.9	41	40.5	40.8
6	38.5	41.1	41	40.2
7	40.1	40.9	39.9	40.3
8	37.8	38.9	38.9	38.5
9	37.5	38.5	37.7	37.9
10	38.4	39.2	39	38.9
11	37.1	39.5	39	37.5
12	35.1	37	36.5	36.2
13	36.6	37.3	37.8	37.2
14	32	32	32	32
15	32	32.9	32	32.3
16	32.1	32.5	33.2	32.6
17	33.5	33.8	33.5	33.6
18	33.5	34.7	34.8	34.3
19	33.9	36.5	35	35.1
20	33.8	36	36.7	35.5
21	35	37.8	36.4	36.4
22	34.7	36	35.9	35.5
23	37.2	36.7	34.7	36.2
24	33.9	36.3	.....	35.1
28	33.5	35	36.7	35.1
29	34	35.9	35.4	35.1
30	33.9	35	34	34.3
31	33.8	34.8	33.6	34.1
Average	36	37.3	37.1	36.8

WATER TEMPERATURES FOR DECEMBER, 1904

Date	6 a. m.	Noon	6 p. m.	Average
1	35°	.....	35°	35°
2	37	37 8°	33 5	36 1
3	32	33	32 5	32 5
4	32	32 9	34	31 9
5	33	34 5	34 5	33 5
6	34 9	33	35.2	35
7	34 5	36	35 2	35 2
8	34 5	34 9		..
9	34 8	35	34	34 6
10	32	32	32	32
11	34	33 8	33 8	33 8
12	32	32	32	32
13	32	32	32	32
14	32	32 8	32	32.2
15	32	32	32	32
16	32	32	32	32
17	33	32	32	32 3
18	33	33	33	33
19	32	33	33 1	32 7
20	33	34 5	35	33 1
21	34 9	34 9	35 2	35
22	35	37	36 5	36 1
23	36 4	35 5	35	35 6
24	35	34 9	35	34 9
25	35	36 2	35	35 4
26	35	35	36	35 3
27	35	34 5	34	34.5
29	34.5		32	
30	34	35	35 1	
31	34	34 8	34	34 2
Average	33 8	34 1	33 8	33 8

WATER-SURFACE TEMPERATURES

Month	Year	Monthly Ranges in Temperature			Lowest Daily Average		Highest Daily Average		Average for month	Average for air
		6 a. m.	Noon	6 p. m.	Date	Temp.	Date	Temp.		
January	1900	32 to 38	32 to 40	32 to 39		32		39	33 8	28 6
January	1901	33 to 39 5	34 to 41	39 5 to 40 6		33 7		42	36	27 9
January	1905	32 to 34	32 to 34 9	32 to 34 8		32		43	33 8	
February	1900	32 to 35	32 to 34	32 to 34 5		32		34 5	32 6	22 6
February	1901	32 5 to 35 5	32 to 34 5	32 9 to 34		32 5		34 3	33 1	19 3
March	1900	33 to 37	33 to 37 5	33 to 38 5	17th	33 1	31st	37 5	35 4	30 1
March	1901	32 3 to 39 8	33 to 49	32 9 to 43 4	1st and 3rd	33	29th	42 4	36 4	36 4
April	1900	39 to 67	44 to 67	45 to 67 5	1st	42 6	30th	67 1	49 8	52 1
April	1901	36 to 60 1	38 5 to 65 5	39 to 69 8		38 6		64	47 9	
May	1900	56 to 72 5	57 to 74	57 to 74	10th	57	30th	73 3		
May	1901	51 9 to 66	50 5 to 70 1	51 1 to 68						

Records for only the first 4 days of the month.

WATER-SURFACE TEMPERATURES.

Month	Year	Monthly Range in Temperature						Lowest Daily Average		Highest Daily Average		Average for month	Average for air
		6 a. m.		Noon		6 p. m.		Date	Temp	Date	Temp		
June	1900	70	to 78	71	to 78	71	to 78	4th	71	26th and 28th	77	....	
June	1901	58	to 79 2	64 5	to 86 2	62 9	to 84 6						
July	1899	70	to 79	75	to 88 5	73 5	to 85 5	10th	71 1	23d	84 2		
July	1900	71	to 80	72	to 83	75	to 82	1st	74 6	5th	80 3		
July	1903	71	to 81 5	73	to 87	71	to 87 5	1st and 2nd	73 1	9th and 11th	83 3		
July	1906	62 5	to 75	72 5	to 82	73	to 83 3	25th	67 5	26th	71 5	74 3	76 1
August	1899	67	to 77 5	77	to 81 5	75	to 81 5	9th and 15th	71 5	27th	82		
August	1900	74	to 79 1	72 1	to 83 6	78	to 83 6	15th	75 1	22d	81 7	79 5	77 5
August	1903	68	to 77 1	71	to 78 5	70 5	to 78	15th	70	5th	76		
August	1906	67	to 76 1	71	to 85	72	to 81 5						
August	1908	65	to 72 9	70 5	to 81	73 5	to 80	27th	69	30th	77	72 6	75 8
September	1899	51 8	to 80	60	to 81 2	56	to 81 2	30th	56 9	3d	81 3		
September	1900	59 3	to 77 5	65 5	to 83	66 5	to 81	28th	65 6	1st	80 5		
September	1906	60	to 76	67	to 80	67	to 80						
September	1907	57	to 70	60	to 74	59	to 73						
September	1908	61 5	to 75	72	to 81	70	to 78						

WATER-SURFACE TEMPERATURES

Month	Year	Monthly Range in Temperature				Lowest Daily Average		Highest Daily Average	
		6 a. m.	Noon	6 p. m.		Date	Temp.	Date	Temp.
October	1899	18.5 to 60.5	58 to 70.5	55 to 65					
October	1900	54 to 69.8	62 to 73.5	60 to 74					
October	1904	47.9 to 59.2	53 to 58	52.5 to 53.5		29th	50.6	31st	58.6
October	1906	44.5 to 59	52 to 65	49.5 to 62.5					
October	1907	43 to 63	45 to 65	46 to 65					
November	1899	42 to 54	42 to 56	43 to 52		29th	43	1st	55
November	1900	32.9 to 59.8	39.6 to 63.8	39.3 to 60.5					
November	1904	37.5 to 51.5	38.5 to 53.9	38 to 53		27th	38.5	4th	53
November	1899	32 to 46	32 to 48	32 to 47		16th, 29th, 30th, and 31st	32	11th	47
December	1900	32 to 40.9	32 to 42	32 to 42.6					
December	1904	32 to 37	32 to 37.8	32 to 36.5		10th, 12th, 13th, 15th and 16th	32	24	36.1

Average for the month, 52.5°.

Serial water temperatures:—In addition to the observations on the temperature of the surface of the lake, many serial temperatures were taken. On July 18, 1899, a regular observation station was established at the deepest place in the lake, known as the Deep Hole, where the water is 89 feet deep at the ordinary stage of water. A buoy was placed to mark the station. Readings were taken daily from July 18 to September 30, 1899, and from July 17, 1900, to June 28, 1901, not daily but usually two to three times a week. Readings were taken at the surface and usually at 5-foot intervals from the surface to the bottom. Usually the temperature of the air also was recorded, and the condition of the sky and direction of the wind noted.

From July 18 to August 14, 1899, a self-registering Negretti-Zambra deep-sea thermometer was used. From August 15 to September 21, a Ritchie thermophone was used, with not wholly satisfactory results, after which the deep-sea thermometer was again used.

A similar serial-temperature observation station was established July 30, 1899, at the Kettlehole, in the southwest corner of the lake, in which the maximum depth is 40 feet. Seven sets of records, at 5-foot intervals, were made there in July, August and September, 1899, and 12 sets in July, August and September, 1900. More than 150 water-temperatures were recorded at the Kettlehole, and over 4,200 at the Deep Hole. The total number of water-temperatures taken and recorded is therefore about 10,000. Most of the surface temperatures are given in the tables on the preceding pages and the serial temperatures will be found in the following tables.

Temperatures at the Deep Hole:—Many serial temperature records were made at the Deep Hole. These are set forth in the tables on the following pages. An examination of these various tables reveals some very interesting facts, particularly with reference to the position of the thermocline, that is, the line or depth of most rapid change in temperature.

During the winter months, when the lake is covered with ice, the temperature of the water from top to bottom is quite uniform, the variation sometimes being nil, and usually not more than 2 or 3 degrees. When the ice goes off in the spring, the sun's rays begin to affect the upper strata of the water to gradually increasing depths. From a mean surface temperature of 33.1° in February, it rose in March to 34.8°, in April to 45.8°, in May to 62°, and so on, until in August it reached 80.1°. By May the water had

warmed up perceptibly to a depth of 25 to 30 feet, and a well-defined thermocline was established. This is shown by the marked difference between the mean temperatures at 25 feet and 30 feet, 5.4°, which is 3.4° greater than for any other 5-foot interval in May. By the end of July, in 1899, it had moved down to 35 to 40 feet, the difference in temperature in that 5-foot interval being 6°. In 1900, it moved down only to the 30 to 35-foot interval by the end of July and showed a difference of 8.4°. In August, 1899, and again in 1900, it stood in the 30 to 35-foot interval. In September, it moved down to the 40 to 50-foot stratum in both 1899 and 1900. In October, it went down to the 50 to 60-foot level, and in November to the 60 to 70-foot interval. The difference, however, was only 1.9°. In this month it disappeared altogether in 1900 (the only year in which late fall observations were made), and did not reappear until in May following.

Pictures cannot do full justice to the beautiful views of Lake Maxinkuckee from the Academy buildings. One of the most attractive vistas shows a glimpse of the main lawn and flag in the foreground.

Serial Water Temperature Tables

SERIAL TEMPERATURES TAKEN IN THE DEEP HOLE, JULY, 1899

Depth	Date													
	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Air														61
Surface	77	77	78	78 2	79 1	80 5	80	79 5	80	80 5	80 4	80 5	79 1	78 5
5ft	77	77	78	78 2	79 1	80 5	80 1	80	80	80 5	80 4	80 8	79 5	78 7
10 ft	77	77	78	78 3	79	79 7	80 1	79 5	80	80 5	80 7	81	79 9	78 7
15 ft	76 5	76 5	76 7	78 5	78 1	78	78 5	79 5	79 5	79	77 4	80 2	79 2	78 5
20 ft	74 7	71 7	75	75	75		75 2	75 5	76	76 2	75 5	76 5	77 3	78
25 ft	72 3	72 3	72 5	73 5	72	74	72 8	72 7	73	73 5	72 8	73 6	73	72
30 ft	69 2	69 2	69	69	69 2	69 5	70	69 5	69 7	70 1	70	71	70	69 7
35 ft		63	63	64 2	61	64	65	64	65	63 2	64 1	65 7	65 5	61 7
40 ft	63	57 5	57 3	58	59 1	58	58 5	58 3	59 1	57 8	58 3	58 8	58 7	59
50 ft	57 5	52 5	53	52 6	53 1	54	53 7	53 7	51	51	54	54 2	54 5	51 5
60 ft	52 5	51 5	51 7	51 2	51 3	50 5	51 5	51 5	52 1	51 7	52	52	52	52 5
70 ft	51 5	50 5	50 7	51 2	51	50 5	51 2	51 3	51 2	51 5	51 8	51 2	51 5	51 5
80 ft	50 3	50 3	50 7	50 8	51	50 5	50 8	50 7	51 5	51 2	51	51	51 7	51 2
85 ft		50 5				50 5	50 5	50 7	51 2	51 2	51	50 8	51 3	51
89 ft	50 5		50 7	50 6	50 5									

SERIAL TEMPERATURES TAKEN IN THE DEEP HOLE, AUGUST, 1899

Depth	Date															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Air[1]			74 5	77 3	74	74 5		66 6	71	72	78 5	71 5		64 5	66 7	64
Surface	78	78 3	78 5	79 5	79	78 5	77 5	77	76 2	75 7	76 5	77	76 7	75	77 4	74
5 ft	78 2	78 3	78 8	79 5	79 2	78 2	77 5	77	76 2	75 7	76 5	77	76 7	75 2	74 5	74 2
10 ft	78	78 3	79 3	79 5	79 2	78 2	77 5	77	76 2	76 2	76 5	77	76 7	75 2	74 5	74 3
15 ft	77 5	78 3	78 3	78	79 2	78 2	75 5	77	76 2	75 6	76 5		77	75 2	75 1 74 5	74 3
20 ft	74	78	78 5	77 2	78	77 7	77 5	77	76 2	75 6	76	76 5	76 5	74 9	74 3	74 3
25 ft	73	75	74	74	74	75 5	75 3	74 8	76 2	76	75 2	75 5	74 4	72 3	73 6	73 8
30 ft	70	69 7	69 5	70	70 2	69 8	70 2	70 5	70 5	70 7	70 2	72	71	68 5	72. 1 70.5	69 3
32 5 ft																66
35 ft	64 5	64 7	63 7	64	64 5	65 5	63 7	64 2	64 2	65 6	64 7	64 7	66	61	62 5	62
40 ft	59 2	59 1	59 2	60 5	59 5	59 5	59 7	58 7	59 8	60 1	59 7	59 2	60	57 5	57 2	57 2
50 ft	54 6	55	54 8	55	54	54 5	54 7	54 5	54 5	54 7	54 8	54 6	55	52 5	55 52 5	52 7
60 ft	52	52	52 5	52	52 5	52 5	52 7	52 4	51 6	52 5	52 3	51 5	53	51 5	51 3	51 3
70 ft	52	51 8	51 7	51	52	52	51 8	51 7	50 7	51 7	52	52	52 2	51	50 8	51
80 ft	51 5	51 3	51 7	51	51 5	51 7	51 8	51 7	50 7	51 7	51 7	51 9	52 1	50 7	50 7	50 7
85 ft	51 5	51	51 3	51	51 5	51 7	51 5			51 7	52	51 9	52 2	50 5	50 2	50 7

SERIAL TEMPERATURES TAKEN IN THE DEEP HOLE, AUGUST 1899

Depth	Date															
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
Air	71 5	71 5	76 5	76	72	83	71	83	72 5	72 3	71 7	74	72	74 2	73	
Surface	75 4	76 7	77 3	77 7	77	76 5	76 5	76 5	76 5	76 3	75 5	77	76 5	77 2	75 7	
5 ft	74 5	76 7	77 3	77 7	77	76 5	76 7	76 5	76 5	76 3	76 5	77	76 5	77 2	75	
10 ft	74 5	75 1	74 7	77 6	77	76 3	76 7	76 3	76 5	76 3	76 3	77	76 7	77	75	
15 ft	74 5	74 4	74	74	76 5	76 5	76 5	76 5	76 5	76 3	76 3	76 5	76 5	77	74 7	
20 ft	74 7	74	73 4	73	75	74 7	75	74 7	75	75 5	75 1	75	76	76 5	73 5	
25 ft	73 5	73 5	72 2	71 7	73	73	73 3	73	73 2	73	73 7	73 3	73 5	73 5	71	
30 ft	71 5	70 5	69 5	69 4	70 5	70 2	70	70 2	70	69 2	69 5	69 5	70	70 7	67 3	
32 5 ft	65 5		64 5	64 5	66	64 8	65 7	64 8	66 5	65	66 7	66 3	66 5	65 5	63 2	
35 ft	61 5	61 5	61	61 5	59 5	60 8	62	60 8	62 7	62	61 2	63 2	63 2	62 2	60 3	
40 ft	57 2	57 2	56 8	57 2	56	56 5	57	56 5	58	57 6	57 6	57	56 7	57	55 8	
50 ft	53 1	53	51 3	52	52 4	52	52 7	52	52 4	52 2	52 5	52 5	51 7	52 5	50 7	
60 ft	51 5	51 5	50 3	50 5	50 5	50 4	50 7	50 4	51	50 8	51	50 7	51	51 5	49 5	
70 ft	51 3	51	50	49 5	50	50	50 4	50	50 5	50 4	50 5	50 5	50 7	51	49	
80 ft	51	50 5	50	49 5	50	49 9	50 2	49 9	50	50 2	50 2	50 5	50 5	51	49	
85 ft	50 7	50 5	49 7	49 3	50	49 5	50 2	49 5	50	50	50	50	50 2	50 5[2]	48 7[3]	

[1] Thermometer.

[2] Deep sea thermometer gave surface 76° and bottom 52.°

[3] Deep sea thermometer gave surface 78 5° and bottom 52°

SERIAL TEMPERATURES TAKEN IN THE DEEP HOLE, SEPTEMBER 1899

Depth	Date																											
	4	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	19	20	21	22	23	24	25	26	27	28	30
Air	73 5	77 6	75	65	79	73	70 5	68 5	62	61	61	63 5	57	50 5	56	68	71	64	60 2	51.5	62	58.5	61.4	56	51 5	48	55	53
Surface	75 8	76 3	77	75 5	76 5	75 5	74	74 5	73 5	72 5	72	68 5	69 5	70	70	68 6	69	69	67 3	66	66	65 5		67	65 5	62 5	57	59
5 ft	75 8	76	77	75 5	76	75 5	74	74 5	73	72 5	72	68 5	69 5	70	70	68 6	69	69	67	66	66	65 5		67	66 5	64 5	57	58
10 ft	75 8	76	76 5	75 5	75 6	74 5	74	74 5	73	72 5	72	68 5	69 5	70	70	68 6	69	69	67	66	65 8			66 5	66	64 5	57	54
15 ft	75		75 5	74 5	75	74	74	74 5	73	72 5	72	68 5	69 5	70	70	68 6	69	69	67	66	65 8			66 5	65	64 5	57	54
20 ft	73		73 2	74	74 5	73	74	73 5	73	72 2	72	68 5	69 5	70	70	68 5	68 9	69	67	66	65 8			66 5	64 5	64	57	54
25 ft	72		70 6	72 2	73 5	72 5	73	72	73	72 2	72	68 5	69 5	70	70	68 5	68 5	68 6	67	66	65 8			66 5	64 5	58	57	54
30 ft	68 8		66 2	64 8	69 5	67	68	68	69	69 5	71	68	68 5	70	70	68	68	68 6	67	66	65			67	63 5	58		54
32 5 ft	63 8		63 3	64	64	63	63	64 5	65 5	65 5	66 5	66	67	69	68 5	67	67	67 7	67	66	64 8			66	63 5	58		54
35 ft	62		59	58 7	61	60 3	59	61	62	62 5	62 5	63	64	66 5	67	66	66	66 7	66 5	66	64 8			66	63 5	55		52
40 ft	56 5		54 8	55 9	56	57	55	56 5	56	56 5	55 5	55 5	57	61	60 5	59 5	58 5	62 5	63	63 5	63 5			65 5	63 5	55		52
50 ft	51		50	51	51	51	50 5	51	51 5	52 5	51 2	51	52	54 5	53 7	53	53	53 5	54 2	53 5	54			56	55	52		52
60 ft	50		48 8	49 9	49 5	51	49	50	50	50 5	50	50	50	53	52 7	52	51 5	52 3	52 1	52 3	52			54	53	45 5		51
70 ft	49 8		48 6	49 9	49	50 5	48 5	49 5	49 7	50 2	49 5	49	50	52	52	51 4	51 4	52	51 5	51 8	51 9			52 5	51 5	45 5		
80 ft	49 5		48 6	49	49	50 5	48 5	49 5	49 7	50	49 2	49	49 5	52	52	51 3	51 3	52	51 5	51 7	51 8			52	50 5	45		
85 ft	49		48 4	47	49	50 5	48 5	49 5	49.7	49 7	49 2	49	49 5	52	51 7	51	51 3	52	51 5	51 5	51 5			53	50 5	42 5		

SERIAL TEMPERATURES TAKEN IN THE DEEP HOLE, JULY, 1900

Depth	Date														
	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Air		69 5°	72°	76 3°	65°	77°	79 5°	81 2°	78°	68°	69 5	69°	76°	74°	79°
Surface	77 1°	76 3	77	78	76 6	77 5	79	80 3	78 1	77 2	77	77	78	78	78 7
5 ft		76 3	77	78	77	77 5	79 5	80 5	78 1	77 5	77	77	78	78	78 8
10 ft	77 1	76 3	77	78 5	77	78	78 1	80 1	78 1	78	77	77	78	78	78 5
15 ft		76 3	77 1	77 9	77	77 2	77	77 1	78	77 8	77	77	77 6	78	78 3
20 ft	77 1	76 3	77	77 1	77	76 9	76 8	76 6	76 3	77 5	77	76 8	76 1	76 4	77
25 ft		75 8	76	76	75	75 5	76	75 9	76	76	76 2	75 2	75 5	76	75 6
30 ft	72	74	74	73 2	72	73 1	72	73 6	72 8	71 5	71	72 1	73	71	72 2
32 5 ft		67	69	70	70	69	68 6	71 3	67	68	68 5	68	67 5	67 3	68 8
35 ft	62	63	64 5	63 5	66 5	65 6	66	68 9	62 2	61 5	63	64	62 8	65	63 2
40 ft	57 3	58 5	57 7	57 4	58	58 8	58 3	58	56 6	57	57	56 8	57	57	57 1
45 ft		55 5	55	55 5	55 8	55	55	55	54	54 6	54 5	53 9	53 8	54 3	54 6
50 ft	52 3	52 8	53 8	54	53	53 3	53	53	52 1	52 3	52 5	52	52	52 6	52 8
55 ft		51 8	51 5	52	51 6	52 3	52	52	51	51	51	51	51	51	51
60 ft	50 5	51	50 9	51	50 7	51 1	50 9	51 1	50 5	50 5	50 6	50 5	50 5	50 5	50 5
65 ft		50 9	50 8	50	50 9	51	50 1	50 5	50 7	50 5	50 6	50 5	50 3	50	50 3
70 ft	50	50	50 3	50	50	50	50 2	50	50	50 5	50 4	50 4	50	50	50
75 ft		49 9	49 9	49 9	50	50	50 2	50	50	50	50 2	50 1	50	50	50
80 ft	50	49 9	49 7	49 9	49 9	50	49 8	50 2	50	50	50	50	49 8	50	49 8
85 ft	49 5	49	49 2	49 7	49 5	49 2	49 1	49 3	49 8	50	49 4	49 3	49 5	49 2	49 5

SERIAL TEMPERATURES TAKEN IN THE DEEP HOLE, AUGUST, 1900

	Date															
	1	3	4	6	8	9	11	13	15	17	18	20	22	24	25	30
Air	73°	73°	73°	83 5°	81°	82°	85°	77°	73 2°	78 5°	76 2°	80°	80°	76 5°	85°	79 8°
Surface	78	78	78 1	81 8	82 4	82 8	83	81	79 8	78 9	78 2	80	80 8	80 2	80 1	80
5 ft	78 1	78	78 1	81 8	82 4	82 8	83	81	79 8	78 5	78 2	79 7	80 8	80	80 1	80
10 ft	78	78	78 1	79 8	82 2	82 8	82 5	81	79 8	78 5	78 2	79 5	80 5	80	80 1	80
15 ft	78	78	78	78 2	79 2	79 5	82	80 8	79 8	78 5	78 2	79 8	80 3	80	80	79 5
20 ft	76 5	77	77 6	77 5	77 5	77 5	77 6	80 3	79 8	78 8	78 2	79 1	79 2	80	80	78 8
25 ft	75 6	76 4	76	76	76	76 2	75 7	75 7	76 8	77	76 6	77 2	76 9	77 5	79 5	78
30 ft	73 2	73	72 5	72	70 5	70 1	70 5	72 3	.	72 1	72 1	71	71 5	73	71 5	73
32 5 ft	67 6	68 6	68 5	68	68 5	69 2	69 5	68		67 1	68	68 3		68	68 5	70
35 ft	64 1	63 2	64	63 9	62 5	64 2	63 5	64		64 6	63 3	65 7	64	64	66 9	66
40 ft	58	57 2	57 9	57	58	58	58	59		58 3	60	59 8	59 9	60 3	61	59 8
45 ft	54 6	55 5	55	54 5	54 5	54 5	55	55		55 5	56	56	56	57	57	56
50 ft	52 6	52	53	52 5	52 1	52 2	52 8	52 6		53	54 2	53 5	54	54 2	54 1	54 3
55 ft	51	51 2	51	51 3	51 1	51 2	51 2	51 5		52	51 5	52 5	52 8	52 8	52 5	53
60 ft	51	51	51	50 8	50 6	50 7	50 6	51		51 5	51	52	52 3	52	52 5	52 2
65 ft	50 1	50 8	50 1	50 3	50 5	50 4	50 5	50 8		51	50 7	51 5	51 8	51 5	52	51
70 ft	50 2	50 5	50 1	50 1	50	50	50 5	50 3		51	50 6	51 2	51 7	51 2	51 8	51 8
75 ft	50	50 2	50	50	50	50	50	50 3		50 5	50 3	51	51 3	51 3	52	51 6
80 ft	49 9	50	50	50	50	50	50	50		50 3	50	51	50 8	51	51 6	51
85 ft	49 5	49 5	49 8	49 8	49 8	49 9	49 9	49 8		49 8	49 9	50 1	50 2	51	51	51

SERIAL TEMPERATURES TAKEN IN THE DEEP HOLE, SEPTEMBER, 1900

Depth	Date								
	1	3	5	12	14	22	24	26	28
Air	82 5°	77 5°	86 5°	68	79°	68°	63°	76	70 5
Surface	80 1	79 8	79	76	75	67 1	67 2	70 2	68 5
5 ft	80	79 8	79 1	76	75	67 4	67 2	70	68 5
10 ft	79 9	79 2	79	76	75	67 4	67 2	69	68 2
15 ft	79 7	78 5	79	75 8	75	67 2	67 2	69	68 1
20 ft	79 4	78 2	79	75 8	75	67 2	67 2	68 7	68
25 ft	78	78 2	79	75 6	74 9	67	67	69	67 8
30 ft	73	75 4	75 6	74 5	74 5	67	66 8	68	67 8
32 5 ft	69	71	70 5	73 9	74	67	66 8		
35 ft	65 2	65 2	65	73 5	73	66 9	66 8	67 9	67
40 ft	60 3	60	60 1	64 5	64 2	66 5	66 6	67 6	67
45 ft	57	57	57					64 5	66
50 ft	54 8	54 3	54 5	54 6	54 5	55 1	56 5	58 5	57 9
52 5 ft								55	54 1
55 ft	53	53 2	53 5			53 6	53 2	53 3	53 5
60 ft	52	52 5	52 5	52 9	52 4	52 9	52 7	53 3	52 5
65 ft	51 5	52	52		52	52			52 4
70 ft	51 5	52	51 5	51 9	51 6	52	51 9		52
75 ft	51 8	51 7	51 3			52	51 7		51 6
80 ft	51 6	51 7	51 1	51 4	51 5	51 5	51 7		51 4
85 ft	51 5	51 5	51	51 1	51 9	51 5	51 3		51 4
89 ft	50 8	50 9	50 8	Bottom temperatures					

SERIAL TEMPERATURES TAKEN IN THE DEEP HOLE, OCTOBER, 1900

Depth	Date													
	1	3	5	8	10	12	15	17	19	22	24	26	29	31
Air	72 5°	72°	75 9°	54 1°	54 5°	59 5°	63°	47 6°	52°	62 9°	56 6°	64 5°	64°	62°
Surface	73	67 5	68 8	67 6	66	65 2	64 9	63	61	61 5	61 2	61 5	61 8	62 5
5 ft	67 9	67 5	69 5	68	66	65 3	64 9	63 5	62 5	61 4	61 2	61 5	61 8	62 5
10 ft	67 8	67 5	69 1	67 9	66	65 3	64 8	63 4	62 3	61 3	61 2	61 5	61 8	62 5
15 ft	67 5	67 5	67 8	67 9	66	65 3	64 8	63 3	62 3	61 3	61 2	61 4	61 8	62 5
20 ft	67 5	67 3	67 2	67 9	66	65 3	64 8	63 3	62 3	61 2	61 2	61 4	61 7	62 5
25 ft	67 4	67 1	66 9	67 8	66	65 3	64 6	63 3	62 3	61 2	61 2	61 3	61 7	62 3
30 ft	67	66 9	66 9	67 6	66	65 2	64 5	63 3	62 3	61 2	61 2	61	61 3	62
35 ft	67	66 7	66 8	67	66	65 2	64 5	63 3	62 3	61 2	61 2	61	61 3	61 9
40 ft	66 5	66 5	66 4	66 7	66	65	64 3	63 3	62 3	61 2	61 1	61	61 1	61 2
45 ft	66	66 1	65 5	66 6	66	65	64	63 1	62	61 2	61 1	61	61	61
50 ft	59	57 6	58	60 6	61 7	62	62 7	62	61 5	61 2	61	61	60 7	60 7
52 5 ft	55	55	55 3	57 1	57 5	56 9	58	61	61 2					
55 ft	54 5	53 5	54	54 9	54 3	54 4	54 1	56 9	59	61 2	60 7	60 8	60 4	60 3
59 5 ft										58 3	51 2	59 4	60 1	59 9
60 ft	52 5	53	52 3	52 9	52 9	52 9	53	52 8	53	53 2	52 3	57 4	58	56 8
65 ft	52 5	52	52	52 2	52 1	52 1	52 2	52 3	52 1	53 1	52	52 3	52 3	52 5
70 ft	52	52	51 9	52	52	52	51 9	52	52	52	52	52	52	52
75 ft	51 5	51 6	52 2	52	51 9	51 9	51 9	52	52	52	51 8	52	52	51 9
80 ft	51 5	51 6	51 3	51 6	51 9	51 9	51 8	51 9	51 8	51 9	51 7	51 8	51 7	51 7
85 ft	51 5	51 5	51 9	51 6	51 8	51 5	51 1	51 6	51 5	51 5	51 2	51 6	51 5	51 5

SERIAL TEMPERATURES TAKEN IN THE DEEP HOLE, NOVEMBER, 1900

Depth	Date						
	2	5	9	19	23	26	29
Air	75°	52 9°	45°	51°	36 8°	36.2°	31 5°
Surface	62	49 9	54	45 9	46 7	44	42 9
5 ft	61 3	59 3	54	45 9	46 7	44	42 9
10 ft	61 3	59 3	54	45 9	46 7	44	43
15 ft	61	59 3	54	45 9	46 6	44	42 9
20 ft	61 3	59 3	54	45 9	46 5	44	42 9
25 ft	61	59 3	54	45 9	46 5	44	42 9
30 ft	61	59 2	54	45 8	46 5	44	42 9
35 ft	60 9	59 1	54	45 5	46 7	44	42 9
40 ft	60 5	59 1	54	45 8	46 4	44	42 9
45 ft	60 5	59 1	53 9	46	46 3	44	42 9
50 ft	60	59 1	53 8	46	46 2	44	42 9
55 ft	60	59	53 7	45 8	46 2	44	42 9
60 ft	59 8	58 8	53 7	45 7	46 2	44	42 9
62 5 ft	58	58 5					
65 ft	56 5	58 4	53 7	45 8	46 2	44	42 9
70 ft	52 4	54	53 3	45.8	46 2	44	42 5
75 ft	52	52	53 3	45 8	46 2	44	42.5
80 ft	52	51 9	53 1	45 8	46 2	44	42 5
85 ft	51 5	51 9	53	46 3	46 2	44	42 5

SERIAL TEMPERATURES TAKEN IN THE DEEP HOLE, DECEMBER, 1900

Date	Date							
	1	3	5	8	11	13	15	17
Air	39 9°	47°	36 5°	36 2°	29 5°	30°	25°	38 9°
Surface	41 7	41 7	41	40 3	38	36 2	34 9	34
5 ft	41 8	41 8	41	40 3	38	36 1	35	34
10 ft	41 7	41 6	41	40 5	38	36 1	35	34
15 ft	41 7	41 6	41	40 1	38	36 5	35	34
20 ft	41 7	41 6	41	40 3	38	36 1	35	34.1
25 ft	41 9	41 7	41	40 3	37	36 1	35	34 4
30 ft	41 7	41 3	41	40 3	37 2	36 1	35 5	34 4
35 ft	41 7	41 3	41	40 3	37	36 5	35 7	34 4
40 ft	41 7	41 2	41	40 8	37 5	36 1	35 3	35
45 ft	41 7	41 3	41 1	40 3	37 4	36 3	36	34 8
50 ft	41 8	41 3	41	41	37 6	37	35 5	34 8
55 ft	41 8	41 4	41	40 2	37 7	37	36	35
60 ft	41 8	41 3	41	41	38	36 4	35 6	35 1
65 ft	41 8	41 3	41	41 3	38 1	36 5	35 7	34 9
70 ft	41 8	41 3	41		37 8	37 5	35 7	35
75 ft	41 8	41 2	41		38		38 8	35
80 ft	41 8	41 3	42		37 9		36	35
85 ft	41 8	42			39		37	36

[1] Bottom at 62 feet.

[2] Certain slight anomalies in the temperature readings occur in our records, but we believe the records as here given cannot be far from correct.

SERIAL TEMPERATURES TAKEN IN THE DEEP HOLE, JANUARY, 1901

Depth	Date						
	1	4	7	9	18	26	30
Air	23.1°	41°	32.1°	32°	16.5°	23.9°	24.9°
Surface	34	34.5	33.7	34	33.1	34.2	33.1
5 ft.	34.1	34.5	34.6	34.8	35.1	36.2	36.7
10 ft	34	34.5	34.6	35.1	35.7	36.3	36.2
15 ft.	34.2	34.5	35	35.3	36	36.2	36.5
20 ft.	34.2	35	35	35.4	35.5	36.3	36.5
25 ft.	34.6	34.5	35.2	37.	35.4	36.3	37
30 ft.	34.5	34.5	35.1	35.5	35.5	36.5	37
35 ft.	34.6	34.7	35.2	35	35.8	36.7	37.1
40 ft.	34.8	34.9	35.7	37.5	35.9	36.9	37.7
45 ft.	34.9	34.6	37	37.2	36	37	37.8
50 ft.	34.9	35.2	36	37.3	36	37	38
55 ft.	34.9	35.3	36	35.5	36	37.1	38
60 ft.	35	35.4	36	36.1	36.2	37.2	37.8
65 ft.	35	35.5	36	36.2	36.4	37.2	37.9
70 ft.	35.3	35.8	35.3	36.2	36.5	37.3	37.3
75 ft.	35.4	35.3	36.3	37.2	36.9	37	37.5
80 ft.	35	35.4	37.6	36	36.8	37	37.5
85 ft.	37	37	37.2	37.5	38.1	38.8	38.3

SERIAL TEMPERATURES TAKEN IN THE DEEP HOLE, FEBRUARY, 1901

Depth	Date				
	5	8	16	25	27
Air	24.9°	26.8	22.5°	36.8°	27.5
Surface	33.7	34	32.3	33	32.3
5 ft.	36.9	37	36	36.3	36
10 ft.	37.9	36.5	36.9	36.4	37
15 ft.	37	36.5	36.9	36.5	37.5
20 ft	36.7	38.2	37.1	37.3	37.9
25 ft	37	37	37.1	38	37.4
30 ft	37	37.1	37.2	38	38
35 ft	37.2	37.3	37.2	37.7	37.7
40 ft	38	37.5	37.3	38.3	38
45 ft	38	38	37.8	37.9	38
50 ft	37.5	38.1	37.8	38.5	38
55 ft	37.7	37.8	38.2	38.3	38
60 ft.	37.5	38	37.9	38.6	38
65 ft	37.4	38.1	37.9	37.9	37.9
70 ft	38	37.5	37.9	38.1	38
75 ft	37.7	37.7	38.4	38.1	38.1
80 ft	38.2	38.5	38.8	38.8	38.9
85 ft.	38.2	39	39	38.9	41.3

SERIAL TEMPERATURES TAKEN IN THE DEEP HOLE, MARCH, 1901

Depth	Date						
	1	4	7	9	14	26	28
Air	31 9°	36°	36 5°	34 5°	30°	42 3°	31 5°
Surface	32 9	32 9	32 3	33 1	32 8	40 1	39 8
5 ft	36 9	37	37 3	37 9	38 5	40 1	40
10 ft	36 8	37 5	37 5	37 8	38 9	40 5	40 2
15 ft	37 3	37 6	37 5	37 9	38	40 5	39 9
20 ft	37 9	37 3	37 7	37 9	38	40 5	40
25 ft	38	37 3	37 6	38 1	38 1	40 5	39 9
30 ft	37 6	38	37 7	38 3	38	40	40
35 ft	37 7	37 7	38	38 3	38	40 3	40
40 ft	37 9	38 1	38	38 7	38	40 4	41 8
45 ft	38	38	38	38 7	38 9	40	40
50 ft	38	38 5	38	39	39	40 3	40 1
55 ft	38	38 2	38	38	38 1	40 1	42 3
60 ft	38	38 1	38	38	38	39 9	40
65 ft	38	38 5	38 1	38 3	39	40 4	39
70 ft	38	39	38 4	38	38 8	39 9	40
75 ft	38 2	38 1	38 1	39 3	40	40	40
80 ft	38 4	39	39	39		40 4	40
85 ft	40 1	40 4	40 1	40 2			40

SERIAL TEMPERATURES TAKEN IN THE DEEP HOLE, APRIL, 1901

Depth	Date								
	1	3	8	10	15	22	24	26	29
Air	37°	39 2°	42°	49 5°	49°	50°	57 7°	63 8°	77 5°
Surface	39 3	39 5	42	42 9	45	45	46	49 8	59
5 ft	39 3	39 5	42	42 8	45	45	46	49	55 1
10 ft	39 3	39 6	42 2	42 8	45 9	45	45 1	47 6	52 8
15 ft	39 9	40	42 2	43	46 5	44 9	45 8	46 9	50 1
20 ft	39 9	39 5	42	42 5	45	44 8	46	46 8	47 5
25 ft	39 5	40	42 2	42 6	44 3	44 8	45 6	46 8	47
30 ft	39 5	39 5	42 6	42 6	46 2	45	45	46 1	46 5
35 ft	41 2	39 5	42	42 9	45 9	45 1	45 6	46	46
40 ft	41 7	39 4	42 2	43	44 2	44 8	45 7	46	46
45 ft	41 7	39 6	42	42 9	44 3	45 1	45 6	45 8	45 9
50 ft	39 4	39 5	42	42 5	44	44 8	45 9	45 5	46
55 ft	39 3	39 5		43	44	44 7	45 1	45 5	45 3
60 ft	39 4	40		42 9	44	44 7	45 1	45 4	45 2
65 ft	39 4	40		42 4	43 3	44 6	45 5	45 3	45 2
70 ft	39 4	39 5		42 4	43 5	45	45	45 8	45 6
75 ft	39 2	40		42 3	43 1	44 7	45 1	45 1	45 7
80 ft	41 5	40		42 7	43 4		45 5	45 1	45 2
85 ft	39 6	40		39	43		45	45	44 8

SERIAL TEMPERATURES TAKEN IN THE DEEP HOLE, MAY, 1901

Depth	Dates								
	4	7	13	15	17	22	24	28	30
Air	76 9°	67°	61°	78°	77 6°	58°	58°	56 5°	57°
Surface	61	63	60	66	68 5	61	62 5	58 2	58
5 ft	61	63 1	60 1	61	63 9	61	62 5	58 9	58 3
10 ft	60 9	63 4	60	60	62	61 1	63	58 2	58
15 ft	60 4	62	59 5	59 1	60	61 4	63	58 8	57 8
20 ft	56 1	56 5	60 6	59 4	59	61 3	63	58 8	57 9
25 ft	50 5	56 4	56 8	58 1	57 2	61 2	63	58	57 1
30 ft	47 5	48 6	49 9	50 1	51 3	52 3	54	58	57
35 ft	47 1	47 3	49	50 2	49	49 2	50 6	54 5	56 5
40 ft	47	47 4	18	49 7	48 2	48 9	49 9	50 3	50 9
45 ft	46 6	46 5	49	47 9	47 3	47 9	49	49	48 9
50 ft	46	46 1	46 8	47 5	47 5	47 9	47 5	48 5	48
55 ft	46	46 2	46 4	46 8	47	47 1	47 5	47 5	47 9
60 ft	45 5	45 5	47	46 3	46 5	47	47	47 1	47
65 ft	46	45 5	46 5	47	47	46 9	46 8	46 9	47
70 ft	45 3	45 9	46 5	46 1	46	47	46 9	46 5	47
75 ft	45 9	45 4	46	46 5	46	46 6	46 8	46 5	47
80 ft	45 3	46	46	46 3	46 5	47 6	46 7	46 5	46 9
85 ft	45 1	45 6		45 9	46	46 3	46 2	46 5	46 6

SERIAL TEMPERATURES TAKEN IN THE DEEP HOLE, JUNE, 1901

Depth	Dates											
	1	3	6	8	10	12	17	19	21	24	26	28
Air	66°	65 3°	67°	54 5°	66 2°	89 5°	74°	83°	77 9°	83 5	83	88 2°
Surface	59 5	60 9	65 5	63 5	65	79 6	76	80	76 9	78 8	82	83
5 ft	59 5	61	65 5	63 5	64 8	72 5	76 1	75 5	77	78 3	82 5	83
10 ft	60	61 1	65 7	64	65 1	69	76	74 9	77	78 2	80 8	83
15 ft	59 7	61	64 2	63 4	64 9	66 5	68 6	71 5	75 9	78	77 1	82 9
20 ft	59	60 2	64	63 2	61	64 5	66 1	66	66 5	67 1	68	67 2
25 ft	58 3	58 8	60	61 9	62 8	62	62 8	62	62 3	61 6	63	62
30 ft	57 9	57 3	58	57 6	59 4	58 7	59	58 1	58 1	58	58	58 9
35 ft	57	55 9	56 2	54 8	54 1	54 8	54 9	54 5	55 6	55 6	55 5	55 6
40 ft	49 9	52 3	53	52	52	52 3	53 5	52	53 2	53	54	53 5
45 ft	49	50	52 1	50 9	50 2	51	50 9	51	50 9	52	51 9	52
50 ft	48 4	48 1	51 6	49 3	49 8	50	50	51	50	50 2	50 1	51
55 ft	48	47 9	51	52 8	48 6	49	50	49 5	49 3	49 9	50 5	50 4
60 ft	49	47 8	48 2	48 2	48 3	48 3	49	49	49 9	49 2	49 5	49 7
65 ft	47	47 1	47 8	48	48 2	48 5	48 8	48 6	49	49	49 1	49 2
70 ft	47	47 5	47 5	48 2	48	48	49	48 1	48 8	48 9	49	49
75 ft	47 5	47	47 5	48	47 9	48 3	48 2	48 2	49	48 8	49 1	49
80 ft	47	47	47 5	47 8	47 9	48	48 1	48 1	49	48 5	49	49
85 ft		46 9	47	47 3	47 3	48 1	48 5	48	48	48 1	48 8	49

SERIAL TEMPERATURES AT THE DEEP HOLE, LAKE MAXINKUCKEE, JULY—SEPTEMBER, 1899

Depth	July			August			September		
	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.
Surface.	80 5°	77 0°	79 2°	79 5°	74 0°	76 7°	77 0°	66 0°	72 1°
5 ft	80 8	77 0	79 3	79 5	74 2	76 8	77 0	66 0	72 0
10 ft	81 0	77 0	79 2	79 5	74 3	76 7	76 5	66 0	71 9
15 ft	80.2	76 5	78 3	79 2	74 0	76 3	75 5	66 0	71 3
20 ft	78 0	74 7	75 7	78 2	73 0	75 6	74 5	66 0	71 0
25 ft	74 0	72 0	72 8	76 2	71 0	73 8	73 5	66 0	70 5
30 ft	71 0	69 0	69 7	72 0	67 3	70 0	71 0	64 8	68 2
32 5 ft	..	..	..	66 7	63 2	65 4	69 0	63 0	65 7
35 ft	69 5	63 0	64 7	66 0	60 3	62 9	67 0	58 7	63 1
40 ft.	63 0	57 3	58 7	60 5	55 8	58 1	63 5	54 8	57 9
50 ft.	57 5	52 5	53 2	55 5	50 7	53 3	54 5	50 0	52 1
60 ft	52 5	50 5	51 7	53 0	49 5	51 5	53 0	48 8	50 8
70 ft	51 8	50 5	51 2	52 2	49 0	51 0	52 0	48 5	50 3
80 ft	51 7	50 3	50 9	52 1	49 0	50 8	52 0	49 5	50 2
85 ft	51 3	50 5	50 8	52 2	48 7	50 6	52 0	48 4	50 1

Moonlight on Lake Maxinkuckee.

SERIAL TEMPERATURES AT THE DEEP HOLE, LAKE MAXINKUCKEE, JULY—DECEMBER, 1900

	July			August			September			October			November			December		
Depth	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.
Air	81 2°	65 0°	73 9°	85 0°	73 0°	78 3°	86 5°	70 5°	74 6°	75 9°	47 6°	61 5°	75 0°	31 5°	45 9°	39 9°	25 0°	36 1°
Water																		
Surface	80 3	76 3	77 7	83 0	78 0	80 2	80 1	67 2	73 7	73 0	61 2	64 7	62 0	42 9	49 3	41 7	34 0	38 5
5 ft	80 5	76 3	77 9	83 0	78 0	80 1	80 0	67 2	73 7	69 5	61 2	64 5	61 3	42 9	50 6	41 8	34 0	38 5
10 ft	80 1	76 3	77 8	82 8	78 0	79 9	79 9	67 2	73 4	69 1	61 2	64 4	61 3	43 0	50 6	41 7	34 0	38 5
15 ft	78 3	76 3	77 3	82 0	78 0	79 3	79 7	67 2	73 3	67 9	61 2	64 3	61 0	43 0	50 5	41 7	34 0	38 5
20 ft	77 5	76 1	76 8	80 3	76 5	78 5	79 4	67 2	73 2	67 9	61 2	64 2	61 3	42 9	50 6	41 7	34 1	38 4
25 ft	76 2	75 0	75 8	79 5	75 4	76 7	79 0	67 0	72 9	67 8	61 2	64 2	61 0	42 9	50 5	42 0	34 4	38 5
30 ft	74 0	71 0	72 5	73 2	70 1	71 9	75 6	66 8	71 4	67 6	61 0	64 0	61 0	42 9	50 5	41 7	34 4	38 4
32 5 ft	71 3	67 0	68 6	70 0	67 1	68 4	74 0	66 8	70 3									
35 ft	68 9	61 5	64 1	66 9	62 5	64 3	73 5	65 2	67 8	67 0	61 0	64 0	60 9	42 9	50 4	41 7	34 1	38 5
40 ft	58 8	56 6	57 5	61 0	57 0	58 8	67 7	60 0	64 1	66 7	61 0	63 8	60 5	42 9	50 4	41 7	35 0	38 6
45 ft	55 8	53 5	54 7	57 0	54 5	55 5	66 0	57 0	61 9	66 0	61 0	63 5	60 5	42 9	50 4	41 7	34 8	38 6
50 ft	54 1	52 0	52 9	54 3	52 0	53 1	58 5	54 3	55 6	62 7	58 0	60 7	60 0	42 9	50 3	41 8	34 8	38 7
55 ft	52 3	51 0	51 4	53 0	51 0	51 8	53 6	53 0	53 3	61 2	53 5	57 1	60 0	42 9	50 2	41 8	35 0	38 8
60 ft	51 1	50 5	50 7	52 5	50 6	51 3	52 9	52 0	52 6	58 0	52 3	53 8	59 8	42 9	50 2	41 8	35 1	38 8
65 ft	51 0	50 0	50 5	52 0	50 1	50 9	52 4	51 5	52 0	52 5	52 0	52 2	58 4	42 9	49 6	41 8	31 9	38 5
70 ft	50 5	50 0	50 1	51 8	50 0	50 7	52 0	51 5	51 8	52 0	51 9	52 0	54 0	42 5	48 3	41 8	35 0	38 6
75 ft	50 2	49 9	50 0	52 0	50 0	50 6	52 0	51 3	51 7	52 2	51 5	51 9	53 3	42 5	48 0	41 8	35 0	39 3
80 ft	50 2	49 7	49 9	51 6	49 9	50 4	51 7	51 1	51 5	51 9	51 3	51 7	53 1	42 5	47 9	41 8	35 0	39 0
85 ft	50 0	49 0	49 5	51 0	49 5	50 1	51 9	51 0	51 4	51 9	51 1	51 5	53 0	42 5	47 9	41 8	36 0	39 2

SERIAL TEMPERATURES AT THE DEEP HOLE, LAKE MAXINKUCKEE, JANUARY—JUNE, 1901

	January			February			March			April			May			June		
Depth	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.
Air	41 0°	16 5°	27 6°	36 8°	22 5°	27 7°	42 3°	26 5°	33 2°	77 5°	37 0°	53 0°	78 0°	56 5°	59 0°	89 5°	54 5°	74 0°
Water																		
Surface	34 5	33 1	33 8	34 0	32 3	33 1	40 1	32 3	34 8	59 0	39 0	45 8	68 5	58 0	62 0	83 0	59 5	72 6
5 ft	36 7	34 1	35 1	37 0	36 0	36 4	40 1	36 9	38 2	55 1	39 3	45 2	63 9	58 3	61 1	83 0	59 5	71 6
10 ft	36 3	34 0	35 0	37 9	36 4	36 9	40 5	36 8	38 5	52 8	39 3	44 8	63 0	58 0	60 7	83 0	60 0	71 2
15 ft	36 5	34 2	35 7	37 5	36 5	36 9	40 5	37 3	38 4	50 1	39 9	44 6	63 0	57 8	60 3	82 9	59 7	69 5
20 ft	36 5	34 2	35 6	38 2	36 7	37 4	40 5	37 3	38 5	47 5	39 5	44 0	63 0	56 1	59 2	68 0	59 0	64 6
25 ft	37 0	34 5	35 7	38 0	37 0	37 5	40 5	37 3	38 5	47 0	39 5	43 8	63 0	50 5	57 6	63 0	58 3	61 5
30 ft	37 0	34 5	35 5	38 0	37 0	37 5	40 0	37 6	38 5	46 5	39 5	43 8	58 0	47 5	52 2	59 0	57 3	58 3
35 ft	37 4	34 6	35 6	37 7	37 2	37 4	40 3	37 7	38 6	46 0	39 5	44 0	56 5	47 1	50 4	54 0	54 1	55 4
40 ft	37 7	34 8	36 2	38 0	37 3	37 8	41 8	37 9	39 0	46 0	39 4	43 9	50 9	47 0	48 9	54 0	49 9	52 6
45 ft	37 8	34 6	36 4	38 0	37 8	37 9	40 0	38 0	38 8	45 9	39 6	43 9	49 0	46 5	48 0	52 1	49 0	51 0
50 ft	38 0	34 9	36 3	38 5	37 5	38 0	40 3	38 0	39 0	46 0	39 4	43 4	48 5	46 0	47 3	51 6	48 1	50 0
55 ft	38 0	34 9	36 2	38 3	37 7	38 0	42 3	38 0	38 9	46 3	39 3	43 4	47 9	46 0	46 9	52 8	47 9	49 7
60 ft	37 8	35 0	36 2	38 6	37 5	38 0	40 0	38 0	38 6	45 4	39 4	43 3	47 1	45 5	46 5	49 9	47 8	48 8
65 ft	37 9	35 0	36 3	38 1	37 4	37 8	40 4	38 0	38 8	45 5	39 4	43 2	47 0	45 5	46 6	49 2	47 0	48 4
70 ft	37 3	35 3	36 2	38 1	37 5	37 9	40 0	38 0	38 9	45 8	39 4	43 3	47 0	45 3	46 3	49 0	47 0	48 3
75 ft	37 5	35 3	36 5	38 4	37 7	38 0	40 0	38 1	39 1	45 7	39 2	43 2	47 0	45 4	46 3	49 1	47 0	48 2
80 ft	37 6	35 0	36 5	38 9	38 2	38 6	40 4	38 4	39 3	45 5	40 0	43 3	47 6	45 3	46 4	49 0	47 0	48 1
85 ft	38 8	37 0	37 7	41 3	38 2	39 3	40 4	40 0	40 2	45 0	39 6	42 3	46 6	45 1	46 0	49 0	46 9	47 9

The Kettlehole:—Similar observations were made at the Kettlehole in July, August, and September, 1899, and again in the same months in 1900. The records are shown in the tables on the following pages. The highest surface temperatures recorded at the Kettlehole was 83.2° on August 7 and 22, 1900, the lowest temperature 48.5° at 40 feet on September 8, 1899. The maximum difference between surface and bottom was 31.9°.

SERIAL TEMPERATURES TAKEN AT THE KETTLEHOLE, LAKE MAXINKUCKEE

Depth	Date									
	July 28, 1899	July 30, 1899	Aug. 3, 1899	Aug. 7, 1899	Sept. 4, 1899	Sept. 8, 1899	Sept 19 1899	July 16, 7:15-9:30 a.m. 1:00	July 17, 10:40-11:30 a.m. 1:00	July 21, 3 p m 1:00
Air					80°	70.5°	57.5°			
Surface	80.7°	79°	79.2°	78°	76.5°	74	68	77°	76°	78.9
5 ft.	80.5	78.5	79.5	77.5	76.5	74	68			
10 ft.	80.5	78.5	78.4	77.5	74.5	74	68	76.5	76	76.8
15 ft	78.3	77.3	77.2	76.8	73.5	74	68			
20 ft.	71.5	72.5	73.6	74	70.5	72.5	67.5	72	74	74
25 ft.	66	64.3	64.2	66	60.5	61	66			
30 ft.	57.3	56.5	56.7	57.1	53.5	53.5	56.3	56.5	59	59
35 ft.	53	52.5	51.2	52.5[1] 50	51.5[1] 50.5	54[1] 51.7				
40 ft.	50.6	50.5	50.7	50.5	49	48.5	50.5	53	50	51
44 ft.	49.6 Light rain and S. E. wind, strong at times.	50 Light North breeze	49.7			Wind from North; lake very rough.				

[1] At 32.5 feet.

SERIAL TEMPERATURES TAKEN AT THE KETTLEHOLE, LAKE MAXINKUCKEE

Depth	Date								
	July 23, 1900 4:10-5 p. m.	July 27, 1900 4:00-4:45 p.	July 30, 1900 10:00-10:50 a.	July 31, 1900 10:10-10:50 a.	Aug. 7, 1900 3:05-3:40 p.	Aug. 16, 1900 7:30-8:40 a.	Aug. 22, 1900 3:55-4.30 p.	Sept. 14, 1900 1:30 p.	Sept. 22, 1900 4-5:30 p.
Air			76°	83 0°		70°		86°	
Surface	83 0°	79°	79 5	79	83 2°	78	83 2°	76 5	69 3°
5 ft								76	67 5
10 ft	77 9	77	77	78 5	79 2	77 9	80 8	75 4	67
15 ft								75	66 6
20 ft	74 2	73 3	75	74.5	75	76 5	77 6	74 3	66 6
25 ft		66 7	67 4	68 4		67 1		73	65.2
30 ft	59	58	58	58 8	58 2	59	59 2	63 3	65
35 ft						50.5		[1] 58	56
								54	
40 ft	51 1	50 9 Sky hazy; wind S. E. slight waves.	50 7	50 4	50 8 Scattered Clouds; S. W. wind; slight waves.	Cloudy N. E. wind; slight waves.	51 3 Scattered clouds; S. E. wind; moderate waves.	52 8 Hazy; threatening rain; S. E. breeze.	54 Very light S. W. breeze.

[1] At 32.5 feet.

MISCELLANEOUS TEMPERATURES TAKEN AT THE KETTLEHOLE, JULY 25, 1899

Depth	Temperatures
Surface	79 5°
1 ft	79 5
2 ft	79 6
3 ft	79 7
4 ft	80
5 ft	79 9
6 ft	
7 ft	
23 ft	62 [1]
35 ft	50 5 [2]
	52 0 [3]
42 ft	50.5 [4]

[1] 20 oar strokes northwest of Kettlehole.
[2] 10 oar strokes northwest of the Kettlehole.
[3] 10 oar strokes north of the Kettlehole.
[4] 10 oar strokes west of the Kettlehole.

Temperatures taken at the Sugarloaf:—A few temperatures were taken at the Sugarloaf. On Algust 26, 1899, the surface was 76.5°, and the bottom 76.3° at 10 feet. On August 9, 1900 (9:55 to 10:15 a. m.), the water on the Sugarloaf was 9.75 feet deep. The temperature at the surface was 82.8°, and at the bot-

tom 82.2°. On August 13, at 10:45 a. m., when the air was 79.8°, the surface was 81.2°, and the bottom 80.8° at 10 feet. On August 20, at 10:30 a. m., the surface was 80.7° and the bottom 80° at 10 feet.

Miscellaneous temperature records:—On July 18, 1899, the following records were made at a plankton station by Messrs. Scovell and Juday, at certain places having the depths indicated:

Depth in Feet	Temperatures	
	Surface	Bottom
30	77°	70°
50	77	67
70	77	52.5
70	77	51.5

On July 18, 1899, a series of surface and bottom temperatures was taken on a line from near the end of Long Point toward the Maxinkuckee road, the last being in the Deep Hole where a regular observation station was then established:

Depth in Feet	Temperatures	
	Surface	Bottom
14	75.2°	75.7°
19		75.2
29	75.2	73
35.5	75.5	69.5
37	75	62
45	75.2	55
58	75.2	52.7
69	75	52
71	75.1	51
75	75.2	51.1
69	76	51.5
89.5	76	51

On August 26, 1899, the following temperatures were obtained with the thermophone on a line between Long Point and the ice houses: surface, 76.8°; at 10 feet, 76.3°; at 20 feet, 75.2°; at 30 feet, 69.5°; at 38 feet (bottom), 59.8°.

On August 19, 1899 (from 8:30 a.m. to 1:30 p.m.), the following thermophone readings were obtained on a line starting opposite the Gravelpit and running east, making a station every 15 oar strokes:

Depth in Feet	Temperature		Notes
	Surface	Bottom	
0 5	77 5°	77 5°	Began at 8:30 a. m.; air in sun 82°.
4 5	77	76 5	
7 5	76	76	
21 0	77	72 5	
9 0	77	75	
4 5	77	76 5	
6 0	77	76 5	
6 0	77	76 5	
6 0	77 5	76 5	
6 0	77 5	76 5	
6 0	77 5	76 5	
6 0	77 5	77	
7 5	77 5	77	
6 0	77 5	76 75	
6 75	77 5	75 5	
7 5	77 5	76	
45	77 5	56	
45	78	58	
55	78 5	52 5	10:40 a. m.
55	78 5	54 5	
55	78	55	
57	78	56 5	
51	78	53 5	
54	77 5	53 2	11:30 a. m.
57	78	52 75	3:15 p. m.
52 5	78	53	
48	78	54 5	
10 5	78	74 5	
10 5	78 5	74	
10 5	78 3	74	
9 0	78 5	74 5	
9 0	79	76	
6 0	79	78	
5 0	79 5	79	
2 75	80	79	
50	83 5	83 5	4:00 p. m. East shore, 570 strokes.

TEMPERATURES TAKEN AT PLANKTON STATION No. 3

Depth in Feet	Temperature July 30, 1900, 11–11:45 a. m.	Temperature August 16, 1900, 8:20–9:30 a. m.
Air	82 8°	74°
Surface	79 8	78 5
10 ft	78	78 9
20 ft. . .	76 5	78 1
30 ft. .	74	72
32 5 ft	69 5	. .
35 ft	61 1	63.8
40 ft	58 6	59 1
42.5 ft	56	. .

THE FOLLOWING TEMPERATURES WERE RECORDED SEPTEMBER 28, 1899

Station	Depth in Feet	Temperature	Notes
1	6	59°	Air at 8:15 a. m. 63°.
2	36	59	Surface temperature at noon, 62°.
3	30	59	
4	34	59.5	
5	28	60	
6	6	59.5	
7	12	60	
8	56	60.5	
9	50	60.5	
10	50	61	
11	50	60	

On August 14, 1900, the following temperatures were taken in Aubeenaubee Creek, between 2:30 and 4 p.m.: Near head of creek, 63°; 10 rods lower down, 66.2°; 50 rods lower down, 68°.

On August 21, 1900, between 8:10 and 11 a.m., the following temperatures were taken in Culver Creek: At bend of creek just east of the Academy grounds, 69°; at bridge at east edge of Academy grounds, 70.2°; just below the bridge, 70.5°, at bridge in Academy grounds, 71.5°; at mouth of creek, 76.5°.

Turning over of the lake:—Perhaps the most interesting phenomenon connected with such bodies of water as Lake Maxinkuckee is the "turning over" which may occur each fall. This can be understood from a consideration of a selected few of the daily serial temperatures. The greatest density of fresh water is reached when the water has attained a temperature of 39.2°. When the temperature goes below 39.2° it begins to expand, and freezes at 32°. When the temperature rises above 39.2° it also begins to expand and continues to do so, however warm the water may become. As water expands its weight decreases. In other words, above the point of greatest density, the weight of water varies inversely with its temperature, the higher the temperature the lighter the water. A cubic foot of water at a temperature of 80° weighs less than a cubic foot of water at 50°.* On July 24, 1900, the surface temperature was 80.3°. From the surface downward the temperature was successively lower until, at the bottom, it was 49.3°, or 31° colder than the surface. A column of water in that part of the lake on that date, one inch square and equal in length to the depth of the lake, 89 feet, may be likened to a column of metal which increases slightly and uniformly in size and weight

*A cubic foot of fresh water at 50° Fahr. weighs 62.331893 pounds; at 80° it weighs 62.186012 pounds, a difference of 2.331096 ounces.

from surface to bottom. So long as the upper end is lighter than the lower, the column will remain upright. But if the metal column should be reversed, bringing the heavy end up and the light end down, any slight disturbance would cause it to reverse itself and again assume the more stable position with the heavier end down. The same is true of the column of water. So long as the colder, heavier water is at the bottom, it will so remain; but let the upper end of the column become the colder and, consequently, the heavier, it will go down, and the lighter bottom water will come up. That is precisely what does happen. If the series of temperatures from July 21 onward be examined it will be observed that the difference between the surface and bottom temperatures becomes successively less. By the 23d of November, 1900, the difference was only .5 of a degree, the surface being 46.7° and the bottom 46.2°. Sometime between the 23d and the 26th, probably on the night of the 24th, the temperature throughout the upper half of the column fell below 46°, or lower than that of the lower end of the column. The upper half of the column then being the heavier, it of necessity went to the bottom, the bottom half came up, and the temperature of the lake became uniform throughout. This is shown by the serial temperature readings of November 26, which show that the temperature at all depths from top to bottom was 44°, a condition which practically continued until the ice went off. It can therefore be safely assumed that, in 1900, Lake Maxinkuckee "turned over" some time between the evening of November 23 and the morning of the 26th; and what occurred then, in all probability, occurs every November or December.

The highest surface temperature recorded at the Deep Hole was 83° on August 11, 1900, the bottom temperature at the same time being 49.9°, the difference between surface and bottom being 33.1°. The lowest summer bottom temperature obtained in the Deep Hole was 48.7° on August 31, 1899; the lowest recorded at the Kettlehole was 48.5° on September 8, 1899.

CONDITION OF THE WATER

Clearness:—The water of Lake Maxinkuckee is generally commented upon by visitors, and boasted about by the natives, on account of its clearness and purity.

After a long sojourn at Winona Lake, Indiana, paying particular attention to the lake, a visit to Lake Maxinkuckee excited a marked sensation of surprise at the clearness of the water; in Winona Lake it was somewhat tea-color; at Lake Maxinkuckee,

at considerable depths, it exhibited an indescribable play of transparent green, something like that of an opal in some lights.

Unfortunately, we have not a long series of records taken under different conditions the year round which would give an absolute test, and if there were such records, it would be difficult to find a large number of other lakes with records with which it might be compared. On September 20, 1907, when the sky was well clouded over, a secchi disk was visible at 9 feet. The same disk at Holem Lake, of the Twin Lakes, Indiana, on September 23, 1907, when the sky was bright and clear, was visible at 13 feet, and at Cook Lake, another of the Twin Lakes, under the same conditions, at the same depth. At Lake Mendota, Minn., September 18, 1907, with a cloudy sky, the same disk was visible at a depth of 6½ feet.

One might, indeed, take as a measure of the clearness of the water, the depth at which green plants grow in the lake, the chief limiting factor in this case being the depth to which light penetrates. The lower limit of plant life in the lake is about 25 feet.

A remarkable feature of the water is its freedom from mud. Even after heavy rains the inlets bring in but little water, and because of the general absence of clay, they bring in but little mud even when they have the swiftest current. Strong winds may make the water turbid near shore, and on one occasion, in the autumn of 1900, the whole lake was rendered slightly turbid by a long continued wind and rough lake, but in all cases the lake soon settles clear. During the winter of 1900-1901, the *Chara* and *Potamogeton robbinsii* showed up so clearly through several feet of water and clear ice that they impressed a very excellent image on a photographic plate, and the experience of traveling over this clear ice and seeing the fine meadows in the bottom, with the turtles and gars and dogfish resting quietly or moving slowly about, impresses one with the great opportunity offered along the lines of a new field of photography, that of subaqueous landscapes.

Any one looking down in the water on a calm, bright day and studying it attentively will note small flecks or motes, the number of these differing in different seasons of the year and in different lakes. These motes usually represent low algal forms which make up the phyto-plankton of the lake. In Winona Lake this suspended matter was so abundant that the sun's rays lighted up the particles in long lines, as in the familiar phenomenon of the light entering a slit in a dark, dusty room, or the "sun drawing water." In some cases the algæ forming these motes have colonies of sufficiently characteristic shape to be recognizable, but generally not. *Lyngbya* has the appearance of short hair clippings; *Clathrocystis* has the

appearance of minute smoke rings; *Aphanizomenon*, which is rare in our Indiana lakes but is common in some northern Minnesota lakes and in the Mississippi River, is easily recognizable, as rather large, green colonies, acute at each end, much like the little duckweed, *Wolffiella*. *Anabaena*, the most common alga of Lake Maxinkuckee, has no definite form. In Lake Maxinkuckee it is rare that great areas are covered with algal scum, though there are sometimes rather long stretches in sheltered bays. The plankton scum usually makes its first appearance about the end of July and continues on calm days until freezing.

The entire lake surface is not frequently calm for longer intervals than a day; June, July and August are generally the calmer months. The surface is generally rippled, usually pretty rough, during the spring and later autumn. Periods of calm during the morning and evening are frequent the year round during fine weather.

Chemical condition:—An important feature of the water is its chemical condition. A chemical examination of the water was made by Prof. Chancey Juday of the University of Wisconsin. The test for hardness used was Siler's method, in which a coal tar product, methyl orange, is used to color the water. The amount of hydrochloric acid necessary to turn it faintly pink indicates the hardness.

The test used for oxygen was Winkler's method given in Sutton's Volumetric Analysis, and is as follows:

1. Add manganous chloride.
2. Add KOH + KI = a precipitate with brown, if oxygen is present.
3. Add Conc. HCl.—dissolves precipitate. If oxygen is not present the liquid is clear. If oxygen is present it is yellowish or brownish. It may now be left several days.
4. To determine *amount of oxygen*, titrate with hypo, 1/80 normal, using (cooked) starch as an indicator. The amount of hypo required to clear up the blue caused by addition of starch is an index to the amount of oxygen. In the following tables, prepared by Prof. Juday, is shown the character of the water.

Both the CO_2 and the oxygen are expressed in cubic centimeters per liter of water. The full face figures indicate the amount of the alkalinity, i. e., it would require that number of cubic centimeters of free CO_2 to make the water neutral. The light face figures in the column marked free CO_2 indicate the acidity. Calcium and magnesium are found in water almost entirely as bicarbonates, and chemists regard the CO_2 as half-bound or bicarbonate CO_2, and bound or carbonate CO_2, so we have indicated them in this way on the tables. In neutral or acid water they are regarded as

equal in amount, but in alkaline water the bound or carbonate CO_2 is in excess of the half-bound. The results of the investigation showed that the water of the lake was softer than that of the well (Chadwick's) with which it was compared; also that the difference between the Kettlehole and the main lake is a curious and interesting thing. They differ as widely as if they were separate lakes and not connected in any way. A further study of them would prove very interesting. In the main lake the excess of alkalinity extends to a depth of 8 meters (26¼ feet). At 9 meters (29½ feet) the water is neutral, below which point it is increasingly acid. The Kettlehole shows less alkalinity at the surface and a much more rapidly increasing acidity at the bottom. In the lake the oxygen decreases rapidly from the surface down to the 13 (43½ feet) meter depth below which there is no free oxygen. In the Kettlehole the free oxygen disappears at 10 meters (32⅘ feet). The free oxygen is more abundant in the surface water of Lake Maxinkuckee than in any of the Indiana lakes with which it was compared, and extends to a considerably greater depth, being found down to 12 (39⅓ feet) meters in Lake Maxinkuckee, 9 meters (29½ feet) at the Kettlehole, 8 meters (26¼ feet) at Cook Lake, 6 meters (19½ feet) at Holem Lake, and disappearing at the 13 meters (43½ feet) in Lake Mendota, Minn.

CHEMICAL CHARACTER OF THE WATER OF LAKE MAXINKUCKEE

Station I, in the Deep Hole, Sept. 20, 1907, 2:30 to 4:40 p. m.
Sky chiefly cloudy.
Wind, rather strong southwest, falling toward evening; a few whitecaps.
Secchi disk visible at depth of 9 feet.

Meters	Depth in Feet	Temperature	Carbon Dioxide			Oxygen
			Free	Bicarb.	Carb.	
0	0	72°	3 8	20 7	24 5	6 3
3	10				24 5	6 3
5	17	72	3 6	20 9	24 5	6 1
7	23	71	3 0	21 5	24 5	5 5
8	26 25	67 5	1 1	23 7	24 8	4 0
9	30		Neutral	25 8	25 8	2 7
10	33	66	0 1	25 8	25 8	2 2
11	36		1 4	25 9	25 9	1 3
12	39	64	2 5	26 8	26 8	0 4
13	42 5	59 5	2 9	28 0	28 0	0 0
14	46			30 9	30 9	0 0
15	49	59	3 2	31 3	31 3	0 0
17½	57 4		3 7	31 3	31 3	0 0
20	67 6	58	3 9	31 4	31 4	0 0
22½	74		4 7			0 0
25	82		5 3	31 6	31 6	0 0
25½	84	57				0 0

CHEMICAL CHARACTER OF THE WATER OF LAKE MAXINKUCKEE

Station, Kettle hole, September 24, 1907, a. m.
Sky, cloudy in west.
Wind, fresh, south; moderate waves.

Meters	Depth, feet	Temperature	Carbon Dioxide			Oxygen
			Free	Bicarb.	Carb.	
0	0	65°	2 3	24 5	26 8	4.9
5	17 4	64 6	2 1	24 7	26 8	4 9
7	23 0	64	..	..	..	..
9	29 5	61 7	3 7	32 2	32 2	0 06
10	32 8	58 6	7 8	38 2	38 2	0 0
11	36 0	57 5	8 6	40 0	40 0	0 0
11½	37 7	56 6	..	..	..	..

For purpose of comparison we give the results of similar oxygen tests made by Professor Juday, at certain other lakes.

CHEMICAL CHARACTER OF THE WATER IN COOK LAKE, INDIANA

September 23, 1907, 10:30—11:30 a. m.
Sky, clear.
Wind, brisk, west breeze.
Secchi disk visible at depth of 13 feet.

Meters	Depth in feet	Temperature	Carbon Dioxide			Oxygen
			Free	Bicarb.	Carb.	
0	0	68 5	0 5	34 6	34 6	5 07
4	13	68 7	0 7			5 1
5	16 4	67 3	1 5	34 9	34 9	4.4
6	19 7	64 7	2 0	..		3 8
7	23	62	2 5	35 2	35 2	1 8
8	26 25	57	3 8	35 9	35 9	0 13
9	29 5	55 6	5 3	35 9	35 9	0 0
10	33	49 5		37 6	37 6	0 0
12	39 4		7 5	40 7	40 7	0 0
14	46		7 5	41 0	41 0	0 0
14½	47	47 5	..	..	..	0 0

CHEMICAL CHARACTER OF THE WATER IN HOLEM LAKE, INDIANA

September 23, 1907, 1:45—2:30 p. m.
Sky, clear.
Wind, strong, west breeze.
Secchi disk visible at depth of 13 feet.

Meters	Depth in feet	Temperature	Carbon Dioxide			Oxygen
			Free	Bicarb.	Carb.	
0	0	69°	1 2	35 5	35 5	4 7
3	10		..	..	..	4 7
5	16 40	69	2 0	35 6	35 6	4 75
6	19 68	65 5	6 0	40 6	40 6	0 04
7	23	59	10 0	41 0	41 0	0 0
8	26	..	18 7	58 8	58 8	0 0
8¼	27	53	..	..	..	0 0

CHEMICAL CHARACTER OF THE WATER IN LAKE MENDOTA, WISCONSIN

Station II, September 18, 1907, 9–11 a. m.
Sky, cloudy; rain.
Wind, light breeze from the south.
Secchi disk visible at depth of 6.5 feet.

Meters	Depth in feet	Temperature	Carbon Dioxide			Oxygen
			Free	Bicarb.	Carb.	
0	0	68°	5 0	28 1	33 1	6 0
5	16 40	67 6	1 3			5 8
8	26 25	67	3 7	29 6	33 3	5 5
10	32 80	66				
11	36 00		2 0	31 6	33 6	4 0
12	39 36	65 3	1 5	32 1	33 6	3 5
13	45 64	63 5	0 75	33 6	33 6	1 8
14	49 0	59	3 00	34 9	34 9	0 0
15	52 00	57	3 50	35 7	35 7	0 0
17	56 00	56	4 30	35 7	35 7	0 0
20	65 60		5 80	36 4	36 4	0 0
21½	70 5		7 00	37 9	37 9	0 0
22	72 2	54				

DEFICIENT IN OXYGEN ONLY FOR A BRIEF PERIOD EACH YEAR

Investigations have shown that Lake Maxinkuckee is deficient in oxygen only during a period of perhaps two months in the fall. The reason for this deficiency is a very interesting one and not difficult to understand. It may be briefly stated as follows: Lake Maxinkuckee furnishes an environment exceptionally favorable to the rapid growth and development of a multitude of species of minute animal and plant life which together constitute the plankton of the lake. These animals and plants, entomostracans and other minute animals (zoo-plankton), and algæ of many species (phyto-plankton), literally swarm in the lake, reproducing with such marvelous rapidity that they would soon fill the lake, converting it into a thick soup, were it not for the fact that millions upon millions of individuals die every day, their dead bodies slowly sinking to the bottom of the lake where they slowly oxidize and disintegrate. This accumulation of dead plankton goes on during the spring and summer; oxidation is doubtless most rapid in later summer and early fall; the oxygen required in the process must necessarily come from the supply contained in the water nearest at hand. This drain upon the absorbed oxygen of the waters in the deeper parts of the lake must inevitably, sooner or later, exhaust the supply, and this condition of exhausted or reduced oxygen content will remain until the winds and storms of late fall and early winter and temperature changes result in thoroughly mixing the waters

f the lake and carrying of oxygen to the deepest parts. In this manner the entire lake will become fully supplied with oxygen early in the winter and so remain until the next fall when the accumulation on the lake bottom of dead animals and plants which have been showering from the upper layers all spring and summer again exhausts the supply and the lower strata again become devoid of oxygen.

This matter has been quite thoroughly worked out on several lakes by Messrs. Birge and Juday of the University of Wisconsin, and the importance of the knowledge thus obtained can scarcely be overestimated.

The important fact disclosed is that the waters of some lakes at certain periods in the year are practically without oxygen below certain depths.

As fishes are dependent for the oxygen they require upon the absorbed oxygen contained in the water it is evident that water containing no absorbed oxygen cannot support fish life. In order that a lake may be suitable for the deeper freshwater fishes it is necessary that the water in the depths shall contain an adequate supply of absorbed oxygen at all times. A lake may have an abundant supply of oxygen at all depths for ten or eleven months of the year, but if the supply is inadequate for one month or even a briefer period, the deepwater fishes will perish unless, perchance, they are of species that can adapt themselves to shallower depths. But few, if any, of our important freshwater fishes possess that ability. Keeping that fact in mind it is now easily understood why certain lakes, otherwise suitable, do not contain any deepwater species such as lake trout, whitefish or lake herring.

During the past 30 years the Federal Government and various States have spent thousands of dollars in making plants of whitefish, lake herring and lake trout in lakes many of which we now know to be deficient in oxygen during at least a portion of the year. Lake Maxinkuckee is included in this list, four large consignments of lake trout having been placed in it in 1890 to 1894. We now understand why nothing was ever seen of the fish after they were liberated in the lake.

In the past millions upon millions of fish have been planted in the lakes and streams of the United States and usually without any scientific investigation whatever for the purpose of determining whether the waters were suitable for the fish which it was proposed to plant in them. The result is that hundreds of thousands of dollars have been spent and millions of fish wasted without any results of value being obtained.

No stream or lake should be stocked with fish until it has been carefully studied by a competent biologist and found to possess the conditions or factors of a favorable environment for the fish which it is proposed to introduce. Fish culturists should adopt this principle and adhere to it as an invariable policy. The rule-of-thumb, cut-and-try method so uniformly followed has brought no credit to fish culture in America.

ICE

Introduction

It is not until one has watched the coming of the ice over the lake several times and during several winters, that he realizes how much variety there can be in that apparently simple process, and how far from correct it would be to judge the behavior of the ice one winter from having seen it during another.

The freezing over of Lost Lake is always about the same. That body of water, being of comparatively small size and shallow depth, readily freezes over the first severe night after the whole mass of water has become chilled down to near the freezing point, and we usually have a smooth clear sheet of ice spread over its surface rather early in the winter. This sheet being transparent, does not greatly alter the appearance of the lake; indeed, on one occasion we saw a duck in the middle of this lake on the slippery ice one evening after it had frozen over, it probably having mistaken the clear ice for open water.

Lake Maxinkuckee, with its greater area and volume of water, cools down much more slowly, and usually has ice simply skirting its edges by the time Lost Lake is completely frozen over. If the weather continues steadily calm and cold, the lake freezes over rather quickly, although it usually takes several days even of the most favorable weather for the lake to freeze entirely over, as its surface is always more or less disturbed by winds, some pools in various places toward the center usually persisting open for a few days. If, on the other hand, the weather in early winter is rough and windy, the freezing of the lake is much delayed and is a slow and long continued process—full of interesting details, resembling in many respects the freezing of large lakes, such as Lake Michigan. The winter of 1900-1901 was just such a blustery winter and gave opportunity to study the ice formation in great detail.

The ice first forms in sheltered calm places and any object that breaks the wind or tends to calm the water tends to the formation of a sheet of ice. Thus ice appears early not only along the shore

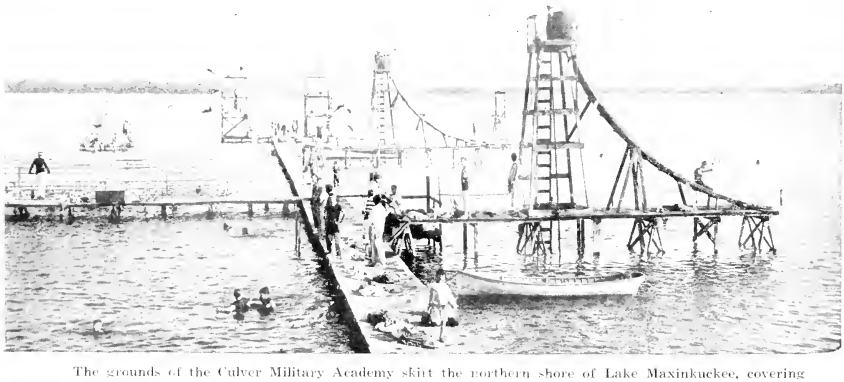
in sheltered bays, but also around any projecting body in the water —a stake, or a patch of bulrushes or pondweeds. Usually the formation of ice proceeds from day to day in a more or less orderly manner from these nuclei to the middle of the lake until the whole is frozen, but in the above-mentioned winter, the ice sheets formed in sheltered places during moments of calm.

Our first regular observation of the ice phenomena at Lake Maxinkuckee began in the fall of 1899. Previous to that time, however, occasional observations, made and recorded by Mr. S. S. Chadwick and by Mr. Samuel B. Medbourn of the Medbourn Ice Company, have been kindly communicated to us by those gentlemen.

The remarkable clearness and purity of the water of Lake Maxinkuckee and the thickness to which the ice freezes, give a very high quality to the ice made from it, and Lake Maxinkuckee ice has always had an enviable reputation for purity and enduring qualities.

The operations required in taking out the vast quantities of ice each winter keep a changing portion of the lake on the west side more or less open for brief intervals in different places, and this has its effect on the plant and animal life of the lake.

Our original plans contemplated a careful study of the ice in all its more important relations to the various species of animals and plants inhabiting the lake, but lack of time prevented such study of many of the phenomena as the importance of the subject justified.



The grounds of the Culver Military Academy skirt the northern shore of Lake Maxinkuckee, covering a tract of 500 acres.

The ice phenomena of the lake, including the formation, thawing, expansion and contraction, forming of ice-beaches and so on, present more or less variety from year to year. In the two years the phenomena were studied there was a wide difference in them, so that different details confidently looked for from previous experience were surprisingly discounted.

Every year, the small body, Lost Lake, freezes over much sooner than the larger lake, and usually freezes over as a smooth sheet of ice, in a single night.

During the winter of 1900-1901, cold weather came on rather suddenly and the weather was rough and windy, so that, though the surface water became quite cold, the wind kept it from freezing except in the form of ice-needles which drifted up at first on the shore in high, conical snow-white masses, which at a distance looked like frozen foam, but which revealed on closer examination an entirely different structure from foam. The surface of the water near shore on the windward side of the lake, was covered with slush ice, composed of long needle-shaped crystals, which, as they were jostled together by the choppy waves, made a cheerful musical sound, like the rustling of dried hay. At other times during momentary bits of calm, or in protected bays, a thin sheet of clear solid ice would be put out from shore, soon to be broken into bits by the wind. These, constantly moved among each other by the waves, produced a musical continuous clinking, like glasses struck together, or at other times larger masses in more violent motion produced a far-heard rumbling like a heavy farm wagon rattling along a road. The bits of ice blown up against the shore gouged the shore considerably and shoved considerable sand before them in places, although finally the result of such gouging was neither conspicuous nor permanent.

As to the final freezing over of the lake, in 1900-1901, the first stage from shore was formed by the needle-shaped crystals already mentioned, these forming concretions around centers, making circular patches from about the size of a dinner plate to several feet across, and these finally drifted together and the becalmed water of the interstices froze, thus cementing the whole together into a solid mass.

From this time on, during moments of comparative calm, stretches of rather smooth clear ice would form out toward the center of the lake, the inner margin of which would soon be more or less chopped up and broken by waves during more windy periods, and then would occur another advantage of calm and cold, another concentric ring of ice would be formed, another attack of

storm and wind on the weak-edged with a line of chopped ice, so that finally the limit of each freezing period was marked by a ring of choppy ice, and the stages of freezing could be counted, like the growth-rings of a tree as seen on a stump. Apparently a sudden coming on of cold reduces the surface temperature greatly without allowing much chance for convection and the water under the ice continues tolerably warm all winter. The large lake was very slow in freezing over, and a few holes remained open quite late, being kept open by winds and by the flocks of ducks which congregated there in great numbers.

Ice on Lake Maxinkuckee:—The earliest appearance of ice as noted in our records was on October 12, 1907, when ice was observed on boards in low places. This was evidently merely frozen dew. On the 22d, ice was seen on Green's marsh and on the boat slip at Outlet Bay. This was observed again on the 23d, 27th, 28th and 29th. In 1906, on October 31, ice was seen in a leaky boat and along the south shore in shallow quiet water. These are our only October records.

For November, in 1899, the first ice was noted on the 12th, when it remained all day in favorable places. In November, 1900, there was a thin fringe along the shore on the 14th, and on the 16th it was frozen out from shore about 4 feet. On the 30th there was a fringe along the south shore, $\frac{1}{4}$ to $\frac{1}{2}$ inch thick and extending out usually 10 to 30 feet. Just west of Norris Inlet two broad points ran out about 200 feet. From this and subsequent observations it is believed that it is on that part of the lake that permanent ice first forms. In 1902, the first freeze was on November 25. In 1904, ice was first noted on November 6, and on the 11th and 21st there was some along the south shore of Outlet Bay, remaining in the boat slip all day. On the 13th, 14th and 16th it was on the boat slip all day; on the 17th there was a thin skirt along the shore, and a little appeared each morning thereafter until the 27th when there was a good deal off the ice houses and in similar situations. On the 28th ice skirted the shore pretty generally, but not far out. In 1898, in December, the ice was one inch thick all over the lake except at the Deep Hole; on the 8th and 9th it was all over the lake and 3 inches thick, and on the 14th it was frozen solid and 7.5 inches thick.

In 1899, in December, it was 1.25 inches thick on the 26th along shore. In December, 1900, on the 10th ice extended out about 50 feet from the end of the Chadwick pier, and about 200 feet out on east side of Long Point. At many places there was only a narrow irregular fringe, with occasional air holes. In places the

ice was choppy. On the 11th snow covered the ice which was grinding and tolerably loud at the south end. On the 12th there was considerable ice, particularly in Outlet Bay and off the ice-houses where it extended out in long sharp points, an unusually long sharp blade extended off Long Point to the northeast. There was a broad fringe along the east side of Long Point and large ice islands around stakes in Outlet Bay and southeast of Shady Point cottage. A brisk wind ground up all the ice except that near the shore north of Long Point, the breaking up being accompanied by considerable rattling and clinking. Ice-chips, small and clear, were thrown up on the north shore near the railroad station with a great roar. By noon all the ice in front of Shady Point cottage had disappeared. Before breaking up the ice was $\frac{3}{4}$ inch thick at the shore and $\frac{5}{8}$ inch thick at end of pier at Shady Point.

The next day a peculiar slush ice formed in front of Shady Point, consisting of circular or oval discs of needle-shaped crystals drifting together and freezing. On the 15th this ice, very rough but weak, extended out more than 100 feet. By the 19th the lake was frozen entirely over except a considerable area in the center and extending well toward the south end.

On the 20th the lake was frozen nearly all over—only a considerable pond in the middle. The ice all around the lake, especially on the west side, was very rough, and would hold one up only 60 to 70 feet out. There was a great deal of clear drift ice, the thickness of window glass, piled up along the east shore. It plowed and heaped up the sand a good deal, making a small ice-ridge. This was not caused by expansion but by the ice being blown up against the sand.

On the 21st the ice was pretty solid out for some distance. The only open water was in parallel north and south strips near the center. In Outlet Bay one could walk out about 400 to 500 feet, but the ice was weak on the east side of Long Point.

On the 22d there was a good deal of water on the ice, and the open spaces enlarged appreciably. On the 23d a strong wind began breaking the ice and piling it up on shore at Culver Bay on the 24th.

On the 28th the lake was again frozen irregularly, with open spaces toward the center. One could walk out in front of the Gravelpit about 600 feet. At one place one could walk within a foot of the open water, so strong was the ice. On the 29th the ice was moving and jamming up some against the shore. At night it was somewhat noisy. In 1901, the first record in December regarding the condition of the ice was made on the 15th, to the effect

that the lake was frozen nearly over. On the 16th the ice was 3 inches thick; on the 18th, 4.5 inches; the 19th, 5.5 to 6 inches, and entirely frozen over; the 20th, 6 inches; the 21st, 7 inches; the 22d, 8.5 inches; and the 23d, 9 inches. On the 24th it began melting and by the 31st was only 8 inches thick. In 1902, the only December records are for the 10th, the lake freezing, and the 14th, when the air at 6 p. m. was 20°, Lost Lake frozen over, but Lake Maxinkuckee still open. In 1904 there are several December records. On the 1st to 3d, the lake was rough and ice cakes were forming. On the 4th and 5th considerable stretches along the shore were frozen, but none along the north shore. On the 6th it was drifting up on the east side and on the 8th it softened and melted some, though it was strong enough to bear up in Outlet Bay. On the 9th it was torn up by waves at the south end. On the 10th Outlet Bay was firm enough to walk over, and by the 13th the lake was all frozen over except several scattered pools filled with ducks and coots. On the 14th, only three or four long open pools left, and these were filled mostly with coots, only a few ducks being left. The ice was clear, only one-half inch thick some distance from shore. On the 15th all the lake except two small pools was frozen over. These pools were full of coots which no doubt helped to keep them open. There were many cracks in Outlet Bay. On the 16th only one pool was left open. The next day the ice company had teams on the lake, scraping the snow off the ice, which was 5 inches thick. On the 18th the last open pool closed. The heavy snow on the ice weighed it down and forced a good deal of water to come up through a large crack that ran from Long Point southeast. On the 21st the ice was cracking and pushing up the shore at Long Point. On the 23d the ice was rotten and melted a good deal; there were many small air holes, and on the 25th there were many open places north and east of Long Point.

We have one record for January, 1893. On the 5th the lake was frozen over 9 inches thick except in a few air holes and cracks caused by expanding ice. In January, 1899, the ice was 8 inches thick on the 1st, 9 on the 8th, 10 on the 29th, 10.5 on the 30th and 11 on the 31st. In January, 1900, it was 7 inches thick on the 1st, 8 on the 2d, 9 on the 3d, 9.25 on the 4th, 7 on the 12th, 6 on the 16th and 17th, 7½ near the ice-houses, 8 at the Norris pier and 4.5 in front of Shady Point on the 21st and very rotten, 6 on the 30th, and 8 on the 31st. On the first there were several cracks, one running off from Murray's, one off mouth of Aubeenaubee Creek, one from ice-houses to Lakeview hotel, one from the ice-

houses to Long Point, and one from Long Point northeast, this last being cooped up like the roof on a house.

There was a large crack from the south end of the lake near the Farrar cottage northward to the shore near the Academy along which the ice buckled up and then fell back by overlapping, a phenomenon which old residents had never observed before. On the 22d the lake was open in deep water and on the 24th the ice was breaking up.

In 1901, on January 1, it was cold and the ice grew very fast; on the 2d the lake was frozen over except one pool near the Deep Hole. Teams were cleaning snow off the ice near the ice-houses. On the 3d the pool was still open; this was between Long Point and the McOuat cottage and was only 18 or 20 feet in diameter. The ice was "cracking" a good deal all day and shoving up on shore and booming and rumbling at night. On the 6th there were 3 or 4 inches of water on the ice and again on the 8th when the ice was full of holes; on the 9th it was dry and clear; on the 10th it was getting rotten and breaking into cakes and by the 12th it was unsafe, but was firmer on the 13th; rotted again on the 14th, but on the 15th again became firm and showed beautiful mosaics. It sang much and loudly nearly all morning, but rotted in the afternoon. On the 18th it was 4¾ inches thick, solid and singing much. On the 19th it was 7.5 inches thick at the ice-houses. There was much noise, a sort of groaning, at night, and many new cracks were noted the next morning. On the 21st the ice was very rotten, and at night a good deal of noise, ringing sharp cracks as if the ice were giving and falling. On the 23d it melted a good deal on top, and was about 5 inches thick. On the 27th the big hole was still open; on the 28th it was 5.5 to 7 inches thick on the east side, but weak. On the 29th, 7.75 to 8 inches thick and covered with water in some places.

The January record for 1902 is brief. The ice was 8.5 inches thick on the 1st, 9 on the 3d, 10 on the 6th, 11.5 on the 16th, 12 on the 17th and 18th, 12.5 on the 20th, 13 on the 21st, 14 on the 27th and 28th, and 15 on the 31st. The lake was very low. On the 27th the ice was shoving up some on the north and east shores but not much on the west side.

In January, 1903, the ice was 5 inches thick on the 7th, 10 on the 12th, 12 on the 19th, and 13 on the 23d. The ice company began to put up ice on the 13th.

In January, 1905, the records are few. On the first, the ice was rotten and rapidly disappearing, and there was a large hole

near the center of the lake. On the 2d, it was nearly all gone east of Long Point and south to Murray's, but Outlet Bay was still covered. On the 4th the lake was again pretty well frozen over, it having grown cold on the 2d and 3d.

In January, 1906, the lake was not frozen over on the first. Later it froze over but ice was all gone by the 22d, following a week of rain.

Our first February records are for 1899, when the ice was 11.5 inches thick on the 1st, 12 on the 2d to 7th, 13 on the 8th, 16 on the 10th, 18 on the 13th, and 15 on the 27th. The next are for 1901. On the 1st the ice was groaning some; on the 4th and 5th it was much sunken by 8.5 inches of snow on it; on the 8th it was groaning again; on the 9th it was still sagging and covered with water in many places; on the 20th it was somewhat noisy and much flooded in the middle; covered with slush on the 23d and still sinking on the 24th; on the 25th much slush and ice groaning a good deal, continuing for the next two days. There was much noise again on the 28th, continuing all day.

In 1902, on February 4th the ice was about 18 inches thick; 17 inches on the 6th and 18 on the 21st. On the 25th the ice began to get dark where the snow had blown off, and in some places slush snow covered it.

In 1903, the ice was 8 to 10 inches thick on February 15, but it had been about 14 inches thick.

In 1906, on February 14, the lake was frozen over, the ice 4 to 6 inches thick, and the ice cutting beginning.

Our March records begin with 1899, when the ice was 10 inches thick on the 11th. On the 12th there was a high west wind driving the ice out from the west shore and piling it up 10 feet high on the east side. On the 22d the ice was rotten; by the 25th it had become so honeycombed that it practically all went off the lake, piling up high on shore in various places; on Long Point it was about 10 feet high, but did no damage.

In 1900, on March 1, the ice was 12 inches thick and 16 inches on the 19th. On the 22d it was open near the center of the lake. On the 25th the ice began to break up, drifting to west and northwest shores, and by 6 p. m. it was all gone.

In 1901, on March 3, the ice was free from snow and there was some water on the surface. On the 4th the air holes that were present on the 3d froze up. On the 6th there was a long crack along the west shore and on the 7th the ice was heaving and pushing on the shore on the east side. On the 8th and 9th it was quite soft and flooded; on the 11th very rotten around the edges,

tightening up again at night, and alternating weak and firm until the 25th when it all disappeared, simply breaking up and melting without piling on shore.

In 1902, the only records for March are: On the night of the 12th the ice moved southeast and piled up 10 feet high on the northwest side of Long Point, and about as high on the east shore at the Edwards cottage. All the west side was open on the 13th. On the 13th the ice left the lake with a southeast wind which piled it on shore at the depot grounds and east to the Palmer House. On the 18th some ice had frozen and piled up some on shore.

In 1903, in March, the 13th was the first warm, calm day of spring, and the ice went off very fast; all gone from Outlet Bay by 6 p. m., and all gone from shore from there to depot. The next day the wind shifted to the south and piled the ice 6 feet high at the tip of Long Point. On the 15th the wind shifted to the northeast and drove the ice into Outlet Bay and along the west shore, but doing no harm. That portion of the lake north of a line from the tip of Long Point to the Edwards cottage and east of a line from the tip of Long Point to the Assembly grounds was free of ice. Then the wind shifted again to the south and drove all the ice to the north end of the lake. By 6 p. m. the ice was all gone. As the ice was very thin no harm was done. Air at 3 p. m. 70°. On March 29 there was some ice again.

In 1905, in March, on the 25th, ice covered about three-fourths of the lake. The surface was very much decayed and broken. It went off rapidly all day and by the evening of the 26th there was only a little left in Culver Bay.

In 1907, the ice left the lake on March 17. Several days of warm rain had rotted it thoroughly and a strong southwest wind on the 16th set it in motion, broke it up, and drove it toward the northeast part of the lake, where it melted.

In 1908, the ice left the lake March 13, the day being very warm and the frogs singing.

In 1910, on March 1, it turned warm, and there was no snow or rain thereafter. On March 22 the ice left the lake. It was 20 inches thick and just rotted out. It did not drift much and no harm was done. It opened as usual on the west side from the Outlet to the depot. Air about 60°.

There are only a few ice records for April. The senior author spent April 6 and 7, 1885, at the lake, and recorded the fact that the ice was still on the lake, with a narrow strip open around the edges, especially along the south shore and at the inlet mouths.

In 1900, on April 1, the ice moved north; on the 3d it moved

southeast and piled high on shore; on the 5th it moved south; and it was all gone by the 6th. The 7th was the first pleasant day of the season, although it snowed some; it had been cold, with an east wind for a week.

In 1901, on April 1, there was some old ice and new ice had formed on the pools the previous night. On the 4th overflow water was frozen, and there was ice on the pools on the 9th. Even on the 19th and 20th there was ice on the pools.

In 1913, the ground was frozen on April 23, and on May 2 the ground and pools were frozen.

Ice on Lost Lake:—Considerable attention was paid to ice conditions on the small lake and the results are here given, in the thought that comparisons between the two lakes may prove instructive.

Ice was observed on Lost Lake in each month from October to April, both inclusive. In October, 1904, a little ice was noted on the 23d and 28th.

In November, 1899, a narrow fringe was seen about the edge of the lake. In 1900, ice froze about 4 to 7 feet out from shore just above the Bardsley cottage on the 14th, and on the 16th the lake was frozen over but not strong enough to bear one up. In front of the Bardsley cottage it was ½ to 2¼ inches thick, but was thinner elsewhere. On the night of the 17th the ice went off, but the lake was nearly frozen over again by the 27th. In November, 1904, there was a narrow fringe of ice around the lake, most of which had disappeared by the 13th. On the 28th the lake was more than half frozen over with ice strong enough to permit one to walk out a short distance. On November 14, 1906, the lake was frozen nearly over.

In December, 1899, Lost Lake was frozen over on December 6, but the ice left the lake on the 11th after 24 hours of rain. It froze again on the 15th. In 1900, it was frozen entirely over on the 10th when the ice was 1 inch thick and would bear up some distance out. Near shore the ice was choppy in places. On the 11th it was strong enough for skating. On the 12th it was 2 13 16 inches thick 30 feet from shore, and did not crack when walked across. The next day it was 3 inches thick, and loud noises were caused by the expansion in the forenoon. On the 17th the ice was about 5½ inches thick and beautifully stratified. On the 19th thin ice had frozen on top of the other, from flooded water. On the 23d the wind tore up the ice at the south end. There were many large bubbles under the ice nearly everywhere, evidently blown under by the wind. The ice was dry on top and apparently solid.

On the 28th the ice was frozen irregularly, with numerous air holes.

In December, 1901, the lake was frozen over on the 11th, and solid on the 19th, the ice being 6 inches thick. In December, 1902, Lost Lake was frozen entirely over on the 14th.

In December, 1904, Lost Lake was frozen over on the first, the ice being quite opaque. On the 2d it was 1½ inches thick and would bear up, but cracked some on the west side where it was not so thick. On the 3d the Outlet was partly frozen below the railroad bridge. On the 9th the stream below the lake was pretty well open.

In January, 1901, Lost Lake was solid on the first and 2d; on the 3d the ice was 10 inches thick and contained 9 planes of bubbles, one of which, 5.5 from the bottom, seemed to divide the whitish upper ice from the lower clearer layer. On the 10th the ice was 8 inches thick and men were cutting it; on the 18th it was 9 inches and showed a hexagonal structure. On the 19th Lost Lake was open at the north end and remained so for several days. On the 20th all the stream below the lake was open.

We have no February records.

In March, 1901, Lost Lake was all open on the 25th, but it was almost frozen over again by the 29th.

In March, 1902, the lake was nearly open on the 13th but frozen over again on the 18th.

THICKNESS OF ICE ON LAKE MAXINKUCKEE AT VARIOUS DATES

Date	Thickness in inches	Remarks
1893		
Jan. 5	9	Entirely covering lake except a few air holes and cracks
1898		
Dec. 8	4	Over entire lake except the Deep Hole
9	3	Over entire lake.
14	7 5	
1899		
Jan. 1	8	
29	10	
30	10 5	
31	11	
Feb. 1	11 5	
2	12	
7	12	
8	13	
10	16	
13	18	
27	15	
Mar. 11	10	
12		High west wind drove ice out from west shore and piled it up 10 feet high on
22		east side. Ice dangerous.

THICKNESS OF ICE ON LAKE MAXINKUCKEE AT VARIOUS DATES—Continued

Date	Thickness in inches	Remarks
1900		
Mar. 25		Ice left lake, it having become honeycombed, piling up in various places 10 feet high on Long Point, but doing no damage.
Dec. 6		Little Maxinkuckee frozen over.
11		Ice went off of Little Maxinkuckee.
15		Little Maxinkuckee frozen over again
26	1 25	On Little Maxinkuckee near shore.
27	2	
28	3	Deep water still open.
29	4 5	
30	5 5	
31	6	
1900		
Jan. 1	7	
2	8	
3	9	
4	9 25	
10		4 inches on Lake Maxinkuckee and 8 inches on Little Maxinkuckee.
12	7	
16	6	Very rotten.
17	6	Ice rotten.
21	5 8	Ice open in deep water.
22	4 5	Ice open in deep water.
24		Ice breaking up.
30	6	
31	8	
Feb 1	9	
2	11	
3	11	
15	6	
16	6	
17	7	
18	8	
19	8 5	
Mar. 1	12	
19	16	
22		Ice open near the Split Rock.
April 1		Ice moving north.
3		Ice moves southeast and piles up high on shore.
5		Ice all gone except where piled up on south shore
6		Ice all gone.
Nov. 14		Coldest day of season, so far, 16°. Ice 1.5 in shallow water; Little Maxinkuckee frozen 4 to 7 feet from shore.
16	7/8 to 2 1/4	Little Maxinkuckee frozen over; frozen out on Maxinkuckee 4 feet from shore.
18		Ice went off Little Maxinkuckee.
27		Little Maxinkuckee again frozen over.
30		Thin ice started around shore.
Dec 10		Little Maxinkuckee frozen entirely over, 1 inch thick.
10		Ice extending out 200 feet from shore on Maxinkuckee.
12	2 13-16	Most of the ice broken up. Ice on Little Maxinkuckee strong enough to bear one.
13	3	On Little Maxinkuckee.
14		Outlet nearly frozen over.
17		A broad fringe of ice around shore.
17		About 1/4 inch of water on top of ice on Little Maxinkuckee.
19		Lake frozen over except a large area in center and extending toward south end. Outlet Bay all frozen over.
20		Open area still present.
21		Lake frozen nearly all over.
22		Water covering ice, and open area increasing.

THICKNESS OF ICE ON LAKE MAXINKUCKEE AT VARIOUS DATES—Continued

Date	Thickness in inches	Remarks
1900		
Dec. 23		Much of the ice disappeared.
28		Ice cracking.
1901		
Jan. 1		Ice extending over lake very fast.
1902		
Jan. 27	14	Ice company has filled all its houses.
Feb. 4	18	
Dec. 26		Lake frozen over.
31		Patrolman made first trip over ice
1903		
Jan. 7	5	
12	10	
13		Ice-men began to put up ice
19	12	
23	13	
1904		
Dec. 28		Ice heaved up some.
1905		
Feb. 20	24	Best ice ever harvested; has been good in all places, and 10 to 18 to 24 inches thick.
1909		
Feb. 17	21½	Snow 12 inches deep; ice all over trees and bushes, many trees broken down. Thickest ice this winter about 9 inches and the ice-men got about half a crop; lake frozen over four different times.
1911		
Nov. 18		Lake open from Long Point to Palmer House, wind in the north, ice very thin and rotten. Air 38°. Rained all night and wind shifted from southeast to north at 6 p. m.
1914		
Feb. 15	10	Air at zero in morning.

CONDITIONS OF ICE ON LAKE MAXINKUCKEE

Year	When first noted	When lake practically froze over.	Thickness	Maximum Thickness		When went off.
				Date	Thickness	
1883					22	
1893		January 5	9	January 5	9	
1898		December 9	3	December 11	7 5	
1899	November 12			February 13	18	March 25
1900	November 14	December 20		March 19	16	March 25
1901		December 16	3			March 25
1902	November 25			February 4	18	March 15
1903						March 15
1904	November 6	December 15				
1905				February 20	24	March 26
1906	October 31					
1907	October 12					March 17
1908						March 13
1909						March 3
1910					20	March 22
1911						March 12
1912						April 6
1913					13	March 14
1914				February 23	14	March 27

BIOLOGY

Introduction

More attention was naturally given to the biology of the lake than to the physical features. The scope of the investigations as originally planned contemplated as careful study of the vertebrate animals of the lake as time and facilities at command would permit. It soon became evident however, that no very satisfactory progress could be made with those groups without consideration of the plants and the various groups of invertebrate animals of the lake. It also became increasingly evident as the work progressed that no hard and fast line could be drawn between the species directly related to the lake and those only indirectly so related. This fact was strongly impressed upon us when we came to study the habits of the mammals, reptiles, batrachians, and birds of the lake and vicinity, and the distribution of the trees and shrubs and other shore vegetation in their relation to the various species of insects upon which fishes and other aquatic animals feed. Many illustrations could be given of the ways in which various species of purely land animals and plants are related ecologically to purely aquatic species inhabiting the lake. A few examples may be mentioned. One might think that the common house mouse and field mouse bear no relation to the life of the lake; but we have found both in the stomachs of large-mouth black bass. We have found the raccoon feeding on the mussels of the lake. The larvæ of certain species of dipterous insects of the genus Chironomus, are exceedingly abundant in the lake and constitute a very important part of the food of the fishes, also of several species of birds such as the various snipes, plovers, phalaropes, and even of rusty blackbirds, red-winged blackbirds, and crow blackbirds. And in September and October, when these larvæ complete their metamorphoses and the air and the trees along the shore about the lake become filled in the evening and on quiet days with vast swarms of the large mosquito-like insects, making the evening vocal with the constant humming of the millions on the wing, they then are fed upon by various species of birds, among which have been observed nighthawks, swallows, yellow-billed cuckoos, yellow-rumped warblers, and even red-headed woodpeckers and song sparrows. But the story does not end here. After the nuptial flight has been made, these insects, myriads upon myriads in number, and all about the lake, return to the surface of the water upon which they lay their eggs, and there fall a prey to various species of fishes from the tiny top minnow to the blue-

gill, yellow perch, and large-mouth black bass. And the eggs laid by those which succeed in escaping all their enemies furnish enormous quantities of food to the multitude of little fishes hatched during the previous summer, while the eggs that escape, hatch sooner or later, and in their new form as Chironomus larvæ, supply even greater quantities of delicious food to the fishes of a somewhat larger growth, and also to the turtles and young water-dogs in the water and to various species of birds which feed along the beach. But even this is not all the story. The millions of Chironomi, after having accomplished their only purpose in life by laying billions upon billions of eggs, die, and their dead bodies, falling upon the surface of the lake or upon the land, are eaten by the fishes, birds, and small insectivores.

One more illustration must suffice. When we came to study the shore vegetation we were struck by the number of trees, shrubs and other plants growing on the immediate lake shore, so close to the lake that their branches overhang the water more or less. The total number of species was not fewer than 50. Insects and insect eggs and larvæ were observed on a great many of these trees, shrubs and herbaceous plants; doubtless every species is fed upon or is the home of one or more species of insects. These insects fall upon or are blown out upon the water now and then. Many of them lay their eggs upon the leaves and these may fall off and into the water, carrying the eggs with them.

The eggs that hatch produce caterpillars and other larvæ which feed upon the leaves of the plant, and many, while feeding, drop into the water where, along with the adults and eggs that had fallen in, they become a prey of the fishes. This is one reason why many fishes come in near shore in the evening and at night; they are attracted there by the abundant and varied fish-food contributed to the lake by the plants along the shore.

With interesting and important inter-relations such as these constantly forcing themselves upon our attention, the evidently proper thing to do was to make our study of the lake sufficiently comprehensive to include all such problems as fully as possible; and this we have done. We therefore endeavored to make such observations as time would permit, not only of the physical features of the lake and immediately surrounding country, but also of most of the groups of animals and plants in and about the lake of which any of us possessed any knowledge. Unfortunately, and very naturally, our acquaintance with some groups was very limited indeed, and concerning those we are able to contribute little or nothing.

While considerable time has been devoted to the study of this lake, and while the amount of knowledge and information now possessed and made available regarding it is probably greater than that possessed regarding any other lake in the world, there are many gaps in the record, many of them large and important. No one can realize this more fully or regret it more keenly than the writers. Nor can any one realize more fully than they the incompleteness and inadequacy of many of the observations, and how desirable it would be to have them repeatedly verified.

A word of explanation regarding the arrangement of subjects in the following pages is perhaps necessary. As the investigations upon which this report has been based were made primarily in the interest of fish-culture, more attention was necessarily paid to the fishes than to any other group; in fact, such studies as were made of other animals and of the plants were made only because it was believed such investigations would contribute some knowledge of value to the main purpose in view.

In view of this fact we thought it best not to adhere too closely to a strictly systematic zoological and botanical arrangement of the various subjects. We have treated the fishes first, and the other groups have been presented in the order which we believe best for the objects in view.

The various species considered have been presented from the natural history point of view rather than from that of the systematist. We have even emphasized this thought by giving unusual prominence to the common or vernacular names by making the scientific or binomial names subordinate to them, and by making the text as non-technical as seemed necessary. It is hoped and believed this treatment will contribute materially to the use and value of the publication.

THE FISHES

Introduction

During the investigations at Lake Maxinkuckee, very naturally more attention was given to the fishes than to anything else. It was desired to know not only what species are represented in the local fauna but an effort was made to study each species from many points of view. Observations were therefore made regarding the abundance, distribution, breeding and feeding habits, period and rate of growth, age, and size at different ages, parasites, diseases, enemies, relation to other species, food value, commercial importance, importance to the angler, seasons and methods of cap-

ture and places where found, and many other problems the study of which was necessary to a full understanding of the life history of the species. Field observations and collecting were carried on in all available and possible places, in all sorts of weather, at all times of day and night, and at all seasons of the year, chiefly, however, in the summer and fall months.

Methods of Collecting

Seining:—Seine collecting was, of course, the method most frequently used and the one yielding the largest collections and results. The seines used were Baird collecting seines. When the physical conditions permitted a 45-foot seine was used; where the character of the bottom or any other factor prevented the successful use of so long a seine, a shorter one was used—sometimes one 15 feet long, at other times one 25 feet in length, and occasionally seines 20, 35, and 150 feet were used. Seining operations were begun July 5, 1899, the initial point being in front of the Duenweg cottage (now known as "Shady Point"), which is on the lake shore just in front of the Arlington station. This cottage was rented by the Fish Commission and used as headquarters by the field party from July, 1899, to July, 1901. (See p. 34.)

From the Duenweg cottage as the starting point the seining proceeded southward along the west shore, eastward across the south part of the lake, then northward along the east side, and on around to the place of beginning. Each succeeding haul began where the preceding one ended, thus every yard of seinable water near shore was covered. Each haul of the seine was called a station and the hauls or stations were numbered consecutively beginning with No. 1. The following data were recorded for each station: Number of station, location, length of seine, date (including hour), condition of sky, direction and strength of wind, temperature of air, temperature of water, maximum depth of water, character of bottom, vegetation as to character and extent, species of fishes caught and number of each, species of other animals caught (as turtles, batrachians, crustaceans, mollusks, etc.), and the number of each. Only a sufficient number of specimens of each species were preserved for future study; all others were returned to the water after being counted and their sizes and other readily observable characters determined. After some little experience in measuring the fishes we were able to estimate their lengths quite accurately. During the first part of July the entire circuit of the lake was made; and this was repeated during the corresponding part of

August and again in September. The principal objects in repeating the work were to secure data on rate of growth, change in distribution, abundance, habits, spawning condition, food, etc. A brief summary of the seining operations and results follows:

July 5, 1:45 to 3:18 p. m. Stations 1 to 11, from Duenweg cottage southward to Murray's; seine, 45 feet. Sky cloudy; no breeze; air 74°; water 76° to 78.5°. All these hauls were made over a sandy bottom, thinly coated with marl in places, covered more or less with mussels (mostly dead), dead *Viripara contectoides*, and two species of live gastropods which fasten to rocks and other objects. The bottom nearly everywhere was covered with a good growth of Chara, not tall but enough to cause the seine to roll a good deal. There was also a considerable growth of algæ, and except in the first four or five hauls, there was a fringe of tall Scirpus (*S. americanus* near shore and *S. validus* further out), 20 to 40 feet wide and in water up to 18 inches in depth. Catch: Log perch, many; yellow perch, 69; bluegill, about 50; grayback minnow, 10; rock bass, 8; straw bass, 9, mostly young; small-mouth black bass, 7, young; straw-colored minnow, 4; pumpkinseed, 2; skipjack, 1; and blunt-nosed minnow, 1.

The majority of the bass were young-of-the-year, each about one inch long. The sunfish and perch were also small, and mostly one year old.

July 6, 2:48 to 5 p. m. Stations 12 to 29, from Murray's to 15 yards west of Farrar's pier; seine, 45 feet. Air 76°; water 77° to 79.5°. Bottom of sand and fine gravel with thin coating of marl in some places, covered with a good growth of Scirpus to the westward, but rare near Farrar's. This of course interfered with hauling the seine. Catch: Bluegill, 1,227; small-mouth black bass, 23; yellow perch, 30; log perch, many; skipjack, 27; blunt-nosed minnow, 11; grayback minnow, 2; pumpkinseed, 2; Iowa darter, 1; straw-colored minnow, 1. The bluegill was by far the most abundant species, the Scirpus patches literally swarming with them. They were nearly all young-of-the-year or of the preceding year. Crawfishes, mussels, gastropods and algæ were fairly common.

July 7, 1:40 to 4:03 p. m. Stations 30 to 52, from Farrar's pier eastward to the high wooded shore on southeast part of lake on Easterday's place; 45- and 15-foot seines used. Air 74°; water 76°. Bottom sandy with slight admixture of gravel to the westward with more or less mud or marl overgrown with Potamogeton, Scirpus and Chara in the last eight or ten hauls. A considerable bed of mussels off the McDonald cottage, and many gastropods.

Catch: Yellow perch, about 150; straw bass, 95; bluegill, about 200; small-mouth black bass, 36; grayback minnow, 113; skipjack, 13; straw-colored minnow, 12; log perch, 9; blunt-nosed minnow, 29; *Notropis heterodon*, 1; rock bass, 8; Johnny darter, 10; Iowa darter, 6; pumpkinseed, several; long-nosed gar, 6; creek chub, 2.

July 8, 1:40 to 3:00 p. m. Stations 53 to 71, beginning at station 11 and working north to Arlington station; 15-foot seine. Air about 73°; water 76° to 78°. Hauls all in shallow water, near shore, and most productive where bottom was free from Scirpus.

Catch: Yellow perch, 185; straw bass, 121; skipjack about 500; grayback minnow, 209; Johnny darter, 61; small-mouth black bass, 36; *Notropis heterodon*, 21; log perch, 33; Iowa darter, 13; rock bass, 2; bluegill, 24; straw-colored minnow, 1; in the last five or six hauls the skipjack was quite abundant, most of the individuals being young-of-the year.

July 10, 1:05 to 4:05 p. m. Stations 72 to 90, in southeast part of lake at station 52 and proceeding east and north to Norris's pier, omitting about 200 yards at mouth of Norris Inlet where the softness of the bottom made seining impossible. The bottom at the first stations was sandy with some slight growth of Potamogeton in places. Nearing the Inlet the bottom becomes more and more composed of decaying vegetable matter and very soft, until finally for a few rods adjacent to the Norris Inlet on either side it is too soft for seining operations. Near the Norris Inlet the bottom was full of deeper mud holes 3 to 10 feet in diameter. Here also occur small patches of lily-pads—mostly Nymphæa, but a few Castalia. The 15-foot seine was at first used, then a 45-foot seine was utilized. At station 82 near the little green boathouse 40 gar-pike (*Lepisosteus osseus*) were secured. Depth 6 feet or less; air temperature 80°; water temperature 78° to 82°.

Catch: Bluegill, about 400; yellow perch, 269; grayback minnow, 101; straw bass, 102; long-nose gar, 11; blunt-nose minnow, 40; log perch, 14; skipjack, many young; pumpkinseed, 14; small-mouth black bass, 9; straw-colored minnow, 23; rock-bass, 5; yellow cat, 1; Johnny darter, 9; brook stickleback, 1; mad tom, 1.

Young skipjacks were taken in great numbers at stations 76, 77 and 78, but only a few in any other hauls. Yellow perch were usually abundant at every station, especially at No. 80. Bluegills were common in nearly every haul, especially at No. 79.

There were added to the list in this series of hauls three species which had not been previously taken, namely, the yellow cat (station 77); mad tom (station 81), and the stickleback (station 89).

July 11, 2:00 to 4:45 p.m. Stations 91 to 110. Air 84°; water 81° to 84°; sky cloudy, showery late in evening; depth 3 feet and under; 45-foot seine. Began at Norris's pier and proceeded up the east side to the McOuat cottage. For most of this distance the bottom is of sand and fine gravel, usually covered with a matting of Chara. In many places, stones, old tin cans, broken bottles and the like made seining difficult.

Catch: Bluegill, 525; log perch, 190; skipjack, very many; small-mouth bass, 40; straw bass, 17; yellow perch, 101; rock bass, 45; grayback minnow, 17; pumpkinseed, 4; yellow cat, 1; silverside, 1; and blunt-nose minnow, 1.

The bluegill was by far the most abundant fish taken, 419 being in haul 109. Young skipjacks were very common, especially in hauls, 93, 104 and 106. The log perch was remarkably abundant, 58, 51, 40 and 64 being taken in hauls 101, 105, 107 and 110, respectively.

In the last few hauls the water appeared roily, caused chiefly by the presence of much plankton, crustaceans and algæ.

July 12, 2:15 to 4:10 p.m. Stations 111 to 120. Air 87°; water 79° to 89°. These stations were in Norris Inlet. Beginning at the bridge where the road crosses, stations 111 to 117 followed up the creek to the heavy woods about its head, while stations 118 to 120 were from the bridge down stream until the creek became lost in boggy ground. Seine, 15-foot.

Catch: Straw bass, 79; bluegill, 22; mud minnow, 17; grass pike, 35; creek chub, 8; pumpkinseed, 4; and dogfish, 3. The straw bass were all young, as were also most of the grass pike. The bottom was usually black soil, sand or decaying peaty matter. In shallow stagnant places the water was very warm.

July 13, 1:45 to 2:55 p.m. Stations 121 to 131. Air 86°; water 76° to 80°; depth 5 feet and under. Same ground seined over July 5, stations 1 to 11, but under different atmospheric conditions. A storm came from the northwest and swept across the north end of the lake while the work was in progress. Some rain fell and strong waves came in from the north.

Catch: Bluegill, 331; yellow perch, about 325; rock bass, 52; grayback minnow, 35; log perch, 28; small-mouth bass, 13; straw bass, 7; pumpkinseed, 6; Johnny darter, 3; hog sucker, 1; yellow cat, 1; blunt-nose minnow, 3. In haul 129, which was through a thick patch of *Scirpus americanus*, young rock bass were very abundant, 28 being caught. Young yellow perch and bluegills also were abundant.

July 17, 1:30 to 3:40 p.m. Stations 132 to 147, from the end

of Long Point to Arlington, connecting with station No. 1. Air 73°; water 80° to 82°; depth 2 feet and under; seine, 45-foot. Bottom sand, covered in most places with a more or less thick mat of *Chara contraria*, with a good deal of *Vallisneria spiralis*, *Naias flexilis* and *Potamogeton pectinatus*. Just off the end of Long Point is a large bed of mussels. Catch: Bluegill, 1,224; yellow perch, 432; pumpkinseed, 244; skipjack, 101; blunt-nose minnow, 21; rock bass, 10; yellow cat, 2; silverfin minnow, 6; log perch, 13; *Notropis heterodon*, 1. As may be seen from the above, bluegills, skipjacks, pumpkinseeds, and yellow perch were very abundant. The vast majority of each of these species were young fish, either of-the-year or one year old.

July 18, 1:35 to 4:25 p.m. Stations 148 to 168, beginning at the McOuat cottage (where station No. 110 ended) and proceeding northward to the Shirk cottage just north of the Maxinkuckee road. Air 80°; water 80° to 84½°; depth 3 feet and under; seine, 45-foot. Rocky shore and gravelly bottom, then sand and gravel bottom with some mud in places, with areas of Chara here and there.

Catch: Bluegill, 1,430; log perch, 366; yellow perch, 202; skipjack, several hundred; small-mouth black bass, 114; silver-fin minnow, 29; silverside, 19; grayback minnow, 16; rock bass, 13; hog sucker, 6; straw bass, 11; blunt-nose minnow, 7. Young bluegills were remarkably abundant, as many as 300 being taken in one haul. Log perch also were very abundant, 151 being taken in a single haul. Young skipjacks were exceedingly numerous.

July 19, 2:30 to 4:30 p.m. Stations 169 to 184, beginning at the Shirk cottage and proceeding northward to near the Indiana boathouse. Air 84°; water 82° to 84°; depth 3 feet and under; seine 15-foot. Sky clear, wind from northwest, lake choppy.

Catch: Yellow perch, 430; bluegill, about 250; grayback minnow, 124; skipjack, many young; small-mouth black bass, 38; straw bass, 45; log perch, 54; rock bass, 87; blunt-nose minnow, 10; pumpkinseed, 139; Johnny darter, 2; rot-gut minnow, 1; straw-colored minnow, 3.

July 20, 1:42 to 4:05 p.m. Stations 185 to 202, northward from just south of Indiana boathouse to Aubeenaubee Bay. Air 87°; water 81° to 84°; depth 4 feet and under; seine, 15-foot at stations 185 to 187 and 202, 45-foot at all others. Sky broken cloudy, moderate breeze south by east. Catch: Bluegill, 669; log perch, 275; yellow perch, 160; skipjack, many young; small-mouth black bass, 69; straw bass, 19; pumpkinseed, 24; rock bass, 51; grayback minnow, 17; blunt-nose minnow, 4; long-nose gar, 1.

July 21, afternoon. Stations 203 to 228, from northeast corner

of lake westward to The Roost. Air 89°; water 79° to 88°; depth, 2 feet and under; seine, 45-foot. Bottom at first mud then sand and some gravel. Much Chara, Pontederia, Scirpus and Potamogeton.

Catch: Skipjack, young, very abundant; bluegill, 267; straw bass, 203; yellow perch, 211; blunt-nose minnow, 84; log perch, 15; grayback minnow, 190; pumpkinseed, 50; rock bass, 43; yellow cat, 4; long-nose gar, 3; green sunfish, 1; small-mouth black bass, 26; *Notropis umbratilis*, 12.

July 22, 2:00 to 5:00 p. m. Stations 229 to 247, from The Roost westward to Kreutzberger's pier. Air 87°; water 81° to 87°; depth, 3 feet and under; seine, 45-foot. Bottom unusually varied, ranging from mud and sand through gravel to boulders; much Chara and some Potamogeton.

Catch: Bluegill, 1,187; log perch, 371; skipjack, numerous young; small-mouth black bass, 66; yellow perch, 158; straw bass, 17; rock bass, 27; pumpkinseed, 13; grayback minnow, 14; blunt-nose minnow, 5; silverside, 2.

July 24, 2:15 to 4:30 p. m. Stations 248 to 263, from end of Long Point west and north to ice-houses. Air 87°; water 83° to 86°; depth 3 feet and under; seine, 45-foot. Bottom mud or marl, very little sand and no gravel. Usually a heavy growth of vegetation consisting chiefly of *Vallisneria spiralis*, *Philotria canadensis*, *Potamogeton pectinatus*, *P. amplifolius*, *Megalodonta beckii*, *Heteranthera dubia*, *Naias flexilis*, *Chara contraria*, and *Potamogeton lucens*. Right at the Outlet is a small patch of *Nymphaea advena* and a few plants of *Castalia odorata*. Just off the ice-houses diatoms are more abundant than at any other place in the lake.

Catch: Yellow perch, 280; bluegill, 211; skipjack, numerous; pumpkinseed, 81; rock bass, 41; log perch, 38; warmouth, 6; straw bass, 21; small-mouth black bass, 9; bullhead, 4; Johnny darter, 2; grayback minnow, 2; short-nose gar, 1; grass pike, 1. In the series of hauls were secured the first specimens of short-nose gar and warmouth. Most of the fish taken were young, as usual; however, some large fish were caught, among them a straw bass weighing 4½ pounds and another of 2½ pounds.

July 25, 2:20 to 5:00 p. m. Stations 264 to 280, from Kreutberger's pier southward to the Assembly grounds. Air 86°; water 81° to 86°; depth 4 feet and under; seine, 45-foot. Bottom usually of sand, sometimes mud or marl in the deeper places. Vegetation, *Eleocharis interstincta* (the only patch in the lake), *Scirpus validus* and *S. americanus*, *Vallisneria spiralis*, *Potamog-*

eton amplifolius and *pectinatus*, *Myriophyllum verticillatum*, *Ceratophyllum demersum*, *Philotria canadensis*, *Hydrodyction*, etc.

Catch: Bluegill, 673 plus many young; yellow perch 369 plus many young; rock bass, 147; pumpkinseed, 118; straw bass, 29; blunt-nose minnow, 18; skipjack, many young; grayback minnow, 13; small-mouth black bass, 6; silverside, 4; *Notropis heterodon*, 3; bullhead, 1; dogfish, 1; Johnny darter, 2; rotgut minnow, 2; warmouth, 1; chub sucker, 1 (first one caught of this species).

July 26, 2:30 to 4:45 p. m. Stations 281 to 293, from Assembly grounds pier south to ice-houses connecting with station 263, and completing the circuit of the lake. Air 83°; water 84° and 86°; depth 5 feet and under; seine, 45-foot. Bottom sandy, with some mud, covered with considerable Potamogeton, Chara and Scirpus.

Catch: Yellow perch, 250; bluegill, 120; rock bass, 82; pumpkinseed, 81; skipjack, numerous young; straw bass, 20; grayback minnow, 11; log perch, 10; blunt-nose minnow, 4; grass pike, 1; *Notropis heterodon*, 13; small-mouth black bass, 2; warmouth, 2; Johnny darter, 1; yellow cat, 1.

July 27, 1:05 to 3:30 p. m. Stations 294 to 312, all but the last eight in lagoons in the Military Academy grounds the remaining eight in Culver Inlet from the upper lagoon into the woods about three-fourths of a mile above. Air 80°; water 65° to 84°; depth 5 feet and under; seine, 15-foot. Bottom of soft mud near shore, gravelly nearer center in the lagoon; creek mostly muddy bottom and marshy shores.

Catch: Straw bass, 186; creek chub, 69; bluegill, 52; chub sucker, 29; rotgut minnow, 14; *Notropis heterodon*, 10; grass pike, 8; yellow perch, 5; mud minnow, 3; warmouth, 3; small-mouth black bass, 4; pumpkinseed, 5; yellow cat, 7; rock bass, 2; mad tom, 1.

July 28, 2:25 to 3:55 p. m. Stations 313 to 327, in the Outlet from Lake Maxinkuckee to Lost Lake. Air 81°; water 82.5° to 83°; depth 3 feet and under; seine, 15-foot. Bottom gravelly for a few feet in upper portion, then sandy, then of soft muck.

Catch: Bluegill, 514; straw bass, 43; warmouth, 16; pumpkinseed, 16; skipjack, several; rock bass, 4; grass pike, 4; big-eared sunfish, 2; yellow cat, 1; *Fundulus dispar*, 1; calico bass, 1; chub sucker, 1.

July 29, 3:05 to 3:50 p. m. Stations 328 to 341, east side of Lost Lake from Sunset cottage south to muck bottom at southwest end. Air 77°; water 82° to 83.5°; depth 2 feet and under; seine, 45-foot. Bottom sandy or muddy, with much Chara, some Scirpus and some lily-pads.

Catch: Bluegill, many, mostly young; *Notropis heterodon*, 78; pumpkinseed, 7; skipjack, several; straw bass, 11; small-mouth black bass, 3; grass pike, 3; blunt-nose minnow, 2; grayback minnow, 1; red-eared sunfish, 1.

July 31, 1:40 to 3:45 p. m. Stations 342 to 363, north and west shores of Lost Lake. Air 76°; water, 81° to 86°; depth 4 feet and under; seines, 15-foot and 45-foot. Bottom sand or mud with much vegetation, such as lily-pads (Nymphæa and Castalia), Scirpus, Myriophyllum, Chara, etc. Afternoon pleasant, growing hazy toward evening; very little breeze.

Catch: Bluegill, abundant, mostly young; *Notropis heterodon*, many; skipjack, many; red-eared sunfish, 22; straw bass, 32; pumpkinseed, 24; *Fundulus dispar*, 6; small-mouth black bass, 2; blunt-nose minnow, 4; mud minnow, 1; grass pike, 1; warmouth, 3; chub sucker, 2.

August 1, 1:37 to 3:30 p. m. Stations 364 to 379, west side of Lost Lake from Hawk's barn south to where the lake narrows, then a few hauls in the outlet and two hauls (Nos. 378 and 379) on east side of outlet. This entire stretch of shore was not seined, as patches of Castalia, etc., made it impossible in some places. The water was very clear and the sunfish could be seen swimming about in large numbers. Air 82°; water 78° to 79°; depth 3.5 feet and under; seines, 15- and 45-foot. Bottom mostly of mud and muck. Rank vegetation.

Catch: Bluegill, about 200; red-eared sunfish, about 50; *Fundulus dispar*, 66; *Notropis heterodon*, about 30; straw bass, 16; warmouth, 19; chub sucker, 4; grass pike, 2; yellow perch, 2; small-mouth black bass, 6; least darter, 3; skipjack, 1; Johnny darter, 1.

August 2, afternoon. Stations 380 to 390, in the Outlet between the two lakes, over the same grounds as Nos. 313 to 327. Air, 82°; water, 83.5° to 84°; depth 2 feet or less; seine, 15-foot.

Catch: Bluegill, 307 and many young; straw bass, 152; small-mouth black bass, 17; warmouth, 15; red-eared sunfish, 12; rock bass, 8; grass pike, 4; mud minnow, 2; calico bass, 1; least darter, 1; *Fundulus dispar*, 1; green sunfish, 2.

August 3, afternoon. Stations 391 to 395, beginning in front of Arlington thence southward. Air 84°; water 80°; depth 4 feet and under; seine, 120-foot.

Catch: Yellow perch, 243; bluegill, 85; log perch, 125; small-mouth black bass, 49; rock bass, 36; grayback minnow, 41; straw bass, 46; blunt-nose minnow, 2.

August 4, afternoon. Stations 396 to 422. First 6 hauls southward from Green's pier, the next in the marsh about Norris

Inlet, and the remaining ones (Nos. 411 to 422) in Aubeenaubee Creek. Air 83°; water, 84.5° to 85.5° in the lake, 72° to 73° in the creek; depth, 2 feet and under; seine, 25-foot in lake, 15-foot in creek.

Catch in the lake: Yellow perch, 52; log perch, 30; bluegill, 25; straw bass, 21; small-mouth black bass, 12; grayback minnow, 16; blunt-nose minnow, 8; skipjack, 1; pumpkinseed, 1; Johnny darter, 1; yellow cat, 2. In marsh: Mud minnow, 11; grass pike, 2. In creek: Creek chub, 57; mud minnow, 10; grass pike, 9; chub sucker, 1; silverside, 1; straw bass, 2; Maxinkuckee darter, 1; Aubeenaubee darter, 11; rotgut minnow, 7. Crawfish and frogs abundant.

August 7, 2:15 to 3:00 p. m. Stations 423 to 426, the first two hauls between Norris pier and Norris Inlet, the other two near Fulton's pier. Air 76°; water 80°; depth 6 feet and under; seine, 125-foot.

Catch: Bluegill, 401; log perch, 576; yellow perch, 111; small-mouth black bass, 147; straw bass, 48; skipjack, 73; grayback minnow, 50; calico bass, 7; rock bass, 10; pumpkinseed, 3; Johnny darter, 1.

August 10, 9:30 to 10:00 a. m. Stations 427 to 433, on east side of Long Point from the Armstrong to the Scovell cottage. Air 83°; water 79°; morning foggy following heavy rain the day before; depth, 2 feet and under; seine, 15-foot.

Catch: Grayback minnow, 74; skipjack, about 100; rock bass, 23; bluegill, 16; yellow perch, 40; *Notropis heterodon*, 11; Iowa darter, 12; Johnny darter, 12; straw bass, 8; log perch, 8; straw-colored minnow, 6; blunt-nose minnow, 1; small-mouth bass, 1.

August 11, morning. Stations 434 to 439, on east side of Long Point from the Meyer to the Armstrong cottage. Air 87°; water 81°; depth 2 feet and under; seine, 15-foot. Catch: Skipjack, about 1,000; bluegill, 135; yellow perch, 108; grayback minnow, 58; straw bass, 30; Iowa darter, 38; rock bass, 29; Johnny darter, 1; small-mouth black bass, 4; log perch, 1.

September 6, afternoon. Stations 440 to 447, in Outlet between the two lakes. Air, 70°; water, 74°; seine, 15-foot. Catch: Bluegill, about 250; least darter, 26; straw bass, 22; warmouth, 21; *Fundulus dispar*, 25; skipjack, 6; green sunfish, 3; yellow cat, 2; pumpkinseed, 1; *Notropis heterodon*, 2; grass pike, 1.

July 17, 1900. 1:00 to 2:30 p. m. Stations 448 to 451, also 460, from Fish Commission pier south to below the first Scirpus patch, 452 to 459, from Arlington pier north to the linden tree. Air, 77°; water, 77°; depth 3 feet and under; seine, 25-foot.

Catch: Yellow perch, 196; bluegill, 141; grayback minnow, 96; skipjack, 81; *Notropis heterodon*, 64; small-mouth black bass, 34; straw bass, 34; pumpkinseed, 25; Johnny darter, 7; log perch, 5; rock bass, 3; mad tom, 1.

The bass (small- and large-mouth) were each about 2 inches long (some only 13 16 inch) and were doubtless present year brood: The yellow perch, bluegills, rock bass, log perch and skipjacks were nearly all of the present year's brood.

July 18, 2:30 to 3:30 p. m. Stations 461 to 467, at south end from Overmyer's spring west to small brook coming out of Overmyer's woods. Air, 74°; water, 79°. Seine, 30-foot.

Catch: Bluegill, 58; small-mouth black bass, 39; straw bass, 25; yellow perch, many; grayback minnow, many; *Notropis heterodon*, several; rock bass, 4; Johnny darter, 2; Iowa darter, 1; skipjack, 1; blunt-nose minnow, 6; common bullhead, 1.

The small-mouth bass were all approximately of the same size and averaged 1½ inches long. The one straw bass saved measured 1½ inches long. The two rock bass measured were 1¼ and 1.06 inches long, and the yellow perch averaged 1⅜ inches. All of these were evidently of the 1900 brood. The graybacks averaged 2.34 inches and 6 examples of *Notropis heterodon*, 2.34 inches. The examples of these two species were probably 2 or 3 years old.

July 19, 2:30 to 4:30 p. m. Stations 468 to 481, from Murray's to Farrar's. Air, 80°; water, 79°; seine, 30-foot.

Catch: Small-mouth black bass, 175; log perch, 25; straw bass, 18; grayback minnow, 13; yellow perch, 12; rock bass, 3; skipjack, 2 large schools of young (hauls 473 and 474); straw-colored minnow, 46; Iowa darter, 2.

August 7, 11:30 to 12:00 m. Stations 482 and 483, at Fish Commission pier. Air, 89°; water, 82°; seine, 45-foot.

Catch: Bluegill, 50; yellow perch, several; log perch, many; straw bass, few; small-mouth black bass, few. Some of the bluegills were large.

August 9, 9:00 p. m. Stations 484 and 485, at Fish Commission pier, with 45-foot seine. Air, 85°; water, 82°. Catch: Bluegill, many; rock bass, common; yellow perch, common; straw bass, small-mouth black bass, log perch, straw-colored minnow, blunt-nose minnow, skipjack and grayback minnow, few; walleyed pike, one 10-inch example.

August 10, 9:00 p. m. Station 486, at Fish Commission station, with 120-foot seine. Air, 85°; water, 80°. Catch: Bluegill, abundant; rock bass and yellow perch, few large and many young; straw bass, small-mouth black bass, log perch, straw-colored min-

now, blunt-nose minnow, skipjack and grayback minnow, few; and one 10-inch walleyed pike.

August 14, 2:30 to 4:30 p. m. Stations 487 to 506, in Aubeenaubee Creek from near source to mouth, with 15-foot seine. Air, 70°; water, 63° to 66°.

Catch: Creek chub, a few in nearly every haul; mud minnow, from 1 to many in each of 6 hauls; yellow perch, from 2 to a few in each of 5 hauls; rotgut minnow, a few in each of 9 hauls; Aubeenaubee darter, a few in each of 2 hauls; straw bass, 1 young; small-mouth black bass, 2; bluegill, 1 young; silverside, 1; blunt-nose minnow, 1; grass pike, 1; black-nose dace, 2.

August 16, 2:30 to 4:30 p. m. Stations 507 to 528, in Norris Inlet beginning near its source and proceeding down stream, with 15-foot seine. Air, 72°.

Catch: No record was kept of the number of specimens taken; the record shows only the species taken at each haul. In the following summary the figure following each species name indicates the number of hauls at which one or more specimens of that species were taken: Bluegill, 6; silverside, 11; mud minnow, 8; straw bass, 7; creek chub, 4; yellow perch, 4; yellow cat, 6; pumpkinseed, 2; small-mouth black bass, 1; grass pike, 3; crawfish, 6; frogs, 5; shells, 2.

August 17, 3:30 to 4:30 p. m. Stations 529 to 539, in Culver Inlet from near its source to first lagoon. Air, 91°.

The following species were taken in the number of hauls indicated: Bluegill, 2; straw bass, 3; silverside, 8; yellow cat, 3; yellow perch, 1; long-nosed gar, 2; black-nosed dace, 1; white sucker, 1; mud minnow, 2; hornyhead chub, 1; chub sucker, 1; rotgut minnow, 1.

At 8 p. m. on August 18, two hauls were made at the Fish Commission pier with the 15-foot seine, catching many skipjacks, several straw bass, black bass, bluegills, log perch, Iowa darters, Johnny darters, grayback minnows, rock bass, and yellow perch.

August 21, 3:10 to 5:00 p. m. Stations 540 to 563. Air, 65 to 81°; water 76° to 84°. Nos. 540 to 551 were in Culver Inlet from the bend east of the Academy grounds to the mouth at the Academy pier. Mud bottom everywhere with much marsh gas. Vegetation abundant; *Potamogeton natans*, Ceratophyllum, Philotria, and water-cress.

The species gotten in this part of the creek were, in order of abundance, bluegill, straw-colored minnow, roach, yellow perch, straw bass, pumpkinseed, chub sucker, warmouth, rock bass, yellow cat, grass pike, white sucker, small-mouth black bass, silver-

side, creek chub, blunt-nose minnow, skipjack, stone-roller, common bullhead, and Johnny darter. There were also crawfish, painted turtles, snapping turtles, map turtles, and water-dogs. Nos. 555 to 559 were in the Outlet between the railroad bridge and Lost Lake; Nos. 560 and 561 in northwest corner of Lost Lake at the boat landing; Nos. 562 and 563 on west side of Lost Lake just south of Hawk's barn.

The following is the list of fishes obtained, in order of abundance: Bluegill, skipjack, rock bass, pumpkinseed, warmouth, chub sucker, straw bass, small-mouth black bass, yellow perch, grass pike, common bullhead, least darter, red-eared sunfish, *Fundulus dispar*, and several painted turtles.

August 23, 7:00 to 8:45 a. m. Stations 564 to 575, from Fish Commission station southward, with 35- and 20-foot seines. Air, 70° to 78°; water, 80°. Cloudy, calm and threatening in morning, strong puffy wind at 10 a. m. and lake rough.

The species obtained, in order of abundance, were: Bluegill, straw-colored minnow, blunt-nose minnow, satinfin, log perch, Iowa darter, Johnny darter, yellow perch, small-mouth black bass, straw bass, grayback minnow, rock bass, skipjack, and pumpkinseed. The Iowa darters and Johnny darters were near shore, the log perch a little farther out, quite abundant and very fine.

August 25, 3 to 4:30 p. m. Stations 576 to 585, in the outlet below Lost Lake at the old millsite. Air, 84°; water, 77°.

Catch: Bluegill, 80; pumpkinseed, 29; *Fundulus dispar*, 20; Iowa darter, 11; chub sucker, 9; straw bass, 4; skipjack, 4; common bullhead, 3; roach, 3; small-mouth black bass, 2.

September 20, 8:30 to 9:30 p. m. Stations 586 to 595, in front of Fish Commission station with 25- and 45-foot seines. Air, 71°; water, 67°.

Fish very abundant, the following species taken: Bluegill, numerous small ones; yellow perch, many small and a few large; skipjack, many small; rock bass, a few large and many small; calico bass, 5; straw-colored minnow, few; grayback minnow, few; mad tom, few; walleyed pike, one very large and 2 smaller ones; white sucker, 2 large ones; dogfish, one large male; a few small crawfish; one large bullfrog; one large map turtle.

September 22, 6:45 to 7:35 a. m. Stations 596 to 600, between Fish Commission station and first Scirpus patch south. Air, 52°; water, 65°. Sky with light clouds; slight northwest breeze; lake smooth. Seines, 15- and 25-foot.

Catch: Log perch, many; small-mouth black bass, several; skipjack, straw bass, rock bass, yellow perch, bluegill and Iowa

darter, a few young of each; Johnny darter, 1; map turtle, 1 young; crawfish, 5.

October 23, forenoon. Stations, 601 to 607, in upper half of Outlet, in open water with 25-foot seine. Air, 65 ; water, 61 .

Catch: Straw bass, a great many (75 in first haul), each 4 to 6 inches long, a few larger; bluegill, many small ones; warmouth, several; red-eared sunfish, many, medium size; pumpkinseed, 3 small ones; rock bass, 5 young; grass pike, 2 young; mud minnow, 1; *Fundulus dispar*, 3; Johnny darter, Iowa darter, and least darter, several of each; yellow cat, several young. Also a few larval salamanders and cricket frogs.

November 28, morning. Stations 608 and 609, with 15-foot seine, in front of Barnes cottage just north of Arlington pier, for skipjacks of which about 2 gallons were caught. With them were a few small straw-colored minnows and blunt-nose minnows.

Besides the more or less regular seining operations detailed in the preceding paragraphs, considerable miscellaneous seining was done at odd times for diverse specific purposes, among which may be mentioned getting material for studies of structure, fish-food, parasites, growth, spawning, enemies, coloration, variation, association and distribution. In these cases the seine hauls were not recorded in the regular series and, usually, only those matters especially under consideration were noted.

This miscellaneous seining, however, yielded much valuable data on many of these questions.

Late in the summer and early fall many hauls were made at night, chiefly with a short seine and in shallow water along the east side of Long Point. These operations demonstrated that there is a general inshore movement at night, not only of the carnivorous species but of other kinds as well; and many of the fishes caught were of large size. Among those that were frequent in these night catches were large-mouth bass, small-mouth black bass, dogfish, walleyed pike, white sucker and water-dogs. All of these except the sucker evidently come in shore at night to feed on the smaller fry abundant in shallow water, as was demonstrated by an examination of many stomachs.

Late in the fall and early winter considerable seining was done with a small seine in shallow water both in the day time and at night for the purpose of securing study material of the small minnows which it was discovered congregate in vast schools at that season. Some of these great schools, consisting of thousands of fish, were found to be made up chiefly of straw-colored minnows with fewer of the variable-toothed minnow, a few of the Cayuga

minnow and a few grayback minnows; other schools would be composed of grayback minnows almost entirely, and still others of skipjacks.

Gill-nets:—Several gill-nets were used in July, 1899, but, as the results were chiefly negative, their use was discontinued at the end of that month.

Nets of 2, $2\frac{1}{2}$ and $3\frac{1}{2}$ inch (bar) mesh were used. The nets were tried in various places, in water of different depths, at different depths (sometimes at the surface, and again at intermediate depths), and under diverse conditions. The conclusion reached after a month's trial was that the results obtained did not justify the time and labor involved. Only 4 different species of fishes were taken in the gill-nets; these, in order of numbers taken, were straw bass, yellow perch, walleyed pike and long-nosed gar. The bass were of moderate size (from $\frac{1}{2}$ to $1\frac{1}{2}$ lbs.), the perch were all of good size, the single walleyed pike weighed 2 pounds, and the single gar was 27 inches long.

The coarse-mesh net caught nothing; the 2-inch mesh was most effective.

The majority of the fish caught were in nets set in shallow water; none was caught as deep as 25 feet. The nets set at the edge of bars or deep holes were the ones in which fish were most often taken. Those set near the surface yielded more than when set deeper in the same water. More fish were caught at night than during the day.

One of the principal objects in using gill-nets was to determine whether the Tippecanoe Cisco (*Leucichthys sisco*) inhabits this lake. The tests seemed to demonstrate that it does not.

Set-lines:—A number of tests were made with set-lines, chiefly in the south part of the lake and in Lost Lake. It was desired to know what species could be taken in this manner, the most suitable places for each, the best kinds of bait, the best season, etc.

Only negative results were obtained in deep water, and usually in all other places except on muddy bottom. The only species caught were yellow cat, common bullhead cat, dogfish, rock bass, water-dog, snapping turtle, soft-shell turtle, map turtle and musk turtle. The catfish could generally be taken in considerable numbers on mud or marl bottom, especially in Lost Lake. Many water-dogs and turtles also were taken in the same and similar places. Only a few dogfish were caught.

Various kinds of bait were used, the principal ones being beef, liver, mussel, crawfish, and cut fish. Liver seemed best, though all were effective.

The interesting fact is that none of the basses (except rock bass) or perches was taken by this means.

Traps:—Various sorts of minnow traps were used to some extent. The results were unimportant. Necessarily only small fishes could be caught in this way, and, as the traps were set at some pier, only those shallow water species frequenting such places entered the traps. These, approximately in order of abundance, were the straw-colored minnow, blunt-nosed minnow, grayback, young yellow perch, skipjack, Johnny darter, young bluegills and young rock bass.

Dredging:—One of the most important parts of the investigation of the lake was the dredging. It is to the work of the dredge that we owe much of our knowledge of the character of the bottom; indeed, all our knowledge of the deeper parts except what could be inferred from such portions of mud as adhered to the sounding-lead. It is also to the dredge that we owe all our knowledge of the character and distribution of the flora of the lake except in the very shallow portions about shore, and all we know about many animals—mollusks, insect larvæ and crustaceans—which escape other means of capture, such as the seines near shore and the plankton nets at the different plankton stations and at the surface. The dredge covered a greater amount of territory and yielded a larger assemblage of objects and data than was furnished by any other implement except the seine. It is not only material, but also conditions that are revealed by the operations of the dredge; and what was learned of the winter behavior of the plants and animals of the lake was obtained chiefly by the use of this valuable instrument.

Indeed, so multifarious are the lines of investigation in which the dredge is used, that the instrument is to a considerable extent concealed behind its work, and, unlike those instruments used but for a single end, such as the thermometer to take temperatures, the seine to capture fishes, the plankton nets to collect minute organisms, etc., it is not always recognized at its full value or associated in mind with all the results it accomplished or helps accomplish. It is, therefore, well to call attention to the fact that not only this brief chapter on dredging, but also the greater part of what has been written concerning the lake bottom, nearly all relating to lake botany, and much concerning food of fishes, and of the ecology of the lake, are due to the operations of this useful instrument.

Of the immense number of dredge hauls made, many need not be specifically considered in this discussion, either because the results obtained have been fully treated elsewhere in connection with

the consideration of the lake bottom or of aquatic botany or the various other subjects mentioned above, or because they are so similar to others given as general types that their repetition would be monotonous without giving any additional information; they serve the important but not spectacular function of confirming and witnessing to the facts presented in the typical hauls.

A good deal of the dredging in shallow water in such places as Outlet Bay, the Norris Inlet region, the Weedpatch, etc., was accomplished by means of a common garden rake, which was used principally during the winter through holes cut in the ice. The rake is not well adapted for use from a boat during the summer, as the manipulation of it requires the use of both hands, and the boat answers too readily to any pull to enable one to get much purchase on objects in the bottom. Two men in a boat, one at the oars and one with the rake can, however, accomplish a good deal in shallow water. When operated either through holes in the ice or from a boat, the rake is useful only in rather shallow water. By fastening a splice to the handle one can work 10 to 12-foot depths fairly well, but beyond this the rake becomes too unwieldy; the handle is too buoyant to allow one to force the rake-head down to the bottom, and too flexible to work the rake satisfactorily when down.

The rake was used extensively during the winter of 1900-1901 and again in 1904. By its means the condition and behavior of the lake plants during the winter were observed, the kinds of soil adhering to their roots noted, and, by washing the plants out in water and straining the resulting liquid, numerous important forms, amphipods, isopods, crawfishes, small mollusks, caddis cases with the enclosed larvæ, damsel- and dragon-fly larvæ, leeches, worms, and protozoa were obtained. Various species of darters (*Etheostoma iowæ; Boleosoma nigrum*) mad toms (*Schilbeodes gyrinus*), Sticklebacks (*Eucalia inconstans*), and the young of many of the game and food-fishes (bluegill, rock bass, etc.) which were among the weeds feeding upon the insect larvæ and amphipods were also captured in the entangled masses of weeds.

For deep water and for summer work various forms of dredges were used, one of the most effective consisting of a sort of double-toothed comb made by fastening together a series of parallel pieces of moderately heavy strap-iron (like that used for tires of light wagons). The pieces of strap-iron, about 18 inches long, with a hole drilled through the center of each, and 2 crosspieces of similar strap-iron, one on each side, were riveted to these parallel

pieces, which became the teeth. The teeth were sharpened and bent in the form of a half circle. A ring was fastened to each end of the crosspieces and to these the dredge-rope was fastened. The resulting dredge, let down to the bottom, was certain to land on one side or the other, and, like the cant hook of the logger's camp, was sure to take hold of whatever it touched, and almost always brought up something.

Below is given, in tabulated form, a record of various dredge hauls and their results. In the first table, an attempt is made, by selecting from a large series of records and arranging in sequence of depth, to give the results obtained by hauls at different depths, proceeding from 1 to 3 feet deep to water 85 feet, close to the greatest depth to be found in the lake.

These tables serve to show in detail what, of course, was well known in a general way, that the greater number of forms, both plant and animal, are most abundant in the shallow water, the first few feet near the surface containing the great majority of organisms in the lake, the deeper waters being comparatively tenantless. Only 2 living forms descend to the greatest depths; one a "redworm" or Chironomus larva, which comes up to near the surface during the night to obtain air. This is one of the most attractive and highly prized tidbits of the various fishes of the lake, and can retire into the depths beyond the pursuit of the most adventurous. The other organism is a species of Sphærium. How it can live in these depths where the water is devoid of oxygen is a mystery. In this connection attention may be called to the habits of a species of Sphærium found in the woodland ponds near the lake. These ponds are dry during the greater portion of the year, and at this time the Sphærium remains among the moist leaves of the bottom, apparently in the condition of suspended animation. The two habits,—one manifested above the lake surface and the other far below, are apparently quite similar.

The following is a brief résumé of the life at different depths, as shown by the dredging and tables:

From 1 to 14 feet, the great mass of life, both plant and animal, of the lake; 24-25 feet, lower limit of plant growth, Nitella being the only plant found in any abundance at 25 feet; 30-35 feet, lower limit of nearly all animal life except the 2 organisms mentioned above; lower limit of *Viripara contectoides*, one of the most abundant and widely distributed organisms of the lake.

TABLE OF DREDGING AND RESULTS

Depth in feet	No. of haul	Date	Locality	Apparatus	Results
1–3	....	Oct. 22, 1904	Off from ice-houses	Rake	*Bottom;* dark, soft, marl. *Plants;* winter buds of ditch moss (*Philotria*), hornwort (*Ceratophyllum*), and stolons of wild celery. (*Vallisneria*), much green algæ, and *Chara*, the *Chara* mostly brown but with bright green bits here and there. *Animals;* isopods abundant; leeches common; amphipods numerous; large dragon-fly larvæ common; various mollusks, such as *Ancylus*, *Vivipara contectoides*, old and young. *Planorbis exacutus;* there were a few crawfishes, (*Cambarus propinquus*).
1–3	.....	Oct. 31, 1904	Off from ice-houses ...	Rake	*Bottom;* dark, soft, marly. *Vegetation;* much as above; chiefly *Chara* and leaves of wild celery. *Animals; Pisidium*, *Sphærium*, *Planorbis*, and Isopods in abundance; some Hydrachnids; *Ancylus* found attached to the leaves of wild celery.
1–3	....	Jan. 12, 1901	Outlet Bay	Rake	*Bottom;* dark, soft, marly. *Plants;* Stout Naias (*Naias flexilis robusta*), hornwort, milfoil, shining pondweed (*Potamogeton lucens*), large-leaved pondweed (*P. amplifolius*), all green; *Chara*, mostly brown and dead-looking but with bright green shoots. *Animals;* Iowa darters, various gastropods, several crawfishes and numerous leathery caddis-cases, the latter elongate and attached to weeds.
3–4	Many hauls.	Various times .... (November and December.) Winter of 1904.	Near Norris Inlet	Rake.	*Bottom;* black, peaty. *Plants;* principally *Chara*. *Animals;* gastropods of various sorts—*Goniobasis*, *Planorbis*, etc.; fishes—Iowa darters, mad toms (*Schilbeodes gyrinus*), young catfishes (*Ameiurus nebulosus*), a few sticklebacks (*Eucalia inconstans*), and numerous young bluegills (*Lepomis pallidus*), about 1½ to 2 inches long, and crawfishes, the animals being all tangled up in the weeds.
5	14	Aug. 14, 1899	Near Murray's..	Dredge	*Plants; Chara.* *Animals;* 2 crawfishes, 1 banded snail (*Vivipara contectoides*), Bryozoan (*Plumatella polymorpha*), 2 gastropods.
10	.....	Nov. 18, 1904	Off Depot Pier. ..	Rake .	*Plants;* water marigold (*Megalodonta beckii*), green; *Philotria* with dense winter buds, *Ceratophyllum* loose (not compacted into winter buds), Small *Potamogeton amplifolius.* *Animals; Plumatella polymorpha* attached to the *Potamogeton.*

TABLE OF DREDGING AND RESULTS—Continued

Depth in feet	No. of haul	Date	Locality	Apparatus	Results
10	12	Aug. 14, 1899	Bulrushes from off Murray's	Dredge	*Animals;* 14 living, 6 dead, *Viviparus contectoides*, 4 living *Spharium*, 1 *Physa*, 2 *Planorbis*, 5 long gastropods (*Gonobasis?*), 2 crawfishes, 2 unios
10	13	Aug. 14, 1899	Near Murray's	Dredge	*Animals;* 4 crawfishes; 11 *V. contectoides*; 6 living gastropods, 2 living *Spharium*; 1 young living *Physa*; 1 Iowa darter.
10	33	Aug. 24, 1899	Top of Sugar-loaf Bar	Dredge	*Plants;* much vegetation, weeds, etc *Animals;* many living *Viripara* and other gastropods.
12–18	24	Aug. 16, 1899	End of Bar Buoy	Dredge	*Plants;* Chara; much weed.
10–20	28	Aug. 23, 1899	South side of Sugar-loaf	Dredge	*Bottom;* some fine marl. *Animals;* 11 large mussels, 5 of them alive. Haul chiefly of broken shells, representing all the common species, *V. contectoides*, long black gastropods, and *Planorbis* being very common.
16–14	. . . .	Aug. 6, 1900	South end of lake east side of Kettlehole.	Dredge	*Plants; Potamogeton* and *Naias*. *Animals;* mud minnow (*Umbra limi*). Two other *Umbra* were obtained a few days earlier in a similar place.
18	18	Aug. 15, 1899	"25-ft. hole"	Dredge	*Plants;* much weed (*Myriophyllum*) *Animals;* a few decayed shells of *Planorbis* and *Spharium*.
20	1	Aug. 14, 1899	Hole off Gravelpit.	Dredge	*Bottom;* mud. *Plants;* weeds. *Animals;* nothing living; a few dead shells
20	7	Aug. 14, 1899	Bar north of 85-ft. hole.	Dredge	*Animals;* The following shells, all dead and more or less decayed: *Viviparus contectoides;* many *Spharium; Planorbis, Physa;* 1 *Amnicola*. Living animals 6 red worms (*Chaetogaster lacteus*) and 15 living *Spharium*
26–24	21	Aug. 16, 1899	Flatiron bar buoy	Dredge	*Bottom;* marl *Animals;* 1 *Unio*, empty and broken shells representing all varieties; numerous red worms; some living *Spharium*

TABLE OF DREDGING AND RESULTS—Continued

Depth in feet	No. of haul	Date	Locality	Apparatus	Results
27–26	26	Aug. 16, 1899	Station where Farrar line crosses bar.	Dredge	Chiefly broken shells.
20–30	32	Aug. 24, 1899	North side of Sugar-loaf bar.	Dredge	*Bottom;* chiefly gravel (rough, not rounded), ranging from stones the size of hen's eggs down to very small sand. *Animals;* 1 red worm, some broken *V. contectoides*, several *Spharium*.
31	15	Aug. 14, 1899	Near Kettle-hole	Dredge	*Animals;* dead *V. contectoides*, *Spharium* and black sharp gastropods; 1 living *Spharium*.
35	11	Aug. 14, 1899	Kettlehole.	Dredge	*Bottom;* much mud. *Plants;* none living; a few leaves. *Animals;* a white worm; 3 dead *V. contectoides*.
33–38	25	Aug 16, 1899	Along bar from buoy	Dredge	*Animals;* chiefly dead and broken shells; dead and empty *V. contectoides*, *Planorbis*, *Physa*, *Spharium*, and black sharp gastropods. Some living *Spharium;* 7 red worms. No plants but a few bits of leaf.
40	10	Aug. 14, 1899	Kettlehole.	Dredge	*Animals;* dead shells, *V. contectoides*, *Planorbis*, and *Physa*.
40–50	9	Aug. 14, 1899	W. of 85-ft. buoy, off Long Point	Dredge	*Plants;* none; several dead leaves. *Animals;* dead *Spharium;* 1 dead *V. contectoides;* 28 living *Spharium;* 2 red worms
50	17	Aug. 15, 1899	Channel in front of Arlington	Dredge	*Plants;* none, some dead oak leaves. *Animals;* numerous *Spharium*, some dead *V. contectoides;* 4 red worms.
60	8	Aug. 14, 1899	W. of 85-ft. buoy	Dredge	*Plants;* none; a few dead leaves. *Animals;* 1 dead gastropod; 1 red worm; 25 living *Spharium*.
70–85	5	Aug. 14, 1899	Near Deep Hole	Dredge	*Plants;* none; some black, dead leaves. *Animals;* living *Spharium* several; 6 red worms.
80–85	4	Aug. 14, 1899	Near Deep Hole	Dredge	*Animals; Spharium*, many dead; a few dead *V. contectoides* and *Planorbis;* 1 red worm.
80–85	3	Aug. 14, 1899	Near Deep Hole	Dredge	*Animals;* many dead *Spharium*, 2 living ones; 1 red worm.

Series of correlated hauls:—In addition to the above tabulated hauls, the records of which were selected out of a large list and so arranged as to show as far as possible gradually increasing depths, the following table is given of certain sets of hauls made in series, beginning in deeper water and gradually working toward shallower places. On account of irregularities of the lake bottom there are, of course, certain numbers in the series which appear out of place.

SERIES I

The hauls of Series I were made by using drag-hooks between bars on a line 40 rods north of the center of Section 22, August 22, 1900.

Haul	Depth in feet	Results
1	25–22	Nothing.
2	25–24	A little *Nitella*.
3	24–20	*Nitella* and several *Vivipara contectoides*.
4	22–18	*Nitella* abundant; *Vivipara*, especially young ones, abundant.
5	18–16	Some *Nitella;* some *Potamogeton robbinsii;* a few *Vivipara*.
6	16–12	*Potamogeton robbinsii; P. compressus; Philotria; Vallisneria* and a good deal of *Vivipara*.
7	10–8	*Chara*.
8	10–8	*Potamogeton robbinsii; Ceratophyllum; Chara;* few *Vivipara*.
9	7	On a bar; marl bottom; little vegetation; some short *Chara* and a little *Potamogeton lucens*.

SERIES II

A second series of dredge-hauls, made on the same date and in the same general locality, is represented by the following table:

No. of haul	Depth in feet	Results
20	26–22	A little *Nitella*.
21	22–13	*Potamogeton robbinsii; Chara;* a little *Naias;* a little *Vallisneria; Vivipara contectoides*.
22	20–16	*Potamogeton robbinsii; P. lucens; Philotria; Vivipara*, 2.
23	10	*Chara* abundant; *Potamogeton robbinsii* abundant; *P. amplifolius* a little; *Vallisneria, Myriophyllum*, and *Naias* a little; *Potamogeton lucens; Vivipara contectoides* several.

SERIES III

This table records a series of hauls made with a drag on east and west half section line, section 22, and east of the middle of the same section in water between shore bar and lake bar, dragging toward the lake bar.

No. of haul	Depth in feet	Results
1	25-22	Mud bottom, *Nitella* abundant, covered with young gastropods, probably *Vivipara contectoides;* 1 large *V. contectoides* and 1 small bivalve. No plants except the *Nitella.*
2	22-18	Mud bottom, chiefly *Ceratophyllum* and some *Nitella;* no other plants; several moderate sized *V. contectoides* and a few small ones.
3	20-18	Mud bottom, *Nitella* plentiful, with several plants of *Ceratophyllum* and 1 of *Potamogeton;* several young gastropods, some evidently *V. contectoides.*
4	22-19	Mud bottom, chiefly *Ceratophyllum;* a good deal *Nitella* and 2 stems *Potamogeton compressus;* plenty of *V. contectoides;* 1 red worm.
5	18-17	Chiefly *Ceratophyllum;* some *Nitella;* a little *Potamogeton compressus* and *P. robbinsii; V. contectoides* common.
6	17-15	*Ceratophyllum,* abundant; *Potamogeton* sp., a good deal; *P. robbinsii,* common; *Naias, Philotria* and *Chara,* a little; plenty of *V. contectoides;* 1 red worm.
7	15-14	Stem of *Potamogeton* sp.
8	14-12	Plenty of *P. compressus;* some *Vallisneria;* a little *Myriophyllum;* two other species of *Potamogeton.*
9	12	*P. compressus,* plentiful; *Naias flexilis robusta,* plentiful; *Vallisneria,* little; *P. robbinsii,* little; *Myriophyllum,* little.
10	12-10	*P. compressus,* common; *P. perfoliatus,* few plants, in fruit; *Potamogeton* sp; few.
11	10	Nearly all *P. compressus.*

Conditions Favorable to Fish-Life

The physical and biological conditions obtaining at Lake Maxinkuckee are favorable in an unusual degree to the development of fish-life; they are sufficiently diversified to provide suitable environments for species possessing widely different habits. The lake-bed varies, in different places, all the way from soft black mud and decaying vegetation through clay, marl, fine sand, coarse sand, and fine gravel to coarse gravel and glacial boulders. In the littoral the bottom, though usually of hard, compact sand and gravel, is, in places, of softer material or very boggy. The depth of water ranges from a few inches to 89 feet. There is a considerable area of water exceeding 40 feet in depth, and there is a very great area

of bars on which the depth is 20 feet or less, and these are distributed about the lake most advantageously. The water appears to be of the best, as to purity, clearness, and temperature; it is warm enough to meet the needs of many species which thrive in warmer water, and cold enough for cold water species. The only important known limitation lies in the absence of absorbed oxygen in the depths, which necessarily bars the lake to deepwater species, such as the lake trout.

The biological environment appears to be equally well adapted to support a varied and abundant fish life. The plankton (both holophytic and holozoic) is adequate both in quantity and quality; its composition seems almost ideal, and its distribution appears to be that which will meet the needs of the fishes in the highest measure.

The larger plants are also well selected as to species and abundance; most of them are certainly helpful in one way or another. Animals of various kinds, many of them useful to fishes and few of them harmful, are present. There are many species of mollusks, many of crustaceans, and a good number of batrachians and reptiles. Aquatic birds, as ducks, coots and grebes, are common, and to be sure, not always helpful to fish-life, but, on the other hand, not wholly harmful. Natural enemies of fishes are not numerous nor very destructive. The purity of the water probably has much to do with keeping the fishes resistant to disease.

Favorable situations for spawning grounds are numerous. There are reedy shallows for pickerel, pike, yellow perch, and the like; sandy and gravelly areas near shore for darters, various minnows, and sunfishes of various kinds; bars of moderate depth well suited to bass, bluegills, walleyed pike and yellow perch; and a great range of situations in which most of the other species find conditions favorable to their eggs and young.

In the following systematic account of the fishes of Lake Maxinkuckee, we have endeavored to treat each species somewhat fully, so that anyone using this report will be able to acquire the general facts in its life history and to be able to distinguish the different species, one from another. A statement as to the known geographic distribution of each is given, followed by remarks on its distribution and habits in Lake Maxinkuckee as made known to us through our studies in that region, and finally by a relatively non-technical description which, it is believed, will enable anyone using the book to identify the species occurring here.

The total number of species of fishes known from Lake Maxinkuckee and its immediately connecting waters is 64. Of this num-

ber, 59 are known to occur in the lake proper and its small inlets, the remaining 5 species being found in Lost Lake and the outlet immediately below.

This is a considerably greater number of species of fishes than is known from any other small lake in the world. For purposes of comparison, the following figures are given:

There are known from the entire basin of the Great Lakes 152 species; from Lake Ontario, 73; from the St. Lawrence River and its tributaries, 71; from Lake Champlain and tributary waters, 54; from Chautauqua Lake, 31; from Cayuga Lake, 59; from Turkey Lake, Indiana, 29; from Eagle Lake, Indiana, 41; from Clear Lake, California, 13; Colorado River basin, 32; Klamath River basin, 15.

The great variety of fish-life in Lake Maxinkuckee is due to the unusual assemblage of favorable factors, constituting an environment, both physical and biological, that conduces in a remarkable degree to the development of a varied aquatic fauna.

The 64 species of fishes known to inhabit this lake are distributed among 15 families and 41 genera. There are representatives of nearly all the families of American freshwater food-fishes—only the salmon, sturgeon, mooneye, grayling, dallia, blindfish, pirate-perch, trout-perch, and sculpin families being unrepresented. And nearly all those families containing species which are useful as food for the food-fishes have numerous representatives here. The families having large representation are the Cyprinidæ (minnows) with 17 species, the Centrarchidæ (basses and sunfishes) with 11 species; the Siluridæ (catfishes) with 4 species; the Catostomidæ (suckers) with 5 species; and the Percidæ (perches and darters) with 13 species.

Of the 64 species inhabiting the lake at least 30 may be regarded as food-fishes of greater or less importance. The most important of these are the two species of black bass, the yellow perch, the bluegill and the walleyed pike. And at least 16 species are regarded as game fishes of greater or less interest. Among these are the small-mouth black bass, the large-mouth black bass, walleyed pike, bluegill, crappie, yellow perch, rock bass, and pike.

Fishes in this lake are not only unusually numerous as to species, but equally so as to individuals. Many of the species are found in very great abundance, some of them swarming in myriads. Even the game fishes are usually abundant. This is particularly true of the yellow perch, bluegill and the basses. When one considers the vast amount of fishing that is done at this lake, it is little less than marvelous that the supply keeps up so well

as it does. The plantings made from time to time by the Bureau of Fisheries doubtless contribute in great measure to the maintenance of this satisfactory condition; nevertheless, the conditions for natural reproduction must be exceptionally favorable.

Of the 64 species of fishes inhabiting this lake, at least 29 are used more or less for food and may therefore be properly regarded as food-fishes. Named approximately in the order of their importance as food, they are the following: Yellow perch, bluegill, rock bass, straw bass, small-mouth black bass, walleyed pike, calico bass, common sunfish, crappie, long-eared sunfish, warmouth, red-eared sunfish, pickerel, pike, eel, white sucker, redhorse, black sucker, chub sucker, carp, common bullhead, yellow bullhead, black bullhead, dogfish, river chub, creek chub, silverside, buffalo and spoonbill cat.

Col. Daniel McDonald, in his interesting "History[1] of Lake Maxinkuckee," states that little or no attention was given to the fish of the lake by the early settlers until about 1840. "There are yet living in Marshall County a few of those who as boys fished with their fathers in those early times, and the stories they tell of the schools of fish to be seen and the quantities caught are enough to make the modern fisherman green with envy. With fish poles cut from the grubs, homemade linen lines, and hooks of antique make, a couple of farmers would man a canoe, paddle to the first bar, and with worms and grubs for bait, an evening's fishing would bring in a bushel of as fine fish as ever swam in lake or river. It was not many months before a longer, a trolling line, with bucktail bait, was used, and a pull across the lake was all that was needed to furnish a small neighborhood with a hearty fish meal."

That this lake was early known to the Indians and resorted to by them on account of the abundance of its fishes, is well known. The Indian villages on its shores and in its vicinity were among the most populous in northern Indiana, and they depended in large measure on this and neighboring lakes for their supply of food.

FISHING AND FISH PROTECTION

In the early days the methods of fishing were primitive and had as their sole object the taking of fish for food. The spirit of the meek and honest Isaak Walton had not as yet penetrated any of those sturdy pioneers; they had other more important, more serious things to do. They caught fish only when needed as food. They caught them in their own way and in such

[1] History of Lake Maxinkuckee, by Daniel McDonald Indianapolis, 1905.

quantities as the condition of the larder in their cabins demanded. It was purely a matter of food supply with them. Forunately for us, as well as for them, fish were abundant and the supply was not easily exhausted. Little or no thought was given to methods of fishing except as related to immediate, tangible results. There was no apparent danger of depleting the supply; fish were abundant and, it seemed, would always remain so. That a time would ever come when the fish would need protection probably never occurred to any one; the fish protection idea was of later birth.

According to Mr. McDonald, spearing fish at night very early became a favorite method of fishing and "if the occupants of a boat got less than a hundred pounds of fish during a night they considered themselves in bad luck."

A little later, between 1850 and 1860, the use of seines became common and great quantities of fish of various kinds were caught each year in this way.

The sentiment favoring the protection of the fish of the lake has developed slowly, but it has developed. It has developed not only in the minds of the regular summer cottagers, but it has grown also in the minds of the casual visitors, the farmers roundabout and the local villagers. There are some exceptions to be found in each of these classes, perhaps as numerous in one as in another, while willful law breakers are rare; those who do all the destruction they can under a liberal interpretation of the law, are more numerous. On the whole, however, the law is well respected and the attitude of the people toward fish protection is wholesome.

ANGLING

According to Mr. McDonald, "it was not until in the '60's that the sporting fraternity—the fishermen with rod, reel and line—began to visit Lake Maxincuckee. By that time a few fairly comfortable row boats had been put on the lake and a small visiting party could find accommodation for a day or two with some of the farmers near by, and the fame of the lake as a fisherman's paradise began to spread abroad. The completion of the I. P. & C. Railroad (now the Lake Erie & Western) brought the cities along its line within eight miles of the lake, and parties from Rochester, Peru and Logansport began to camp upon its shores, and their white tents could be seen all through the fishing seasons beneath the shady groves of Long Point, Edwards' Landing and Peebles's Point. And after the completion of the Vandalia

Railroad to South Bend the Terre Haute people came in goodly numbers. The good qualities of the lake were first made known to the Indianapolis people by Hon. Martin H. Rice, who had known the lake since 1855, and when the railroad was completed the fishermen from the capital city came up, first singly, then by twos and threes, and finally by the dozen, to try their luck in the clear waters of our beautiful lake. They found good quarters at the Allegheny House, and they brought along their finest fishing tackle, their well-tried fly rods, their Frankfort reels, and the most approved artificial baits, and they all caught fish—all kinds of fish—and enough to make a goodly show in their fish baskets, and nearly every man of them had a bundle of smashed fishing tackle to take home to prove the truth of his story of the big fish he had hooked, but which got away. And the men from these cities came again and again, and they caught something besides the fishes; they caught a vision of the glory of the lake, with its clear waters, its tree-lined shores, its wooded bluffs, its clean sandy beaches over which gurgled the cool waters of its crystal springs, and the vision went with them to their homes, to their business rooms, and it would not depart, and they began to long for a portion of bluff, of

The charm of Maxinkuckee rests partly on its brilliant water above a clean gravel floor, and partly on the elevated shore line covered with grass and grove down to the water edge.

shore or beach, where they might abide for days or months and take into their souls all the beauties that vision had revealed to them, and shortly after they became possessors of jutting points, of stretches of beach, of tracts of wooded shores, of acres of the shady bluffs, and there they built the row of artistic cottages that now encircle the lake like rich tinted gems set around a luminous pearl."

And thus the angler has come more and more in evidence as the years have passed. At first the fishing was done wholly with live bait. The usual method—still largely in vogue among the farmers of the region—was by means of the long cane pole and angleworms, grubs, grasshoppers, mussels, or cut fish for bait. Minnows and artificial lures were not popular nor much appreciated. Later, a greater refinement of method gradually developed. Jointed split bamboo, lancewood and Bristol steel rods came into use, the lightness and cost of the rod varying with the experience, skill and professional pride of the angler. The grasshopper has continued a favorite for summer fishing and it is likely to ever so remain. The live minnow has grown in use and is now indispensible to fall fishing. Artificial lures of various kinds have come into use, some to be discarded, others as the frog and the Dowagiac, to remain in favor.

A brief description of these various methods of angling will, it is believed, prove of interest and value.

The long cane pole:—This primitive and very effective method is still popular and will doubtless remain so. A good long stem of the giant cane (*Arundinaria macrosperma*) is selected. The length may vary from 10 to 25 feet. The longer the pole the better, as the areas over which one may fish vary as the squares of lengths of the poles. The devotees of this method of fishing usually go out in pairs and each with two poles. One fishes from the bow of the boat, the other from the stern. The line used is as long as can be properly handled without the use of a reel, and thus the fisherman is able to reach water 30 to 50 feet distant on either side, in front, or behind. He whips first on one side and then on the other until the fish are found when he anchors and settles down to steady fishing. A cork or wooden float is almost invariably used and it is adjusted from time to time to suit the depth of water. The line is usually inexpensive. The bait used consists chiefly of angleworms, cut bait and grasshoppers. Angleworms (and grubs when they can be had) are always popular. From early spring until midsummer they are the chief bait. In July, when

grasshoppers appear, they largely take the place of worms and continue to be the principal bait until fall when they can not be easily obtained. Cut bait is always resorted to when other kinds fail, and by some is even preferred. Various species of fishes, mussels and even meat are utilized. Sometimes a stringer is used on which to keep the catch, but usually a gunny sack is preferred. The sack, securely fastened to the boat, is allowed to hang in the water, by which method the fish are kept alive and in excellent condition.

The species most often caught are bluegills, yellow perch, rock bass, calico bass and catfish, though an occasional bass or wall-eyed pike is taken. A hundred fish to the boat is not an unusual catch.

This method is very effective and, on occasion, appeals to many an angler who usually uses more expensive tackle.

Trolling:—Trolling has long been, and still is, a popular method of fishing. It can be practiced any time in the year when the ice is off the lake, and it seems to be about equally effective at all times. The rod used varies from a short stiff cane pole to a high-priced split bamboo. The line is usually of better quality than that used by the long cane fisherman. It may vary in length from 50 to 200 feet. Among the popular lures are the Hildebrandt spinner, the Skinner fluted spoon, and other spoons, phantom minnows, and the like. Perhaps the most effective is the Hildebrandt spinner. When this method is employed the angler usually throws out his line immediately after putting out from shore and free of weeds, and then rows slowly to some favorite bar across or along the edge of which he will carefully row, doubling and recrossing as occasion requires.

The species most often caught are the straw bass, small-mouth bass and the walleyed pike in the order named. Now and then a rock bass, calico bass or yellow perch is taken. The straw bass, however, is, above all, the species most frequently caught by trolling.

Bait-casting:—This method has grown in popularity greatly during the last few years, whereas it was little practiced 10 years ago. A short rod, either of split bamboo, steel or lance wood, $3\frac{1}{2}$ to 6 feet long, and a good 60-yard quadruple reel, with 50 yards of light, flat raw silk line, of 10 to 14 pounds tension, together with surface artificial lures such as the Dowagiac, pork rind, or pork chunk with weedless hooks or frog, constitute the proper outfit. Sometimes live frogs are used and with commendable success.

The boat is slowly rowed over what is thought to be likely water, the angler casting the meanwhile, on either side or from the bow, 50 to 75 feet, depending upon the skill he happens to possess in the art. Many of those who come to the lake are quite successful and easily reach the lawful limit. The species taken are large-mouth bass, small-mouth black bass, and walleyed pike. Occasionally two bass or a bass and a walleyed pike are taken at one cast.

A favorite and usually successful method practiced by those who are seeking large-mouth bass is to row slowly late in the evening or very early in the morning along near the shore and cast into the edges of the patches of weeds.

Fly-casting:—Not many fly fishermen come to Lake Maxinkuckee and not much fly casting is seen there. Those who do come use a 9 to 10-foot rod, and a very light oiled or Japan waxed silk line of 10 to 14-pounds tension. The small-mouth bass is the species usually taken; rarely a large-mouth bass or a walleyed pike is secured. But several other species will rise to the fly on occasion; among them may be mentioned the rock bass, yellow perch, pumpkinseed, bluegill, calico bass, crappie, and the warmouth bass.

Baits and lures:—The baits and lures used by the fishermen who visit this lake have a very wide range. They include, among live bait, minnows, frogs, grasshoppers, crickets, grubs, angleworms; among cut bait, mussels, meat, cut fish, crawfish, etc.; and among artificial lures, Dowagiacs of all patterns, Hildebrandt spinners, Skinner fluted spoons, buck tail, squirrel tail, pork rind, pork chunk, and doubtless others.

Beginning in the spring live *minnows* are used. The principal bait minnows are the following: creek chub, river chub, blunt-nosed minnow, Storer's chub, common shiner, silverside, young goldfish, mud minnow, straw-colored minnow, grayback minnow, mad tom, darters of various kinds, and various other small fishes. For large bass and walleyed pike, creek and river chubs of moderate size are preferred; for smaller bass any of the other species mentioned are good; and for bluegills, rock bass and perch, small minnows of almost any kind are suitable if not too large. The value of any particular kind of minnow depends largely upon its ability to live on the hook; if the minnow is delicate and dies promptly, it is not of great value, however attractive it may otherwise be. For this reason the common mud minnow (*Umbra limi*) is popular. Its dark, somber color, however, prevents it from being very attractive to bass and walleyed pike. The mad tom

and other small catfish, so popular with bass fishermen on the Susquehanna River, are not much used at this lake.

Unfortunately good bait minnows are not abundant in the streams about Lake Maxinkuckee. The nearest streams from which good minnows can be obtained are the Yellow River, about two or three miles north of the lake, and the Tippecanoe River at Delong, four miles south. Most of the minnows used at the lake come from a distance, mostly from Bachelors Run, Wild Cat Creek, and Deer Creek in Carroll County, and from the Wabash River and small creeks near Logansport. Many of the anglers who come to the lake for a few days' fishing bring a bucket of live minnows with them.

Minnows will be used in the spring and early summer until the water becomes so warm that they will not keep well; then they give way to grasshoppers which constitute the principal live bait from the middle of July until in September or the first frosts, after which they can no longer be found in any abundance. As soon as grasshoppers become scarce and the water becomes cool, minnows again become popular and continue so throughout the late fall and winter. After the temperature of the lake water gets down to 45° most any of the minnows can be kept alive in minnow buckets all winter.

Grasshoppers become popular as a bait just as soon as they are abundant enough to be caught in any numbers. At Lake Maxinkuckee this happens in the first half of July, and they continue in demand as long as they can be obtained. About the last of September, after a few good frosts have come, grasshoppers disappear. Most of the grasshoppers used at this lake belong to one or the other of two species, *Melanoplus differentialis* and *Melanoplus bivittatus,* more of the former than of the latter. Both species are abundant in the meadows and fields about the lake, particularly on the west and south. In 1898, a boy living 2¼ miles south of the lake sold $25 worth of grasshoppers to anglers about the lake, and in 1899, $43.35 worth. He charged only 5 cents a dozen. Several other boys supplied grasshoppers more or less regularly during the season, and the total amount of money received by them per season for hoppers has been conservatively estimated at $200, which would represent 4,000 dozen grasshoppers. Perhaps another 1,000 dozen were caught by the fishermen themselves, thus making the total number used each season at the lake not fewer than 5,000 dozen or 60,000 grasshoppers.

Considerable numbers of *white grubs* also are used. In 1899,

the grasshopper boy sold 140 dozen white grubs at 5 cents a dozen, or $7.00. The grubs are a very killing bait as long as they last for any fish with mouth large enough to take them. Of all species perhaps the rock bass is the one that likes them best.

Angleworms are always in demand and can usually be depended on to appeal strongly to rock bass, crappie, calico bass, yellow perch and bluegills; and, when properly impaled, they are not without attraction to bass and walleyed pike. Perhaps they possess the greatest charm to the goggle-eye and yellow perch, and it is a poor angler, indeed, who, when armed with a liberal supply of angleworms, can not reach the lawful limit of these species. Fortunately for the fish, the region about Lake Maxinkuckee is entirely too sandy for angleworms, and those who wish to use this old familiar bait must bring them from other more favored localities.

Frogs are not much used for bait at this lake. Small examples of the common leopard frog (*Rana pipiens*), and the little cricket frog (*Acris gryllus*), are the species most used. At times good catches of straw bass have been made with these by casting along the edges of patches of Scirpus or lily-pads, particularly in Lost Lake. In the fall of the year when it is a little too cold for grasshoppers and a little too warm for minnows, black crickets (*Gryllus abbreviatus*) are sometimes used with good results. These crickets can be had late in the fall after grasshoppers have practically disappeared. Favorite places to find them are in tiles lying on the ground or under pieces of old canvas or tarpaulin lying spread out on the ground. By examining such situations early in the morning large numbers may often be found. Crickets are most attractive to bluegills and goggle-eyes.

Of the various kinds of cut bait *cut fish* is probably most used and most popular, as well as most easily obtained. An eye, a pectoral fin, or a piece of flesh of a yellow perch, is quite attractive to goggle-eyes, yellow perch and sometimes, to bluegills; occasionally good catches of crappie, calico bass, and even small-mouth bass can be made with this sort of bait.

Mussels or freshwater clams are not much used except by the long cane pole fishermen who are after goggle-eyes, bluegills and yellow perch. The "foot" is the part of the mussel generally used.

Crawfish are frequently used for bait. Small soft ones are often used whole; larger ones are cut up and only the fleshy part of the tail made use of. This sort of bait is of course used only in still fishing.

Of *artificial lures* the kinds are many and diverse that one may see about the lake. Among a few of the more popular are the Hildebrandt baits of various kinds, particularly the double tandem and single spinners, Skinner's new casting spoon No. 2, various weedless hooks such as Bing's, Mayer's, Maloney's, Hasting's and McCurdy's, buck tails, reverse double-blade spinners, vacuum bass-baits, moonlight floating bait, weedless porkers, Hedden's surface and minnow baits, and Dowagiacs of various patterns. All these and many others are more or less popular. Aberdeen hooks, Kendall sneck, Cincinnati bass, sproat and Pennell, are popular, No. 4 for bluegills, yellow perch, redeyes and crappie, and Nos. 1 to 4 0 for bass and walleyed pike.

Reels of many kinds are in use, and rods of many styles from the long cane pole to the most expensive split bamboo and lancewood and green heart; an 8½-foot rod for bass, 7½-foot for walleyed pike and 10-foot No. 4 for bluegills and perch.

LAKE MAXINKUCKEE AS AN ANGLING RESORT

No very close estimate can be made of the number of anglers who visit Lake Maxinkuckee annually, or of the quantity of fish of each species annually taken from the lake. There are now about the lake about 175 summer cottages. Each of these is occupied from two to five months each season. There will probably be at least one person at each cottage who does more or less fishing. Then a great many more come and spend from one to several days fishing. In the spring, and more particularly in the fall, farmers and farmers' boys from the surrounding country make frequent fishing trips to the lake. Then many of the permanent residents about the lake and in the town of Culver do more or less fishing throughout the year. It is believed that 2,000 is a conservative estimate of the number of people who fish at Lake Maxinkuckee for an average of twenty days each year, and that the average daily catch is five fish for each person. This would make an annual catch of 200,000 fish. Putting the average weight at one pound, this would make the annual catch 200,000 pounds. The species caught, in order of number, are yellow perch, bluegill, rock bass, straw bass, black bass, and walleyed pike. Considered by weight the order would be straw bass, bluegill, walleyed pike, rock bass, yellow perch, and black bass.

The following table will give some idea of the angling possibilities at this lake.

FISH BY SPECIES AND NUMBER CAUGHT BY ONE ANGLER AT LAKE MAXINKUCKEE

Date 1899	Small-mouth Black Bass	Large-mouth Black Bass	Rock Bass	Bluegill	Walleyed Pike	Yellow Perch	Catfish	Remarks
Aug.								
18	1			24				Grasshoppers and minnows were used as bait up to Sept 30. After then minnows alone were used.
19	3			12				
21	2		4	20		1		
23	4		1	9				
25	5			12				
26	2		2	3				
27	2		1	3				
28	1	2	2	10	1			
30	6		2	12			1	
31	1			8				
Sept.								
1		1	2	14				
3	2	1		12				
5	1			6	1		1	
12			6					
15	4		2	5				
17	4		2	2				
18	3			2				
21	1	6	4	4				
22		5	3	1	1	10		
24	1	2	1			1		

Date 1899	Small-mouth Black Bass	Large-mouth Black Bass	Rock Bass	Bluegill	Walleyed Pike	Yellow Perch	Catfish	Calico Bass	Remarks
Oct.									
1					3				
5					6				
7		2			1				
8		1	1		2				
9	1	6							
12		2							
14		6							
15		4	3		1				These
16		1			4				thirty-six
17					6				walleyed
18		2			7				pike
19		3			10				weighed
20					1				100 pounds.
22					7				
23		1							
24		1							
25		1							
26		1							
30		2		1				1	
Nov									
5									
7		1							
9								7	
10		1			1	12			
14						13			

FISH BY SPECIES AND NUMBER CAUGHT BY ONE ANGLER AT LAKE MAXINKUCKEE—Continued

Date 1899	Small-mouth Black Bass	Large-mouth Black Bass	Rock Bass	Bluegill	Walleyed Pike	Yellow Perch	Catfish	Calico Bass	Remarks
Nov.									
15						10		1	
16					2	4			
17					5	2			
18	2				1	12			
20					2	1			
22	2				1				
1900									
Jan.									
3						55			
4		3							
5		9				5			
6		16	2			2			
7		15						1	
13		4		1					
14		2				2			
15		4				3			
Feb.									
6		24							
		36 lbs.							
7		11	2						
9		2	1						
10		4	6			3		3	
11		5	2	2		6		2	
23		2	1	1		10		1	
April									
22		3							
27		8							
29		12				2			
May									
4		8				3			
6		1							
12	3	9	3						
13	2	3	4						
July									
9	5		2						
10	3		3			1			
11	4		1						
12	5	1	1	2					
19	2	1	1		1	2			
22	16	1	1						
23	1								
25	9								
	98	200	66	166	64	160	2	16	

Some idea can be gotten of the amount of fishing at Lake Maxinkuckee by noting the number of anglers' boats observed on the lake from day to day. A few records of this kind were made and they are here summarized in the following table:

	A. M.			P. M.		
Date	Sky	Lake surface	No. of boats	Sky	Lake surface	No. of boats
July						
14	Cloudy	Choppy	33	Cloudy	Rough	18
15	Rain	Rough	2	Rain	Rough	17
16	Partly cloudy	Choppy	12	Cloudy	Choppy	15
17	Fair	Smooth	15	Fair	Rough	17
18	Fair	Smooth	13	Fair	Very smooth	9
19	Fair	Smooth	11	Fair	Choppy	9
20	Fair	Smooth	6	Fair	Rough	5
21	Fair, east wind	Smooth	7	Fair	Smooth	5
22	Fair, east wind	Rough	6	Fair	Rough	11
23	Fair	Rough	8	Fair	Rough	5
24	Fair	Choppy	17	Fair	Smooth	11
25	Rain	Smooth	20	Fair	Rough	12
26	Fair	Choppy	12	Fair	Choppy	7
27	Fair	Smooth	3	Fair	Choppy	5
28	Rain	Rough	3	Fair	Smooth	7
29	Fair	Smooth	11	Cloudy	Smooth	13
30	Fair	Smooth	5	Fair	Rough	7
31	Fair	Smooth	14	Fair	Smooth	
August						
1	Rain	Very rough	1	Fair	Rough	3
2	Fair	Smooth	7	Fair	Choppy	5
3	Partly cloudy then fair	Smooth	21	Fair	Smooth	7
4	Partly cloudy	Rough	18			
5	Cloudy	Rough	Few			
6	Clear	Smooth	Few	Clear	Smooth	7
7	Clear	Rough	7	Cloudy	Rough	5
8	Partly cloudy	Rough		Partly cloudy	Rough	3
9	Cloudy	Rough	4	Rain	Rough	15
10	Fair	Choppy	9	Fair	Choppy	12
11	Fair	Smooth	7	Fair	Rough	11
12	Fair	Smooth	9	Fair	Choppy	15
13	Fair	Rough	5	Cloudy	Rough	3
July						
17			11	Partly cloudy	Smooth	18
18			16			
19			20			13
20			18			13
21			20			11
24	Rainy		Few			
August						
10			Good many			
15	Rain		Good many			
18						7
28						11
September						
3						15

Ice-fishing:—One of the most interesting methods of fishing practiced at Lake Maxinkuckee is that known as ice fishing, or fishing through the ice. A rather careful study was made of this method during the winter of 1900-1901, and a large amount of interesting and valuable data secured.

The apparatus and the method may be described as follows:

The apparatus consists of a small stick about 15 inches long, $\frac{3}{4}$ inch thick, 2 inches wide at the reel end and tapering to one inch at the smaller end. On the larger end is placed a spool, usually $1\frac{3}{4}$ inches in diameter and $1\frac{3}{4}$ inches long, upon which the line is wound. The axis of the spool projects on one side as a handle, bent to the shape of the handle of the ordinary reel. About 4 or 5 inches from the spool is a hole through the stick through which a round stick somewhat smaller than the hole is placed. An oblong hole is cut in the ice, through which the lower end of the stick is placed until the cross-stick rests upon the ice, adjusted so that the stick stands at an angle of about 40 degrees from perpendicular. A piece of red flannel is tied to the handle of the reel which is adjusted so as to stand up. Live minnows are used for bait. Each fisherman will have several, sometimes 15 to 20, spools arranged in a circle in the center of which he stands, keeping watch on all. When the red signal of any reel is observed to be turned down he assumes that a fish has taken the minnow of that line and, going to it, he takes the spool in his hand, gives it a jerk to hook the fish, then winds it in.

Another somewhat similar contrivance used to some extent by ice-fishermen is the tip-up. This consists of a board 24 inches long, $\frac{3}{4}$ inch thick and about 2 inches wide. A hole is bored through the board from edge to edge about 8 inches from one end. This detached piece, upon the outer end of which the spool is placed is supported by a wooden pin passing through the hole already mentioned and is so balanced that, when the tip-up is properly placed, a slight pull on the upper end brings it down. Usually a small leather flap is fastened upon the frame at the lower end so as to aid in holding the movable piece in place until pulled upon by a fish. The tip-up is set in the ice at an angle of about 45 degrees and the hook is let down through a hole underneath. Live minnows are used for bait. When the bait is taken the movable piece tips, the spool end going down.

Sometimes the tip-up is simply laid flat on the ice over the hole. The inner (or base) end of the movable piece is painted red so that it may be seen the more readily when it tips up.

Ice fishing usually begins as soon as the ice is strong enough to bear up well, and continues as long as it remains safe. In the winter of 1900-1901, it began on December 13 and continued until March 22. Fishing is best when the ice is covered with snow or has become sufficiently opaque to prevent the fish from seeing the fishermen.

As Lost Lake freezes over earlier in the winter than the large lake, ice fishing begins there first. On the first fine morning after the ice has become strong enough to be safe and sufficient snow has fallen to render it opaque, the ice fishermen will be found out in force. Usually there are about a half dozen who make ice fishing a regular business in winter. Besides these there is a varying number of others who fish irregularly. The fishermen usually arrive upon the scene early in the morning and, unless the weather becomes too disagreeable, continue until evening, and every day until the ice becomes so rotten as to be unsafe.

The number of ice fishermen will vary from 2 or 3 to 20 or 30; perhaps the average daily number would be about 6.

The species of fishes that are caught in this way at this lake are the following: Straw bass, black bass, bluegill, rock bass, wall-eyed pike, yellow perch, warmouth, crappie, calico bass, grass pike, and catfish. Water-dogs and turtles are also occasionally taken.

The straw bass is the principal fish caught, though large numbers of the other species are sometimes taken. The method is a very successful one and on favorable days large catches are made.

The following table shows by species the number of fish caught by certain ice fishermen in the winter of 1900-1901:

Date 1900	No. fishing	Yellow Perch	Crappie	Catfish	Straw Bass	Grass Pike	Warmouth	Black Bass	Bluegill	Rock Bass	Wall-eye	Water-dog
December												
14	1	4										
16	2		1	1	1							
17	3	2			8	1	2					
18	1			11								
19	1			2			1					5
22	2	8			39							
28	1				8							
29	3				60			1				
30	2				30				1			
31	2				12							

Date 1901	No. fishing	Yellow Perch	Crappie	Catfish	Straw Bass	Grass Pike	Warmouth	Black Bass	Bluegill	Rock Bass	Walleye	Waterdog	Dogfish
Jan.													
1	4	2			25								
2	6				22					1			
3	3	1			4								
4	5				16								
5	6				13								
6	7	4			17						1		
7	9	5	1		65						1		
8	1				9								
9	3	6			13								
10	4				7								
11	5	1			3					4			
12	1	1											
13	6	1			10								
14	1				21								
15	3				24								
16	2	1	1		2								
18	2				6			1					
19	1	3			1								
21	5	3			40			2					
22	1				1								
23	5	30			54			1					
30	2				2			2					
Feb.													
7	1												1
11	1				1								
13	2				7								

Date 1901	Number fishing	Yellow Perch	Crappie	Catfish	Straw Bass	Grass Pike	Warmouth	Black Bass	Bluegill	Rockbass	Walleye	Waterdog	Dogfish	Calico Bass
February														
15	5				2									
16	2				18									
19	2				2									
23	2				21									
24	1				15									
25	3				18									
27	1				2									
28	2	6			8			3						
March														
1	11				56			5	1					
2	3				24									
3	1				8									
4	4	1			84			2			1			
7	7				112									2
8	8	9			52		1	1		1				1
9	4				6						1			
10	2				3						1			
11	2				5									2
12	6	5			27									
13	4	3			6			17		1				
14	3	8						19						
15	3				10			2						
16	4		3		13						1			
17	2				14			1						
18	5	22			18			1						1
19	1		2		2									
22	3				1						1			11
	195	126	8	14	1,068	1	4	58	2	7	7	5	1	17

FISHES PLANTED IN LAKE MAXINKUCKEE

The people interested in Lake Maxinkuckee have been and are alive to the value of the artificial propagation of food and game fishes and the inadequacy of natural reproduction to keep up the supply in the lake. The officials of the Vandalia Railroad, the Maxinkuckee Association, and a number of private individuals have kept in touch with angling conditions at the lake and have been active in their efforts to keep up the supply of fish. The United States Bureau of Fisheries has always responded promptly to requests for fish for this lake, and during the last 23 years has planted in the lake a total of more than 34,138,830 fish.

So far as known the first plantings of fish in Lake Maxinkuckee were made in September, 1889, and August, 1890, by the senior author of this report, then professor of biology in the Indiana State Normal School at Terre Haute. In his investigations about Terre Haute he had observed that, during high water in the spring, many fishes, including both the large-mouth black bass and the small-mouth black bass, run out into the overflow ponds and bayous along the Wabash River, and, as the water recedes, become caught there. And in the fall the majority of these ponds dry up and the fish in them perish. He conceived the idea of seining out these fish and transplanting them into the Wabash River and Lake Maxinkuckee. Large tin transportation cans were borrowed from the U. S. Fish Commission, and with the assistance of his students several hundred valuable fish were saved which would otherwise certainly have perished had they been left in the ponds. Many hundreds of large-mouth black bass, small-mouth black bass, rock bass, crappie, calico bass, sunfish and catfish of several species, suckers, buffalo, saugers, and other less important kinds, were turned loose in the Wabash River near by, and one shipment was made to Lake Maxinkuckee. Two other shipments were made in August, 1890. Mr. George E. Farrington, general agent of the Vandalia, with the true public spirit and a keen appreciation of the advantages of keeping Lake Maxinkuckee an attractive fishing resort, kindly arranged for the free transportation of the fish to the lake, and the three plants were made from the pier at Knapp's hotel. The three plants aggregated a total of 750 adult fish and consisted chiefly of large-mouth black bass though there were many of the small-mouth species among them.

Since then the U. S. Fish Commission (now the Bureau of Fisheries), has planted a great many fish in Lake Maxinkuckee, as may

be seen from the following tabular statement. It is doubtful if any lake in the country has been more liberally supplied with fish by the Government. It is also doubted if there is any other lake where the results of artificial plantings of fishes have been more satisfactory. Perhaps the best results have been obtained with the walleyed pike, locally called "salmon." While this species is undoubtedly indigenous to the lake, it does not seem to breed well in this lake. In order to keep up the supply to any considerable abundance it is therefore necessary to make large plants of fry from time to time. It is believed that the majority of "walleyed" pike caught each year are the grown up fish from the fry planted two or more years previously. It is different, however, with the large-mouth black bass, the small-mouth black bass and most of the other species planted; they all breed freely in this lake and every plant made increases the breeding stock correspondingly.

It will be observed from the table that four plants of lake trout aggregating 10,587 fish have been made in this lake. So far as we have been able to learn there is no evidence that any of these survived; there is no authentic record of the capture of a lake trout in this lake. If the physical and biological conditions obtaining in Lake Maxinkuckee had been as well understood before the lake trout were planted, as they are now, those plants would not have been made. One of the important results of our investigations was the discovery that there is little or no absorbed oxygen in the deeper waters of the lake in the fall. Deep-water species, such as the lake trout, whitefish, etc., finding no oxygen in the depths they inhabit, can not survive. This interesting problem is discussed more fully in another part of this report (page 221). If this important fact had been known in time the plantings of lake trout would not have been made and the Government would have been saved an expense greater than the entire cost of all the investigations that have been made of Lake Maxinkuckee.

The following table shows the number of fish of the various species that have been placed in Lake Maxinkuckee. In the earlier plantings the two species of bass were not differentiated; each planting usually contained both species, the large-mouth more often predominating:

PLANTS OF FISH IN LAKE MAXINKUCKEE

Date	Species	Fry	Fingerlings and adults
1889-90	Black Bass		750
1890			
Feb. 15	Lake trout		1,900 yearling
1891			
Jan. 14	Lake trout		3,250 yearling
June 12	Pike perch or salmon	800,000	
1892			
Feb. 1	Lake trout		2,531 yearling
Nov. 10	Black bass		1,190 yearling
10	Warmouth bass		400 yearling
10	Crappie		50 yearling
10	Yellow perch		385 yearling
1894			
Mar. 10	Lake trout		2,906 yearling
May 4	Pike perch	2,000,000	
1896			
Dec. 29	Black bass		2,200 yearling
29	Crappie		1,600 yearling
29	Crappie		300 adult
1898			
Oct. 20	Black bass		200 yearling
29	Crappie		500 yearling
1899			
Aug. 23	Large-mouth black bass		5,198 adult
1900			
May 16	Pike perch	800,000	
1902	Pike perch	10,000,000	
	Black bass		800
1903	Pike perch	8,200,000	
	Black bass		400
1904	Pike perch	7,700,000	
1905	Catfish		5,700
	Crappie		750
	Black bass		6,900
1907	Pike perch	1,000,000	
1909	Black bass		625
1911	Black bass		45
	Pike perch	1,500,000	
1912	Pike perch	2,100,000	
1913	Black bass		250
	Total	34,100,000	38,830

From this it is seen that a total of over thirty-four million fish have been planted in Lake Maxinkuckee. These represent different species, as follows:

Lake trout	10,587
Pike perch	34,100,000
Black bass, both species	18,558
Warmouth bass	400
Crappie	3,200
Yellow perch	385
Catfish	5,700
Total	34,138,830

All of these species do well in Lake Maxinkuckee except the lake trout. It is not certain that any of that species has ever been seen in the lake after the plants were made, but all the others do well.

On April 1, 1908, 600 rainbow trout were put in the outlet stream just below Walley's and 150 in Culver Creek north of the Academy grounds. The trout were 3 to 5 inches long.

Although an examination of those streams indicated favorable conditions under which trout ought to do well, none of the fish has been seen since the plants were made. The conditions are so favorable that it is hoped the experiment may be repeated soon.

The establishment of a fish-cultural station or fish hatchery at Lake Maxinkuckee has often been suggested.

It is believed that an excellent site for a pond station could be secured at this lake. There are two or three excellent locations on the east side where a gravity supply of water could be secured and where ground suitable in character and ample in area for a series of ponds can be found. There are also good locations on the north and west sides.

A well-equipped hatchery at this lake could easily keep, not only Lake Maxinkuckee, but all suitable waters in northern Indiana well stocked with bass, walleyed pike, bluegills, and rock bass.

MORTALITY AMONG DIFFERENT SPECIES OF FISHES

At various times in the year dead fish of different species are found in some numbers washed up along the shore. The species most affected appear to be the bluegills and white suckers. The bluegills die in the spring, in May and June, and the white suckers in the fall, usually in September. Although a large number of dead fish were examined no satisfactory explanation of the cause or causes of their dying was discovered. The fish were usually infested with water mould, or Saprolegnia, but it is not believed that was the agent that caused the fish to die. This saprophytic plant first becomes evident by appearing as a soft white mould on the surface of the fish, particularly in places where the scales have been rubbed off or where the fish has been otherwise injured. But by the time it becomes evident to the naked eye, the fish is probably past helping. When the fish becomes injured in any way or when its vitality is lowered because of foul water or any other reason, it is apt to be attacked by water mould and nothing can be done to save it.

In the spring of the year, soon after the ice goes off the lake, unusual numbers of dead fish, water-dogs, crawfishes, etc., are apt to be washed up on shore. These do not indicate any sudden or un-

usual mortality among the fishes; they probably simply represent the accumulated mortality of the past winter, during which time the lake was covered with ice, the water inadequately aerated, and many fish died as a result. Fishes or other animals dying under such circumstances would decay very slowly in the ice-covered water and, remaining well preserved in the ice-cold water, would accumulate and be washed up on shore soon after the ice disappears and winds again disturb the lake surface.

COMMERCIAL FISHING

There is now no commercial fishing at this lake. The important species in it are all game fishes under the law, the sale of which is not permitted.

A canvass made of the fisheries of Indiana in 1894, credited Lake Maxinkuckee with five hand-line fishermen with 10 hand-lines valued at $30 and five boats worth $50, and a catch of

600	pounds of rock bass, valued at	$72 00
2,833	pounds of black bass, valued at	368 00
300	pounds of walleyed pike, valued at	24 00
500	pounds of yellow perch, valued at	60 00
4,233	pounds total, valued at	$524 00

This of course represents only the fish actually sold; the vastly greater amount caught by sportsmen does not appear.

Until the present law prohibiting the sale of game fishes became effective, a considerable part of the catch of the ice-fishermen was sold.

OBSERVANCE OF FISH LAWS

Public sentiment about Lake Maxinkuckee in relation to the fish and game laws is wholesome and favors their observance. There has been a notable improvement in the last ten years. In the spring of 1900, it was not uncommon to see lights in the south part of the lake where spearing was going on at night. Sometimes the violators operated in Outlet Bay. In the same year some spearing was done about the middle of November. Some netting was done also. A favorite method was to cut a long narrow slit through the ice across the mouth of Norris Inlet. A gillnet would be let down through this and by pounding on the ice the fish would be driven into it. Little or none of this sort of fishing has been observed recently.

It was reported that some seining was done in May, 1907, and three arrests were made, and a conviction secured, in each case.

Considerable illegal fishing was thought to be going on in March and April, 1911, but no actual case was observed.

There have doubtless been more violations of the bird law. Even prominent cottagers and citizens have been suspected of shooting or hunting ducks illegally and some convictions have been secured. In October, 1904, a prominent cottager on the east side was caught chasing coots with a motor boat, after sunset and on Sunday, all three acts being unlawful. He was fined on all three counts.

We are informed by the present deputy fish and game warden stationed at the lake that he has known of only one violation of the fish law in the last two years. One arrest was made for having a fish spear in possession. Conviction was secured.

It is believed that both the fish and game laws are now fairly well observed in the vicinity of the lake.

Minnows

In the fall of the year, about when the water becomes chill and the first ice forms, minnows of various species begin to congregate in great numbers in shallow water along the shore. On November 12, 1899, a narrow fringe of ice appeared along the shores of Lost Lake and minnows were observed crowded thickly under it. Similar conditions existed at the south end of Lake Maxinkuckee and thousands of minnows were crowded under the ice. Some that had hidden under boards and boats were more tame and more easily caught than those found elsewhere.

On September 16, 1900, a large school was seen near shore in front of the Fish Commission station; on the 18th, a considerable school remained near shore all day. On October 17, a good many were again observed, and on the 26th, a large school remained near shore. The day was quiet, the water very smooth, and the little fish could be heard breaking water and splashing for some distance. They were probably feeding on surface plankton. On the 29th, they could be heard at night making a "snipping" noise. On the night of October 30, they could be heard making a sort of lisping noise. Early in the morning of November 3, great numbers were seen near shore, playing very lively at the surface. Again on the 10th, 11th, and 12th they were very lively, splashing and making considerable noise.

On November 30, several grayback minnows among a large number taken were found to be ruptured slightly in the abdomen. This was probably caused by freezing. Many large schools of minnows, chiefly skipjacks, were seen under the ice at south end of lake.

On December 1 and 2, only a few were seen near shore, some in Lost Lake and some in the big lake. On the 3rd, there was an

immense school, very dense and compact, of straw-colored minnows and skipjacks along the east side of Long Point for a long distance.

On the 5th, enormous schools, considerably larger and denser than ever noted before, were seen along the east side of Long Point. They made great dark patches on the bottom, like Chara carpet. On the 12th, a good many under the ice near shore all day; a large and very dense school under the bow of a small steamer at the Arlington station. Many were noted also on the 14th, in each lake, under the ice, and a few under the ice in Lost Lake on the 15th; none seen in the Outlet.

Similar conditions were observed in 1904. On December 16 and 24, several schools were seen along Long Point, but they were not so dense as in 1900. On the 27th, enormous schools were seen under the Depot pier. The next day many skipjacks were noted under the Outlet bridge. On January 4, 1905, considerable numbers were seen along the north shore where there was some ice, and Culver Inlet was full of straw-colored minnows.

In 1906, a great many were seen on east side of Long Point, November 13, and on the 14th, many in Lost Lake.

Migrations and Seasonal Movements of the Fishes

In a body of water as small as Lake Maxinkuckee and with no considerable tributary streams or outflow, the movements of the fishes are necessarily much restricted. There are, however, certain movements that may be considered, as follows:

1. *From one depth to another:*—Movements of this kind occur at various times.

a. During the summer, when the deeper parts of the lake are abundantly supplied with absorbed oxygen, certain species, such as the walleyed pike and to some extent the small-mouth black bass, the large-mouth bass, the bluegill and the yellow perch, will be found in deep water. This is particularly true of the walleyed pike; of the other species named it is true only to a very limited extent. In the fall, even as early as September, the oxidation of the vast amount of dead plankton which during the summer has been slowly falling to the bottom of the lake in a continuous shower from above, will have exhausted the supply of oxygen in the deep water. The walleyed pike and other fishes which were able to live there during the summer are now forced to move up to shallower depths to which, fortunately, they are able to adapt themselves. This movement is not usually until toward the end of September or in October. By the middle of October they have come out into

water 30 to 45 feet deep and may be taken on or about the bars between those depths. Later in the season they will be found at still more shallow depths. Whether they return to deeper water during the winter has not been definitely determined. It is known that they are in relatively shallow water during the spring where they remain until in June, or early July; then they go to deeper water.

b. There is another seasonal movement from greater to lesser depths and back again, that is probably not related in any way to the oxygen content of the water, but which is caused chiefly by temperature differences. This manifests itself in a number of ways, of which a few illustrations may be given: The little stickleback, *Eucalia inconstans*, prefers relatively cold water. During the summer and early fall they may not ordinarily be found in water less than 15 to 20 feet in depth; indeed, they seem to go down to the depths which mark the maximum for Chara and other aquatic vegetation. In all of our summer seining operations about the lake only one stickleback was obtained; but in the late fall and during the winter, specimens were frequently obtained when dredging in 4- to 12-foot water. During summer dredging they were found only in considerably greater depths. Evidently these little fish remain during the warm summer months at considerable depths, and some, not all, come out into shallower water only when the temperature there has become equally cool.

Then again, young of many of the fishes of the lake, especially basses, bluegills and perch, are found in greatest abundance during the summer in shallow water near shore where they not only find protection in the masses of vegetation which they inhabit but where they also find an abundant supply of suitable food. But as fall comes on, and the shallow water near shore becomes more and more cold until finally near the freezing point, these young fishes move out into deeper and slightly warmer water and secrete themselves in the masses of Chara, Nitella and other vegetation. There they spend the winter, returning to shallower water in the spring.

Still another movement occurs late in the fall, usually not until after the first frosts have come, when several species of small fishes gather up in unusual numbers in shallow water along the shore. The species most concerned are the straw-colored minnow (*Notropis blennius*), the Cayuga minnow (*Notropis cayuga*), the blunt-nosed minnow (*Pimephales notatus*), the skipjack (*Labidesthes sicculus*), the grayback minnow (*Fundulus diaphanus menona*), and the log perch (*Percina caprodes*). Each of these species is found at all times in greater or less numbers pretty well

distributed in shallow water everywhere along shore. But in the fall they gather up in schools. Sometimes these schools are of immense size, containing many thousands of individuals. The different species mentioned are present numerically usually in the order named, and there will be along with them a few individuals of several other small fishes, chiefly Cyprinidæ. Usually the skipjacks and log perch school by themselves. The log perch schools come earlier than the others; in 1913, they were first noticed in large numbers on October 3, when a school of 100 to 200 or more was seen at Johnson's pier on Long Point. They were lying quietly on the clear sandy bottom or moving slowly about in shallow water. The same school was observed on several subsequent days. On the same day, October 3, a large school of skipjacks was seen near the same place. Others were seen later and continued to be noted as opportunity afforded so long as our observations were kept up, or until October 31.

The very large schools of small fishes that may be seen along the shore in the fall consist, however, chiefly of the species of Notropis mentioned, particularly *Notropis blennius* and *N. cayuga*, and do not appear until some time later. Perhaps the largest schools ever noted by us were seen on November 5, 1907. On that day the shallow water on the east side of Lost Lake was alive with small fishes all the way from the Bardsley cottage to the south end of the lake. More than a bushel were caught at a single haul with a 12-foot seine. There were actually millions of them, chiefly *Notropis cayuga*. In other places *Notropis blennius* was the most abundant species.

These schools seen in the fall vary much in size, from small to very large. They are seen to best advantage on still, bright sunshiny days, even when the air is quite cold. They are seen most often about or under piers or boats.

We are unable at this time to explain why these small fishes collect in schools and come out into shallow water in the fall. It evidently has no relation to their feeding habits or their breeding habits; nor does it appear to be for the purpose of getting away from the bass and other carnivorous fishes; as a matter of fact many of them fall prey to water-dogs which crawl up close to shore and devour the fishes in considerable numbers. It may be a reaction to temperature.

c. There is still another movement that occurs daily during the summer and early fall. We refer to the coming of bass and other fishes into shallow water at night. This is a well-marked movement and occurs more or less evidently every still night in

summer, especially in August and September. The species that participate are both large- and small-mouth black bass, rock bass, yellow perch, walleyed pike, dogfish and even suckers and catfish. This movement is clearly a factor in the feeding habits of the species concerned; they evidently come at night into shallow water along shore for the purpose of feeding upon the young and small fishes and other life found there, especially insects which oviposit in the water surface near shore.

For this reason seining operations along shore at night were always interesting, because species could then be gotten which could not ordinarily be found there in day time.

The intelligent anglers, well aware of this habit, particularly of the large-mouth bass and the walleyed pike, will be found trolling or casting near shore in the evening. And the enthusiasts who fish after dark know that it is worth while to do their casting and trolling near shore at the edges of the rushes and other vegetation.

2. *From Lake Maxinkuckee to Lost Lake:*—To what extent do bass and other fishes leave Lake Maxinkuckee in the fall and go down into Lost Lake and on to Tippecanoe River? And to what extent do they return in the spring? These are very important questions. The abundance and the permanence of the supply of fishes in the lake will be dependent in large measure upon the facts suggested in these questions.

In the opinion of many residents about the lake and of many of the anglers who visit it, a great many of the game fishes leave the lake in the fall and go through the Outlet down into Lost Lake. Some think they all stop and spend the winter in Lost Lake and return to Lake Maxinkuckee in the spring. Others think that many of them go on down the Outlet stream to Tippecanoe River, perhaps to return to the lake in the spring, or perhaps not. All are agreed that the species most concerned is the large-mouth bass, and the small-mouth black bass to a less extent.

So general and strong is the belief in this alleged migratory movement that, at various times, those holding this view have succeeded in having a screen put across the Outlet at the railroad bridge in the fall to prevent the fish from going down. The screen would be installed in September and kept in place until sometime in the winter or early spring when it would be removed in order to let the fish return if they wished to do so.

During our investigations we gave considerable attention to this question. As the Outlet is only a few rods (about 40) from where we stopped when at the lake we were able to make almost daily observations on the fish at that place. Our observations cov-

ered practically all of the fall of 1900, 1904, 1906, 1907, and 1913, and during parts of other falls.

A few of our records may be given as typical.

September 28, 1900, a good-sized school of straw bass of various sizes, mostly small, under railroad bridge.

October 21, 1904, a few small straw bass in Outlet above the screen this morning; about as many near a minnow box in the Outlet below the screen.

October 23, one small straw bass against the screen.

October 25, a small school of little straw bass under the railroad bridge.

October 26, a school of small straw bass and one yellow perch under the railroad bridge, the perch having moved down from under the wagon bridge.

October 27, water too rough and foamy for observation.

October 28, a good sized school of small straw bass near the screen. In the afternoon there was a school of perhaps 1,000 skipjacks under and at each side of the wagon bridge, heads up stream and skipping some.

October 29, a number of small straw bass in morning and at noon; also a school of skipjacks and a few common sunfish (*Eupomotis gibbosus*).

October 31, only a few straw bass (same school previously noted) under railroad bridge. Immense school of skipjacks under wagon bridge at noon; nothing seen in evening.

November 1, nothing seen early in morning but probably the same school seen later, also on 2d, and a smaller one on the 3d.

November 4, a few small straw bass under railroad bridge all day.

November 5, 6, 7, and 9, only a few seen each day.

November 11, 12, 13, and 15, no fish at Outlet.

November 17, a few straw-colored minnows at noon.

November 18, nothing in morning, a few straw-colored minnows at noon.

November 19, nothing under railroad bridge; a few straw-colored minnows under wagon bridge at morning and noon.

November 20, nothing except a few straw-colored minnows under railroad bridge in morning, nothing at noon, a few in evening.

November 23, nothing.

November 26, nothing.

December 10, a large school of straw-colored minnows.

December 12, nothing.

The observations of other years show essentially the same conditions.

Much to our regret, spring records are largely wanting, due to the fact that neither of us was at the lake during the spring except in 1901, when the importance of this question had not yet been fully realized. Such observations, however, as were made in the spring do not confirm the belief that there is any appreciable spring movement into Lake Maxinkuckee.

It will be noted that the large-mouth black bass (straw bass) is the species that was most frequently observed, and that the individuals seen were almost without exception young or very small ones.

Migration of fishes through the Outlet of Lake Maxinkuckee might consist of any one or more of the following movements:

1. From the lake into Lost Lake either (a) to remain permanently or (b) to return to the larger lake in the spring.

2. From the lake into Lost Lake and on down into the Tippecanoe River either (a) to remain there permanently or (b) to return to Lake Maxinkuckee in the spring.

3. From Tippecanoe River to Lake Maxinkuckee either (a) to remain in it permanently or (b) to return to the river in the fall.

4. From Lost Lake to Lake Maxinkuckee either (a) to remain permanently, or (b) to return to the smaller lake in the fall.

It is evident that the only movement that can seriously affect the fishing in the larger lake is that which is not followed by a return migration. If a fall migration *out* of the lake is followed by a corresponding spring migration *into* the lake, the supply of fish in the lake is not materially affected. This is true whether the fall migration carries the fish only to Lost Lake or on down into the Tippecanoe River. If the fish should go into Lost Lake and remain there the supply in the larger lake would be deceased by so much and that in Lost Lake correspondingly increased. As the two lakes are only a few rods apart this would not greatly affect the fishing in the general Maxinkuckee region; if the fish could not be found in one lake they could in the other. But if the fish go on down to the Tippecanoe River and do not return the fishing in the Maxinkuckee region suffers.

Aside from the evidence secured through observations at the Outlet, very important, if not conclusive, evidence has been obtained as one of the results of another and very different investigation, namely, a study of the geographic distribution of the Unionidæ or freshwater mussels in the Maxinkuckee-Tippecanoe region.

As is now well known, the young of the various species of fresh-water mussels are carried as parasites on the fins and gills of fishes for a considerable period. When sufficiently developed, these young, known as glochidia, slough off and drop to the bottom at any place where the fish happens to be at the time, and there enter upon an independent existence. If there were any considerable migration of fishes from one of these waters to the other it is highly probable that glochidia of mussels from the one body of water would be carried to and dropped in the other. We should therefore find some river mussels in the lake and some lake mussels in the river; in other words, the mussel faunas of the lake and that section of the Tippecanoe River adjacent to the outlet stream should closely resemble each other. But such is not the case; as a matter of fact, they are almost wholly different. It is not believed this would be possible if there were any marked interchange of fishes between the two waters. This feature of the case is considered more fully in the discussion of the mussel fauna of the lake, to which the reader is referred.

Another important fact must be kept in mind. As already stated the large-mouth black bass is the species which, of all, is popularly believed to leave the lake in the fall, and which is most often seen in the Outlet. But that these fish go down to Tippecanoe River is rendered extremely doubtful by the fact that this species is not known from the portion of the Tippecanoe River concerned. Considerable and frequent collecting in the river at and near the mouth of the outlet stream has failed to discover a single example of the large-mouth black bass in those waters; and anglers familiar with the Tippecanoe River rarely, if ever, find that species in that stream.

During the autumn of 1906, on various occasions, hauls with the seine were made in the Outlet about two or 2½ miles below Lost Lake, and on various occasions trips were made along the whole or part of the Outlet, and the species of fishes noted. Although both the seine-hauls and several of the trips were made at a time of year when the fishes are supposed to be migrating, and the seining was done in just such places as they would naturally lurk, no bass were observed, only a few small suckers, minnows, and darters, some species of which make their home in the Outlet but do not ascend to the lake at all. We are therefore forced to the conclusion that such migration or movement of fishes in and out of Lake Maxinkuckee as may occur is negligible and that screening the Outlet will serve no useful purpose.

FOOD AND PARASITES OF THE FISHES

By Charles Branch Wilson

Introduction

The paper herewith presented is one of those resulting from an investigation of the animal and plant life found in Lake Maxinkuckee and neighboring waters. The author was sent to the lake in the summer of 1906, and directed to study the parasites and diseases affecting the fishes of the region.

Mr. H. Walton Clark assisted the writer during his stay at the lake in 1906, and, at various times thereafter, collected and sent to him additional material which has been useful in the study of the food and the external parasites of the fishes of this lake.

Unfortunately no record could be found of such a study of a limited area of fresh-water, where the entire ground could be covered. Consequently there has been no precedent to serve for guidance and much of the work has been preparatory rather than conclusive.

The fishes studied were mostly the game and food fishes caught by local and visiting sportsmen, and hence just the ones most desirable. Young fish of the same species and others too small or otherwise unfit for food were caught with a seine.

In this way nearly 1,500 fish, adults and young, were examined during July, August, and the first week in September, and careful records were kept of the food and parasites observed.

It was soon realized that any intelligent discussion of the parasites must include their life histories and also a careful study of their habits, their enemies, and the physical conditions which might prove advantageous or detrimental to their growth.

For the three genera of parasitic copepods these data were all obtained, in the case of two of them for the first time; for the various genera of cestodes, trematodes, and Acanthocephali, the data have been already published by Dr. Edwin Linton in his various excellent papers dealing with the internal parasites of fresh-water fishes. But for the leeches, which bid fair to prove the most important of the parasites, only a crude beginning could be made. Their importance was not realized until late in the season; only a little time could then be given to them, and they are not a group that can be easily handled.

The lake was found to be exceedingly well balanced in both its animal and vegetable life, and the fish proved to be disappoint-

ingly healthy. And yet, on second thought, a region where the various kinds of life are well suited to their environment and properly balanced can be made fully as profitable a subject of study as one filled with contamination and disease.

A remedy or preventative is always of more value than the disease which it cures; indeed, the only true incentive for the study of any disease is the hope of thereby finding an effective cure or preventative. Hence the careful investigation of such conditions as prevail at Lake Maxinkuckee ought to reveal the proper balance between parasite and host, and show how the former are prevented from multiplying fast enough to become dangerous. With such a purpose the following observations have been recorded, and it is hoped they may also serve as a basis for future work along the same lines.

The physical and general ecological conditions obtaining at Lake Maxinkuckee are considered in detail in another portion of this report. The conditions which make possible the abundant fish-life of the lake are fully considered—the depth of the lake, the character of the water, the remarkable richness and profusion of plant life, and the abundance and variety of many groups of aquatic animals—and need not be repeated here.

Of the 64 species of fishes known to inhabit Lake Maxinkuckee and immediately connecting waters 27 species were studied by the writer with relation to their food and parasites. Among these are included practically all the food and game fishes of the lake (at least 12 species) and also a considerable number of minnows and darters, of which there are in the lake no fewer than 10 species.

This wealth of small fishes bears a most important relation to the general economy of the larger food and game fishes, as will be seen in the following considerations.

In the first place, they furnish food directly to the larger fishes, the majority of which are carnivorous. Ten of the species certainly depend upon these small fish for a portion of their food. And these ten include all the game fishes of the lake except the crappie and the bluegill. For the different kinds of bass and perch there is no bait that can compare with a lively minnow. And the best of the artificial baits are made in imitation of the minnow, either directly simulating its form (Hildebrandt), or indirectly imitating the gleam of its body darting through the water (the various trolling spoons). Then, too, every fisherman knows by repeated experience that it is not the food fish alone that are partial to minnow bait. Many of the worthless fish are only too

willing to seize the tempting morsel and bring disgust to the angler who, after a hard fight, was looking for something much better. Again it must be remembered that the fish just enumerated were examined during the summer season when their other food is especially abundant. They could be expected therefore, to yield only minimum returns in the line of fish food.

In the winter, on the other hand, when the plankton, frogs, crawfish, mollusks, and algæ are less numerous, the proportion of fish food probably increases. And it would not be surprising to find even the crappie and bluegill eating darters and minnows then. There is much reflection in the thought that not only is a minnow the one bait available for fishing through the ice, but in all probability it is the best that could be offered. Necessity and choice go hand in hand for once.

In the second place, the minnows themselves feed almost entirely upon plankton and insect larvæ, and hence an abundance of these foods is requisite to keep up the supply. Fortunately the lake is very rich in just these creatures, and although the swarms of may-flies, gnats and other dipters may occasion the angler some inconvenience at times, he has but to remember how essential they are to the life of the fish he is endeavoring to secure.

Species of fish studied:[9]—In discussing the food and parasites as here recorded it will be better to take up the different kinds separately, considering their relative importance and abundance, and proposing such recommendations as have been suggested during the progress of the work.

1. Dogfish; bowfin. *Amia calva.*

Only six specimens were examined, in whose stomachs were found chiefly crawfish and minnows, with the remains of other small fishes, mollusks and algæ. Each of the six fishes contained internal parasites, trematodes in the mouth and throat, and cestodes and Acanthocephali in the stomach and intestine. There was also a trematode (*Azygia tereticolle*) in the gills of four of the specimens. On the outside of the body one fish yielded *Argulus americanus*, and three gave two different species of leeches.

The dogfish in Lake Maxinkuckee seem to be unusually free from tapeworms. All those examined elsewhere are invariably found loaded down with masses of tapeworms, the penalty of their voracious and carnivorous habits, but here they seem to have escaped.

[9] Considerable additional data regarding the food of Maxinkuckee fishes will be found in the chapter on Fishes (pp. 306-451).

2. Yellow Cat. *Ameiurus natalis.*

One hundred and twenty-two specimens of this species were obtained, all but 10 of them from Lost Lake. Such of the food as could be recognized consisted entirely of small fish and crawfish, but in the great majority of cases nothing could be distinguished. This species is the true host of *Argulus maculosus* and more than 60 specimens were obtained, nearly half of the fish examined being infested with the parasite. On the yellow cat, also, a new species of *Ergasilus E. versicolor,* was more abundant than on the bullhead. Leeches were commonly found in the mouth and around the lips, and occasionally on the fins, while nearly every specimen showed trematodes and many of them Acanthocephali in the stomach.

3. Common Bullhead. *Ameiurus nebulosus.*

Twenty specimens were examined, half of which were caught in Lake Maxinkuckee and the other half in Lost Lake.

Partially digested fish were found in the stomachs of four specimens; in a fifth many seeds of the water lily, *Castalia odorata,* while in the remainder there was a small mass of indistinguishable animal remains. About one fish out of four proved to be the host of *Argulus maculosus,* three or four of these parasites being obtained from the outside surface and fins of a single fish. A single leech was found fastened to the lip of the fish in three specimens; on the gill-filaments of eight others were a very few specimens (only 12 in all) of a new species of *Ergasilus,* which has been named *E. versicolor,* and which will be found described on page 341, Proc. U. S. Nat. Mus., Vol. 39. In the stomach of nearly every fish were found trematodes and Acanthocephali.

4. Mad Tom. *Schilbeodes gyrinus.*

The stomachs of the specimens examined contained beach-fleas, which are very common in the lake. The mad toms lie among the Chara where these crustacea are plentiful.

We thus see that the cat-fishes as a whole are omnivorous, eating both animal and vegetable food. The larger cats feed mainly on small fish and crawfish, while the smaller ones eat the smaller crustacea.

5. Buffalo-fish. *Ictiobus cyprinella.*

A single specimen of this large sucker was found dead and floating at the surface in one of the deeper parts of the lake.

It had not been dead more than an hour or two when secured, and so was practically freshly caught. It measured 4 feet in length and 3 feet in girth, and weighed 75 pounds.

Its stomach was filled to distention with chironomus larvæ and the remains of algæ, the latter so digested as to be incapable of identification. A few trematodes were found on the gills and cestodes in the stomach and intestine, but no external parasites of any kind were seen.

6. White Sucker. *Catostomus commersonii.*

Only four specimens of this fish were examined and two of these were found dead near the shore. From one of them and from the two freshly caught, were obtained eight specimens of *Argulus catostomi,* four males and four females. The stomachs of these fish contained only an indistinguishable mass of dirt and vegetable remains. Many leeches were found on the dead fish but it was impossible to determine whether they had fastened to the fish before or after their death.

7. Hog-molly; Stone-roller. *Hypentelium nigricans.*

Two specimens of this sucker were obtained from Yellow River four miles north of Lake Maxinkuckee. Their stomachs were found to be filled with mud and a mixture of animal and vegetable remains, the only things distinguishable being a few insect larvæ. No parasites were found anywhere upon them.

8. Chub Sucker. *Erimyzon sucetta.*

Two specimens of this sucker also were obtained from Yellow River in connection with the preceding species. The stomachs of both were empty and no parasites were found anywhere upon them.

9. Blunt-nose Minnow. *Pimephales notatus.*

One of the most common forms, and also one of the best for bait because it is so hardy and long-lived. The stomachs of five specimens showed insect remains and plankton, the latter chiefly Bosmina[1] and Cyclops.

10. Silver-fin. *Notropis whipplii.*

Another common form, and one greedily eaten by all the food fishes. The stomachs of two specimens showed insect larvæ, water mites, and plankton.

11. Grass Pike; Pickerel. *Esox vermiculatus.*

A single specimen of this pickerel from Lost Lake showed the usual fish remains in the stomach together with trematodes and cestodes. A trematode (*Azygia tereticolle*) was also found on the gills, and a leech was fastened to the tongue near its tip.

[1] We have not endeavored to distinguish between the genera Bosmina and Chydorus.

12. Grayback Minnow. *Fundulus diaphanus.*

Abundant in shallow water and makes excellent bait. The stomachs of four of these killifish contained several small snails, six water mites, many Bosmina and a few Cypris. In each of them were also found several trematode parasites.

13. Top Minnow. *Fundulus dispar.*

Fairly common along shore, but more abundant in the Outlet and in Lost Lake. The stomach contents of three examined consisted entirely of surface plankton, amongst which was a copepodid larva of Achtheres which also swims at the surface.

14. Brook Stickleback. *Eucalia inconstans.*

Nothing was learned of its food under natural conditions but some which were kept in an aquarium eagerly snapped up red worms (Chironomus larvæ) and small entomostraca, such as Cypris, shaken from the towing net into the water.

A single specimen was secured in a good state of preservation from the throat of a large-mouthed bass which was just endeavoring to swallow it. There was nothing recognizable in the stomach and no parasites of any kind were found.

15. Skipjack. *Labidesthes sicculus.*

This species is also abundant in shoal water along the shore. Like the top-minnow it feeds almost exclusively at the surface, frequently jumping out of the water. Neither this species nor the top-minnow is of much value for bait since they die so quickly in the minnow buckets and when placed on the hook.

16. Calico Bass. *Pomoxis sparoides.*

Twenty specimens were examined, whose food so far as could be determined consisted entirely of plankton and insect remains.

From the gills of two of them were obtained six specimens of *Ergasilus centrarchidarum*, while in the mouth of two others were found several leeches. It was noticeable that the largest fish examined, one and a half and one pound respectively, were entirely free from parasites, while the smallest ones were most infested.

17. Red-eye; Rock Bass. *Ambloplites rupestris.*

Two hundred and sixty specimens of this fish were examined, and they were of all sizes from one inch to 11 inches in length. The small ones were captured in a minnow seine, while the larger ones were obtained from the fishermen.

The food of the smaller ones, four inches and under, was found to be chiefly plankton, and small fish. The plankton was largely Bosmina, Daphnia, and Cyclops, and there were also a few mayfly and other insect larvæ. Among the small fish were two mad

toms, *Schilbeodes gyrinus*, the pectoral spine of one of which had pierced the stomach wall of the red-eye that swallowed it, and was imbedded in the flesh of the body wall. Other small fish that could be identified amongst the food of the red-eyes were *Etheostoma iowæ*, *Labidesthes sicculus*, and *Notropis whipplii*.

On several occasions some of the small red-eyes were kept over night in minnow buckets along with minnows, and in nearly every instance they improved the opportunity and swallowed some of the minnows. From the stomachs of these red-eyes, in addition to the small fish just mentioned, there were taken also specimens of *Pimephales notatus*, *Notropis cornutus*, *Fundulus dispar*, and *Fundulus diaphanus menona*.

The larger red-eyes, four inches and over, ate mostly crawfish, minnows, and darters of the various kinds just mentioned.

For parasites, *Ergasilus centrarchidarum* was found upon the gill-filaments of even the smallest specimens examined. With rare exceptions the gills of every fish contained some of these parasites, and often 50 to 75 could be obtained from a single fish. To the gill-arches of the larger specimens were attached *Achtheres ambloplitis;* these were much less plentiful than the Ergasilus and many of the fish were entirely free from them.

Leeches were found in the mouth or on the fins of about one-third of the fish, while cestodes and trematodes were nearly always present in the stomach and intestine.

18. Warmouth Bass. *Chænobryttus gulosus.*

Only three specimens of this fish were examined, and nothing could be determined as to the food of any of them. On the gills of one were found three specimens of *Ergasilus centrarchidarum* and on another seven. No other parasites were found.

19. Bluegill. *Lepomis pallidus.*

One hundred and fifty of these sunfishes were examined, including many small ones caught in the minnow seine.

The smaller ones, like the smaller red-eyes, had eaten mostly plankton. From the stomach of one, three-quarters of an inch in length, were taken many Bosmina, five or six Cyclops, one Daphnia, and much that was indistinguishable. From another fish, two and a half inches long, were secured two green beetles and the remains of other insects. In a third, 65 millimeters in length, were many Bosmina, two blue, and 12 red, water mites, and two insects like ants. A fourth, 18 millimeters in length, contained several Cyclops, Bosmina, and Daphnia like the first one, but in addition there were two copepodid larvæ of Achtheres. As these larval

parasites were attempting to fasten themselves to the gills of the little fish, they evidently met their just deserts and were swallowed.

The stomachs of the larger bluegills contained many Chironomus larvæ. Of 50 obtained near the middle of August the stomach of every one was gorged with the tender tips of Potamogeton, Heteranthera, Naias, and other water plants. But most of the vegetable matter was so chewed and digested as to be incapable of identification.

Ergasilus centrarchidarum was obtained from the gill-filaments and *Achtheres ambloplitis* from the gill-arches of a few fish, but neither parasite was at all common.

To the sportsman, acquainted with the carnivorous habits of most game fishes, this vegetable diet of the bluegill comes as a surprise, but of course the fish eats many animals also. In the summer they eat Potamogeton, Ceratophyllum, Naias, some Chironomus larvæ, and a few Sphæriums. In the fall they eat large branches of the brown bryozoan of the lake, *Plumatella polymorpha*, Rivularia, and bits of Chara.

These bluegills are particularly infested with leeches, some being found on nearly every fish, and often eight or 10 huddled together on the roof of the mouth of one fish. Trematodes also occur on the gills and cestodes and Acanthocephali in the stomach and intestine.

20. Sunfish; Bream. *Eupomotis gibbosus.*

Only six specimens of this fish were examined, the food of which consisted of insect larvæ, mollusks, and small crawfish. One example had two tapeworms in its stomach, but there were no external parasites on the gills or the outside of the body.

21. Small-mouthed Black Bass. *Micropterus dolomieu.*

Twenty-five specimens of this fish showed almost nothing beside crawfish and minnows; what there was of other material was so digested that it could not be identified.

Every bass had at least some specimens of *Ergasilus centrarchidarum* on its gill-filaments, and about half of them (11) had also *Achtheres ambloplitis* on the gill-arches. There were usually but two or three of the latter on a single fish, but from one bass weighing one and a half pounds there were taken 37 specimens, including both sexes and every stage of development from a copepodid larva just attached up to the mature adult.

Cestodes were also found on the gills and in the stomach, and Acanthocephali in the stomach and intestines. A single leech was taken from the pectoral fin of one of the smaller specimens.

22. Large-mouthed Bass. *Micropterus salmoides.*

Fifteen of these fish were obtained for examination during the summer, and in most of them the digestive tract contained nothing that could be identified with certainty. From three were obtained crawfish, and from one of these and four others the remains of small fish. Five young fry taken in the minnow seine gave better results. One, 45 millimeters long contained many Cypris, Daphnia, and other entomostraca, one Chironomus larva, and an Achtheres copepodid larva. Another, the same length, contained the same entomostraca and their eggs, and a strange alga. A third, 52 millimeters long, had its stomach nearly filled with amphipods. A fourth, 55 millimeters in length contained an Achtheres larva and a lot of indeterminable material. The fifth one, 70 millimeters long, contained only fish remains.

All the larger fish and four of the small ones contained cestodes and Acanthocephali; the fourth small one just enumerated yielded four species of these parasites from the stomach alone.

Achtheres ambloplitis was found on the gill-arches of four of the large fish, and *Ergasilus centrarchidarum* on the gill-filaments of four of the smaller ones.

23. Wall-eyed Pike; "Salmon". *Stizostedion vitreum.*

Twenty-four of these perch were obtained for examination, the largest of which weighed four pounds and the smallest a pound and a half. The only thing obtained from their stomachs in the way of food was the remains of small fish, too far digested in every instance to allow of identification.

They were all badly infested with Acanthocephali, six or eight large specimens being often found in the stomach of a single fish. Trematodes were also common in the stomach and intestines. *Ergasilus centrarchidarum* in small numbers was found on the gill-filaments of three of the fish.

No leeches were found on any of the fish, but this is no doubt partly due to the fact that during the summer the walleyes stay in deep water. In the spring when they come into shallow water to breed they are probably as badly infested with leeches here in this lake as they have been found to be elsewhere.

The author had the privilege of examining 200 walleyes at the Hatching Station at Swanton, Vermont, on the extreme northern end of Lake Champlain, in the spring of 1905.

With very few exceptions every fish had at least a few leeches somewhere on its body, and from the roof of the mouth of one four-pound female were taken 40 large specimens.

24. Yellow Perch. *Perca flavescens.*

One hundred and fifty of these perch were examined at different times, and in their stomachs were found insect larvæ, amphipods, small fish, mollusk remains, crawfish, and in the smaller specimens, plankton and a few algæ.

Ergasilus centrarchidarum was found on the gill-filaments of nearly every fish, but although careful search was made not a single specimen of Achtheres was secured.

A large species of cestode was found in the throat of many specimens whither it seemed to have crawled from the stomach after the fish's death. Large leeches were also found in the mouth of 50 of the fish; trematodes and Acanthocephali were found in the stomach and intestine of about one-third of the specimens. Of two examined October 27, 1904, one contained a rather large rock crawfish, and the other a number of Sphæriums.

One found dead on shore November 1, 1904, contained a large dragon-fly larva.

On October 3, 1904, many perch were caught fishing from the pier. They all contained medium sized crawfishes. Of two perch about six inches long examined October 22, 1904, one contained 8 small Physa and the other a well digested fish. Of a number of small perch caught off the Gravelpit September 25, 1900, three contained crawfishes, one had 28 small Physas, five others had a few Physas each, and one had two Vivipara opercula.

25. Manitou Darter. *Percina caprodes zebra.*

The largest and one of the most common darters in the lake. Eight specimens from two and a half to three and three-quarters inches in length were examined. They all contained much indistinguishable insect remains; in four, may-fly larvæ could be recognized, in two others beach fleas, and in one Bosmina, Daphnia and Chironomus larvæ.

26. Johnny Darter. *Boleosoma nigrum.*

Another very common species found everywhere in shallow water. Of the five specimens examined, two yielded beach fleas, two Chironomus larvæ, and one an ant-like insect which could not be determined. In addition they all contained partly digested insect remains, and one had a trematode parasite in its stomach.

27. Iowa Darter. *Etheostoma iowæ.*

Fairly common along shore in the shallow water where it lurks amid the algæ on the bottom. Of the three specimens examined each contained several beach fleas and a mass of indistinguishable insect remains.

The algæ and water plants furnish ideal breeding places for these entomostraca and insect larvæ on which the minnows and darters feed, and so long as they remain there need be no fear of any diminution in this important food item.

Amongst their other food the minnows which frequent the surface eat more or less of the larvæ of the parasitic copepods which infest the larger food fish. They thus not only serve as food for the larger fish, but also are of great value in helping to keep these obnoxious parasites within due bounds.

This double service greatly increases their economic value and makes their preservation a matter of considerable importance.

There is every probability that the darters which frequent the eel grass at the bottom of the lake feed to some extent upon the small leeches which breed there. These leeches are the worst enemies of the food fish, and anything that contributes to their destruction is worthy of careful fostering and protection.

Such being the relation between the minnows and darters and the food fish the following facts become worthy of careful consideration:

1. None of the darters and only three or four of the minnows are of any value as bait. They die quickly in the minnow buckets and still more quickly when placed upon the hook.

Every one that dies in a minnow bucket acts as a killing agent to the minnows left alive, and every one put upon a hook decreases by so much the angler's chance for success.

2. The very kinds that are of least value as bait are of most service in keeping down the parasites which infest the food fish. Under natural conditions also they are as often eaten by the large fish as any of the bait species.

3. In seining for minnow bait all kinds of minnows and darters get into the net, and nearly always the young fry of larger fish, particularly those of the large and small-mouthed bass, bluegills, red-eyes, sunfish, and catfish.

4. Very few of the fishermen and none of the boys who seine for minnows can distinguish these different kinds one from another. Those who can do so have never been taught the economic value of these small fish, and, if they stop to think at all, consider them good for nothing if they do not make suitable bait.

Consequently the good ones, or usually all that are large enough, are put in the minnow bucket, and the rest are left to die on the shore where the seine was pulled out and examined.

5. Such indiscriminate destruction is a serious menace to the

fishing interests. The supply of bait, if obtained in this manner, is by no means "inexhaustible" as Judge Capron would have us believe. And worse than all is the wanton destruction of small fish that are of no value directly to the angler, but are of immense importance in the economy of the fish life of the lake. Hence the following recommendations seem in order:

a. Some means should be taken to acquaint the fishermen and especially the seine boys with the common minnows and darters, and with such fish fry as they are likely to get in their seines.

A collection of the common species, well labelled and placed in the office of the hotels frequented by fishermen would help greatly in this direction. The publication of a small folder setting forth these facts briefly and plainly, and its free distribution among fishermen would also tend to arouse their interest and turn it in the right direction.

b. There is already a law which limits the size of the seine that can be used in catching minnows. There should be a corollary to that law making it compulsory to throw back alive into the water everything that was not kept for bait.

c. There should be some restriction in the use of minnows. Most anglers take too many in their buckets, and they die rapidly and are thrown away without having served any legitimate purpose.

Insect Larvæ

Amid the wealth of insect forms which surround the lake and teem in its waters, a few may be selected as of more importance in consequence of their value as fish food.

I. *The Diptera.* Two-winged Flies.

This immense order is represented by an abundance of the aquatic larvæ of the Culicidæ (mosquito) and Chironomidæ (midge) families.

Species of Chironomus are particularly abundant, and the long jelly strings containing their eggs are common everywhere among the algæ during the earlier part of the season. Some of these eggs were hatched and reared in aquariums and it was found that the young larvæ ate Spirogyra and similar algæ greedily.

These larvæ are eaten by many of the fish in the lake, notably the crappie, the darters, young bass fry, and even by the huge buffalo-fish.

The larvæ of some culicid were found in the stomachs of two darters, *Etheosoma iowæ* and *Percina caprodes*, and in the young fry of *Eupomotis gibbosus* and *Perca flavescens*.

These Culicidæ also furnish food for the dragon-flies and damsel-flies; the adult dragon-fly eats the adult mosquito, gnat, midge, etc., while the dragon-fly nymph feeds just as voraciously on their wriggler larvæ. The larger fish feed upon the dragon-flies, both adults and nymphs, and thus indirectly upon these Diptera.

II. *The Ephemerida.* May-flies.

These may-flies or shad-flies are all aquatic, and their nymphs can be found everywhere in countless numbers amid the algæ and near the surface of the water. Several times during the early summer the tow consisted almost entirely of these nymphs and their cast skins from which the sub-imagos had emerged.

These were the larger species having a limited period of emergence, the adults of which suddenly appear in countless numbers along the lake shore and as suddenly disappear.

At such times the sub-imagos and imagos fairly covered the screens at the doors and windows after nightfall, and there was no difficulty in collecting a sixteen-ounce bottle full every evening around the lantern on the wharf. In the morning the entire top of the wharf would be found covered with the sub-imago skins fastened as closely together as they could stand.

But most of the species are not thus limited, and only a few adults emerge at a time, the nymphs being taken commonly in the tow during the entire summer up to the first of August. The larvæ are very active and swim about among the water plants, feeding for the most part upon algæ, including beside the plankton scums, diatoms and confervæ. The larva lives from one to three years, thus compensating in a measure for the short life of the adult.

Both larvæ and adults are eaten by nearly every fish in the lake, and thus constitute an important item in their food.

In particular they are a favorite food with the crappie, the redeye, the perch, the darters, the catfish, the suckers, and the minnows. The fact to which Howard calls attention in his Insect Book is worthy of repetition here in emphasizing the value of these insects for fish food. Imitation shad-flies furnish one of the best possible baits in regions where the real insects abound. The flies known as duns, drakes, and spinners, which are used by English anglers, are imitations of Ephemerids. One of the best artificial baits at Lake Maxinkuckee is known as the Hildebrandt spinner, in which the hook is covered with a tuft of feathers to simulate an Ephemerid.

III. *The Odonata.* Dragon-flies and Damsel-flies.

Treatment of the species of this order in their relation to fish-life will be found in the chapter of this report (p. 648) giving a systematic list of the species of Dragon-flies and Damsel-flies known to occur in the vicinity of Lake Maxinkuckee.

Leeches

These are found in great numbers everywhere around the lake, and it is safe to say that there is not a species of fish that does not suffer from their ravages. They are frequently found on mussels also, as well as on turtles, crawfish, and mud-puppies. And they do not refrain from attacking cattle and even human beings while wading through the eel-grass near the shore.

They often congregate in considerable numbers upon some animal which has been subjected to adverse conditions and make it so much the harder for it to recuperate. Fifty-three specimens of *Glossiphonia parasitica* were taken from the neck of a snapping turtle whose shell was only seven inches long. The turtle was fairly clean when caught but had been kept for ten days in a fish-car with several others of its kind.

The leeches are more abundant at certain seasons than at others, especially in the spring, and there can be no doubt that they at least contribute to the killing of the fishes, which perish in such numbers at that season.

They constitute therefore a serious menace to the fishing interests; once let them get the upper hand and they would destroy the fish rapidly. Hence it is of interest to ascertain what keeps them down and prevents their multiplication in sufficient numbers to prove destructive.

No study of this problem has ever been published so far as known; indeed, but very few papers have appeared upon American leeches, and they are concerned entirely with morphology and systematization. The most that can be done here is to call attention to the importance of the study and record a few observations.

Leeches lay their eggs in cocoons which are either deposited in moist earth or glued to some object in the water. In one or two genera the cocoon is covered by the body of the parent, who further cares for the brood by carrying them about with her for some time after they have hatched. But usually on hatching the young seek the shelter of the algæ and water plants in the shallow water along shore. From this shelter they emerge to fasten upon whatever host they may select.

Here among the algæ, therefore, we should look for the chief enemies of the leeches, and this period immediately after hatching must constitute a critical period in their lives.

There are two groups of animals which frequent the algæ, both of which probably eat many of the young leeches, although unfortunately there is no direct proof of such a fact in the observations here recorded. The importance of the leeches was not realized until the very close of the summer's work and it was then impossible to secure the evidence.

The first is the group of small fishes called darters, that live and breed amid the algæ. In the few whose stomachs were examined were found the larvæ of many animals that breed in the algæ and of some parasites (see p. 300). There is good reason to believe that further investigation of the food of these fishes would show that they occasionally eat leeches also.

The second group is even more promising; it is the dragon-fly nymphs whose greed and voracity are only too well known.

They seize and devour everything in sight, and it must happen sometimes that they get hold of leeches amongst their other prey. At least there is promise enough in these two groups to warrant a careful study in the future.

The fishes get back at the leeches in another way also, since the latter are often found in the fish's stomach mingled with other food. Marshall and Gilbert, in their "Notes on the Food and Parasites of some fresh-water Fishes from the Lakes at Madison, Wisconsin" (Appendix to the Report of the Commissioner of Fisheries for 1904, pp. 513-532) record leeches amongst the food of *Esox lucius*, *Lepomis pallidus*, and *Micropterus salmoides*.

That they are eaten by other fish also seems probable from the testimony of City Marshal Fisher of Culver, who says they make the best fish bait he ever tried. All sorts of fish bite at them eagerly, bass, perch, bluegills, sunfish, etc. They are tough, so the fish cannot tear them from the hook easily, and often two or more fish can be caught with the same bait.

Here is a good suggestion for the fishermen, especially when other bait is scarce, and one that will help to rid the fish of their worst enemy.

Copepod Parasites

The Copepod Parasites will be found fully treated in connection with the other Crustaceans, pp. 717-720.

LIST OF SPECIES OF FISHES

In the following annotated list we use the nomenclature and sequence of species of Jordan and Evermann's Fishes of North and Middle America.

1. WESTERN BROOK LAMPREY

LAMPETRA AEPYPTERA (Abbott)

No lampreys have been seen by us in Lake Maxinkuckee itself and it is possible that they do not occur there. A few catfishes were found dead along the east side of the lake in the spring of 1901, and from marks on their sides it was thought that they might have been killed by lampreys, but this is by no means certain.

Young lampreys, however, are not rare in the Outlet of the lake and in some of the smaller lakes of the region. Fishermen about the lake who go seining for minnows in the Outlet and other streams and waters of the region report the capture of "young eels."

On June 18, 1901, one of the fishermen living near the lake reported that he had two young eels, obtained while seining for minnows in an old outlet of a drained mud pond. He said that when the lake was drained it was quite full of young eels, and that he could get many more where the two had been caught. The supposed eels were found to be lampreys. In 1906, a fisherman reported finding "young eels" in the Outlet, but none was seen by us at that time.

On October 7, 1907, a trip was taken with men going to seine for minnows at a point in Outlet Creek, about 3 miles below the lake. The net was dragged through a hole with a muddy bottom, and upon being drawn ashore was found to contain a large amount of mud in which were several lampreys. A few more were taken in a subsequent haul, the total number taken in 4 hauls being 14.

None of the specimens seen was adult; the largest obtained were the two secured in June, 1901, one of which was 132 mm., and the other 124 mm. in length. This is less than half the length given for the adult, which is given as 12 inches (304.8 mm.). Of the 14 specimens secured in the fall of 1907, the largest was 116 mm. and the smallest only 29 mm. long.

An interesting characteristic of this species is the size it attains while still in an immature condition; none of the specimens obtained has either teeth or eyes developed, while considerably smaller examples of the related *I. castaneus*, with which it was compared, have teeth and eyes well formed. *Lampetra wilderi*

also has well-developed teeth and eyes before it reaches the size of the specimens of *I. aepyptera* at hand.

The following is a description of the specimen 116 mm. in length:

Head 5.8 in length; depth 19.3; dorsal finfold beginning as a low ridge a short distance behind last gill-opening, reaching its greatest height (about 8 mm.) a little behind vent, no notch separating it from caudal; caudal fold quite low; the dorsal and ventral folds extending nearly to end of body; barely any membrane beyond caudal tip of body; ventral fold similar to dorsal, beginning as a mere ridge a little behind the last gill-opening. Body elliptical in cross-section, not much compressed, the thickness from side to side being about five-sixths the depth; gill-openings 7 in number, branchial space about 9 in body; nostril small, single, median, consisting of a small pore somewhat lengthened along the axis of the body, surrounded by 3 low flaps forming an equilateral triangle with one apex at the anterior end; upper lip a prominent horseshoe-shaped projection, thick at the base, thinner at the edges, curving somewhat downward along each side and ending in a rounded lobe; lower lip a low open V-shaped ridge; buccal disk covered with small, somewhat fringed flaps or papillæ; teeth and eyes not developed.

Color: Back and sides slaty blue, belly whitish, the branchial area somewhat paler than the remaining portion of the sides; the small dusky spots mentioned in current descriptions as being present above each gill-opening and usually conspicuous even in the larvæ, are not present in our (alcoholic) specimens. The number of muscular impressions between the last gill-opening and vent in the specimens examined is somewhat larger than given in current descriptions, there being 53 to 55 instead of 51.

These larval lampreys are exceedingly active little creatures, and move rapidly through the water or mud by quick lateral flexions of the body, their actions much resembling those of some of the aquatic salamanders in this respect. They appear to spend most of their time in the mud, upon which they feed for the sake of the microscopic organisms contained in it, and the fringed flaps on the buccal area probably assist in washing the mud into the mouth, or in selecting food. The stomach of an example 100 mm. long was examined. The intestine, a straight tube from the mouth to the vent, was pretty well filled with mud. The mud was examined and found to contain numerous diatoms, among which Navicula was represented by several species; species of Synedra, Epithemia, Gomphonema, Stauroneis and Cymbella and

an example of *Cymatopleura solea* were also present. In addition to the diatoms 2 examples of the desmid, *Closterium dianæ*, one of Gleocapsa, one of Pediastrum, and 2 tests of the rhizopod *Euglypha alveolata* were found.

It is quite likely that this actively wiggling creature might make an attractive bait for some species of fishes, although it is not used at the lake. Prof. Simon H. Gage* says of a similar form (*Lampetra wilderi*) "from the tenacity with which the larvæ retain life they have been found excellent bait for all kinds of ordinary carnivorous fishes. The fishermen along the Cayuga and Seneca Lake inlets make considerable use of the larvæ for bait. This form of bait has not up to the present been much used in the lake fisheries, as apparently its excellence is unknown. At Owego, on the Susquehannah River, however, quite a business is carried on in supplying larval lampreys to fishermen of all kinds, and many are shipped to distant points." The larvæ are, therefore, to be regarded as "non-injurious and positively beneficial by serving for bait. The adult Lamprey, however, is injurious, and is a common parasite of the sturgeon and other large fishes. The following is a description of the adult form:

Body considerably compressed; head broad, with a large buccal disk, which is moderately fringed; teeth strong and nearly uniform, the 2 supraoral teeth being similar to those on the rest of the disk; lateral teeth all simple; infraoral cusps connivent, 7 in number, the middle ones the longest; upper margin of dorsal scarcely depressed in front of the vent; origin or dorsal nearly midway between tip of snout and end of tail; 51 muscular impressions between gill-openings and vent. Head 7.5; depth 12.

Color silvery, bluish above, sometimes with bluish spots; a small dusky spot above each gill-opening, usually conspicuous even in the larva. Length 12 inches.

2. PADDLEFISH

POLYODON SPATHULA (Walbaum)

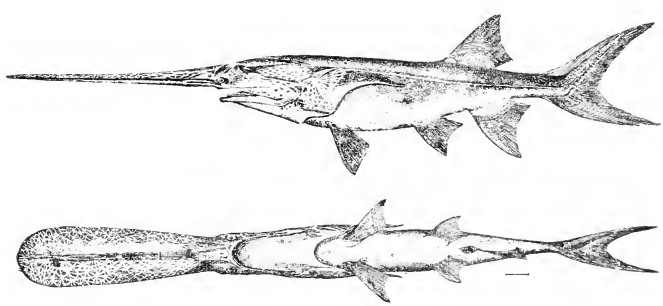
The Paddlefish, known also as the Spoonbill Cat, Duckbill Cat and Spade-fish, is a fish of the shallow lakes and bayous and sluggish lowland streams of the Mississippi Valley. It is perhaps most abundant in those portions of Mississippi, Tennessee and Arkansas bordering on the Mississippi, though it occurs as far south as Texas and as far north as Minnesota. It is fairly common in the Ohio River, at least as far east as Pittsburgh, and a single example, said to have been 6 feet 2 inches long and weighing 123.5 pounds, has

* The Lake and Brook Lampreys of New York. Wilder Quarter-Century Book, 1893, 457.

been reported from Chautauqua Lake. The senior author has taken it in the Missouri Basin as far west as Chamberlain, South Dakota. At least one specimen has been taken in Lake Erie*; which it had probably reached through the Wabash and Erie Canal.

The Paddlefish attains a considerable length, but as much of this is taken up by the bill, it does not weigh heavy in proportion.

Mr. George D. Shannon of Penns Grove, New Jersey, reports one from Natchez, Mississippi, 7 feet in total length, which weighed about 50 pounds dressed. A male example caught in White River near Chamberlain, South Dakota, was 4 feet 5 inches long and weighed 18 pounds. The average length of those now caught near Natchez does not exceed 4 or 5 feet, and the weight (dressed), 30 or 40 pounds. A large number examined at Louisville, Kentucky, in May, 1898, averaged very much smaller, though all were mature fish. They varied in weight (dressed) from .5 to 15 pounds.



Paddlefish (*Polyodon spathula*)

Some were quite small, not exceeding a foot in length, exclusive of the bill and tail. The female is larger than the male. Mr. Shannon gives the average length of the females taken at Natchez as 5 feet 4 inches, and the weight 40 pounds, and of the males 4 feet average length and 30 pounds weight. The weight of the roe is given by Mr. Shannon as 5 to 12 pounds, but not usually exceeding the former figure. The weights given by Mr. Shannon seem rather large for the lengths, and verifications are much to be desired.

The only record of the occurrence of this fish in Lake Maxinkuckee has been furnished by Mr. M. V. McGilliard of Indianapolis. In 1891 or 1892 he was present when a Paddlefish was

* McCormick, Descriptive list of the fishes of Lorain County, Ohio, Laboratory Bull. No. 2, Oberlin College, 9, 1892.

caught with hook and line in this lake. The fish was about 14 inches long and weighed about 2 or 2.5 pounds. Mr. McGilliard has for many years been familiar with this species in the Illinois River and elsewhere, and his identification is entirely trustworthy.

It is rather surprising that this fish has not been more frequently reported from the lake. It is possible that the dam which existed until recently in the Outlet of Lake Maxinkuckee has been effective in keeping it out. It is not uncommon in the Wabash River, at least as far up as Logansport, and it has also been reported from Lake Manitou at Rochester, only about 10 miles east of Lake Maxinkuckee, and from Tippecanoe Lake about 35 miles northeast.

Very large examples have been reported from Lake Manitou. The largest is said to have been speared many years ago (sometime in the fifties) by Wilson Newell, and it weighed 173 pounds. While spearing bass from the shore in a little channel connecting Manitou or Devils Lake and Clear Lake he saw the fish working its way through the channel and struck it with his spear, leaving it fast in the fish. The shaft fastened to the spear by a long cord becoming detached, floated and indicated the course of the fish. Newell followed the fish all day, finally exhausting and killing it. Another weighing 163 pounds was shot in the same lake a few years later, and still another, 7 feet 8 inches long and weighing 116 pounds, was caught by Andrew Edwards in a gillnet about the middle of May, 1890. It is said that this fish was a female and that "nearly a wooden pail full of spawn was taken from it." One has been recorded from Tippecanoe Lake which weighed 150 pounds. These are the largest paddlefishes of which we have any trustworthy record.

The Spoonbill Cat is, of course, not a catfish at all, it being more closely related to the sturgeons than to the catfishes. It is the only American representative of the family to which it belongs; indeed, the family has but two known species, the present one and another (*Psephurus gladius*) which is known only from the fresh-waters of China. The family is an old one which has been long upon the earth. Because of its representing an ancient type, the Paddlefish is of much interest to zoologists, and especially to embryologists, though its embryology has never been fully worked out. The young are rarely seen.

According to Dr. George Wagner, who studied the habits of the Spoonbill at Lake Pepin, this fish lives practically always near the surface in deep water; it feeds mainly during the night and early in the morning, its food consisting entirely of plankton organisms.

The rostrum or bill is not, as is frequently stated, used in stirring up the mud, but probably serves purely as a sense organ.

Very little is known of the spawning time or place of this fish. The little that is known indicates that in the lower Mississippi Valley the spawning season is during February, March and April, while in the Ohio and northward it is during the latter part of May and June. Among a large number of fish examined by the senior author at Louisville, Kentucky, during the third week in May, only a few were fully ripe. At that time the fish were running up stream, swimming near the surface, and evidently seeking their spawning grounds, which are thought to be in the ponds and bayous along the river. At this time they are caught in seines lightly leaded so as to fish the surface. At other seasons the Paddlefish may be caught on set-lines.

The greatest enemy of the Spoonbill is the silvery lamprey, *Ichthyomyzon concolor*. Dr. Wagner reports as many as 20 of these lampreys having been taken from a single Spoonbill, while Mr. Horace Beach reports "as many as a half a dozen on a fish in the spring of the year", and says that the fishes leap out of the water and fall on their sides, probably to rid themselves of the parasites.

Not until recently was the Paddlefish considered of any value, its flesh being regarded as worthless; but now it is one of the most highly valued and most assiduously sought fishes of the Mississippi Valley. It is chiefly sought on account of its roe, which is manufactured into caviar, for which it is regarded as not inferior to the sturgeon. The eggs are greenish black in color, about three times the size of shad eggs, and very numerous. The flesh of the Paddlefish, though coarse, is nutritious and not unpalatable, closely resembling that of the catfish when fresh, and when smoked not much inferior to that of the sturgeon. There is great demand for the roe, and the flesh always finds a ready sale. One dealer at Louisville, during the four years preceding 1901, handled over 700,000 of these fish.

Head, with opercular flap, more than half total length; without flap, about 5; opercular flap long, nearly reaching ventrals; premaxillary extending far behind the small eye; skin smooth or nearly so, except for the rhombic plates on sides of tail; ventrals near middle of body, dorsal well behind them; anal mostly behind the dorsal and somewhat larger, these fins somewhat falcate; finrays slender; spiracle with a minute barbel; isthmus papillose in the young; spatula broad, 2.5 to 4 in length of body, proportionally longer in the young. Color pale olivaceous; length 2 to 7 feet.

3. LONG-NOSED GAR

LEPISOSTEUS OSSEUS (Linnæus)

The Long-nosed Gar occurs in the Great Lakes and all the rivers of the United States from Vermont to the Rio Grande and west to Kansas and Nebraska. It is generally abundant and very variable, the local variations having given rise to not fewer than 28 specific names.

This fish is, unfortunately, abundant in Lake Maxinkuckee. In our seining operations, though confined chiefly to shallow water near shore, numerous examples were caught. At one haul with a 45-foot seine near Norris Inlet, 40 examples were taken varying in length from 1.5 to 3 feet. With a larger seine drawn in deeper water, a great many of this destructive fish could doubtless be caught. They were occasionally caught in other hauls of the seine. On July 29, 1899, a 27-inch example was caught near the top of a gillnet in 8 feet of water, and on July 21 of the same year 3 were taken in one haul of the net at the Academy pier. They are also sometimes caught on hooks. On July 26 one was caught by Miss Burford of Indianapolis which was 4 feet 2 inches long and weighed 14 pounds. On August 16, 1900, a small one was caught on a trot-line set off Long Point over night, and on September 20, 1903, a gar which was 4 feet 5 inches long and weighed 16 pounds, probably this species, was caught by an angler.

The Gar has a habit of basking on the surface, especially in warm shallow bays during hot weather. While thus occupied, they look very much like a stick. It is possible that they sometimes use this method of capturing other fishes instead of chasing them. In the latter part of August, 1900, a fisherman reported that they were seen basking in considerable numbers in Culver Bay, and about the same time several were seen on the Weedpatch. Sometimes the basking fish seem to be actually asleep. On August 11, 1906, an example about 9 inches long was seen basking among the weeds near shore in the Inlet region and was nearly caught by the hand before it escaped. It was reported that in the spring of the same year a member of the Military Academy saw a large gar in Culver Inlet and, wading in, stabbed it with a sword. It was 41 inches long and weighed 14 pounds. During the summer of 1907 little Gars about 6 inches long were occasionally seen basking in shallow water near the shore of the upper Mississippi River, at St. Paul and in Lake Pepin, and one was caught by hand. It still had the long streamer or filamentous projection extending from the upper lobe of the caudal; a peculiar feature characteris-

tic of young Gars. On October 17, 1907, after the water had become quite chilly, two young Gars of this species were seen lying perfectly still at the bottom in water 2 or 2.5 feet deep off the east shore of Long Point. They looked much like sticks in the bottom. One was pinned to the bottom by a thrust with a rake which happened to be at hand, and was captured. It measured 12.5 inches in length. The other example escaped.

During the winter the Gars are occasionally seen through clear ice. They are never up close against the ice, but those seen were 2 feet or so below the surface. They do not dart away when seen, as bass and most other fishes do, but remain stationary or swim slowly and unconcernedly along. On December 23, 1900, an example about 2 feet long was seen in Lake Maxinkuckee off the Gravelpit. It swam along slowly and was followed up until it stopped and could not be urged to swim farther even by pounding and stamping on the ice. A trip was made a quarter of a mile for an ax and hooks with which to capture the fish, and on returning it was found at the same place. While the ice was being cut above it, it started off and moved with great deliberation to the shore where it was hidden by opaque ice.

This Gar is a large fish, attaining a length of 5 or 6 feet. It is a voracious creature, feeding largely upon the young of other fishes, and is believed to be very destructive to the young of the various food fishes which inhabit the waters in which it is found. It is fair to state, however, that an examination of many stomachs and their contents does not bear out fully the reputation which it has for destructiveness to other fishes. Small fishes were frequently found in their stomachs, but not to the extent that popular belief would indicate. It is certain, however, that the two species of Gar in this lake are destructive to other fishes, and it is not known that they serve any useful purpose whatever. They are not scavengers in any sense of the word. They are essentially carnivorous and rapacious in their habits, and the only fishes upon which they could feed in Lake Maxinkuckee are either food fishes or species which serve as food for useful species. Sometimes they fall a victim to their own rapacity. One large example was found dead from trying to swallow a catfish 10 inches long.

Every effort to reduce the number of Gars in the lake is worthy of commendation. Whether it is possible to rid the lake entirely of them is doubtful, but much can be done toward greatly reducing their numbers and holding them in check. Perhaps the most effective method would be by seining. By using a large seine in as deep water as possible and when the Gars are out near shore in

relatively shallow water, good results ought to be obtained. In the spring, during early May and June when the Gars are spawning, they will come out near shore and can then be seined to advantage; and during the summer they may now and then be seen in considerable schools feeding upon other fishes near shore, particularly near Norris Inlet and in Culver and Outlet bays.

Gillnets of 1.5- to 2.5-inch mesh would also yield good results. These nets should be set where the Gars have been observed to run, and should be examined at least once a day. On calm sunny days when they are lying at the surface basking in the sun, they could be shot from the deck of a steamer. They can also be caught on set-lines and may occasionally be speared. By taking every opportunity to destroy these fish and keeping it up for a few years, it is believed that their numbers could be very greatly reduced.

The Gars are exceedingly prolific. A female example of the Long-nosed Gar, 3 feet 4 inches long, and weighing 9 pounds, was examined by the senior writer at Morgan City, Louisiana, April 23, 1897. This fish was in mature spawning condition, the ovaries weighed 1 pound 3 ounces, and the number of eggs was, by actual count, 36,460. The spawning time of the Gars in Lake Maxinkuckee is during May and early June.

Head 3 in length of body; depth 9; eye 12 to 15 in head, about 10 in snout; snout about 1.5 in head, or 4.5 in body; D. 8; A. 9; V. 6; P. 10; scales about 58,—20.

Body long, slender, and sub-cylindrical; snout very long and narrow, its length usually more than twice that of rest of head, its least width 15 to 20 times in its length.

Color grayish silvery, brightest on side; under parts yellowish white; snout and top of head greenish gray; side of head silvery; snout and side with a few small dark brown spots; vertical fins each with several large black spots, most numerous on caudal; ventrals and pectorals sometimes with one or two black spots. Young with a broad dark brown band from snout through eye to caudal, bounded above by a narrow pale line, then by a broad light brown one; below by a broad milky-white band; under parts white, dusted over with fine dark specks, which assume the character of lines at sides of belly; fins profusely spotted with brown. Young, 2.25 inches in total length, are pale olivaceous above, silvery white below, with a broad, somewhat darker lateral band.

The snout of this species is much longer and narrower than in the next. An examination of 8 examples varying in length from 2.25 to 18.5 inches, does not indicate that there is any variation in the length of the snout with age. The longest snout possessed

by any one of these examples was that of the smallest fish (1.375 in head), while the shortest snout was that of the fish next in size, 3 inches (1.5 in head).

The color, however, varies greatly with age, the lateral line and most of the spots disappearing and the color becoming more silvery.

Young Gars 3 inches long have no scales developed. The scales appear to develop on the caudal end of the body first, an example 6.5 inches long had the posterior third of the body scaled, and one 5.75 inches long, had about the posterior half scaled. The development of scales does not affect the color further, though it appears to make this somewhat less distinct.

4. SHORT-NOSED GAR

LEPISOSTEUS PLATOSTOMUS Rafinesque

The Short-nosed Gar is found throughout the Great Lakes region and south and west in all the lowland waters and larger rivers, being more abundant southward. In Lake Maxinkuckee this Gar is common, though probably less so than the long-nosed species.

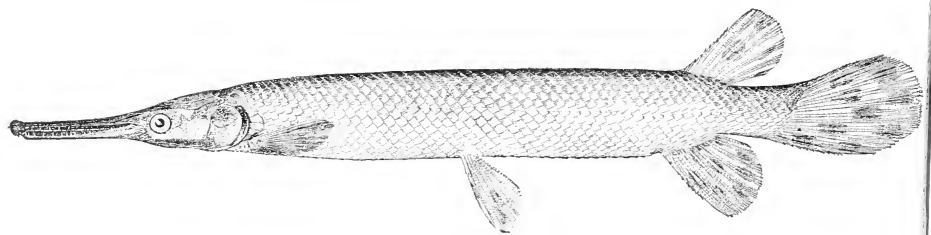
The largest example from this lake of which we have any definite information was caught near Long Point some years ago by Mr. Thomas Medbourn. This specimen, which was afterward mounted and which is now in the possession of Mr. Morris, of Culver, was 4 feet 1.75 inches long. In our own seining operations, an individual 15 inches long was caught near the Outlet, July 10, 1899, and another 28 inches long was taken on a set-line August 16, 1900. On December 15, 1900, men who were fishing through the ice on Lost Lake saw two of these fish through the ice. They cut holes in the ice above them, and by cautiously letting down a hook under the chin and jerking, managed to capture them. One was 20.5 inches long and the other 22.5. Shortly afterward another, 12.5 inches long, was caught in the same manner.

On June 8, 1901, while rowing along the south shore of Outlet Bay, a small one, 11.5 inches long, was seen lying at an angle near the surface of the water head upward, apparently dozing. The boat was cautiously rowed up to the fish and, by making a sudden grab, it was caught by hand. On June 20, 1901, a fisherman caught one 28.5 inches long.

The habits of this species are similar to those of the Long-nosed Gar. Like them they spend hot days in shallow water basking, and they are occasionally seen lying motionless in the water under clear ice. In cases where the fish were not captured it was not

possible to say with certainty what species they were. A very large Gar, thought to be this, was seen under the ice in rather shallow water in Outlet Bay, January 16, and holes were cut through the ice and an attempt made to capture it, but without success.

This species spawns at the lake during May and early June. On June 12, 1901, two large Gars thought to be this species, were seen lying close together among the weeds at the north end of Lost Lake. They lay still until the boat was nearly upon them, when they went off with a loud splash. Much splashing was taking place in other parts of the same region and it was thought that these fishes were sporting about. The next day a large school of Gars was reported basking off Long Point. Frequent reports were heard of Gars being caught by fishermen, but the species could not be ascertained.



Short-nosed Gar (*Lepisosteus platostomus*)

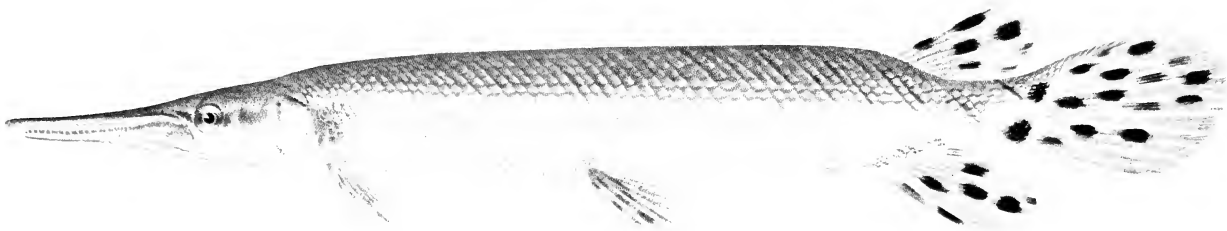
Like its near relative, the Long-nosed Gar, this species feeds chiefly upon small fishes, great numbers of which are destroyed by it. It could be captured and killed in the same manner as the other.

Head about 3 in length of body; depth about 8; eye 12 to 15 in head; snout 1.75; D. 8; A. 8; V. 6; scales 56,—20.

Body long, slender and sub-cylindrical, but stouter than in the preceding species. Snout shorter than in *L. osseus*, its length 5 to 6 times its least width, and usually about one-fifth longer than rest of head, though sometimes about equaling head.

Color grayish silvery; top of head with 15 or 20 large round dark spots; side of head with similar spots; a small dark post-ocular spot sometimes connected with a broad dark spot extending forward from opercle; under parts of head much mottled with light and dark; a few distinct dark spots on side; under parts pale; vertical fins each with a few large black spots; ventrals and pectorals pale at base, but with much dark toward the tips. In the

BROOK LAMPREY, *Lampetra wilderi* Gage
Ammocoetes stage



SHORT-NOSED GAR, *Lepisosteus platostomus* Rafinesque

young the dark markings are more pronounced. In a specimen 15 inches long the back was distinctly marbled with whitish and black, and the side had a broad dark lateral band, interrupted posteriorly; the spots on the fins were darker, and even the ventrals and pectorals were plainly spotted.

Examples of the Long-nosed Gar of the same size (15 inches) are much more silvery and are comparatively free of black spots. Length 2 to 4 feet. Weight 2 to 15 pounds. It is a very variable species, the young being difficult to distinguish from related species.

5. DOGFISH

AMIA CALVA Linnæus

(Plate 2)

The Dogfish, or Bowfin, is found in the Great Lakes and sluggish waters from Minnesota to Virginia, Florida and Texas, and is generally abundant throughout its range. It does not appear to be common in Lake Maxinkuckee, but in Lost Lake it is quite abundant. During our investigations not many Dogfish were seen; 3 were seined in Norris Inlet, and on July 25 one was seined which weighed 4.75 pounds. Occasionally one would be found dead on shore, while now and then one would be caught on a hook. Anglers fishing in Outlet Bay, or near Norris Inlet, or off the Gravelpit, were liable to get this fish, particularly if they were fishing for catfish or doing bottom fishing. While seining in Norris Inlet several young examples were secured, and a few were obtained in Culver Creek; a few were also taken on set-lines. Some of the largest examples ever seined were taken in front of the Fish Commission station late at night, September 20. These had apparently come in near shore to feed upon other fish which were then abundant in shallow water. On May 8, 1901, a fisherman caught an immense one which he thought would weigh 10 pounds, and Patrolman Wiseman caught on a set-line one which was 23 inches long and weighed 4.5 pounds. Later in the year an example 25.5 inches long was found dead on shore by Murray's and some fishermen caught a male 22.5 inches long, weighing 4.5 pounds. On November 7, 1904, six were found dead on shore where they had probably been left by men who had been seining. Their lengths were 16.5, 17.75, 18, 19.75, 20.5, and 21 inches. The stomachs of all except one, which contained a young sunfish, were empty. In the autumn of 1906 they were caught occasionally by fishermen; one was seen 19 inches long and another, 24.

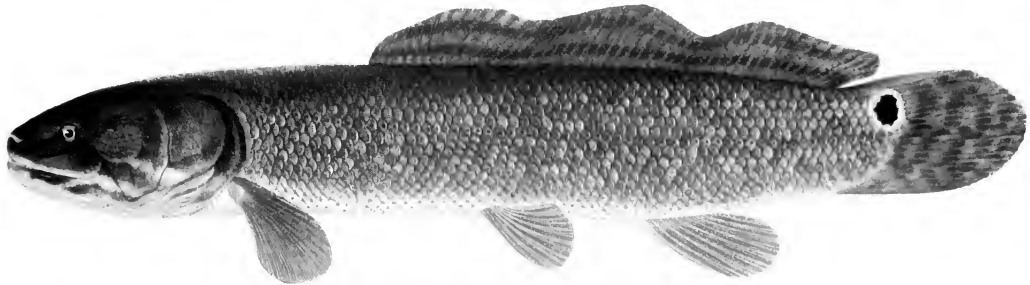
In Lost Lake and the Outlet, this fish is more abundant, and

numerous specimens were secured from that lake, chiefly on set-lines, the large examples obtained by us varying in length from 16 to 24 inches. On April 22, 1901, one was found in a boat in the Outlet, a male 21 inches long, weight 3 pounds. The smallest individual secured by us was 3.75 inches long.

The Dogfish resembles the gar-pike in many of its habits. With the exception of its feeding near the bottom and including more crawfishes in its dietary, the habits of the two are very similar. Both love to bask in warm shallow water. The Dogfish is, perhaps, more fond of muddy bottom. One of the best places for Dogfish fishing used to be the Little Wabash River, locally known as the "Little River," a sluggish stream, coursing its way through a large flat prairie, its shores quaking and edged with willows. A fisherman, standing on entangled willow-roots, could shake a large area and could push down a 20-foot fishing pole vertically between his feet without touching bottom. Here, on hot still days, the Dogfish would almost fight for bait, and there three fishermen landed 55 big fish in the course of an afternoon.

Like the gar-pike, also, the Dogfish can frequently be seen motionless in the water under clear ice in winter. On December 18, 1901, one about 2 feet long was seen under the ice in Lost Lake, swimming along very leisurely. On January 7 several large ones were seen in Outlet Bay where the ice men had cut out ice. They were in three or four feet of water, lying perfectly still on the bottom where they were almost wholly covered by the Chara which abounds there. When disturbed they made off, but not very fast nor very far, propelling themselves with lateral flexions of the tail like the water-dog. The same place was visited again in the afternoon and 6 large individuals were seen. One was speared which proved to be a male 22.75 inches long, weighing 4 pounds. The Dogfish is not particularly heavy for its length. Two males from Lake Erie, each a foot long, weighed one-half pound each.

At Lake Maxinkuckee this fish spawns toward the end of April. On April 24 and 25 large ones were seen in a pool in Green's marsh. The next day it was discovered that they were making nests there. The nest is made by hollowing out a place in the muck, and is of good size,—about 18 inches to 2.5 feet in diameter. The fish bite off such rushes as are in their way, and also make paths for themselves leading to and from the nests. The eggs, small and yellowish in color, are quite numerous and are in the bottom of the nest, some of them apparently sticking to the projecting vegetable fibres of the muck. A male was usually found on the nest. Besides the nests found in Green's marsh, another was



DOGFISH, *Amia calva* Linnæus; male

found July 3 near the Inlet, guarded by a male. After the young are hatched they follow the parent about. Mr. S. S. Chadwick speaks of having seen one accompanied by "a couple of gallons of young, in a thick cloud."

A good many people near Culver eat the Dogfish in winter, but say that "in summer the flesh turns green and is not good." There is probably a heightening of color during the breeding season to which they refer. The fins of these fishes as seen in the water June 7 and later were of a fine opalescent green.

This fish is quite free from external parasites such as copepods on the gills, etc. Several individuals examined contained trematodes attached to the gills and a few had leeches attached, and one had two fish lice (*Argulus*), but they were on the whole remarkably clean. Internally they have numerous parasites, especially distomids and trematodes.

The Dogfish is of peculiar interest to zoologists as the remains of an ancient stock of fishes; it is the only surviving species in the whole order to which it belongs. Its habits, however, render it a nuisance, as it is carnivorous and very voracious.

Its good qualities as a game-fish have not been sufficiently appreciated, doubtless, chiefly, because not many have ever angled for it, and because the fish has not been regarded as having any food-value. But the true angler cares nothing for the edible qualities of the fish he catches. His desire is to match the strength of his tackle and his skill in handling it against the strength and intelligence of the fish he hooks. Thus it is with the ever-increasing large number of real sportsmen who seek the large ocean fishes,—the white sea-bass, the tuna and the albicore; the shark, the yellow-tail, and the silver king. And so it is with the few who have cultivated the Bowfin. It will take almost any kind of bait, but prefers cut bait of some sort, such as cut fish, a freshwater clam, or a piece of meat. It takes the bait deliberately, but when the sting of the hook is felt, the fish wakes up and gives the angler as pretty a fight as one could desire.

In the Report of the New York Fisheries, Game and Forest Commission for 1898 is an article by Dr. Bashford Dean on the Dogfish, which contains so much interesting information that we take the liberty to reproduce it here. Dr. Dean says:

"The Dogfish has been described by some as diurnal, by others as nocturnal in its habits. In the daytime during the season of breeding the fish can readily be seen in shallow waters, and, when not actually on its nest, can sometimes be made to take a bait. At night, however, judging from my own experience with set-lines, the

fish is not often taken. And the result of my later observations is not favorable to the view that the dogfish is distinctly nocturnal in habit. With a view of determining how active the fish were at night, I have kept them in captivity and I have also watched them at different hours on their spawning grounds, when light was no more than sufficient to enable their outlines to be seen. My conclusions indicate that the dogfish is rather to be regarded as most active at twilight. It takes the hook best shortly after sundown and during the early morning, and at these times I have seen it exceedingly active under natural conditions. In a general way the fish can hardly be described as shy. As far as taking an alarm is concerned, it behaves very much as a catfish; it is certainly less apt to notice one's approach than, for example, many common teleosts.

"The general habitat of the fish varies greatly at different seasons of the year. In summer it frequents deeper water; in spring it comes into the marshy shallows and makes its way through reedy places where the water is scarcely deep enough to cover its dorsal fin. In general it affects muddy water.

"In the matter of feeding, the rapacious nature of the dogfish has already been noted. Its common articles of diet, as Fülleborn, for example, has noted, are small fishes and crayfish. The latter are especially common in the stomach contents. Among the specimens examined by the present writer was noted one, a female, measuring twenty-eight inches, which had eaten among other things, a pickerel twelve inches in length. Another, a female measuring thirty-one inches, contained the columns of eleven fishes, cyprinoids, each about three inches in length. Another, taken at twilight near the margin of a rubbish heap, had eaten scraps of meat and a lump of raw potato, the latter having been taken from the stomach altogether undigested. Among the local fishermen of the Wisconsin lakes, salt pork is well known as a 'killing' bait. I have no evidence that the dogfish eats fish, or more accurately *some* fishes, after they are dead. Dead perch and sunfish remain untouched, even in regions where Amia is very abundant.

"The dogfish deposits its eggs in more or less definitely prepared nests.* These often occur very abundantly in the reedy shallow in the margins of the lakes. A particular region of the shore will often be given marked preference: in one case observed by the writer eleven nests occurred within a radius of fifty feet, and seven of these within a radius of fifteen feet. The spawning

* The writer has obtained good evidence that inconvenient rushes are **bitten off** when the fish prepares the nest. This is also noted by Reighard.

season, like that of all fishes, varies somewhat from year to year. In Wisconsin, where the fish have been most accurately observed, the height of the spawning occurs about the middle of May. It, however, varies in this locality from the first day of April until the early part of June. There is usually a maximum period of spawning, as in the case of other fishes.

"The actual nesting habits of the fish have not as yet been examined in sufficient detail. There is good evidence to believe that the fishes divide into spawning parties, as in the case of the garpike, *Lepisosteus*, each party consisting of a female and several males. In a single instance the writer has seen three fishes on a nest after spawning had commenced. Whitman, on the other hand, maintains, also from a single observation, that but a single male is present. The eggs are scattered over the nests thickly, in number varying from a few hundreds to possibly a hundred thousand. A single male tends the nest, keeps away intruders, and by vigorous breathing produces a current of water which probably retards the growth of fish fungus. The fish stands guard, sometimes for hours motionless, save for its movements in balancing and breathing; at other times it appears restive, turning about in the nest, making short detours, and returning by the 'runaway' which it provides. A favorite position is for the fish to lie in the 'runaway' with its head projecting over the nest. It usually remains in the shaded side of the nest, but appears occasionally in bright sunlight, so that it can be seen quite a distance away. * * * Such a fish, for example, has been photographed. The pictures clearly demonstrate that Amia does not hesitate to show itself in the sunlight, as Fülleborn early maintained. The outline of the nest in this case was clearly seen from the surface, and all of the 'supernatant' rushes must have been brushed aside, or even removed by the fish, since the nest was photographed as it first appeared.

"The eggs hatch out in the course of about a week, the length of time varying notably with the temperature of the water. The larvæ pass their first few days deep in the nest, where they attach themselves to débris by means of curious sucking disks developed on the under side of their snouts. In the course of another week or so, the young are probably herded together by the male fish, who leads his flock of young to various points in the neighborhood in search of food. This peculiar "nursing habit" of the male is known to continue until the fish attain a length of several inches. During the later spring it becomes a common sight to see

the male fish accompanied by a dense swarm of young, the latter appearing dark in color, and at first sight tadpole-like.

* * * * * * * *

"The foregoing notes upon the spawning and habits of the dogfish provide the fish culturist, I am convinced, with data which should enable him, and with relatively little trouble, to materially reduce their numbers in localities where they abound. He learns, for example, that these fish will repair to a more or less definite locality at the time of spawning, and that here in the shallows their nests can readily be found and destroyed. He concludes, furthermore, that without extraordinary effort he can secure the male fish which guards the nest and young. This he can take either by snare or by spear. As the first step in reducing the numbers of dogfish, he finds it of course necessary to determine accurately the time of spawning; in this he is helped, since the general limits of the season have been already indicated. The exact time of spawning may usually be determined with little difficulty, for the splashing of the fish during the early days of spring may be looked upon as an indication that spawning has either begun or is about to begin. An occasional rise in the shallows is thus found to mark the preparation for spawning; a continuous and noisy splashing, one which can be noted at a distance of a hundred yards or more, is, in the experience of the present writer, a most useful sign that the fish are actually spawning. At this time, perhaps, the greatest difficulty will be experienced in approaching the fish closely enough to capture one or more of them. A slight movement is sometimes enough to give the alarm. And a further difficulty in capturing them at this time is the muddiness of the water, caused by the energetic movements of spawning. In some localities, no doubt, nests are more easily found than in others, but in a general way the writer believes that there are few fishes in our fresh-water lakes whose eggs and young can be secured with less difficulty than those of the dogfish. Should the novice in collecting fail to find at once one of their nests, the rush and splash of the escaping guardian fish will often give a sufficiently obvious hint as to the location of a nest. I may note, furthermore, that the dogfish does not prove itself skillful in throwing a human enemy off the scent; one rarely finds that a fish will move away quietly from the nest and then make a noisy escape in order to divert the collector. The fish, on the other hand, is far more likely to remain on the nest till the boat is actually upon it, when with a sudden plunge it reveals the exact position of the nest. So fearlessly does it stand its ground that in several cases noted by the writer, the

fish was not discovered until the stern of the boat had passed over it. There may indeed be cases where, although almost touched by the bottom of the boat, the fish has been actually overlooked; but as the writer has noted, the shape of the nest is so often shown at the surface of the water, that one can frequenly detect it before any sign of the fish is visible.

"Furthermore, the habit of the dogfish in accompanying its young for a number of weeks after hatching gives the fish culturist another valuable hint. With little difficulty many schools of young dogfish can be found and destroyed. The very fact that the young when alarmed draw together into a more and more compact mass puts them readily into the hands of the collector—although on the other hand, this habit has doubtless proved of great value as a means of preserving them from rapacious fishes; for should the young scatter at the first alarm, they could obviously be less perfectly protected by the parent fish.

"In conclusion, accordingly, I think it is fair to assume that whenever it becomes necessary, dogfish can be readily destroyed. The fish themselves can be speared when they appear at the season of spawning; their nests can be found and destroyed; and young fish can later be taken, and in large numbers, when in company with the male fish. I am led to believe that a single collector, operating in a lake several miles in length, could in one season reduce the supply of dogfish in a very effective way."

Head 3.75; depth 5 to 6; eye 11 to 12; snout 5.75; maxillary 2.25 to 2.75; D. 48; A. 10 to 12; V. 7; scales about 10-70-12.

Body long, not compressed; head moderate; mouth large, slightly oblique, snout broadly rounded, lower jaw slightly the shorter; maxillary reaching far beyond eye; eye small;* back broad, not elevated; caudal peduncle deep, somewhat compressed; dorsal fin very long, beginning well in front of ventral fins and extending to near base of caudal; anal fin small; caudal fin rounded; lateral line nearly median, directed slightly upward at each end.

Dark olivaceous or blackish above, inclining to greenish, paler below; side with traces of reticulate markings; lower jaw and gular plate often with round blackish spots or irregular mottlings; fins mostly pale, somewhat mottled, especially the dorsal and anal; male with a round black spot at base of caudal above, surrounded by an orange or yellowish shade; this spot usually not present in the female. Length of male about 18 inches; length of female 2 feet or more.

* In the young examined at the lake the eye is proportionally nearly twice as large as in the adult, and the snout from .25 to .2 larger.

6. YELLOW CATFISH

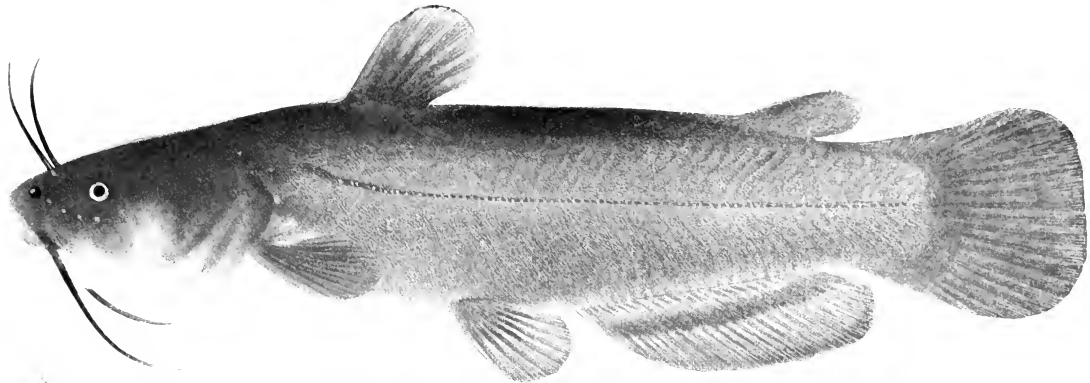
AMEIURUS NATALIS (Le Sueur)

(Plate 3)

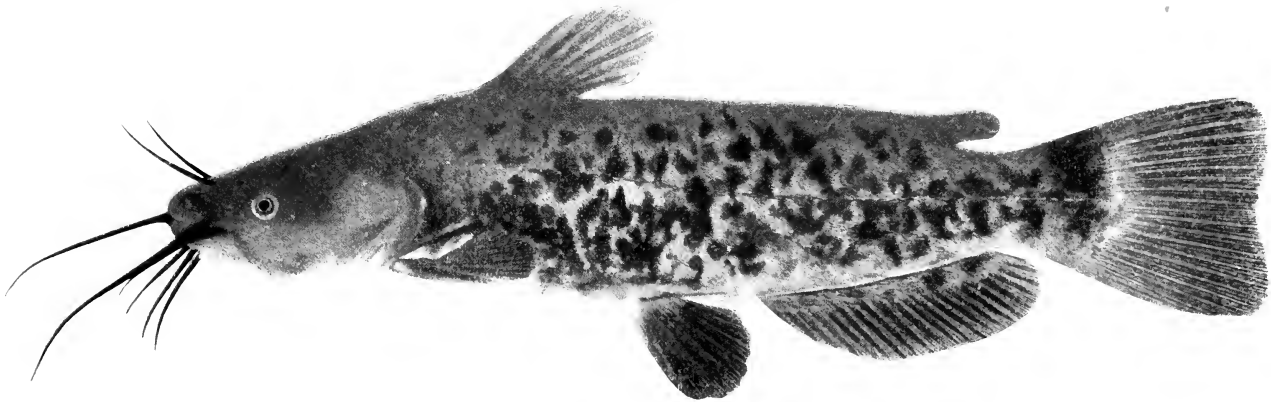
The Yellow Cat is generally abundant from the Great Lakes region to Virginia and Texas and southward. It is extremely variable, running into several subspecies. Of the four species of catfish known from Lake Maxinkuckee, this is by far the most abundant. It is very common in Lost Lake and in favorable places in Lake Maxinkuckee it is not rare. No attempts were made to get a large number, but our collection contains specimens from many parts of the shore and from the various inlets of the lake. They are mostly quite small and exhibit much variation in general appearance, especially as regards depth, some being short and plump and others rather elongate. The mature specimens appear to be equally diverse as shown by the table of weights and measures given below. The Yellow Catfish frequents the region of the inlets and those portions of the lake where there is soft bottom; usually it may be found in water 5 to 15 feet deep where the bottom is of marl, and even in somewhat deeper water in muck bottom.

The Yellow Cat in these waters rarely attains a greater length than a foot or 15 inches and a weight of a pound or a pound and a half, though considerably larger examples are sometimes taken. The largest seen by us weighed 3 pounds, and the largest of which we have heard is said to have weighed 5 pounds. The following table shows the lengths and weights of 22 individuals examined at various times.

Date caught	Length	Weight
May 9	6 inches	8 ounces
10	9 inches	8 ounces
10	10 inches	12 ounces
9	10 inches	14 ounces
9	11.5 inches	1 pound 1 ounce
14	12 inches	12 ounces
7	12 inches	1 pound
10	12 inches	1 pound 2 ounces
7	12 inches	1 pound 4 ounces
15	12.25 inches	12 ounces
15	12.25 inches	12 ounces
7	12.50 inches	1 pound 2 ounces
9	12.50 inches	1 pound 2 ounces
10	12.50 inches	1 pound 8 ounces
9	12.75 inches	1 pound 4 ounces
November 3	12.875 inches	1 pound 1.75 ounces
May 7	13 inches	1 pound 8 ounces
14	13 inches	12 ounces
11	13 inches	1 pound 8 ounces
14	14 inches	1 pound 4 ounces
10	14 inches	2 pounds



YELLOW BULLHEAD, *Ameiurus natalis* (Le Sueur)



SPECKLED BULLHEAD, *Ameiurus nebulosus marmoratus* (Holbrook)

In the autumn the young of this fish appear to be fond of hiding under logs and stones in shallow water. They also hide among Chara in the winter and are occasionally raked up with other fishes. The stomachs of a few individuals examined contained crawfish.

The habits of this fish, the methods of its capture, and its food qualities are not essentially different from those of the common bullhead, and are discussed more fully in connection with that species.

Head 3.66; depth 4; eye 10; snout 3.66; D. I, 6; A. 26; maxillary barbel 1.33 in head; nasal barbel 2.25. Body short and stout; head heavy; jaws subequal; eye small; barbels moderate; origin of dorsal fin nearer tip of snout than to origin of adipose fin; dorsal spine short, equal to snout and eye, or $1\frac{2}{3}$ in longest dorsal ray; anal large, its base 4 in body; pectoral fin short, 2.5 in head; caudal fin regularly rounded.

Color, dark olivaceous yellow above, becoming clearer on sides; yellowish white below maxillary and nasal barbels.

7. COMMON BULLHEAD

AMEIURUS NEBULOSUS (Le Sueur)

(Plate 4)

Though this is the Common Bullhead or Horned Pout of every pond or sluggish stream of the east and north, it is not so abundant at Lake Maxinkuckee as the Yellow Cat. The two species are usually associated and are not usually differentiated by fishermen. The characters most useful for diagnostic purposes are the color and the number of anal rays, the Common Bullhead being more or less marbled or mottled and having but 21 or 22 anal rays, while the yellow cat is quite uniform in color on the back and sides and has 23 to 27 anal rays. The two species in Lake Maxinkuckee reach about the same size—1 to 3 pounds, very rarely more—and have essentially the same habits.

They are, as every one knows, bottom feeders; and most of them frequent those shallower parts of the lake where there is mud bottom, where they feed upon crawfish and some of the softer-shelled mollusks, as Sphærium, and the young of various species of Unionidæ. They are also said to feed pretty extensively on the eggs of other species of fishes. One example was found gorged with water-lily seeds. A young one 2.125 inches long, raked up in Chara December 22, 1904, contained a beach flea. Their spawning time is in late May and June. This seems to be a period of considerable mortality among them, and a good many are found dead on shore about this time. The eggs are relatively large and

few in number and these are placed under chunks or sticks, the edges of rocks or about the bases of water plants. They hatch in about 5 days in water at a temperature of 77°, and in the cooler waters of the lake probably require some time longer. The whole school of young follows the parent fish about for some weeks after hatching, forming a thick black cloud of actively wiggling black creatures bearing considerable resemblance to tadpoles. This species, more perhaps than any other fish, frequently gets entrapped in drying-up lagoons and ditches and dies in great numbers. It is considerably afflicted with leeches; the majority caught have the slender fish-leech of the lake attached to the chin, or small red spots are usually found there where the leeches have been. The leech also often attaches itself to the roof of the mouth just behind the teeth. Among other external parasites are *Argulus maculosus*, and a new species of Ergasilus found at Lost Lake, *Ergasilus versicolor*. Two individuals examined contained encysted in the mesenteries long round worms bearing a considerable resemblance to the horse-hair snake.

In our seining operations not many adults were caught, scarcely any in Lake Maxinkuckee, and only a few in Lost Lake. A good many young 1.5 to 3 inches in length were taken, however. While these young were most abundant in the mouths of inlets they were often found in limited numbers almost everywhere, even on bottom covered with Chara. They were more often found, however, on marl bottom. Several examples of good size were taken on setlines placed in 4 to 7 feet of water just off the Gravelpit. Others were taken in Outlet Bay and off the ice-houses, while the cane-pole fishermen frequently make good catches in the south part of the lake.

Among the cottagers of Long Point was one lady who appreciated the game qualities of this fish, and she made many excellent catches in a shallow channel just east of the Point.

There are not many people who have ever fished at all who can not remember many happy days spent in angling for bullheads. The individual whose experiences do not include days of this kind has missed one of the real joys of youth.

The following racy account of the habits of the Common Bullhead was written by the author of "Peck's Bad Boy," and published originally in the Milwaukee Sun. Though written as a burlesque, it presents a truthful and vivid picture of the game qualities of the Bullhead: "It seems that the action of the Milwaukee common council in withdrawing the use of the water works from the fish commissioners will put a stop to the hatching of white-fish.

This is as it should be. The white-fish is an aristocratic fish that will not bite a hook, and the propagation of this species is wholly in the interest of the wealthy owners of fishing tubs, who have nets. By strict attention to business they can catch all of the white-fish out of the lake a little faster than the State machine can put them in. Poor people cannot get a smell of white-fish. The same may be said of brook trout. While they will bite a hook, it requires more machinery to catch them than ordinary people can possess without mortgaging a house. A man has got to have a morrocco book of expensive flies, a fifteen dollar bamboo jointed rod, a three-dollar trout basket, with a hole morticed in the top, a corduroy suit made in the latest style, top boots of the Wellington pattern, with red tassels in the straps, and a flask of Otard brandy in a side pocket. Unless a man is got up in that style a speckled trout will see him in Chicago first, and then it won't bite. The brook trout is even more aristocratic than the white-fish, and should not be propagated at public expense.

"But there are fish that should be propagated in the interest of the people. There is a species of fish that never looks at the clothes of the man who throws in the bait, a fish that takes whatever is thrown to it, and when once hold of the hook never tries to shake a friend, but submits to the inevitable, crosses its legs and says, 'Now I lay me', and comes out on the bank and seems to enjoy being taken. It is a fish that is the friend of the poor, and one that will sacrifice itself in the interest of humanity. That is the fish that the State should adopt as its trade-mark, and cultivate friendly relations with and stand by. We allude to the Bull-head.

"The Bull-head never went back on a friend. To catch the Bull-head it is not necessary to tempt his appetite with porterhouse steak, or to display an expensive lot of fishing tackle. A pinhook, a piece of liver, and a cistern pole is all the capital required to catch a Bull-head. He lies upon the bottom of a stream or pond in the mud thinking. There is no fish that does more thinking, or has a better head for grasping great questions, or chunks of liver, than the Bull-head. His brain is large, his heart beats for humanity, and if he can't get liver, a piece of thin tomato can will make a meal for him. It is an interesting study to watch a boy catch a Bull-head. The boy knows where the Bull-heads congregate, and when he throws in his hook it is dollars to buttons that 'in the near future' he will get a bite.

"The Bull-head is democratic in all its instincts. If the boy's shirt is sleeveless, his hat crownless, and his pantaloons a bot-

tomless pit, the Bull-head will bite just as well as though the boy were dressed in purple and fine linen, with knee-breeches and plaid stockings. The Bull-head seems to be dozing on the muddy bottom, and a stranger would say that he would not bite. But wait. There is a movement of his continuation, and his cow-catcher moves gently toward the piece of liver. He does not wait to smell of it, and canvass in his mind whether the liver is fresh. It makes no difference to him. He argues that there is a family out of meat. 'My country calls and I must go', says the Bull-head to himself, and he opens his mouth and the liver disappears.

"It is not certain that the boy will think of his bait for half an hour, but the Bull-head is in no hurry. He is in the mud and proceeds to digest the liver. He realizes that his days will not be long in the land, or water, more properly speaking, and he argues that if he swallows the bait and digests it before the boy pulls him out, he will be just so much ahead. Finally, the boy thinks of his bait, pulls it out, and the Bull-head is landed on the bank, and the boy cuts him open to get the hook out. Some fish only take the bait gingerly, and are only caught around the selvage of the mouth, and they are comparatively easy to dislodge. Not so with the Bull-head. He says if liver is a good thing, you can't have too much of it, and it tastes good all the way down. The boy gets down on his knees to dissect the Bull-head, and get his hook, and it may be that the boy swears. It would not be astonishing, though he must feel, when he gets his hook out of the hidden recesses of the Bull-head, like the minister who took up a collection and didn't get a cent, though he expressed thanks at getting his hat back. There is one draw-back to the Bull-head, and that is his horns. We doubt if a boy ever descended into the patent insides of a Bull-head to mine for limerick hooks, that did not, before the work was done, run a horn into his vital parts. But the boy seems to expect it, and the Bull-head enjoys it. We have seen a Bull-head lie on the bank and become dry, and to all appearances dead to all that was going on, and when a boy sat down on him, and got a horn in his elbow, and yelled murder, the Bull-head would grin from ear to ear, and wag his tail as though applauding for an encore.

"The Bull-head never complains. We have seen a boy take a dull knife and proceed to follow a fish line down a Bull-head from head to the end of his subsequent anatomy, and all the time there would be an expression of sweet peace on the countenance of the Bull-head, as though he enjoyed it. If we were preparing a picture representing 'Resignation', for a chromo to give to subscrib-

ers, and wished to represent a scene of suffering, in which the sufferer was light-hearted, seeming to recognize that all was for the best, we should take for the subject a Bull-head, with a boy searching with a knife for a long-lost fishhook.

"The Bull-head is a fish that has no scales, but in lieu thereof has a fine India rubber skin, that is as far ahead of fiddle-string material for strength and durability as possible. The meat of the Bull-head is not as choice as that of the Mackerel, but it fills up a stomach just as well, and the Sun insists that the fish commissioners shall drop the hatching of aristocratic fish, and give the Bull-heads a chance."

But the editor of *London Punch* does not agree with the editor of the Milwaukee Sun, and when the introduction into England of one of our catfishes was being suggested, Punch printed this protest:

"Oh, do not bring the Catfish here!
The Catfish is a name I fear.
Oh, spare each stream and spring,
The Kennet swift, the Wandle clear,
The lake, the loch, the broad, the mere,
From that detested thing!

"The Catfish is a hideous beast,
A bottom-feeder that doth feast
Upon unholy bait;
He's no addition to your meal,
He's rather richer than the eel;
And ranker than the skate.

"His face is broad, and flat, and glum;
He's like some monstrous miller's thumb;
He's bearded like the pard.
Beholding him, the grayling flee,
The trout take refuge in the sea,
The gudgeons go on guard.

"He grows into a startling size;
The British matron 'twould surprise,
And raise her burning blush
To see white catfish as large as man,
Through what the bards call 'water wan',
Come with an ugly rush!

"They say the Catfish climbs the trees,
And robs the roosts, and down the breeze
Prolongs his caterwaul.
Oh, leave him in his western flood,
Where the Mississippi churns the mud;
Don't bring him here at all!"

Though the cat-fish is a good deal of a scavenger in its tastes, its flesh is firm, flaky and well-flavored, and there are many who will agree with the old darky when he says:

"Don't talk to me o' bacon fat,
Or taters, coon or 'possum;
Fo' when I'se hooked a yaller cat,
I'se got a meal to boss 'em."
—*The Darkey and the Cat-fish.*

"Sat'day night come arter,
De niggers went a-fishin',
Dey call for Billy Carter,
'Case he want to go a-cattin',
Dey filled de jug an' started
For de Pocomoka river,
Chicken-guts was better bait,
Dey dug a gour o' wurrims."
—*From "Pleasantry of the South."*

Head 3 to 4; depth 4 to 4.5; snout 3.66; eye 10 to 12; D. I, 6; A. 21 or 22; V. 9.

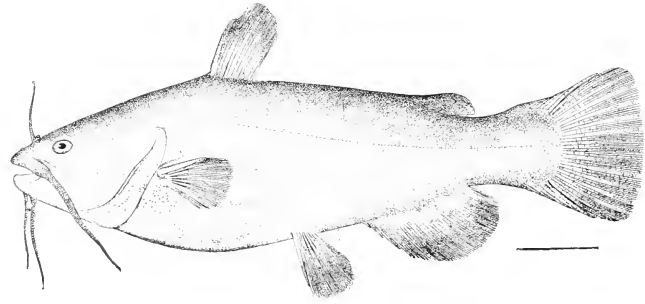
Body rather long; upper jaw usually distinctly longer than the lower; humeral process more than half length of pectoral spine, which is rather long; length of base of anal 4 in that of body; dorsal fin inserted rather nearer adipose fin than tip of snout.

Color dark yellowish brown, more or less clouded, sometimes yellowish, sometimes nearly black, but usually distinctly marbled or mottled. Length a foot to 18 inches.

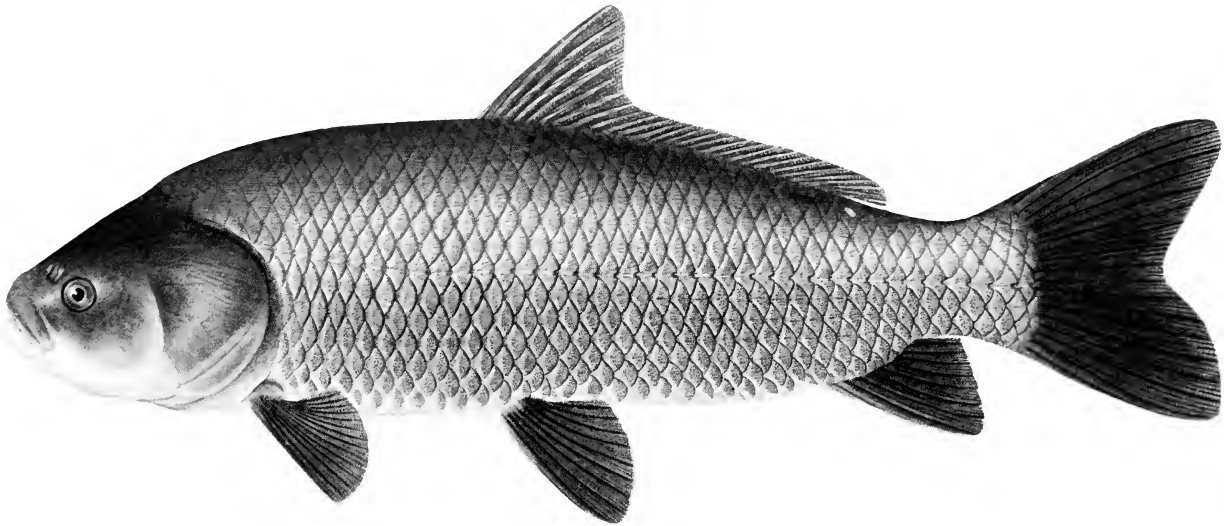
8. BLACK BULLHEAD

AMEIURUS MELAS (Rafinesque)

The Black Bullhead is found in brooks, ponds and lakes from northern New York westward to Kansas and Nebraska and south



Black Bullhead (*Ameiurus melas*)



RED-MOUTH BUFFALO, *Ictiobus cyprinella* (Cuvier & Valenciennes)

to Texas, and is usually abundant, especially west of the Mississippi. It is very variable and is closely related to both *A. natalis* and *A. nebulosus*. It is, however, a smaller fish and can usually be known by the fewer rays in the anal and by the marked contrast between the pale anal rays and the dark interradial membranes.

This species is not at all common in Lake Maxinkuckee, only a few individuals having been seen there, and the majority of these were obtained in the Outlet and in Lost Lake.

Head 3.5; depth 3 to 4; eye 8 to 9; snout 3; D. I, 6; A. 17 to 19.

Body short and stout; head blunt; mouth moderate, jaws subequal; origin of dorsal midway between tip of snout and origin of adipose fin, dorsal spine long, 2 in head, equalling pectoral spine; anal short, its base 4 to 5 in length of body, its rays 1.75 in head; barbels long, maxillary barbel much longer than head.

Color usually almost black; anal rays pale, the membranes black, the contrast being quite marked. Size a foot or less.

9. MAD TOM; TADPOLE CAT

SCHILBEODES GYRINUS (Mitchill)

(Plate 5)

This little fish is common from the Hudson River westward through almost the entire Mississippi Valley and upper lake region. In Lake Maxinkuckee it is rather common. It seldom reaches a length of more than 3 inches here, though specimens 5 inches long have been reported from elsewhere. Of 35 examples measured at the lake the largest was 2.6 inches long, the shortest .9 inch, and the average was 1.74 inches. Several of these examples were mature fish. This is the only species of the genus occurring in Lake Maxinkuckee, although other species are common in the various streams of Indiana. It may be readily known from the young of any of the other catfish found there by its adnate adipose fin which is continuous with the caudal fin, and also usually by its color.

It was found by us both in the main lake and in the small one. It is not at all uncommon in shallow water near shore, where we would frequently find it more or less completely secreted in the Chara or in patches of Nitella or dwarfed Potamogeton. Specimens were also brought up with vegetation by the dredge or grapple from depths of 8 to 16 feet. Throughout the winter raking in the Chara would frequently bring up one or more of these fishes. With the exception of the Iowa darter this is one of the most common fishes taken in this manner. They were also often

found under sticks and stones. The species is capable of inflicting a very painful sting, as it has a poison gland at the base of the pectoral spine. According to Prof. H. D. Reed it also has poison glands under the skin surrounding the pectoral and dorsal spines.*

The food of this species consists mainly of small crustaceans and insect larvæ. One of 2 examples raked up in Chara November 25, 1904, contained a small beach flea and the other an Asellus; of 4 examples raked up in Chara in Outlet Bay, December 21, 1904, one, 1.19 inches long, contained a large water flea and an ostracod (Cypris), another 1.125 inches long, contained 2 ostracods and a few other entomostraca; the third, 1.875 inches long, had eaten a good-sized insect larva and an ostracod; the fourth, 1.25 inches long, contained a worm and 2 ostracods. One example, 2.31 inches long, examined in the summer, contained 5 individuals of Asellus, and another contained beach fleas. Stomachs of 2 examined May 7, 1901, contained may-fly larvæ and larvæ of Chironomus.

The species apparently spawns in June and July. One found dead on the shore by Lakeview Hotel, May 18, was much distended with ova; the eggs were yellow, large (11 to the inch) and about 50 in number. Another example, 2.63 inches long, taken in the lake July 10, contained 93 mature eggs each about 1/15 of an inch in diameter. All the others examined in July were either spent fish or immature individuals.

Head 3.9; depth 5; eye 6; snout 3; D. I, 6; A. 13; body short and thick, the head large, its width 3.5 to 4.5 in body; posterior part of body compressed; spines stout and long, that of the pectoral straight, grooved behind, but not serrated, its length about 2⅔ in distance from snout to origin of dorsal; dorsal higher than long, inserted nearer anal than snout; jaws about equal; humeral process short; adipose fin continuous with the pointed caudal.

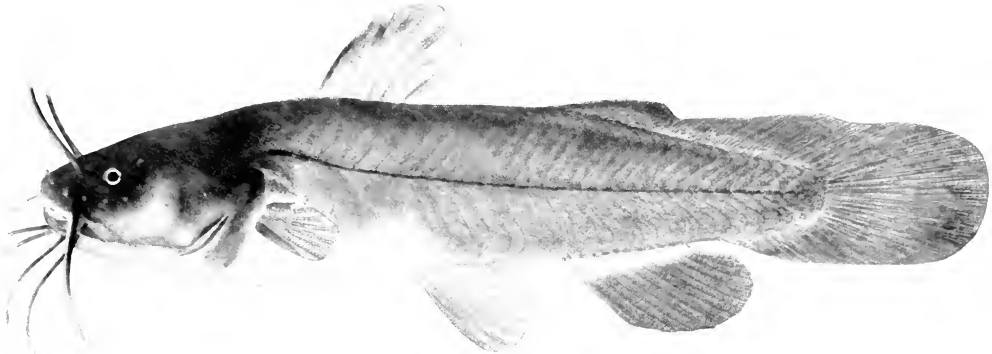
Color uniform yellowish brown, sometimes blackish; a narrow dark lateral streak and one or more dorsal ones.

10. COMMON BUFFALO-FISH

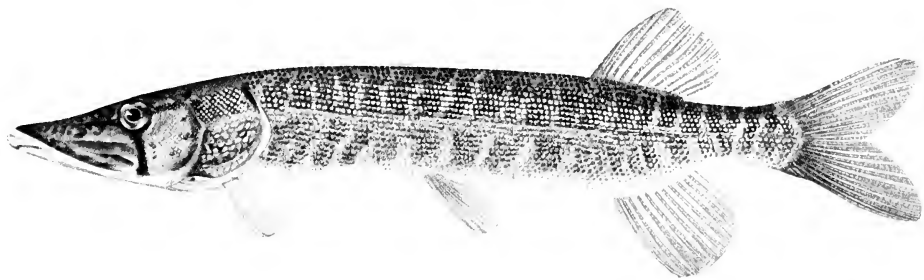
ICTIOBUS CYPRINELLA (Cuvier & Valenciennes)

The Buffalo-fish was formerly abundant in the larger streams of the Mississippi Valley, and was also plentiful in many of the lakes in that region. In Lake Maxinkuckee it appears to be rare; only one example was seen during the course of our investigations.

* The poison glands of Noturus and Schilbeodes, by Hugh Daniel Reed, Amer. Nat., XLI, 1907, pp. 553-567.

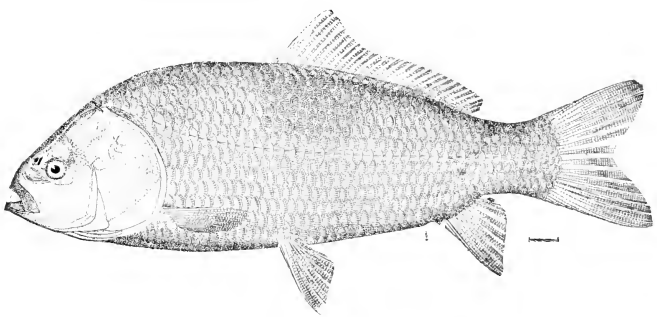


TADPOLE CAT, *Schilbeodes gyrinus* (Mitchill)



GRASS PIKE, *Esox vermiculatus* Le Sueur

On the morning of August 24, 1906, Mr. George W. Davis and a friend went out fishing toward the south end of the lake in a launch, but soon returned with a large fish in tow. It was landed at the Assembly grounds and placed on the pier at that place where its size at once attracted attention, for it was not only the largest fish known to have been taken in this lake, but considerably the largest Buffalo-fish yet reported; previous records gave the Buffalo-fish "a length of nearly 3 feet and a weight of 20 to 30 pounds." This fish was 4 feet in length, 35 inches in girth and weighed 75 pounds. It was taken to the laboratory and skinned. The fish was quite fat; it had immense scales—some of them larger than a silver dollar. The stomach appeared to be full of Chironomus larvæ. It contained more than a bucket full of roe, the ova being quite small.



Common Buffalo-fish (*Ictiobus cyprinella*)

The Buffalo-fish, like the paddle-fish, is one of those fishes which might exist in the lake in some numbers without the fact being known, as they generally stay near the bottom and never take the hook.

Old settlers along tributaries of the Mississippi report that Buffalo-fish used to run in such schools in spring that it was impossible to ford streams while the run was in progress. In general appearance and in some of its habits the Buffalo-fish bears some resemblance to the carp. In some of the lakes of the Mississippi Valley extraordinary runs of very large Buffalo-fish occur occasionally. During the high water of spring the fish run out in great numbers into the overflowed marshes where they are killed with clubs, pitchforks or other weapons at hand. The flesh is of an inferior flavor, but nutritious.

Old settlers about the lake report that 20 or 30 years ago they used to catch a good many Buffalo-fish in Lake Maxinkuckee with the spear. A large one is reported to have drifted ashore some 30 years ago near where the Farrar cottage now stands.

Head very large and thick, 3.5 in length of body; depth 2.5 to 3.5 in length; developed rays of dorsal 27 to 29; anal rays 9; ventrals 10; scales 7-37 to 41-6. Body robust, moderately compressed, the outline somewhat elliptical, but the back rather more curved than the belly. Opercular apparatus very strong, the operculum itself forming nearly one half the length of the head. Coloration dull brownish olive, not silvery; fins dusky.

11. COMMON SUCKER

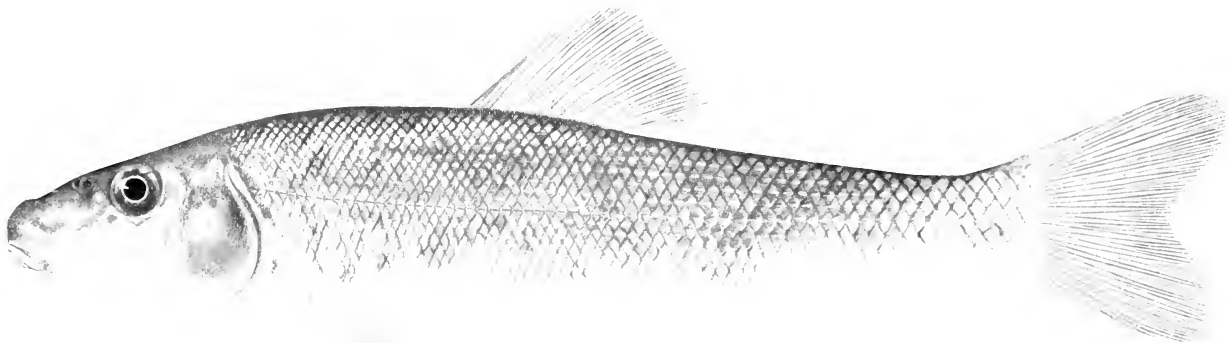
CATOSTOMUS COMMERSONII (Lacépède)

(Plate 6)

This is the most abundant sucker in the streams and lakes from Quebec and Massachusetts westward to Montana and Colorado and southward to Missouri and Georgia. It does not appear to be at all abundant in Lake Maxinkuckee. On the night of September 20, 1900, two large examples, each about 18 inches long and weighing about 2.5 pounds, were seined in shallow water in front of the Fish Commission station. A few small ones were found dead along the shore of the lake in the summer of 1906. No examples were caught in any of the gillnets which we had set. A few young individuals were seined in Culver Inlet and in the Outlet below Lost Lake, and on one occasion a good number were seen in the Outlet some distance below the lakes.

This fish does not take the hook, and when captured is usually taken in nets and traps. The flesh is of good quality, but very full of small bones. No opportunity was had to study its food or habits, as so few were seen.

Body moderately stout, varying with age, subterete, heavy at the shoulders, the depth 4 to 4.56 in length. Head rather large and stout, conical, flattish above, its length 4 to 4.5 in body (3.5 to 4.25 in young). Snout moderately prominent, scarcely overpassing the mouth. Mouth rather large; the lips strongly papillose, the upper moderate, with 2 or 3 rows of papillæ. Scales crowded anteriorly, much larger on the sides than below; scales 10-64 to 70-9. Coloration olivaceous; males in spring with a faint rosy lateral band; young brownish, more or less mottled, often with confluent blackish lateral blotches or a lateral band. Lateral line imperfect in the very young. D. usually 12. L. 18 inches.



COMMON SUCKER, *Catostomus commersonii* (Lacépède)

12. HOG-SUCKER

HYPENTELIUM NIGRICANS (Le Sueur)

(Plate 7)

The Hog-sucker is abundant in swift and rocky streams from New York to Minnesota and Kansas, Arkansas and the Carolinas. Like all other well-known species of wide distribution, it has received many different common names, among which are Stone-roller, Stone-toter, Crawl-a-bottom, Hammerhead, Stone-lugger, Boot-leg sucker, Spotted sucker, Black sucker and Hog-molly.

The Hog-sucker is not at all common in Lake Maxinkuckee. Six examples were seined July 18 near the Maxinkuckee pier, the largest about 8 inches long, and another example 12.75 inches long, was obtained later. A small one about 3 inches long was washed up dead in front of the Fish Commission station April 1, 1901. Mr. Gardner on the east side caught a specimen about August 16 from a pool by his house. In the autumn of 1907 one was frequently seen in the Outlet just below the wagon bridge, and one was seen near shore along the south edge of Outlet Bay.

This fish is not a lake species, but one which prefers clear pebbly streams, such as the Tippecanoe. Its occurrence in any abundance in Lake Maxinkuckee would, therefore, hardly be expected. It is present in some abundance in the Outlet; on April 2, 1901, a trip was taken about a mile down the Outlet and 9 examples, each about a foot long, were seen in a pile on the shore with spear marks on them. In a trip down the Outlet in the autumn of 1907 (September 30) a good many were seen. On August 9, 1906, 2 examples about 9 inches long were seined in Yellow River. The stomachs were examined and found full of mud and a few bits of insect fragments.

The Hog-molly can often be seen lying motionless at the bottom of clear, rather swift brooks, the black stripes across its back showing distinctly at a distance. In general coloration it resembles a pebbly bottom considerably and this frequently makes it difficult to see. In its general aspect, while in this position it resembles somewhat a large darter or a miller's thumb. It cannot usually be induced to bite, though a hook baited with a tempting morsel be let down to its very nose. It probably lives chiefly on insect larvæ and such microscopic organisms as it can suck up from the bottom.

This sucker reaches a length of about 2 feet. Although not extensively used as food its flesh is firm and flaky and possesses a flavor peculiarly sweet and agreeable. The chief objection is the abundance of small fagot bones.

At certain places in the Mississippi Valley this fish, along with other species of suckers, is utilized to some extent by salting for winter use.

Head 4 to 4.5 in body; depth 4.5 to 5; eye rather small, 4.5 to 5 in head, placed very high. D. 10 or 11; A. 7; V. 9; scales 7-48 to 55-6. Head flattened above, transversely concave between the orbits, the frontal bone thick, broad and short, the physiognomy being, therefore, peculiar. Upper lip very thick, strongly papillose, with a broad free margin, which has upward of 8 to 10 series of papillæ upon it; lower lip greatly developed, considerably incised behind, but less so than in related species. Fontanelle shorter and smaller than in *C. commersonii*, pectoral fins usually larger. Color olivaceous; sides with brassy luster; belly white; back brown, with several dark cross-blotches, irregularly arranged, these becoming obsolete in old individuals; lower fins dull red, with some dusky shading; young considerably variegated, the sides spotted.

13. CHUB SUCKER

ERIMYZON SUCETTA (Lacépède)

(Plate 8)

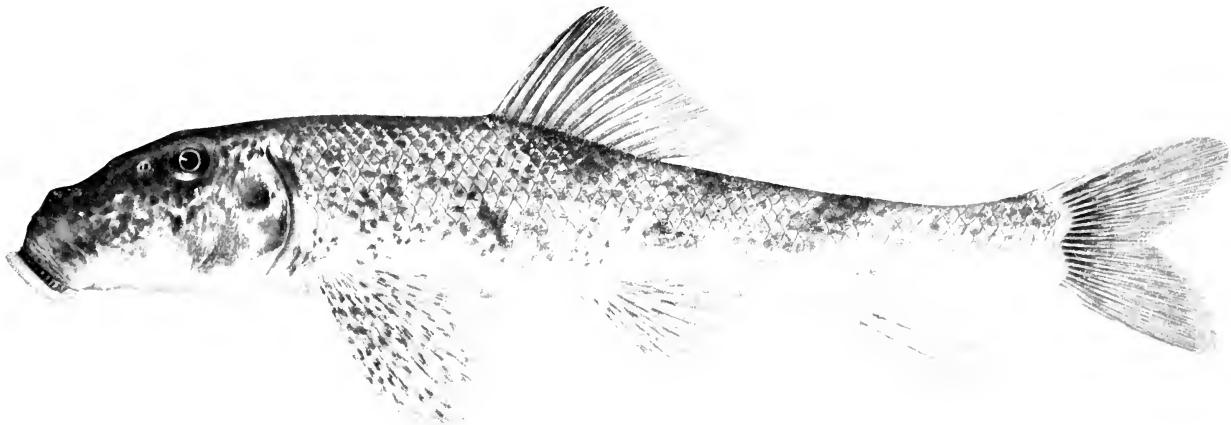
The Chub Sucker, or Creek Fish as it is sometimes called, is found throughout the Mississippi Valley, the region of the Great Lakes and in coastwise streams from Maryland to Texas. It prefers small lakes, bayous and sluggish lowland streams, and, where found, is usually not uncommon.

At Lake Maxinkuckee it is not often seen in the main lake but in the Outlet and in Lost Lake it is not rare.

In our seining operations about the lake numerous specimens were secured. Between July 25 and August 25, 612 hauls were made and Chub Suckers were taken in 24 of them, the total number of specimens being 109. The largest number in any single haul was 23. Specimens were obtained in Culver Inlet, Lost Lake, and in the Outlet between the two lakes. A few were got near the Vandalia pumping station at Culver and a few in Norris Inlet. On May 29, 1901, one was found dead in Aubeenaubee Bay, and another May 31 near the Assembly grounds.

The young of this species bears but slight superficial resemblance to the adult, the jet black lateral band and the small mouth making it easy to mistake them for minnows.

This species reaches a length of 6 to 8 inches. Like all suckers it is quite full of fagot bones but is, nevertheless, a delicious little panfish. The flesh is firm and of attractive flavor.



HOG-SUCKER, *Hypentelium nigricans* (Le Sueur)

Head 4.25; depth 3.25; eye 4.25 to 6; snout 2.5 to 3; D. 12; A. 7; V. 9; scales 36 to 42-15.

Body oblong, compressed, becoming gibbous with age, the antedorsal region more or less elevated in the adult; head short and stout, the interorbital space wide; scales closely imbricated and more or less crowded anteriorly; mouth small, somewhat inferior, the upper lip well developed and freely protractile, the lower small, infolded ∧-shaped in outline, plicate, with 12 to 20 folds on each side.

Color varying greatly with age; back usually dark olivaceous, the sides with pale streaks along the rows of scales; belly white; young with a broad black lateral band bordered above by paler, becoming broken up later into a series of blotches which sometimes assume the form of broad transverse bars; often the band is jet black and ends in a jet black spot at base of caudal. As the fish gets older this black band becomes less distinct and finally disappears, leaving the color nearly uniform dusky with a brassy or coppery luster; the fins are dusky, the lower ones sometimes tinged with reddish.

A young example 2 inches long, taken in Lost Lake July 31, had the following colors in life:

Back greenish-olive, side with a broad black band beginning as a large black spot at base of caudal and running along side a little above axis of body to tip of snout; under parts and lower part of side silvery-white, with golden or coppery wash; caudal pale brick-red; dorsal dark, particularly on the anterior 2 or 3 rays; all the other fins pale; pectoral with a thin dark edge. An adult 8 inches long was rich greenish-olivaceous, with rich brassy iridescence; fins all greenish brassy, no trace of black lateral band.

The sexual differences are usually well marked, the males in spring with large tubercles on the snout and the anal fin more or less swollen and emarginate.

14. SPOTTED SUCKER

MINYTREMA MELANOPS (Rafinesque)

This species, known locally as Black Sucker, is not common in these lakes. The only specimens we have seen were four examples seined in Lost Lake, October 21, 1913, by some commercial fishermen who undertook to "rid Lake Maxinkuckee of carp." These specimens were 14 to 16 inches in length.

This fish is also known as Winter Sucker. It attains a length of a foot to 18 inches and, as a food fish, is one of the best of the family, the flesh being firm, flaky and particularly sweet and palat-

able. It occurs throughout the region from the Great Lakes south and west through the upper Mississippi Valley, it being perhaps most abundant in Missouri.

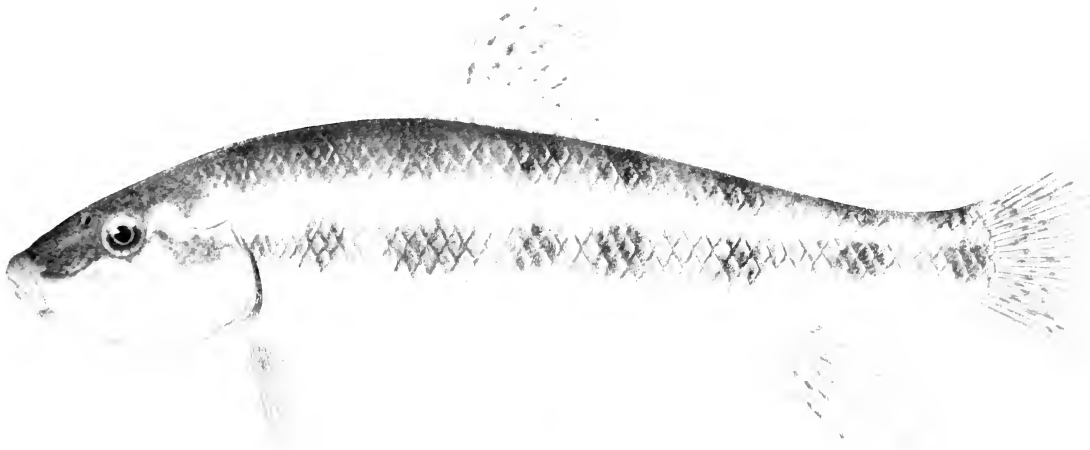
It may be known from all other suckers by the following description: Dorsal fin short, with only 12 rays; air-bladder in two parts; lateral line incomplete, most evident in the adult, the scales large, firm, regularly and smoothly imbricated, in 44 to 47 longitudinal series. Color dusky above, usually with a black blotch behind the dorsal fin; each scale along sides with a small blackish spot, these spots forming interrupted lines along the rows of scales, especially distinct in the adult, faint in the very young.

15. REDHORSE

MOXOSTOMA AUREOLUM (Le Sueur)

This species of sucker, so common in most of the rivers and creeks in the upper Mississippi Valley and the Great Lakes region, is apparently very rare in Lake Maxinkuckee. It is essentially a fish of moderately swiftly flowing streams and its occurrence in this lake was unexpected. Our records show but a single specimen, an example 6.5 inches long, obtained in the summer of 1900. In neighboring streams, such as Yellow and Tippecanoe rivers, it is a common and well-known fish. It is variously known as the Common Redhorse, White Sucker, Large-scaled Sucker and Mullet. In Indiana it is most commonly called the Redhorse, and is a familiar fish to the boys and others who go a-fishing in the spring and early summer. It is not often caught on the hook, though when the hook is baited with angleworms and allowed to lie on the bottom it will sometimes be sucked in by the Redhorse. The method usually employed in the capture of this and other species of suckers, however, was by means of the wire snare. Favorite places were in the interstices in the old log drifts which occurred all too frequently in the smaller Indiana streams 30 to 40 years ago. As a game-fish not much can be said for the Redhorse, although it fights well when once it is hooked. As a food-fish it is excellent except for the abundance of fagot-bones. In a fish taken from clear cold water, the flesh is firm and flaky and deliciously sweet. At various places in the Ohio basin, and doubtless elsewhere where these suckers occur abundantly, they are salted or put up in brine for summer use.

The breeding habits of the Redhorse are well-known. In the fall, when cold weather comes on, they run down stream and retire to the quiet, deeper portions of the river where they remain



CHUB-SUCKER, *Erimyzon sucetta oblongus* (Mitchill)

through the winter. When the warm days of spring return these fish leave the deeper water and run up stream into the shallow, swifter portions. This spring run of the suckers was, in the early days, one of the phenomena in Indiana and Illinois which never failed to attract the attention and excite the interest of those who were at all observing.

The Redhorse may be readily known from all other species of suckers of this region by the following description, based on the one Maxinkuckee specimen:

Head 4.2 in length; depth 3.9; eye 4.75 in head; snout 2.6; interorbital 2.5; dorsal I, 13; anal 7; scales 7-42-4. Body stoutish, varying to moderately elongate, considerably compressed, dorsal outline arched; head rather long, bluntish, rather broad, flattened above; lips full, the nose projecting; lower lip strongly plicate. Color in life yellowish or light rosy above, paler on sides, whitish beneath; fins more or less red, fading to light yellow in alcohol.

16. ROT-GUT MINNOW

CAMPOSTOMA ANOMALUM (Rafinesque)

(Plate 9)

This minnow is common in streams from central New York westward to Wyoming and south to Tennessee and Texas. It is usually most abundant in deep or still places in small streams with muddy bottom. In the spring it runs into the smaller brooks at spawning time. Although not a lake fish it occurs in Maxinkuckee in some numbers. In July and August, 1899, more than 30 specimens were seined in various places about the lake, though chiefly in the small streams flowing into it. It was most abundant in Aubeenaubee Creek; it was found also in Norris Inlet, Culver Inlet and the Outlet. Only rarely have we taken it in the lake proper; two were got July 25, 1899, near the pumping house of the Vandalia railroad in the northwest corner of the lake on sandy bottom covered with Hydrodyction and other aquatics, and another was obtained near shore west of Lakeview Hotel, June 18, 1901. The smallest specimen in our collection is 2 inches long, the largest 5.625 inches.

This species is known also as Stone-roller, Stone-lugger, Steel-backed Chub, Mammy and Doughbelly. It attains a length of 5 to 9 inches. As a food fish it possesses very little value, albeit, it often adorns the small boy's string. Its flesh is soft and doughy, full of small bones, and quick to decay, hastened, no doubt, by the character and quantity of food usually found in the remarkably

long intestine. If dressed immediately after being caught and quickly consigned to the frying pan well rolled in fine meal and seasoned with butter, and browned to a turn, it is a dainty morsel. It is as a bait minnow, however, that this fish is of most value, and it is often seen in the minnow buckets of anglers about the lake. It is fairly good as a deep troller, and is excellent in shallower water provided it is kept near the surface. Its tendency is to bear down and become entangled in the weeds if there be any present, where it will pout and sulk. It lives well and is active on the hook when held up. It is a good bait for bass and wall-eyed pike but too big for yellow perch.

This species can be readily distinguished from any of the other minnows of the lake by an examination of the very long intestine, which is spirally coiled around the air-bladder, a feature peculiar to the genus to which it belongs.

The males are so greatly modified by the development of tubercles over the body during the breeding season that they hardly look like the same fish; an example 4.75 inches long caught in the Outlet at the railroad bridge June 16, 1901, was so decorated. Several large tubercles adorned the head, and the greater number of scales on the upper part of the body contained each a small tubercle near the center. These tubercles appeared to be composed of a horny substance and were each seated in a more or less pit-like depression.

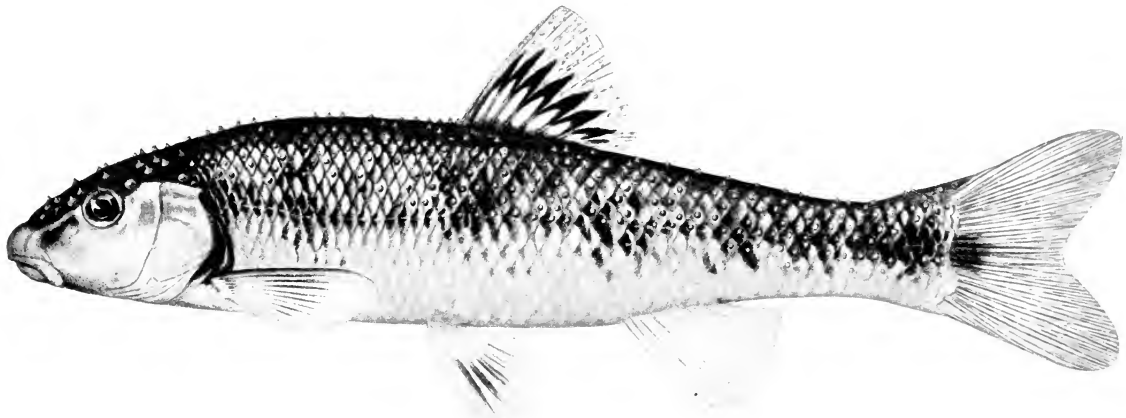
Head 4.2 in body; depth 4.4; D. 8; A. 7; scales 7-53-8; teeth 4-4 or 1, 4-4, 0. Body stoutish, moderately compressed, the antedorsal region becoming swollen and prominent in the adult. Snout moderately decurved. Scales deep, rather small and crowded anteriorly; maxillary not reaching to opposite the front of eye. Intestine very long and wound around the air bladder. Color brownish, with a brassy luster above, the scales more or less mottled with dark; a dusky vertical bar behind the opercle; dorsal and anal fins each with a dusky crossbar about halfway up; the rest of the fin, olivaceous in females, fiery red in the males in the spring, the iris orange in males. Extremely variable. The young very different in appearance from the old males. Length 6 to 8 inches.

17. CARP

CYPRINUS CARPIO Linnæus

(Plates 10, 11, and 12)

During the seining operations of 1899-1900 not a single Carp was taken in the lake and we have no specimens of this species in



STONE-ROLLER, *Campostoma anomalum* (Rafinesque)

the collection made at the lake. So far as known, no Carp has yet been taken out of the body of the lake itself, but as they have been taken in the marshes at both the Outlet and Inlet regions, they are in all probability present in the lake. They have never been noted splashing about in shallow water of the lakes as they usually do when abundant. The Carp made its first appearance in the region on the night of July 1, 1902. At about 2 o'clock that night Mr. S. S. Chadwick heard several big fishes floundering about in Green's marsh. He and Mr. E. Hatton took a lantern and tried to see them. There appeared to be a good many large fishes splashing among the grass and bushes, and sometimes their dorsal fins could be seen projecting above the water. The fins indicated quite large fish. In the afternoon of July 2 two men took a boat and rowed all over Green's marsh, but saw nothing. The fish had either returned to Lost Lake or were hidden in the grass or bushes. Late the same evening a large fish was seen at the lower end of the tile under the railroad. It swam down the ditch among the grass. The next day several large fish were seen in the marsh, and one was shot which proved to be a Carp 22 inches long, and weighing just 5 pounds. Another much larger one was seen. Part of the Carp which was shot was fried, and those who partook of it reported it pretty fair eating.

On December 30, 1905, some large fish thought to be these, were seen through clear ice in the Outlet about a mile below the lakes.

So far as known the Carp first appeared here in considerable numbers about May 13, 1905. The following extract from a letter from Mr. S. S. Chadwick, June 4, 1905, describes the Carp situation at that time: "Water was very high and Carp came out in the field west of me [Green's marsh]. Mr. Green came up to my place Friday, May 12, and said that the Carp were plentiful out in the pasture. I went and got 9. The next morning I got up at 4:30, took a 4-tined fork, crossed the road, and opened up on them. At 5 Mrs. Chadwick brought out a washtub and I put in 11 Carp that filled it. The largest, 32 inches long, weighed 19 pounds. In the two mornings I killed 21 Carp. I gave 15 to my neighbors and skinned the other 6, rolled them in paper and put them on ice. We had fish for 8 days, split the large one and made cut chops out of it, 1 rib to the piece, enough for an order, and I will say this for the Carp, the 5 to 8 pound ones are perhaps better than the larger ones. Flesh sweet and much better than the large-mouth black bass. I was surprised, indeed; so were my guests. Mrs. C. fried them and every one pronounced them fine.

There were from 150 to 200 Carp taken out of that field and the Outlet between the two bridges. In Harvey Norris's field south of his house, one 16-pounder and 20 or more smaller were caught."

In 1907, late in June, many Carp were seen in Green's marsh. One man shot two and speared five others, and many others were taken. The largest obtained this year that we have any record of weighed 8 pounds.

In the autumn of 1907, a trip was taken by boat from Lake Maxinkuckee down the Outlet to the Tippecanoe River. No sign of Carp was seen either in Lost Lake or in the Outlet. It is somewhat surprising that this fish, so much in evidence in the flats in the high water of spring, should appear to be wholly absent during the rest of the year.

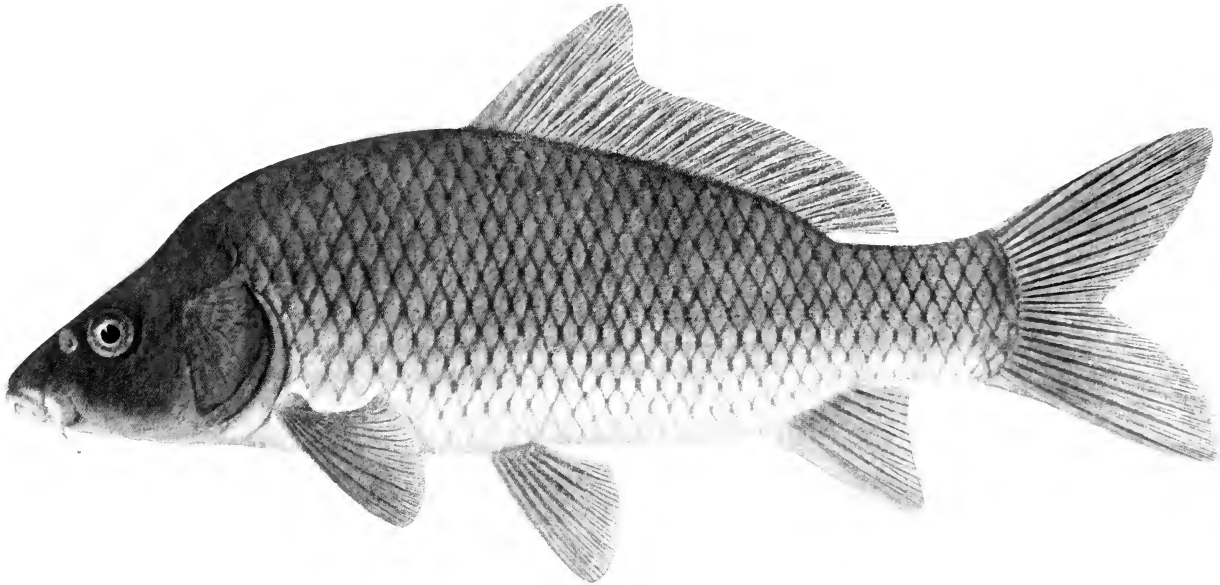
In October, 1913, a party from Wisconsin came to Lake Maxinkuckee prepared to "rid the lake of the carp." They were equipped with a seine several hundred yards long and all the necessary boats, winches and all other needful paraphernalia and authority, including a permit and moral support from the State Fish and Game Commission. On October 20, one haul was made in Aubeenaubee Bay; result, about 1,000 bass, but not one Carp! The next day Lost Lake was seined with only slightly better success, the catch consisting of an immense number of straw bass (some weighing about seven pounds each), a great many bluegills, a few dogfish, a few redhorse, two striped suckers, a lot of miscellaneous species, and *three Carp!*

From which it appears that the Carp is not, as yet, very common in Lake Maxinkuckee.

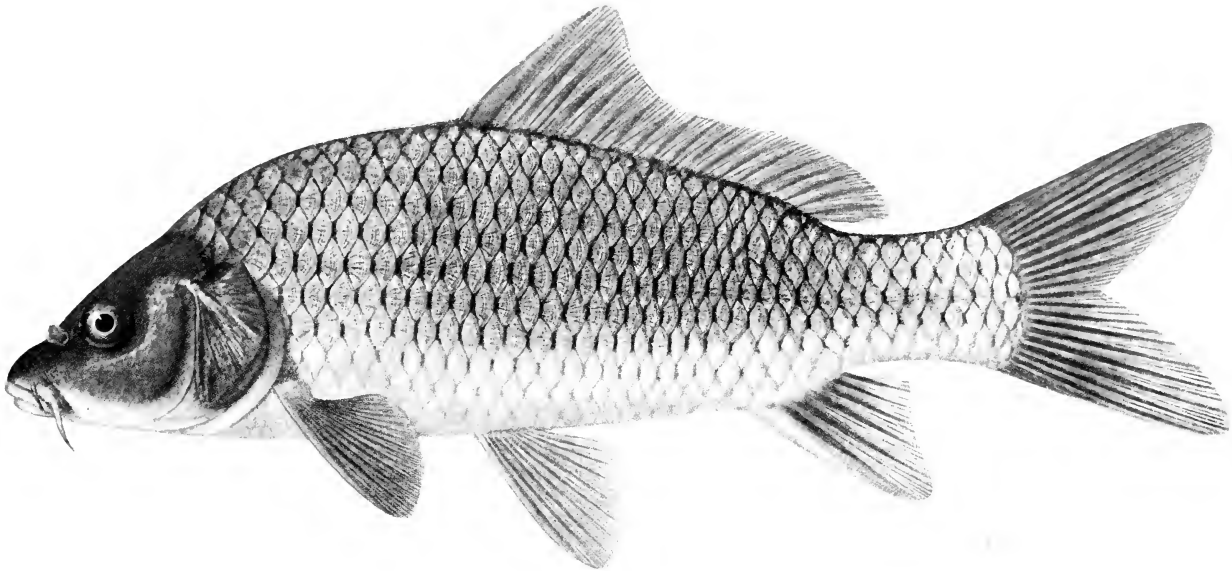
About the lake, as in other places throughout the country, there is a good deal of prejudice against the Carp, which has no foundation in fact. They are supposed to devour the eggs of other fishes, but very few eggs have ever been reported as having been found in their stomachs.* They are supposed to drive away other fishes, but almost any of our spiny-rayed fishes could probably drive away the Carp. They are omnivorous, living on vegetable food, and almost anything else small enough to take into their mouths. The young furnish a large amount of food to carnivorous fishes, such as bass and perch.

In the winter of 1903 Carp were observed in great numbers in lagoons in Jackson Park, Chicago; the fishes swarmed up to air-holes by the thousands and many people caught them in their bare hands.

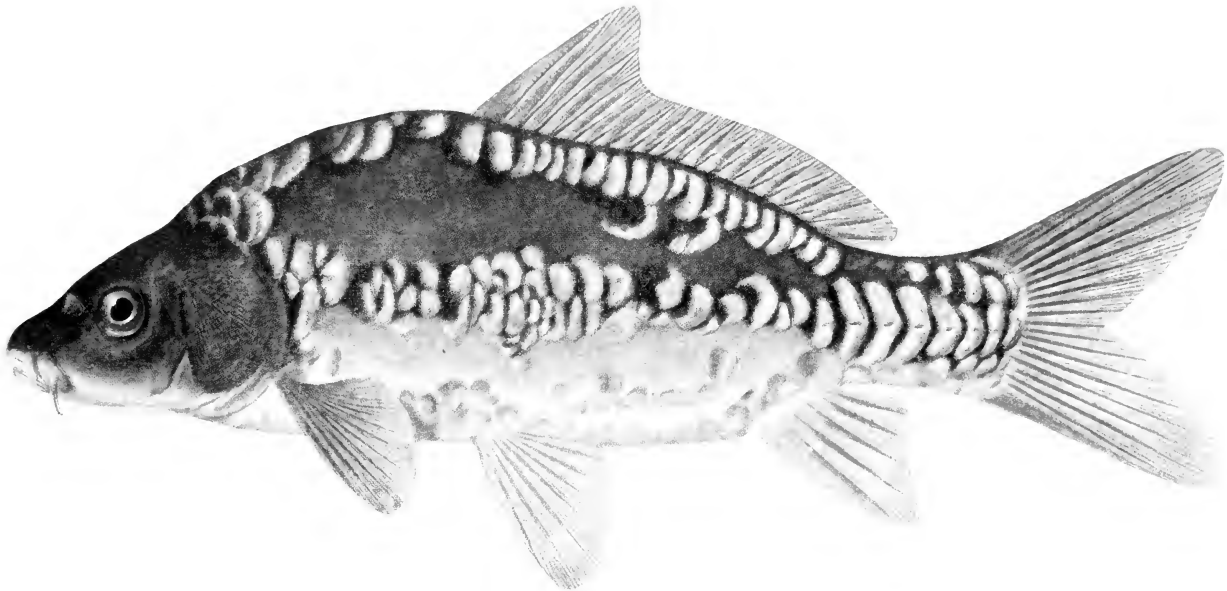
* Leon J. Cole examined the stomach contents of 33 carp critically and many others less carefully and found only 3 fish eggs.



EUROPEAN CARP, *Cyprinus carpio* Linnaeus
Darker-colored scaled form from cleaner waters with vegetation



EUROPEAN CARP, *Cyprinus carpio* Linnaeus
Commoner scaled form from river and muddier lakes



EUROPEAN CARP (MIRROR CARP), *Cyprinus carpio* Linnaeus

Carp are usually caught by net, as they are not, as a rule, ready biters at the hook. Small ones are, however, frequently caught on the hook along the upper Mississippi. The favorite bait is the dough ball, or a bit of potato. They will, however, also take the angleworm and are sometimes caught on set-lines baited with angleworms. As a game-fish the Carp is not to be despised; indeed, in some regions it is held in high esteem and eagerly sought by local anglers. It is really quite gamy, and a 4 to 10 pound Carp is able to make a fight that will delight even the most expert angler.

The Carp is very productive, the number of eggs reported for 4- to 25-pound fish ranging from 100,000 to more than 2,000,000. Dr. Cole found that the eggs of a 17-pound Carp weighed 27 per cent of the entire weight of the fish.

The Carp makes no nest but simply leaves the eggs scattered about on the vegetation in shallow water and gives no further attention to them.

As a food-fish in American waters the Carp has undoubtedly come to stay. The annual catch now amounts to many million pounds, valued at hundreds of thousands of dollars.

Body robust, compressed, resembling that of the buffalo-fish. Mouth moderate, anterior, with 4 long barbels. Snout blunt, rounded; D. III, 20, the first spine strongly serrated; A. iii, 5; teeth, I, I, 3-3, I, I; scales normally 5-38-5, but sometimes few and large, scattered (mirror carp) or absent (leather carp); many variations present, due to domestication. Habitat, fresh waters of Asia; introduced into Europe and America as a food-fish.

18. BLUNT-NOSED MINNOW

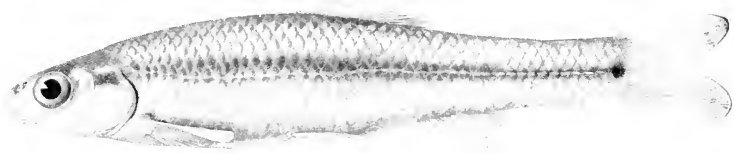
PIMEPHALES NOTATUS (Rafinesque)

This little fish is found from Quebec to Delaware, Arkansas and the Dakotas. It is generally abundant in small streams.

In Lake Maxinkuckee it is a very common and well-known fish. In our seining operations many specimens were obtained, the number taken at each haul varying from 1 to 30. The species was represented in 79 out of 612 hauls and by 268 specimens. They are most frequently met with where the water is shallow and the bottom of mixed sand and gravel covered sparsely with vegetation. During the spring and summer they are usually found singly or only a few together, but later they bunch up and in the fall and winter they are found in considerable schools. These schools are usually found near shore, particularly under or about the piers.

On bright sunny days they may be seen swimming along in shallow water and feeding upon entomostraca and other plankton elements at the surface. Even after ice has formed these schools may be seen. On November 14 and 27 many were found frozen in pools along shore, 59 being taken from one pool.

The breeding season of this minnow is early in June. On June 6 several nests were found in shallow water near the south shore of Outlet Bay. On June 8 more were found. They were invariably found under small pieces of boards or other flat objects lying on the bottom. Eight nests were found under one long board and two are often seen under one small piece of board. Upon lifting the board a rather broad but shallow burrow or depression is found under it, and usually a small fish is seen swimming anxiously back and forth in the burrow. The eggs are found attached to the under side of the board in a single compact layer. They are pinkish white or transparent pinkish in color and about 17 to the inch



Blunt-nosed Minnow (*Pimephales notatus*)

in size. The eggs in some of the nests were evidently fresh, while those of other nests examined on the same date showed eye-spots and light wiggling motions. Several of these nests were examined again on June 16 and the parent fish were still present.

Crawfishes apparently feed to some extent on the eggs of these fishes. One or more were seen under nearly every board which contained a nest, and the eggs disappeared before ready to hatch.

As a bait minnow this species is one of the most desirable, perhaps the best of those found in the lake. All except the largest are too small for trolling, but for deep-water fishing it is excellent. It is very tough and lives well in all kinds of water and at all depths. It is a good fighter and very active on the hook. It may be used at any season and is good for wall-eyed pike, bass and perch, and all other game fishes of the lake except the bluegill.

The Blunt-nosed Minnow is the only species of the genus found in the lake. It may be readily known from the following description:

Head 4.3 in body; depth 4.6; eye 3.1 in head; snout 3.6; dorsal I, 8; anal 7; scales 6-41 to 45-4; teeth 4-4.

Body rather elongate, not much elevated, only moderately compressed; head rather short, the snout blunt and convex; top of head depressed, cheeks vertical; mouth small, inferior, horizontal. Fins small, the dorsal moderate, the first ray distinct and spinelike in the male, slender in the female; anal fin small, caudal fin short. Scales moderate, deep, closely imbricated, 23 rows in front of dorsal; eye small.

Color, back olivaceous; sides bluish silvery, belly white; nose bluish; a black spot on the dorsal fin in front near the base; a dusky blotch at base of caudal fin; fins often reddish.

Comparative measurements were taken of 150 examples of this species. These specimens ranged in length from 1.5 to 3 inches, the aveage being 2 inches.

19. COMMON CHUB

SEMOTILUS ATROMACULATUS (Mitchill)

At Lake Maxinkuckee this fish is confined practically to the small tributary streams. Numerous specimens varying in length from 1 to 9 or 10 inches were obtained in each of the inlets, perhaps most numerously in Aubeenaubee Creek; and a few were obtained in the Outlet. In all of these little streams it pushes well toward the head, and good-sized examples may be found where the stream is but a few inches deep. Their favorite place, however, is in the deeper, more quiet pools of these small streams. Though they can endure a relatively high temperature and water which is not very pure, they are often so crowded in these pools that the water becomes poorly aerated and quite impure, and the fish becomes infested by various sorts of psorosperms and other parasites. These, however, rarely seem to prove fatal, and when the fish are removed to favorable surroundings they speedily recover.

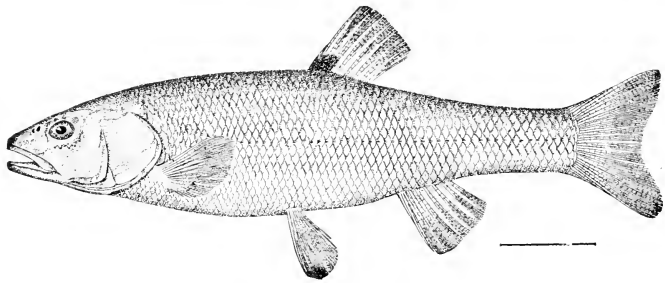
The Common Chub reaches a length of 8 to 10 inches and is one of the fishes quite sure to be found on the small boy's string. It is one of the most voracious of the minnows and the sum total of sport which it brings to the youth of the land is no doubt quite as great as that which better fish bring to these same boys when no longer young. But while the mature angler no longer seeks the festive chub for its own sake, he nevertheless finds it a very useful fish, for when he would land the wall-eyed pike, great pike, or muskallunge, he finds no better bait than this same Chub; the larger ones for these species and smaller ones for black bass. The Chub

is a hardy bait, active on the hook and attractive to the game fishes just named.

The principal food of the Chub consists of insect larvæ, aquatic insects, worms and small crustaceans.

Head 3.75 to 4; depth 4.75; eye 7.5; snout 3; interorbital 2.4; D. 8; A. 8; scales 9-57-5,—about 40 before the dorsal; teeth 2, 5-4, 2.

Body stout, not much compressed, the dorsal outline arched somewhat in front of dorsal, the body tapering backward from a point considerably in front of dorsal, so that the base of that fin is quite oblique; head large, bluntly conic, broad and rounded above; snout broad; mouth broad, oblique, lower jaw somewhat included, the upper lip entirely below level of pupil; maxillary



Common Chub (*Semotilus atromaculatus*)

barely reaching front of orbit; maxillary barbel small, sometimes not evident; eye small; scales small, greatly reduced and crowded anteriorly; lateral line strongly decurved.

Color, dusky bluish above, side with a vague dusky band, quite black in the young, but almost or entirely disappearing with age; belly whitish, rosy in breeding males; dorsal fin with a large black spot on base of anterior rays, bordered with red in the adult male; a dusky vertebral line; scales everywhere black at base and dusky on edges; a broad black bar on shoulder behind opercular opening; males in spring with the snout coarsely tuberculate; young with a small black spot at base of caudal. The Chub varies somewhat in the number of scales, northern specimens having an increased number. Our specimens have from 57 to 60. The number of fin-rays is also large in our specimens, one having D. 8; A. 9, and another D. 9; A. 9.

20. ROACH

ABRAMIS CRYSOLEUCAS (Mitchill)

(Plate 13)

The Roach, known also as the Golden Shiner or Bream, is a common fish from Nova Scotia and Maine to the Dakotas and south to Texas, on both sides of the Alleghenies, and is usually abundant in weedy ponds and sluggish streams. It is not abundant in Lake Maxinkuckee; specimens were obtained in only 7 hauls of the seine and of these 6 were made in Culver Inlet, and one in the outlet below Lost Lake. A few were seen, along with calico bass and bluegills under the Merchant pier, near Culver, Nov. 15, 1906. In all, 59 specimens, ranging from $1\frac{1}{4}$ to $5\frac{3}{4}$ inches, were taken. It is a handsome, hardy fish, and would make a very attractive aquarium fish. It is sometimes used, along with other minnows, for bait.

This species reaches a maximum length of about a foot and may be known from other minnows inhabiting this lake by the greatly compressed body, the small mouth, the large anal fin and the greatly decurved lateral line.

Head 4.5; depth 3.5; eye 4; snout 4; maxillary 4.3; mandible 3; interorbital 2.6; caudal peduncle 2; D. I, 8; A. I, 12; scales 11-51-3.

Body elongate ovate, strongly compressed; head small and short, moderately pointed; snout short, pointed; eye moderate, in axis of body; mouth small, oblique, maxillary not reaching eye; jaws subequal. Fins moderate; origin of dorsal behind insertion of ventrals and a little nearer base of caudal than tip of snout; first dorsal ray longest, 1.2 in head; last ray about $\frac{1}{3}$ length of first; base of dorsal 1.75 in longest ray; free edge of anal concave, the first rays longest, about 1.2 in longest dorsal; last anal ray about 3 in first, base of anal equal to longest ray; caudal widely forked, the notch rounded, the lower lobe slightly longer, greater than head, the upper scarcely equal to head; pectoral small, short, 1.3 in head, not reaching insertion of ventrals; ventrals shorter than pectoral, reaching $\frac{2}{3}$ way to anal; scales rather small, not very firm, and not closely imbricated; lateral line complete, strongly decurved.

Color, clear greenish above; side silvery, with bright golden reflections; fins yellow-greenish, the tips of the lower fins sometimes somewhat orange in breeding males.

21. BLACK-STRIPED MINNOW

NOTROPIS BIFRENATUS (Cope)

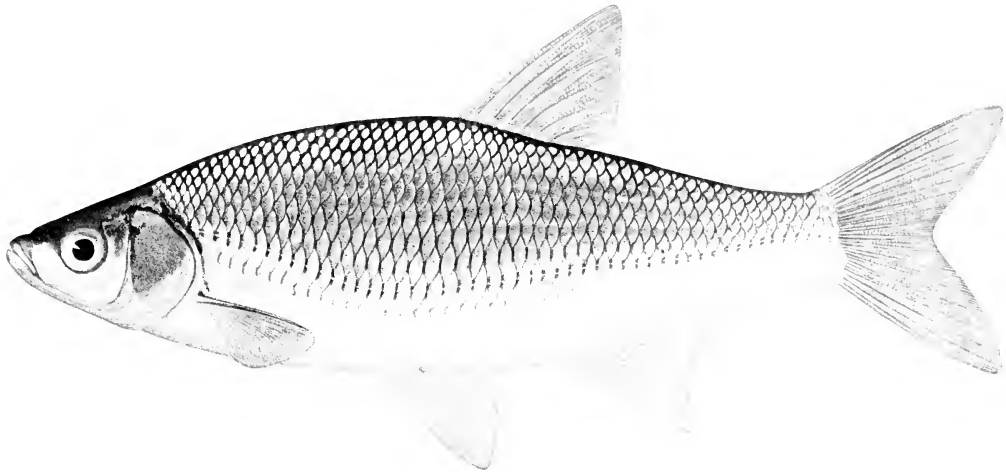
Up to 10 or 11 years ago, this handsome little minnow was known only as a rather uncommon fish in streams along the coast from Massachusetts to Maryland. In 1898, Dr. W. C. Kendall of the Bureau of Fisheries, obtained a good number in a bay near the mouth of Songo River, at Sebago Lake, Maine. At Lake Maxinkuckee, 5 specimens of this species have been found, 2, each about 1¼ in. long, in Lost Lake Aug. 25, 1900, a third about an inch long of which the date has been lost, another example 1½ inches long was taken in Aubeenaubee Creek near the mouth November 15, 1904, and the fifth, 1⅜ inches long, in Lost Lake, Dec. 24, 1904. These specimens agree perfectly with those obtained at Sebago Lake, Maine, by Dr. Kendall, except that ours have a slightly larger eye and a slightly larger mouth.

The Black-striped Minnow very closely resembles the young of the chub sucker, from which it can be distinguished by the structure of the mouth. It can be at once distinguished from any other of the minnows of the lake by its intense contrastive markings. It differs from *Notropis cayuga*, which it resembles more closely than any other minnow of the region, in the larger mouth, black lower jaw, stouter body, and much blacker lateral band. The black lateral band in *bifrenatus* is solid and continuous, that in *cayuga* is made up of a series of black vertical bars, somewhat lunate in the anterior part of the body, separated by less black, silvery interspaces.

Head 4.2 in length; depth 4.2; eye 3 in head; D. 8; A. 7; scales 5-36-3; 13 scales before dorsal; teeth 4-4. Body with both dorsal and ventral outlines somewhat arched; the caudal peduncle somewhat contracted. Head moderate, the muzzle very obtuse. Mouth oblique, the jaws about equal; upper lip opposite lower part of pupil. Eye large, greater in diameter than length of snout; pores of lateral line developed on only a few of the anterior scales.

Straw-colored, the scales brown-edged above; a shining black band from snout through eye to caudal, including edge of lower jaw; an orange band above this on the snout; regions below the black band silvery. Length 1½ to 2 inches.

On account of its rarity, this minnow is not generally known to the anglers of the vicinity. Its small size would probably prevent its being used as a bait minnow, though its attractive colors might make it a good lure.



GOLDEN SHINER, *Abramis crysoleucas* (Mitchill)

22. CAYUGA MINNOW

NOTROPIS CAYUGA Meek

(Plate 14)

The Cayuga Minnow is a rather common fish in lakes, ponds and streams from Cayuga Lake and northern New York, westward to Assiniboia, South Dakota, Nebraska, Kansas and Arkansas. It is an insignificant little fish, usually too small to be used for bait, and chiefly useful as food for other fishes. It is generally overlooked by minnow seiners and anglers, and is usually known only from regions where systematic collecting has been done; its small size and modest colors enable it to elude common observation.

It does not appear to be common in Lake Maxinkuckee proper; our only record is of 5 specimens taken July 7, 1900. It appears, however, to be quite abundant in Lost Lake. On July 29, 1899, 19 specimens were obtained there, and the species appeared to be exceedingly abundant at that place during the late autumn of 1907. Late in October and during the first week of November of that year, it swarmed in myriads in the shallow water along the shore. On November 5, 1907, more than a bushel were taken in one haul with a 12-foot seine dragged through a space not exceeding about 50 square feet of water, near the Bardsley cottage. Of these about a gallon were saved and found to consist of 1,907 of this species, 48 *Notropis heterodon*, 25 *Pimephales notatus*, 7 *Abramis crysoleucas* and 4 *Notropis blennius*. The stomachs of a number of the Cayuga minnows taken in this haul were examined and found to contain various kinds of entomostraca and several different sorts of diatoms; among the entomostraca were Diaptomus, Bosmina and Daphnia; among the diatoms were species of Navicula, Pleurosigma and Cymatopleura. It was thought at first that these came from the stomachs of the waterfleas, but these were quite free from them. One filament of Spyrogyra and one of Lyngbya, observed were probably taken by accident. At that time the entire east shore of Lost Lake from the Bardsley cottage southward was a mass of these small minnows, so uniformly abundant and crowded that it was practically impossible to observe any segregation into schools.

Our specimens differ somewhat from the descriptions of typical *N. cayuga* in having the lower jaw subequal or included, and not projecting. In this respect they resemble *N. anogenus*, from which they differ, however, in having the lateral line incomplete. The chin usually has a few minute punctulations, but would be called

pale in comparison with that of *N. heterodon*. The following is a description of a typical specimen:

Head 4.1 in length; depth 5.1; eye 3 in head; snout 3; D. 8; A. 8; teeth 4-4; scales 5-36-4, -14 before dorsal; lateral line usually quite incomplete. Body rather slender, moderately compressed, heaviest forward; caudal peduncle long and slender; head rather broad; snout short, bluntly rounded; mouth small, maxillary not nearly reaching eye, the lower jaw usually included or little projecting; eye large; fins moderate, origin of dorsal slightly behind insertion of ventrals; caudal rather deeply forked, the inner rays scarcely exceeding half length of outer ones.

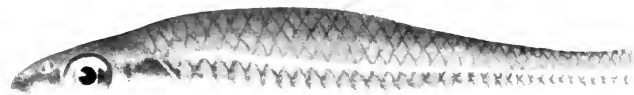
Color, pale yellowish or straw-color above, whitish below; back and two rows of scales on each side with a border of dark stippling about each side; middle of side with a broad plumbeous band overlaid with black arranged in short vertical masses separated by silvery interspaces which are less heavily punctate with black, this black band extending on to base of caudal fin and through eye around snout. Length 1 to 2.5 inches.

Variable-toothed Minnow (*Notropis heterodon*)

23. VARIABLE-TOOTHED MINNOW

NOTROPIS HETERODON (Cope)

The Variable-toothed Minnow is rather common from New York to Michigan and Kansas. Like its near relative, the Cayuga minnow, it is a rather insignificant little fish, so much like a host of relatives that it is not generally distinguished from the great mass of "minnows" by most people. It can be distinguished from the Cayuga minnow, which it closely resembles, by the larger mouth and bit of black on the chin. The young of this species have a broad black band on the side, and quite closely resemble the young of the chub sucker (*Erimyzon succetta*). They are not so deep, however, and have a differently shaped mouth.



CAYUGA MINNOW, *Notropis cayuga* (Meek)

Our collection contains 111 specimens, ranging from 1.12 to 2.5 inches in length, 34 of which were obtained in Lake Maxinkuckee, 75 in Lost Lake, 1 in Aubeenaubee Creek and 1 in Culver Inlet.

Head 4 in length; depth 4; eye 3 in head; snout equal to eye; D. 8; A. 8; scales 5-36-3, the lateral line extending about half the length of the body; teeth 4-4 (sometimes 2, 4-4, 2) often crenate. Body moderately stout, the back somewhat elevated; head rather pointed, the muzzle acuminate; mouth rather oblique, lower jaw projecting; upper lip opposite upper rim of pupil; maxillary extending to opposite front rim of orbit; thirteen scales in front of dorsal.

Color: Back golden olivaceous; top of head black, snout paler, yellowish; middle of side with a broad, black, zigzag line beginning often as a black spot at base of caudal and running along middle of side through eye and around snout; tip of lower jaw black; lower half of side and under parts silvery. In mature examples there is a steel-blue wash along lateral line, and the whole body has a pale golden tinge; a small dark spot on back at origin of dorsal.

24. STRAW-COLORED MINNOW

NOTROPIS BLENNIUS (Girard)

(Plate 15)

The Straw-colored Minnow is generally abundant in small streams from Ohio and Michigan to Tennessee, Dakota and Kansas, and southward to Texas. At Lake Maxinkuckee it is very abundant. During the seining operations of 1899-1900, 499 examples or more were taken. Throughout the summer individuals of this species seem to be pretty well distributed in the lake from the shore to some distance out; with the coming of winter, however, they crowd together and are frequently seen in immense schools along the shore, sometimes alone, and sometimes associated with skipjacks and blunt-nosed minnows. A sudden cooling of the water in autumn appears to benumb them and other small fishes and they are frequently found washed upon shore where they perish. This particularly happens if there is a storm with high waves about the time of a rapid lowering of water temperature. When the first skirt of ice is formed along shore they are sometimes found frozen on top of the ice as if they had jumped up there to escape some larger fish, or had been blown there in the spray.

The Straw-colored Minnow is a rather delicate fish and cannot

stand severe cold. On November 30, 1900, a number of these, with graybacks and other fishes, were found in a pool by Farrar's where they had washed up during a storm. The pool was frozen almost solid. The graybacks revived after being thawed out but the Straw-colored Minnows were all dead, many of them having actually burst asunder in the process of freezing.

Throughout the whole winter of 1900-1901 and during the fall and early winter of 1904, these minnows were seen quite frequently in various situations. They congregated in great numbers under the first clear ice, appearing to crowd up as close to the shore as possible, and they seemed to be enjoying the sunlight shining through the ice. Whenever a hole was cut through the ice near shore, they could be seen, apparently attracted by the light and air. They also lurked about dark sheltering places such as piers, and congregated in great schools about the steamboats during the winter. They also sometimes crowded about the Outlet in company with skipjacks. When they are associated with skipjacks, the latter are usually nearer the surface of the water, while the straw-colored minnows are more or less the bottom part of the school. On November 1, 1904, a good many of these were noticed with thousands of skipjacks near Long Point. When disturbed, if under a pier, the skipjacks moved out into deeper water, while the straw-colored minnows moved nearer shore. In the early winter of 1904 they were seen crowding under pieces of boards and sticks which lay on the bottom near shore. Those under boards appeared to be dazed when the board was suddenly removed, and were easily caught. When out in open schools, however, these fish are quite alert, and rather more difficult to catch with the dipnet than the skipjack.

In the spring of 1901 they were seen quite frequently, and, though not in dense schools as in the autumn, were still often abundant along shore as late as June 25.

This fish appears to subsist chiefly on animal food, and occasionally on algæ. An example 1.19 inches long contained a good number of Bosmina, one Daphnia and remains of insect larvæ. Of a number examined October 7, 1904, several were empty, 2 contained entomostraca and several contained *Anabæna flos-aquæ*. A lot were caught at the depot pier the next day; most of these were empty, but several contained Anabæna. On December 7, 1904, five were examined of which 2 were empty but the other three contained insect larvæ. One examined May 22 contained a few mature insects, others examined June 15 contained a few insect fragments, but little else.

The Straw-colored Minnow spawns early in June; several specimens examined June 6 were found to contain ripe eggs. Another collected May 22 contained numerous immature eggs. An example 2¼ inches long caught at Long Point June 2, was examined. The egg-mass was thick club-shaped, somewhat sharper behind, apparently occupying all the body cavity behind the liver and closely pressed against the air-bladder, almost surrounding it. The intestine was inconspicuous. The egg-mass was 19 mm. (nearly an inch) long and 7 mm. (a third of an inch) in diameter. The individual eggs were small, pale in color, 305 in number and measuring 33 to the inch. They were probably nearly mature. Besides these there were many immature eggs.

This little minnow is used for bait only when better ones are not available. It is too small and tender to prove entirely satisfactory. Its abundance, however, and the difficulty which anglers coming to Lake Maxinkuckee frequently experience in obtaining larger minnows, result in the use of a good many of this species for bait. For rock bass, crappie and yellow perch it proves pretty attractive and effective.

It is also doubtless of much importance as food for other fishes of the lake. At night, when the bass, rock bass, perch, walleyed pike and other species come in near shore to feed, the Straw-colored Minnow is one of the species preyed upon most persistently. Many doubtless fall a prey to the waterdogs which creep up among them when crowded in schools near shore in late autumn.

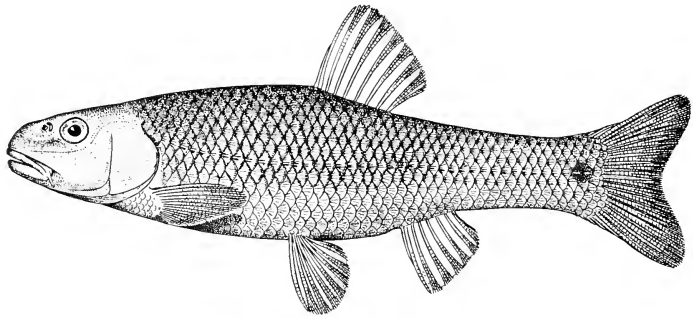
Head 4; depth 5; eye large, 3 in head. Scales 5-36 (32 to 38)-4; teeth 4-4. Body moderately stout, little compressed; head rather broad, with rounded angles; mouth small, inferior, horizontal; snout very obtuse; 15 rows of scales in front of dorsal; dorsal low, its longest ray ¾ head.

Back greenish-olive, scales dusted, darkest on edges, resulting in cross-hatching; a dark blotch on back in front of dorsal; median line on back behind dorsal fin black, not reaching caudal fin; top of head darkish; side usually pale, silvery, a faint line of dark specks along middle of side, with a series of larger black specks along lateral line; under parts pale; an indistinct dark spot usually present at base of caudal fin; fins all plain. Length 2 to 3 inches. Of 161 examples measured the longest was 2.63, the shortest 1.25 inches and the average 1.7 inches in total length.

25. SPOT-TAIL MINNOW

NOTROPIS HUDSONIUS (DeWitt Clinton)

The Spot-tail Minnow is a species of wide distribution. It is found from Vermont westward to the Dakotas and southward to the Carolinas. It is abundant throughout the Great Lakes region and is not rare in certain waters east of the Alleghenies. In Lake Ontario it is particularly abundant. It probably occurs in all the interior lakes of New York draining into Lake Ontario and is very abundant in Lake Chautauqua. In Bass Lake and some others of the small northern Indiana lakes it is quite common. At Lake Maxinkuckee, however, it appears to be rare. The only record of its occurrence there is that of a few specimens seined September 20, 1899.



Spot-tailed Minnow (*Notropis hudsonius*)

Like most species of wide distribution this minnow has many vernacular names, among those in most general use being Shiner, Spot-tail minnow, Spawneater and Hudsonian minnow. In Chautauqua Lake it is called Cisco. How this name of a species of whitefish ever got transferred to this little minnow is not easy to understand.

The Shiner reaches a length of 3 to 6 inches and is an attractive little fish. As a bait-minnow it is highly esteemed. On Lake Ontario and the St. Lawrence River it is regarded as the best live bait for bass. At Chautauqua Lake large examples are popular muskallunge bait. In northern Indiana it is a good general purpose bait minnow, although not abundant enough in many places to be well known. The smaller ones are excellent for yellow perch, those of medium size are good for bass, and the larger ones for walleyed pike and pickerel. Its bright silvery color makes it an

attractive bait, and it is active and vigorous on the hook, swimming clear of vegetation and at a good distance above the bottom if used in deep water. It is not the most hardy of minnows; its scales rub off rather easily, thus giving a chance for attacks by the fungus Saprolegnia in the live-box. But in the minnow bucket or on the hook it lives fairly well and is, withal, a pretty satisfactory bait minnow.

It may usually be readily known from the following description, the black caudal spot being the most distinctive character mark:

Head 4.75 in body; depth 4; eye 3 in head; D. 8; A. 8; scales 5-39-4; teeth, 1, 4-4, 0 or 1, or 2. Body elongate, considerably compressed in the adult; head quite short, muzzle blunt, decurved, shorter than the very large eye; mouth moderate, nearly horizontal, the jaws nearly equal, the maxillary reaching nearly to the eye; lateral line nearly straight, slightly decurved anteriorly; 18 scales before dorsal; pectoral not reaching ventrals, the latter not to vent. Coloration very pale, with usually a dusky or black spot at base of caudal, especially in the young; side with a broad, silvery band, which is sometimes dusky. Length 4 to 6 inches.

26. SILVER-FIN

NOTROPIS WHIPPLII (Girard)

This handsome minnow is generally common in clear streams from central New York to Minnesota, northern Alabama and Arkansas, and is very abundant in the Ohio Valley. It is a stream fish and not at all abundant in the lake, only about 41 specimens having been secured. These were obtained along the east side of Long Point from July 17 to 20, and on August 23, 1899, and a few more were seined in front of the Fish Commission station on the evening of Sept. 20.

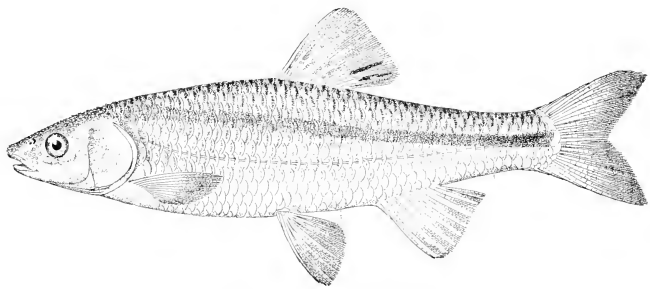
It is preferably, a fish of the larger, clearer creeks and rivers, delighting in the rush and swirl of the waters on the riffles where it feeds on the insect larvæ, small crustaceans and other small life among the stones or adhering to the Potamogetons and other aquatic plants which grow in such places. It is a trim, active minnow, and one of the most handsome of the family. Like most other minnows used as bait it has several common names; shiner, blueback, flat minnow, silver-fin, and hornyhead being among those most often heard, the last being applied to breeding males.

This species evidently spawns in the lake toward the end of July; of those obtained July 18, many were full of spawn and ripe; of 2 females examined, one contained 686 eggs, .03 of an

inch in diameter, and another contained 745 eggs which ran 30 to the inch.

As a bait minnow the Silver-fin is not without value. It is very active when on the hook; and this, with its bright silvery coloration, should make it attractive to black bass. It is hardy and lives well in the live-box, minnow bucket, and on the hook. The smaller ones are good bait for perch and rock bass, the largest ones for walleyed pike.

Head $4\frac{1}{4}$ in body; depth 4 in adult males; females and young more slender, $4\frac{1}{4}$ to 5; eye small, $4\frac{1}{5}$ to $4\frac{1}{2}$ in head; snout 3 to $3\frac{1}{5}$; maxillary $3\frac{1}{2}$ to $3\frac{4}{5}$; mandible $3\frac{1}{2}$ to 4; D. 8; A. 8 or 9; scales 5-38 to 40-3; teeth 1, 4-4, 1, the edges more or less distinctly serrate. Body moderately elongate, somewhat compressed, the dorsal and ventral outlines regularly and gently arched; head rather long,



Silver-fin (*Notropis whipplii*)

triangular, the snout pointed; mouth rather small, quite oblique, the lower jaw received within the upper when the mouth is closed; maxillary not reaching orbit; eye small, in axis of body; caudal peduncle rather long and compressed. Fins moderate, origin of dorsal midway between tip of snout and base of caudal and over base of ventrals; origin of anal posterior to base of last dorsal ray; free edge of dorsal straight, the longest rays 1.2 in head; free edge of anal somewhat concave in the depressed fin, more nearly straight when the fin is expanded, the longest ray 1.25 in head; pectoral slender, slightly falcate, 1.3 in head; ventrals short, barely reaching anal, 1.4 in head; caudal broadly forked, the notch rounded, the lobes equal, 1 in head; scales firm, closely imbricated, much deeper than long, not crowded anteriorly; top of head of male in breeding season covered with prominent tubercles.

Color of male leaden silvery, brightest and with bluish luster on middle of side; back darker, inclining to olivaceous; underparts

silvery; cheek and opercles silvery, with faint brownish dustings; caudal peduncle with an ill-defined plumbeous spot posteriorly; dorsal fin dusky anteriorly, the rays white; last 3 interradial membranes satiny-black, especially that between last 2 rays but one; caudal pale, dusky on edges; anal and ventrals satiny-white; pectoral pale, with faint lemon wash in richly colored males; female less brilliant than the male, the side more plumbeous. Length of specimens described 3 to 4 inches.

The Silver-fin can be readily distinguished from any other minnow of the lake by the elongate dark spot on the posterior part of the dorsal fin.

27. SHINER

NOTROPIS CORNUTUS (Mitchill)

(Plate 16)

The Shiner or Red-fin is distributed through the entire region east of the Rocky Mountains, excepting the South Atlantic States and Texas, and is almost everywhere the most abundant fish in small streams.

Although usually a creek fish it is not uncommon in Lake Maxinkuckee; during the seining operations, 688 specimens were secured. The greatest number obtained in one haul was 208. It was frequently seen during the spring of 1901, usually in the Outlet under the wagon or railroad bridge or between them. On April 19, 1901, a fisherman, fishing from the pier by the Ice-houses, caught an 8-inch example. On September 30, 1907, on a trip down the Outlet, good schools of these fish, some of large size, were seen.

The Shiner is one of the handsomest and best known of the minnows. It reaches a length of 8 to 10 inches and, with the exception of the species of Semotilus and Hybopsis, is one of the largest species in the Eastern States. While it prefers the smaller streams it may also be found in lakes and rivers as well. In small brooks and in quiet places in creeks and rivers the young may be found in myriads. The adults are vigorous, active fish frequenting the rapids and swifter parts of the streams.

This fish takes the worm-baited hook with avidity and is the minnow most frequently seen on the small boy's string. The large individuals possess considerable game qualities often agreeable to boys of larger growth. Although attaining some size and sometimes used as food, it is not of much value for that purpose, as the flesh is soft and spoils very soon after death; hence the name Rot-gut or Rot-gut minnow often heard applied to it in southern Ohio, Indiana and southward.

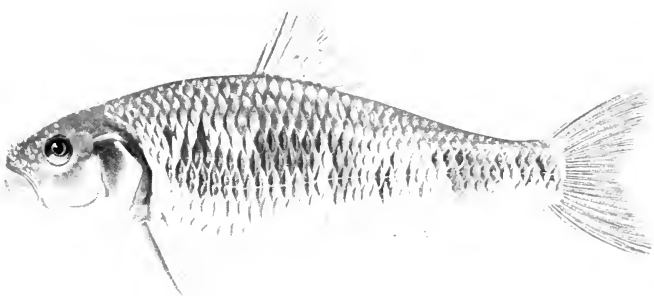
As a bait minnow, the Shiner is one of the best and most popular. At Maxinkuckee it is one of the species most often used. Owing to its general distribution and abundance in northern Indiana it is easy to obtain examples of any desired size up to 6 or 7 inches, for which reason this species is used for all sorts of bait fishing at the lake. Those 3 to 5 inches long are regarded as among the very best lures for large-mouth black bass, and those 2 to 2½ inches long for yellow perch and crappie. It is a fine trolling minnow when the water is not too warm; when the water is above 70° they are apt to suffer and die too readily.

Head 4¼ in body; depth 3¼, varying much with age; eye 4 to 5; D. 8; A. 9; scales 6-41-3; teeth 2, 4-4, 2, with rather narrow grinding surface. Body elongate in the young, in the adult short, compressed, with the anterior dorsal region much swollen and gibbous; head rather heavy, compressed, rounded between the eyes, the snout bluntish; mouth moderate, nearly horizontal, the jaws nearly equal, the lower somewhat included; eye moderate; maxillary scarcely reaching front of eye, the premaxillaries below the level of the eye. Scales always deeper than long on the sides, becoming extremely deep in the adult; lateral line decurved. Dorsal moderate, inserted directly over ventrals in young, thrown somewhat backward in adult by the growth of the nuchal region; pectorals barely or not reaching ventrals, the latter about to vent; region in front of dorsal typically with about 23 scales, the number ranging from 15 to 40. Coloration, dark steel blue above, the scales with dusky edges, the bases also dusky; a gilt line along the back and one along each side, these distinct only when the fish is in the water; belly and lower part of the sides silvery, bright rosy in spring males; dorsal fin somewhat dusky; other fins plain; the lower fins all rosy in spring males; head dark above; a dark shade behind scapula; lower jaw and region in front of dorsal to tip of snout covered with small tubercles in spring males; female and young fishes are plain olivaceous above and silvery below.

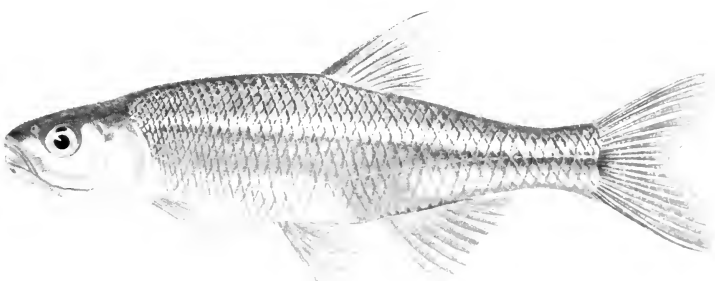
28. RED-NOSED MINNOW

NOTROPIS RUBRIFRONS (Cope)

This dainty little minnow is a common species from Vermont and western Pennsylvania to Michigan, Kansas, and Kentucky. It is by preference an inhabitant of the larger, clearer streams, though it is also found in small rivers and creeks. It delights to dwell on the riffles and in the swifter water. Sometimes it is found in large schools swimming near the surface in the deeper,



COMMON SHINER, *Notropis cornutus* (Mitchill)



BLACKFIN, *Notropis umbratilis atripes* (Jordan)

quiet pools or in still eddies near shore. At such times it can be caught in great numbers in the minnow seine.

At Lake Maxinkuckee it is apparently a very rare species. Our collections contain but a single specimen; this is a good typical example $2\frac{3}{4}$ inches long, obtained in Aubeenaubee Creek, near its mouth, April 27, 1901. The fact that only this one specimen was obtained suggests that the species is not really native to the lake and that the example caught was a bait minnow escaped from some live-bait bucket.

The Red-nosed Minnow attains a length of 2 to 2.5 inches, scarcely large enough to be used much as a bait minnow, although it is not infrequently seen in the angler's minnow pail. Its bright silvery color and its activity make up in a measure for what it lacks in size. For yellow perch and the smaller bass it is a very satisfactory live bait, and several on one hook have proved attractive to the walleyed pike.

Head 4 in length; depth 6; eye 4.7 in head; snout 3.1; dorsal 9; anal 10; scales 7-47-4, teeth 2, 4-4, 2. Body long and slender, considerably compressed; dorsal and ventral outlines but slightly arched; head rather long, snout pointed; mouth moderate, somewhat oblique, the maxillary reaching vertical at front of orbit, the lower jaw projecting; scales firm; lateral line complete, somewhat decurved.

Color, pale lemon above, the edges of the scales with fine dark punctulations; side bright silvery, somewhat metallic blue above; sides of head silvery, more red in breeding season; under parts straw-yellow.

29. RED-FIN

NOTROPIS UMBRATILIS (Girard)

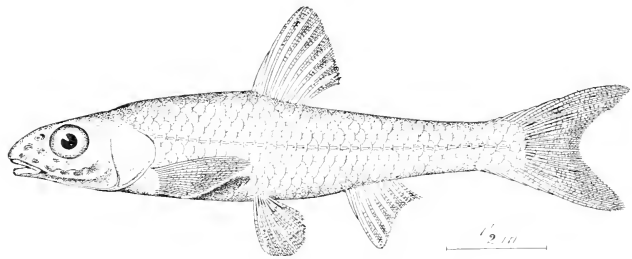
(Plate 16)

This is an exceedingly variable minnow, widespread in distribution, its range extending from Minnesota to western New York, North Carolina, Alabama and Texas. It is represented in different regions by well marked subspecies and is usually abundant in small clear streams. It is not common in the lake, only 22 specimens having been secured, 12 in Aubeenaubee Bay and 10 just east of the Culver Military Academy pier on July 21, 1899.

Head $4\frac{1}{4}$ in body; depth 4 to $4\frac{1}{2}$; eye 3 to 4 in head; D. 7; A. 11; scales 9-40 to 52-3; teeth 2, 4-4, 2. Body compressed; the caudal peduncle long; head long, conic, rather pointed; mouth large, moderately oblique, the premaxillary on level of pupil, the maxillary extending to opposite eye; lower jaw somewhat projecting; eye

moderate, about equal to muzzle; scales closely imbricated, crowded anteriorly, about 30 before dorsal. Dorsal fin high, inserted about midway between ventrals and anal; pectorals not reaching ventrals, the latter to vent; caudal fin long. Coloration, dark steel blue above, pale or silvery below; a more or less evident black spot at base of dorsal in front; the fins otherwise all plain; males with the anterior dorsal region and the head profusely covered with small whitish tubercles, the belly and lower fins being of a bright brick red in the spring; females very pale olive, sometimes almost colorless. Length 3½ inches.

The subspecies represented in the lake is *lythrurus*, which has the body moderately elongate, the depth 4¼ in length, the females nearly 5; eye large, about 3½ in head; scales 9-47-3; dorsal with a conspicuous black spot in front, rest of the fin mostly pale; no anal spot.



Cavern-jawed Minnow (*Ericymba buccata*)

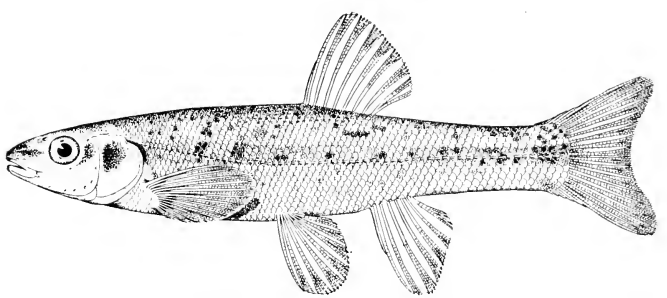
30. CAVERN-JAWED MINNOW

ERICYMBA BUCCATA Cope

This interesting little minnow, which appears never to have received any distinctive vernacular name, is found from Pennsylvania westward to Michigan and Kansas and south to Florida. In some streams, notably in central Indiana, it is abundant. It is a stream fish, rarely, if ever, occurring in lakes. We have not found it in Lake Maxinkuckee proper, but we have one specimen taken by us September 11, 1906, in the outlet below Lost Lake near the site of the old mill. It is known to occur in the Tippecanoe River at Delong. We have also found it in the minnow buckets of anglers at the lake.

It may be readily known from any other minnow of the United States by the cavernous structure of the head which shows particularly in the lower jaw which appears to be made up of a series of rectangular cavities or compartments.

Head 4; depth 5; eye large, 1 in head; dorsal 8; anal 8; scales 5-33-3; teeth 1, 4-4, 0. Body fusiform, rather elongate, little compressed, the back not elevated; head rather long, somewhat depressed above, with broad and prominent muzzle; mouth rather small, horizontal, subinferior, the lower jaw considerably shorter than upper; upper lip below level of pupil; maxillary not reaching to eye; dentary bones dilated, the mucous channels conspicuous; suborbital very broad, silvery, with an elevated longitudinal ridge and conspicuous cross lines; opercle small; fins small, dorsal over ventrals; scales moderate; lateral line nearly straight; breast scaleless; 15 large scales before dorsal. Color olivaceous, rather pale; sides bright silvery with bluish reflections; a dark dorsal streak, conspicuous posteriorly; fins plain; males without tubercles or bright colors. Length 3 to 5 inches.



Black-nosed Dace (*Rhinichthys atronasus*)

31. BLACK-NOSED DACE

RHINICHTHYS ATRONASUS (Mitchill)

The Black-nosed Dace is a very abundant fish in clear brooks and mountain streams from New England to Minnesota, northern Alabama and Virginia. It is extremely variable in different parts of its range.

It is not common about Lake Maxinkuckee; no specimens were taken in the lake itself, and only 19 in all were taken in the region. Of these, one was taken in Aubeenaubee Creek and the remaining 18 in Culver Inlet.

As a bait minnow this species possesses some value, particularly for bass and walleyed pike. It is unusually hardy and lives well on the hook as well as in the minnow bucket and live-box. It is also extremely vigorous and active. Its dull colors, however, render it less attractive than it otherwise would be.

Head 4 in body; depth 4½; eye 1½ in snout, 4½ in head. D. 7; A. 7; lateral line 64; teeth 2, 4-4, 2. Body moderately elongate, little compressed; head moderate, rather broad and flattish above; snout moderate; mouth small, horizontal, sub-terminal, the lower jaw included; barbel minute but probably always present; upper lip on level of lower part of pupil, maxillary not reaching nearly to eye, eye small, nearly median; fins rather small; dorsal fin well back, its insertion about midway between nostril and base of caudal; scales quite small, somewhat embedded. Color, blackish above, some of the scales irregularly darker; a black band passing from snout through eye and along side of body; a paler streak below this; belly silvery; males in spring with the lateral band and the lower fins and sometimes the whole body, bright crimson; males in late summer with the lateral band scarlet or orange, the red color growing faint later in the season. Length 3 inches.

The specimens obtained varied in length from 1.06 to 2.55 inches. They differ in several respects both from the description of the typical species and from the subspecies *lunatus*, in the range of which the Lake Maxinkuckee region is included. The head varies from 3¾ to 4, the depth from 4½ to 5, eye from 3½ to 4, usually 4, snout from 3 to 3½, usually 3, scales 10 or 11 above lateral line, from 60 to 67, usually 60, in lateral line, usually 7 below. One example had scales over only ½ of the body. In all examples except one, the dorsal had 8 rays instead of 7.

32. RIVER CHUB

HYBOPSIS KENTUCKIENSIS (Rafinesque)

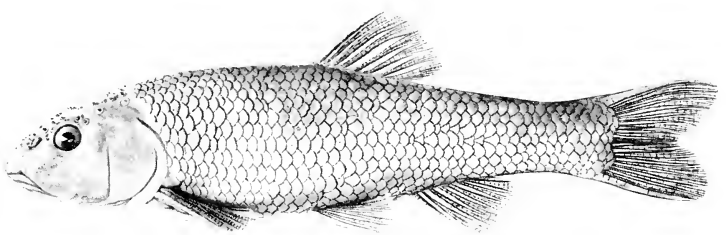
The River Chub is a species of wide distribution; from New England and Pennsylvania its range extends westward to Wyoming and southward on both sides of the Alleghenies to Alabama. It is nearly everywhere abundant in the larger streams, but it does not by preference so often frequent smaller streams or lakes. Like all other familiar species of wide distribution it is favored with many common names, among which may be mentioned hornyhead, jerker, river chub, common chub, horned chub, Indian chub, and red-tail chub.

At Lake Maxinkuckee where the streams are all small, the river chub is not common. The only specimens (3 in number) obtained by us were seined in Aubeenaubee Creek. They range in length from 3.25 to 6 inches.

Like all other members of the family the Hornyhead spawns in

the spring,—in northern Indiana in May and June. It builds a considerable nest of relatively fine gravel, usually on a gravel bar where the water is comparatively swift.

The food of the River Chub consists chiefly of worms, insect larvæ, small crustaceans, and small fishes. As a game fish it is of some importance, especially to the small boy with whom all is fish that comes to his net. It attains a length of 9 or 10 inches, a size which appeals to the young angler who, with worm-baited hook, is usually quite sure to meet with gratifying success with this fish. It takes the hook greedily and fights vigorously and with the proper spirit. It is never known to give up and sulk as some fishes do but always continues the fight to the last.



River Chub (*Hybopsis kentuckiensis*)

As a bait minnow, the River Chub is one of the best known and most highly esteemed. It is *par excellence* the bait minnow for all kinds of American freshwater game fishes. Hornyheads of small size, say 2 to 3 inches in length, can not be excelled for crappie, calico bass, rock bass and medium-sized large-mouth and small-mouth bass. Those of somewhat larger size can not be surpassed for the larger bass and wall-eyed pike; while for him who desires to capture large pickerel, great northern pike, or the wily muskallunge, an 8 or 10 inch River Chub is just the lure to use.

The Hornyhead is unusually tenacious of life, and when on the hook is exceedingly active, fighting with a vigor, viciousness and persistency which justly entitle it to rank with the game fishes.

An expert angler, speaking of this minnow, says it is especially fine for trolling. The best sizes for Maxinkuckee are those from 2 to 4 inches long. It is tough and wily and will endure much punishment in the water. Its good qualities are its toughness and activity on the hook. It is a fine bait for wall-eyed pike and both species of black bass. A dozen river chubs of assorted sizes are worth double that number of any other species.

Another feature which particularly commends this minnow in the upper Mississippi Valley is the ease with which a supply can be captured. Not only can they be secured in the usual way with the minnow seine, but they also readily enter the minnow trap, and in the absence of other means, a sufficient supply can often be taken by means of a small hook baited with grub or angleworm.

Head 4 in length; depth 4½; D. 8; A. 7; scales 6-41-4; teeth 1, 4-4, 1, or 1, 4-4, 0, sometimes 4-4. Body rather robust, little elevated, not much compressed; head large, rather broadly rounded above; the snout conical, bluntish; mouth rather large, subterminal, little oblique, the lower jaw somewhat the shorter; upper lip rather below level of eye; maxillary not reaching to front of eye, eye small, median, high up; barbel well developed; suborbitals very narrow; preorbital large; fins moderate; the dorsal rather posterior, slightly behind insertion of ventrals; caudal broad, little forked. Scales large, not crowded anteriorly, 18 rows in front of dorsal. Lateral line somewhat decurved. Color, bluish-olive; sides with bright green and coppery reflections; a curved dusky bar behind opercle; scales above with dark borders; belly pale, but not silvery, rosy in spring males; fins all pale orange, without black spot; males in spring with a crimson spot on each side of head; adults with the top of the head swollen, forming a sort of crest, which is sometimes a third of an inch higher than level of the neck and is covered with large tubercles; young with a dark caudal spot. Length 6 to 9 inches.

33. COMMON EEL

ANGUILLA ROSTRATA Le Sueur

The Common Eel is an abundant and well-known fish all along our Atlantic coast from Maine to Mexico. From the ocean it ascends all rivers south of Canada and east of the Rocky Mountains, and is resident throughout the Mississippi Valley. It does not appear to be common in Indiana and is not well known to Indiana anglers generally. At Lake Maxinkuckee it seems to be rather uncommon, although it is occasionally caught on set-lines at night, especially during the spring. Only a few examples were actually seen. On August 19, 1899, Mr. Thomas Large found floating far out in the lake an Eel 43 inches long and weighing 6½ pounds. On May 15, 1901, one 22 inches long was caught on a set-line in Outlet Bay, during the night. Besides these, reports were heard of several having been caught about the same time. About the last of June, 1907, Mr. S. S. Chadwick got a very large Eel at his pier.

He saw it under his pier 2 or 3 different mornings, then shot it. It had been crippled some way and had a wound on the belly 3 or 4 inches long. The fish was at least 40 inches in length. There seemed to be a general impression about the lake that they were rather common and could be obtained in numbers by any one who took trouble to fish for them, but the logic by which this conclusion was reached ("there must be a good many eels in the lake, because nobody has ever taken many out") is not particularly convincing. No eels were ever seen in the Outlet, although it was watched pretty closely for migratory fishes. Lampreys were occasionally taken in the Outlet by fishers with minnow seines and were usually thought to be young eels. The eelskin is in good local repute as a remedy for rheumatism and sprains, the dried skin being placed over the affected parts as a bandage.

Common Eel (*Anguilla rostrata*)

Nothing was observed at the lake concerning the habits of the Eel. They are said to be carnivorous and voracious and very fond of crawfishes. Specimens kept in the aquariums at the Bureau of Fisheries are affected by fish lice more than any other fishes except the toad fishes.

The Eel can be distinguished at once from the lamprey by the presence of jaws and fins, the single gill-opening and embedded scales. It could not be confounded with any other species of fish in the lake.

Body elongate, compressed behind, covered with embedded scales which are linear in form and placed obliquely, some at right angles to others; lateral line well developed; head long, conical, moderately pointed; the rather small eye well forward and over the angle of the mouth; teeth small, subequal, in bands on each jaw and a long patch on the vomer; tongue free at tip; lips rather full, with a free margin behind, attached by a frenum in front; lower jaw projecting; gill-openings rather small, slit-like, about as wide

as base of pectoral and partly below them; nostrils superior, well separated, the anterior with a slight tube; vent close in front of anal; dorsal inserted at some distance from the head, confluent with the anal around the tail; pectoral well developed; distance from front of dorsal to vent 1.16 to 2 in head; pectoral 2.83 to 3.4 in head; head 2 to 2.5 in trunk. Form rather robust. Brown, nearly plain, often tinged with yellowish; paler below, the color extremely variable. Length 4 or 5 feet.

34. MUD MINNOW

UMBRA LIMI (Kirtland)

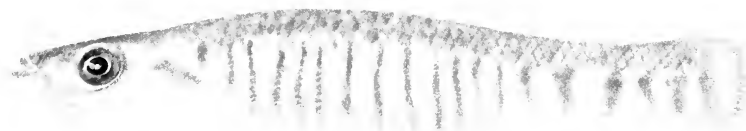
(Plate 17)

The Mud Minnow is a common fish from Quebec to Minnesota and southward to the Ohio valley; it is especially abundant northward throughout the Great Lakes region in weedy streams and ditches and in the smaller muddy lakes. At Lake Maxinkuckee it is fairly abundant in Norris Inlet, Aubeenaubee Creek, Culver Inlet, in the Outlet above Lost Lake, and in the small ponds in Green's marsh. Specimens were also secured in Lost Lake and its outlet. It delights to dwell in small creeks, ditches or ponds where the water is cool, the bottom muddy and aquatic vegetation abundant. There were a good many in a ditch two miles or so west of the lake. Mud minnows were frequently seen under the clear ice in the Inlet and in the ponds in Green's marsh, and they were quite active during the winter.

Professor Baird says of this species that "A locality which, with the water perfectly clear will appear destitute of fish, will perhaps yield a number of mudfish on stirring up the mud at the bottom and drawing a seine through it. Ditches in the prairies of Wisconsin or mere bog-holes, apparently affording lodgment to nothing beyond tadpoles may thus be found filled with Umbras." The same remarks apply equally well to such places in northern Indiana. The little streams, ponds and ditches everywhere are apt to have the Mud Minnow as one of their inhabitants. The abandoned Wabash and Erie Canal is a favorite place for this fish, and old mill-races that have grown full of Myriophyllum, Ceratophyllum and other aquatic plants are sure to be the home of this species.

One of the writers recalls many visits to the old Dillen mill-race and the cold, boggy Armstrong pond near Camden, Indiana, many years ago, when he had his first experiences with this curious fish. The race was literally filled with ditch moss (*Philotria*

MUD MINNOW, *Umbra limi* (Kirtland)



GRAYBACK MINNOW, *Fundulus diaphanus menona* (Jordan & Copeland); male

canadensis) and any mass of this vegetation that might be raked out was sure to contain one or more mud minnows. They were also common in and about the Armstrong pond; they sometimes would be found in the mud at the bottom of cow tracks some distance from water.

These are oviparous fishes, the sexes similar, small in size, carnivorous in their habits, feeding upon small crustaceans, insect larvæ and the like. One specimen examined contained an Asellus, and they are also said to feed to a large extent on the minute duckweed, Wolffia. They are extremely tenacious of life and will live a long time in the mud in the bottom of a pool which has entirely dried up. When dug out of the mud and placed in water they usually seem normally vigorous and active. They can be kept indefinitely in minnow buckets or old rain barrels without change of water.

They are frequently used by anglers as bait for pickerel and wall-eyed pike, but they are chiefly valuable on account of their great tenacity of life. Anglers who have tried this bait at Lake Maxinkuckee, however, have not found them a very killing lure.

The Mud Minnow is familiar to almost everyone who ever goes seining for minnows; but, as it bears a superficial resemblance to the dogfish, *Amia calva*, the young of which are rarely seen, they are usually supposed to be young dogfish. The interesting remarks by Charles Halleck regarding the young of the dogfish as bait doubtless refer to the Mud Minnow.

Various anglers at Lake Maxinkuckee to whom specimens of the Mud Minnow were shown pronounced them young dogfish. The two species are not at all related, however, and may be easily distinguished by the much larger dorsal fin of the dogfish, in which there are about 48 rays while in the Mud Minnow there are but 15 dorsal rays.

Specimens of Mud Minnow examined on April 9, appeared to be nearly ripe, and they probably spawn about the middle of April. The eggs are 1/20 of an inch in diameter and varied from about 425 to 450 per individual.

Head 3.5 to 3.75 in length; depth 4.5 to 4.75; eye 5.5 to 6 in head; snout 4.5 to 5; dorsal 15; anal 10; pectoral 14; ventral 6; scales about 37,-13; branchiostegals 6. Body oblong, somewhat compressed, covered with rather large, cycloid scales; head rather short, bluntly conic, little depressed; caudal peduncle deep, compressed; eye moderate, high up; mouth rather large, slightly oblique, lower jaw projecting, maxillary reaching vertical of anterior part of pupil; cheeks, opercles and top of head scaled; dor-

sal fin posterior in position; caudal rounded. Color, dark olive-green, mottled with darker and coppery or brassy blotches, and with about 12 irregular dark crossbars; a dark postocular spot and a large dark blotch on opercle; a broad dark band in front of eye; a broad black vertical bar on caudal peduncle at base of tail, and a narrow dark band on base of caudal rays; caudal beautifully marked with fine crossbars; under parts paler, sometimes rosy coppery. Length 3 to 5 inches.

Almost all of the specimens obtained at Lake Maxinkuckee were considerably undersized, ranging in length from 1¼ to 3.55 inches, only 12 in the 84 individuals examined being 3 inches or over in length. The numbers representing the proportions are smaller throughout, the head being usually 3⅓ in length; depth ranging from 4¼ to 5, usually about 4⅓; eye 3⅔ to 5½, frequently 4; snout 3⅓ to 5, usually a little over 4; it will thus be observed that the Maxinkuckee specimens have a somewhat larger head, greater depth, larger eye and longer snout than is given in current descriptions.

35. GRASS PIKE

ESOX VERMICULATUS Le Sueur

(Plate 5)

The Grass Pike occurs abundantly throughout the middle and upper Mississippi Valley and in streams tributary to Lakes Erie and Michigan. It is not known from east of the Alleghenies nor from Texas. Throughout most of its range it is generally common in all ponds, bayous and small sluggish streams in which there is much aquatic vegetation.

At Lake Maxinkuckee only 86 specimens were secured during the seining operations, and the greatest number taken in one haul was 17. It is, however, quite a common fish, and it is probable that the alacrity with which this fish gets out of the way at the first sign of danger accounts for the small number taken. It is frequently found basking near shore in shallow weedy places. In late autumn they bask in considerable numbers in the neighborhood of the Outlet. During the latter part of October and the first part of November, 1904, considerable numbers of these fishes were seen close to the Outlet. On October 28, about 10 were seen, and two days after about 40 or 50 were seen at the same place at noon. They were also seen in late autumn on various occasions basking in the region of the Inlet and along the bayous of the Outlet. When basking they usually lie perfectly still, and look so much like a stick that they are not seen until an arrowy streak

in the water marks where they have dashed from shore. They were occasionally seen under the clear ice. In December, 1904, they were observed hiding under the ice-fringes along the edge of the Outlet. A good many of them about the same time went into the lagoons in Green's marsh and some froze there. On one occasion about a dozen dead ones were seen at that place. As soon as the ice melts in spring and the melting snows and early rains raise the waters over the flats and fill the little rills, the grass pikes may be seen pushing their way out into even the shallowest places. The tiniest rill that runs into the lake is ascended to its very source, and it is surprising how far they will manage to wiggle up some tiny thread of a brook. They scatter out over the flats and bayous, and are common in the ditches. In 1901 the spring run began about April 1, and they were frequently seen in shallow lagoons and ponds in Green's marsh until April 30. Even earlier in the spring before the ice has gone off, they may be seen through the ice in the shallow water of the bayous and along the lake shore. And a little later, when open places in the ice begin to appear, Grass Pike may often be seen in such places and in open places in the ditches. One may sometimes kill them in such situations by striking them with a stick.

Ordinarily the Grass Pike is not sought by anglers; its small size and disinclination to take the baited hook preclude its becoming a game-fish of any importance. It will, however, take the hook and is sometimes seen on the small boy's string. The flesh is white, firm, flaky, and of delicious flavor.

Like other species of the genus, the Grass Pike is a voracious fish which preys largely on other fishes. An example six inches long contained a small straw bass.

Distomid parasites are often found in its stomach.

The spring invasion of the shallow, reed-covered places is for breeding purposes. A few fish were examined about April 4, and the eggs appeared to be nearly mature, about 15 to the inch, and one example caught contained about 1,896 eggs.

Head $3\frac{1}{4}$; depth 5 to 6; eye large, $2\frac{1}{2}$ in snout, about 6 in head. Branchiostegals 11 to 13; D. 11 or 12; A. 11 or 12; scales 105. Body moderately stout, somewhat compressed; head rather short, the eye being exactly in the middle of the head; middle of eye nearer tip of chin than to gill-opening; snout $2\frac{1}{5}$ in head; caudal well forked.

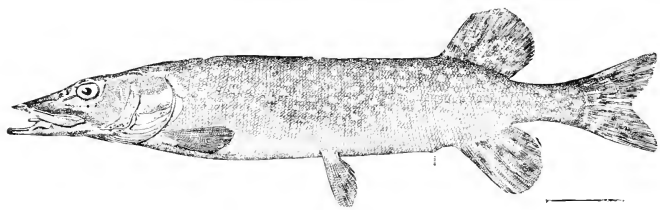
The following are life colors of a female example 10.5 inches long captured at Green's marsh, April 4, 1901: Back olivaceous, lighter along median line, bounded on each side by a series of ir-

regular darker spots; side olive green, mottled and blotched with darker, and with more or less brassy in thin close lines; opercle and cheek greenish, blotched with dark; a broad dark line downward from eye; upper part of head dark olivaceous, a narrow paler median stripe; under jaw pale, darker at tip; lower fins pale reddish; dorsal and caudal light olivaceous, tip of dorsal blackish, belly white.

36. COMMON PIKE

ESOX LUCIUS Linnæus

The Common Pike has a remarkably wide distribution. It is the only member of the family found outside of America, and is found in the fresh waters of the northern parts of Europe, Asia and North America north to Alaska and Siberia; in the eastern United States south to New York and the Ohio River; and in Europe south to Italy and Greece, and is generally abundant



Common Pike (*Esox lucius*)

throughout its range. It is not at all common in Lake Maxinkuckee. One was obtained some years ago 3 feet long and weighing 10½ pounds, and another was caught on July 20, 1900, which weighed 3¾ pounds. It appears to be rather common in waters not far distant from the lake. The largest of which we have any record was seen at Round Lake, 4 miles west of Bass Lake. It weighed 32 pounds and had died trying to swallow a large bass. One of the best streams of which we know for pike fishing is the Kankakee. In November, 1892, a fisherman caught one there weighing 26½ lbs. On August 4, 1906, one 40 inches long and weighing 16 lbs. was caught in the Yellow River, a branch of the Kankakee.

Head 3⅓; depth 5; eye 6⅓ in head, 3⅓ in snout; snout 2⅔ in head; branchiostegals 14 to 16; D. 16 or 17 (developed rays); scales 123. Body moderately elongate, the back little elevated; head rather long, the eye exactly midway in its length, middle of eye midway between tip of chin and gill-opening; cheeks entirely

scaly; lower half of opercles bare. General color bluish, or greenish gray, with many whitish or yellowish spots, which are usually smaller than the eye and arranged somewhat in rows; dorsal, anal and caudal fins with roundish or oblong black spots; young with the whitish spots coalescing, forming oblique crossbars; a white horizontal band bounding the naked part of the opercle; each scale with a grayish V-shaped speck. Length 4 feet.

37. GRAYBACK

FUNDULUS DIAPHANUS (Le Sueur)

(Plate 18)

Fundulus diaphanus is represented in Lake Maxinkuckee by the subspecies *menona*, the range of which extends from northern Ohio to Mississippi. It is a northern fish, not found far south of northern Illinois.

At Lake Maxinkuckee this is known as the Grayback or Greyback Minnow. It was formerly very abundant, frequently swimming in considerable schools near shore, especially in late autumn after the water had become chilled. They remained rather near shore the whole year round, but were not bunched up so much in schools during the summer as during the winter. In 1899 and 1900 these fishes were taken in considerable numbers in the seining operations, the total catch amounting to 1,197, and in the autumn of 1900 great schools were observed near shore. It was quite abundant during the spring and summer of 1901. Of late years they appear to be decreasing in numbers. In 1906 and 1907 they did not appear to be nearly so abundant as formerly. This is probably due to the fact that this is the most desirable fish in the lake for bait, and as it stays near shore, it falls an easy prey to people who seine for minnows. In looking over a haul, people usually pick up the graybacks first and sort them out quite thoroughly.

The Grayback is a handsome, somewhat chubby fish. Although not strikingly colored the silvery bars make it quite attractive, and it is this, combined with its hardiness, that makes it so valuable as a bait minnow. It will live under all sorts of conditions and endure much cold without injury.

On November 30, 1900, a number of fishes—small catfishes, straw-colored minnows, etc., were found in a small pool near Farrar's. The sand had washed up, cutting the pool off from the main lake, and it was frozen almost solid. Most of the fishes, especially the straw-colored minnows, were dead; among the fishes in the pool were 13 graybacks, all females which, on being thawed

out, revived and were lively as ever. The longest measured 2⅝ inches in length, and the shortest 1½ inches. In raking up weeds through the ice in winter, small graybacks were frequently brought up along with Iowa darters, mad toms and crawfishes.

The Grayback subsists chiefly on small animals; the stomach examined contained insect larvæ and some entomostraca. The stomach of another 2.1 inches long, examined July 3, contained several small snails, several small mites, 1 Bosmina and a few Cypris. It also contained several distomid parasites.

On June 24, 1901, a number of this species were observed at a boat landing north of Long Point and appeared to be mating. They were in pairs, and the male, the paler of the pair, kept swimming along below the other, see-sawing back and forth and rising until their noses touched. He followed her about like a shadow, leaving only to chase away other fishes that came near, but always returning to her. She occasionally dashed her nose at the base of some growing Chara obtaining a mouthful of material, working her mouth and allowing sand and pebbles to drop out. On June 27, one examined contained large roe. Some were observed spawning July 14, 1899. On July 22, 1906, some of these fishes appeared to be ripe, but had not yet spawned. On subjecting them to slight pressure masses of light yellow eggs oozed out.

Head 3⅗ in body; depth 5; eye 3½ in head; D. 12; A. 10; B. 5; scales 48-12. Body rather slender, not elevated, compressed posteriorly; head moderate, quite flat above, teeth pointed, curved, the outer not much enlarged; fins not large; dorsal and anal rather low; ventrals scarcely reaching vent in females, somewhat longer in the males. General color olivaceous, sides silvery; males with about 20 silvery vertical bars, narrower than the dark interspaces; female with 15 to 20 dark transverse bars shorter than the silvery bands of the male. Dark bands very distinct, somewhat irregular in position; the back always spotted; the dark bands often replaced by about 16 shining silvery, vertical bands, which are narrower than the dark interspaces; the interspaces broadest behind; fins plain. Length 3½ inches.

38. TOP-MINNOW

FUNDULUS DISPAR (Agassiz)

(Plate 18)

This little fish is to be found in lakes and sluggish streams from northern Ohio to Missouri and south to Mississippi. In many of the waters in this area it is not to be found; in others it is quite

Fundulus dispar (Agassiz), male

Fundulus dispar (Agassiz), female

abundant. It is rather common in Lost Lake and the Outlet, but none was found in Lake Maxinkuckee. During the seining operations of 1899-1900, 101 specimens were secured, the greatest number taken in one haul being 25.

This is a very prettily marked little fish, the fine stripes of the female, and the combination of bars and stripes on the male making the species one of the most handsome fishes of the lake. The contrast in markings of the different sexes is quite striking, and makes a pair of these fishes especially interesting; they hardly look like the same species.

The characteristic bars of the male seem to be assumed quite early in life, although this seems to differ considerably in different individuals; one specimen 1¼ inches long showed the bars quite plainly, while others 1¾ inches long showed them rather faintly. The shortest specimen obtained was about an inch long, and the longest 2¼ inches. These fishes prefer shallow waters, and usually swim about the surface two or three together, and not in great schools. The dark patches over the eyes of these fishes remind one somewhat of the markings on the head of the wood frog.

Head 3.75 in body; depth 3.5; D. 7; A. 9; scales 35-10; body short and deep, much compressed; head short and very broad, the flat interorbital space being ⅔ of its length, and barely twice the diameter of the eye; the distance between the eyes above greater than the distance between them below; snout broadly rounded; fins moderate; dorsal much smaller than anal; outer series of teeth somewhat enlarged. Coloration, pale olive, bluish in life; a very distinct brownish line along the edges of each row of scales, appearing wavy or serrate, as it follows the scales; about 10 of these longitudinal stripes present; males with the lines interrupted, appearing as a series of dots, and further marked by about 9 dark crossbars; adults with a black blotch below the eye, sometimes confluent with it. Oviduct free from anal. Length 2½ inches.

39. SPOTTED TOP-MINNOW

FUNDULUS NOTATUS (Rafinesque)

This pretty little fish is quite common in ponds and canals from Michigan to Alabama, Mississippi and Texas. It is usually seen swimming about, singly, in pairs or small schools, at the surface of the water. It does not appear to be common in Lake Maxinkuckee. The only specimen in the collection is an example 1½ inches long, caught in the Culver Academy lagoon, April 4, 1901. It is not rare in Lost Lake, however; individuals were often seen swimming

along on the surface in shallow water near shore. The Top-minnow is a tantalizing little fish; it looks like the easiest thing in the world to catch one by closing the hands together under it and gently lifting it out of the water as it swims unconcernedly along. It generally manages to escape somehow, and the experiment can be tried time and again on the same fish.

On July 23, 1906, a good many of these fishes exceedingly various in size, some quite small, some medium sized, and some full grown, were seen together in the shallow water among the weeds of Lost Lake. They had apparently spawned and hatched before this time. A good many of these fishes were seen in Bass Lake on August 14, 1906, and they were very abundant at Twin Lakes when visited August 31, 1906.

The Top-minnow can be recognized in the water by the translucent spot on the head, along with its habit of swimming about slowly at the surface.

Head 4; depth 4.5; eye large, less than snout, about 3 in head. D. 9; A. 11; scales 34-11. Body rather slender, compressed behind; head low, depressed, and rather elongate; the snout somewhat produced, the lower jaw scarcely projecting; interorbital space broad, its width about half length of head; fins moderate, the dorsal and anal elevated in the males; teeth in a broad band, the outer series considerably enlarged and canine like. Coloration, brownish olive, with a broad dark, purplish-black lateral band running from tip of snout through eye to base of caudal, darker in males than in females; young specimens have the edges of the band serrated; a few series of small black dots along the sides of the back; dorsal, caudal and anal fins dotted with black; top of head with a conspicuous translucent spot in life; concentric striæ on scales strong. Length 2 to $3\frac{1}{2}$ inches.

40. BROOK STICKLEBACK

EUCALIA INCONSTANS (Kirtland)

(Plate 17)

The Brook Stickleback is found in small creeks and lakes from New York westward to Kansas, northward to Saskatchewan, and southward to central Ohio and Illinois, the southernmost record being Decatur County, Indiana. It is abundant in the Great Lakes region.

At Lake Maxinkuckee it does not appear to be rare. Throughout the summer, however, they appear to stay in rather deep water in the lake. Only one specimen was taken in the net during the

seining operations. Specimens could almost always be obtained however, any time of year by dredging in rather deep water for them, in which case they would become entangled in the long water-weeds among which they appear to dwell. Specimens were obtained by dredging up Vallisneria at the Sugarloaf bar in water from 13 to 16 feet, and by dredging at the Kettlehole. The best place for them, however, was the Weedpatch, where by dredging up the long Nitella from a depth of 18 to 23 feet, specimens could almost always be brought up. They were raked up in weeds from the same region during the winter.

In the winter they appear to come near shore, and stay among the weeds in shallow water. During the winter of 1901 a good number of specimens were raked up in weeds near shore, both in Outlet Bay and in the Inlet region, along with Iowa darters, young bluegills, mad toms and the like.

During the autumn of 1900, some of these fishes were caught and kept in jars as aquarium fish. They lived throughout the winter and proved very interesting; they fed eagerly on the red Chironomus larvæ raked up in mud. They also fed on Cladocera and Copepods taken in the towing net, darting after them and swallowing them with great avidity. It was hoped they would nest and spawn in the jars used as aquariums, but with the appearance of warm weather they became restless and finally died (May 15), the water having evidently become too hot for them.

The Stickleback is carnivorous, subsisting mainly on small animals of the lake. A full grown example obtained June 27, 1901, contained insect larvæ and Entomostraca; a half-grown one captured the same time, contained Copepods. Of those examined in December, one 1.81 inches long containef a small beach flea, Cyclops, Daphnia, Bosmina and insect larvæ; one 1⅝ inches long contained Cyclops, Daphnia and beach fleas; one 1.69 inches long contained insect larvæ and Cladocera; one 1.94 inches long contained 2 beach fleas, some Ostracods, Cyclops, water fleas (Daphnia) and insect larvæ; another 1¾ inches long contained Cyclops, and another of the same length contained 1 Ostracod and 2 Daphnias.

This little fish with its elegant form, slender caudal peduncle, and handsome speckled coloration, is one of the prettiest fishes of the lake.

Notwithstanding the fact that the Stickleback is a very spiny object, it is sometimes eaten by other fishes. One was found in the stomach of a yellow perch in June, 1901, and in the summer of 1906 a small straw bass 1¾ inches long was found dead with a Stickleback lodged in its mouth.

Sticklebacks are occasionally found dead along shore. On May 22, 1901, sixteen examples were found dead drifted up in a pile of drift near Murray's. This was the largest number obtained at one time, and appeared to indicate either an epidemic or some crisis connected with the breeding season. One of the specimens of the lot was examined and contained a good number of medium-sized yellow eggs.

41. SKIPJACK

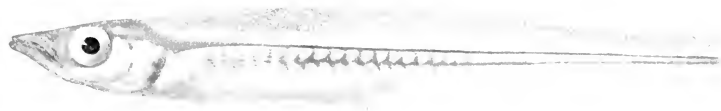
LABIDESTHES SICCULUS (Cope)

(Plate 19)

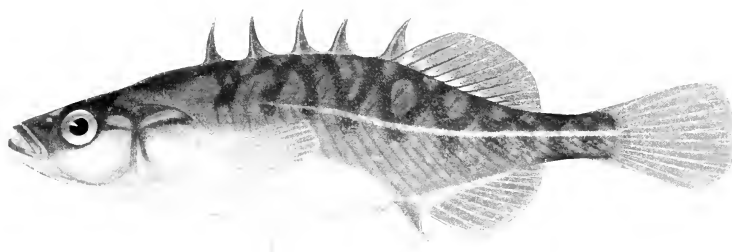
This graceful little fish is widely distributed in ponds and sluggish streams from Lake Ontario and southern Michigan to Iowa, Florida and Texas. At Lake Maxinkuckee it is, with the possible exception of the straw-colored minnow, the most abundant fish. During the summer these fish are pretty well distributed throughout the surface waters of the lake, where they can frequently be seen jumping out of the water in low horizontal curves, a whole school sometimes jumping at the same time and forming a very attractive spectacle. Usually they appear to be jumping to escape some enemy beneath, but sometimes seem to be jumping for mere sport. On July 31, 1899, a school of very small fry were seen at the surface near the buoy in 85 feet of water, and on September 21 several schools were seen far out in the lake.

During the seining operations, most of which were carried on during the summer when these fishes are not especially crowded near shore, great numbers were caught and thrown back without counting. Record was kept of 1,206 specimens captured, and on July 17 over 500 young were taken at one haul.

The skipjacks swim near the surface, and a few can be seen along shore almost any day the year round, and people seining for minnows during the summer usually get a few of these fishes every haul. With the coming of cold weather in autumn, especially after the water begins to get chilled, they come near shore first in the evenings, and their presence is manifested by a great deal of lisping. On September 10 and 11, 1906, much of this characteristic sound was heard near shore, and the towing-net was taken out on the pier and an attempt was made to collect the surface plankton found there at the time to discover if any particular abundance of plankton was related to the habits of these fishes. The gentle dipping of the net sounded somewhat like the lisping of the skipjacks, and they gathered around, apparently either to satisfy their curiosity as to the cause of the noise, or in



SKIPJACK, *Labidesthes sicculus* (Cope)



BROOK STICKLEBACK, *Eucalia inconstans* (Kirtland)

the hopes of finding better feeding grounds. A few were caught in the towing-net, and the stomachs found to contain Entomostraca. They also appeared to be attracted, or at least undisturbed, by the light of a lantern held close to the water. Single individuals would lie perfectly still poised in the water almost precisely like pickerel or the gar-pike, disappearing with a sudden dart, probably after prey. Later in the year they come up along shore in great numbers and remain there most of the day, sometimes alone, sometimes in company with various species of minnows, especially the straw-colored minnow, *Notropis blennius*. When they are with the straw-colored minnow, the latter usually form the lower layer of the school, while the skipjacks form the upper part near the surface. On November 11, 1900, in 2 hauls along shore with a 15-foot seine about 2 gallons of these fishes, most of which appeared to be adults, were taken, and they appeared to be equally numerous on various other occasions. When the fishes thus crowded along the shore, are approached, they will make for deeper water, heading in one direction, and swimming with rapid lateral flexions of the posterior part of the body. If suddenly frightened, however, they scatter in every direction. They appear to remain near shore all winter, as they can be seen in great schools under the clear ice during the winter, and are seen along shore in large numbers in spring. They are sometimes seen in considerable schools in the Outlet near the wagon or railroad bridge in the winter. They are often seen running in schools and jumping out of the water as if pursued by some enemy. On September 12, 1907, a black bass about a foot long was observed to come up nearly to the shore for them. In the winter of 1901 a grebe (*Podilymbus podiceps*) was seen swimming along under water near shore, and a number of small fishes, probably these, were seen jumping out of the water ahead. The Skipjack is perhaps the most persecuted fish in the lake, and it is a wonder how they keep up their numbers, feeding at the surface in large conspicuous schools as they do. They are attacked by the pike, bass, and other carnivorous fishes, as well as by the helldiver from below, and darted at by the terns, gulls and kingfishers and other birds of prey from above, so that they are somewhat in such desperate plight as the ancient Britons whom the barbarians drove down into the sea, and the sea threw back on land. They certainly serve a useful purpose in furnishing much food to fishes of the lake.

The stomach of a black tern examined August 14, 1900, contained 19 young of this species. They appear to escape the waterdog. During the winter, because of their activity, or the fact that

they stay near the surface, occasionally they, like other small fishes, fall victims to cold, as the water, on chilling, benumbs them somewhat, and rough water in Autumn is likely to wash some of them ashore.

The Skipjack probably spawns during the latter part of June and through July. On June 13, 1901, some were examined and found to contain eggs which were clear, of a yellowish cast, and about 1 27 inch in diameter. On the next day 3 or 4 were seen coming up the Outlet in arrowy dashes. They seemed to be mating, 2 pairs were seen swimming about together a good deal, and they chased each other considerably.

In the seining operations of 1899, frequent mention is made of getting many, mostly young, (they may have been young of the year before) about July 8 to 31. On July 20, 1906, a few of these fishes used for bait had not yet spawned; they were so ripe that the eggs extruded while placing them on the hook. Two days after this they were seen sporting about as if ready to mate.

No use is made of the Skipjack at the lake. Perch and red-eye will bite at them, but they die too easily to be used as bait for game fishes. It is quite probable that its flesh would prove to be well-flavored and firm, as many of its larger relatives, which are found usually near the coast in temperate and tropical seas, are famous for their excellence. Its small size, however, has prevented any attempt to use it for food. Of 200 examples measured, the longest (2) were 3.25 in. long. The shortest was 2.25 inches long, and the average 2.67. They are, moreover, quite slender fishes.

Their food consists chiefly of insects and Entomostraca. One caught September 9, 1906, contained Bosmina and Diaptomus; 2 captured September 10, mature insects and quite large masses of Bosmina; 2 others contained several mature insects, and several Daphnias. One contained a small parasitic round worm; 4 caught October 20, contained large insects and Copepods, and one examined June 26, contained insect larvæ. The Skipjack is also abundant in Lost Lake and in Culver Inlet. It is a particularly handsome fish in the water, the changeable colors glowing opal and enhanced by the transparency of the body.

Head $4\frac{1}{2}$; depth 6; eye $3\frac{1}{2}$; D. IV-1, 11; A. I, 23; scales 75. Body elongate, very slender, compressed; head long, flattened above, narrow below; snout slender, conic; premaxillaries broad posteriorly, very protractile, produced forward; snout longer than the large eye. Edge of upper jaws strongly concave; teeth very slender, mostly in one series, forming a narrow band in front; scales small, thin, with entire edges; spinous dorsal very small;

soft dorsal short; anal fin long; caudal forked; pectorals moderate; first dorsal inserted somewhat behind the vent. Pale olive green, translucent; lateral silvery band very distinct, scarcely broader than the pupil, bounded above by a dark line; back dotted with black. In the black waters of the lowland swamps, the silvery is underlaid with black. Length 3½ in.

42. CRAPPIE

POMOXIS ANNULARIS Rafinesque

(Plate 20)

The Crappie occurs throughout the Great Lakes region, west to Nebraska and Kansas and south throughout the lowlands of the Mississippi Valley to Texas. It is rather rare northward, but in the lower Mississippi basin and the coastal region of Texas, it is generally abundant. It prefers the sluggish waters of ponds, bayous, lagoons, and lowland streams. It attains a length of about a foot, and a pound in weight. Examples weighing 3 or 4 pounds have been reported in the south, but such weights must be very unusual. The examples of this species obtained in the north rarely weigh over three-quarters of a pound.

The true Crappie is very rare in Lake Maxinkuckee. During the summer and fall of 1899 when we were doing our most thorough collecting of the fishes of this lake, a few specimens of the Crappie were obtained. These were all young fish 1 to 3 years old and were seined in shallow water. No specimens were seen in 1900. A great many of the fish which the anglers call "crappie" were examined but they all proved to be the calico bass (*Pomoxis sparoides*). The 2 species are entirely distinct, though difficult to distinguish except by an examination of their technical characters. The most evident and most reliable differential character is found in the number of dorsal spines. The dorsal fin in the Crappie has 5 or 6 sharp spines, while the calico bass has 7 or 8. In the Crappie the anal fin is usually plain and the anterior profile is strongly curved, while in the calico bass the anal fin is strongly reticulated or marbled, and the anterior profile is more nearly straight. The calico bass is also a deeper fish than the Crappie, its depth being half its length, while that of the Crappie is only ⅔ its length.

Within the last 11 years the United States Fish Commission has planted in this lake 3,200 so-called "Crappie" but it is probable that the majority of these were really calico bass.[1] But as

[1] See p. 280.

they all came from the ponds along the lower Illinois River it is likely many of them were crappies.

In habits the Crappie does not differ greatly from the calico bass. It is more southern in its distribution, a fact doubtless determined largely by its ability to thrive in warmer water than the other species; and intimately associated with this is its apparent preference for shallow water and mud bottom, conditions nearly everywhere found in the overflow ponds, lagoons, lakes and bayous of the lower Mississippi Valley. Among the small lakes of northern Indiana, the Crappie is more numerous in the shallow, warmer ones (such as Bruce, Fletcher, Bass and Eagle) than in those of greater depth and colder water.

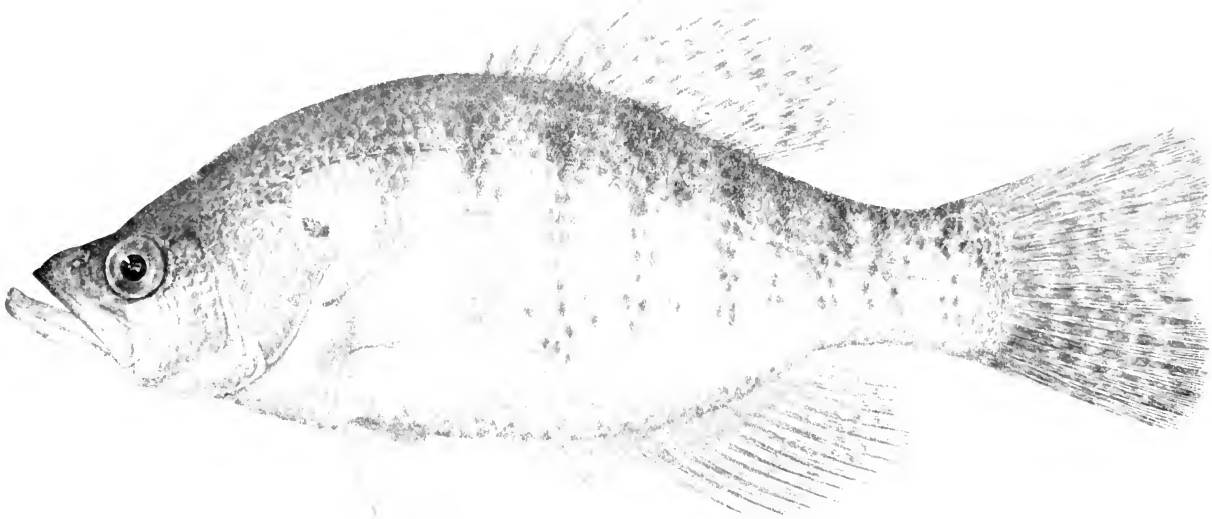
Very little seems to be known regarding the game or food qualities of this species as distinguished from those of the calico bass. Its habits being essentially the same, it probably does not differ greatly in other respects. Owing to the warmer water in which it is usually found it is apt to be somewhat less gamy and may not be as delicately flavored.

In different parts of its habitat it bears different vernacular names. In the Ohio Valley it is called Bachelor; in Illinois, Indiana, West Virginia and Kentucky it is the Newlight, Campbellite or Lamplighter,—names given to it by the irreverent during the great Campbellite movement in the Ohio Valley in the early part of the Nineteenth Century; in the Southern States it is called Sac-a'-lait and Chinquapin Perch. Other local names are Tin-mouth, Paper-mouth, Bridge Perch, Goggle-eye, Speckled Perch, Shad, and John Demon. Most of these names are also applied to the calico bass. The only place where we have heard the name "John Demon" was at a small lake in northeastern Indiana, and the species meant was more likely the calico bass than the Crappie.

Among the Louisiana anglers, especially about Lake Pontchartrain, the Crappie is a prime favorite, for it will take a minnow bait as promptly as a black bass. It is not very pugnacious, however, and will not fight as long as the bass, and it is more easily frightened, requiring greater caution on the part of the angler.

A correspondent of the American Angler[2] describes the fishing in Cedar Lake, Indiana. Angling is carried on from little flat-bottomed skiffs and from sail-boats, with bait minnows, worms or pieces of fish. In 5 hours 2 men caught 57 bass and 82 crappies. Trolling is a favorite mode of fishing among the people who live near the lake, who, using 2 lines with spoon bait or "whirl",

[2] American Angler, II, 87.



WHITE CRAPPIE, *Pomoxis annularis* (Rafinesque)

and fishing from a sail-boat, frequently take 200 or more Crappie in a day, besides occasional pickerel, perch, and bass. Two men fishing for pleasure, took, in June, 1882, in the course of 3 days, a thousand crappies, weighing from 4 to 24 ounces each. Of course any two men who can be satisfied to destroy fish in that way, and who find pleasure in it, are game hogs of the most conscienceless kind.

Another correspondent of the same journal writes entertainingly concerning Crappie fishing near St. Louis. "Our Crappie, the greatest pan-fish of the West, is highly esteemed by us for the table. We have seen a monster crappie this spring, weighing over 3 pounds, taken at Murdock Club Lake, near St. Louis, on the Illinois side. We consider one of 1½ to 2 pounds a large one. They are taken about logs and fallen tree-tops, on the water's edge, in our rivers and sloughs. They are greedy fellows, but as soon as hooked, step right into the boat without a struggle for liberty.

"A gentlemen of this place, a member of one of our old French families, who turned the scale at about 300 pounds, was noted for his success in crappie fishing. He would have his large flat towed to a tree; when tied to a limb, he would settle himself for the day, on a pillow, placed in a large split-bottom chair. Hauling his live-box and minnow-pail alongside, he would bait 2 hooks attached to a strong line, using a weak snell, so that in case the hook should foul, he could break it loose. He used a float and short, stout bamboo rod and, shaking the bushes a little, 'to stir up the fish', would select an opening and carefully drop in the minnow, 2 feet below the surface, pass the ends of the rods through rings in the side of the boat, light his pipe, and wait for something to happen. It was not long, and after the fun began, it was the same monotonous lifting out of fish, and dropping them into the live-box all the day long, and was continued on the next, until he had brought to creel over three hundred.

"I have always associated in my mind the crappie, and the love of ease and quiet of our old French inhabitants. Nothing could more truly represent contentment and ease than the picture of this simple-minded old gentlemen on his annual crappie fish at King's Lake."

Head 3; depth 2⅓; eye 4; D. V or VI, 15; A. VI, 18; scales 7-36 to 48-14, 4 or 5 rows on cheek; body rather short, greatly compressed; head long, the profile strongly curved owing to the projecting snout, depressed occipital region, and very prominent thickened antedorsal region; mouth very wide. Color, silvery-olive, mottled with dark green, the dark markings chiefly on the upper

part of the body and having a tendency to form narrow vertical bars; dorsal and caudal fins marked with green; anal fin pale, nearly plain; fins very high, but lower than in the calico bass.

43. CALICO BASS

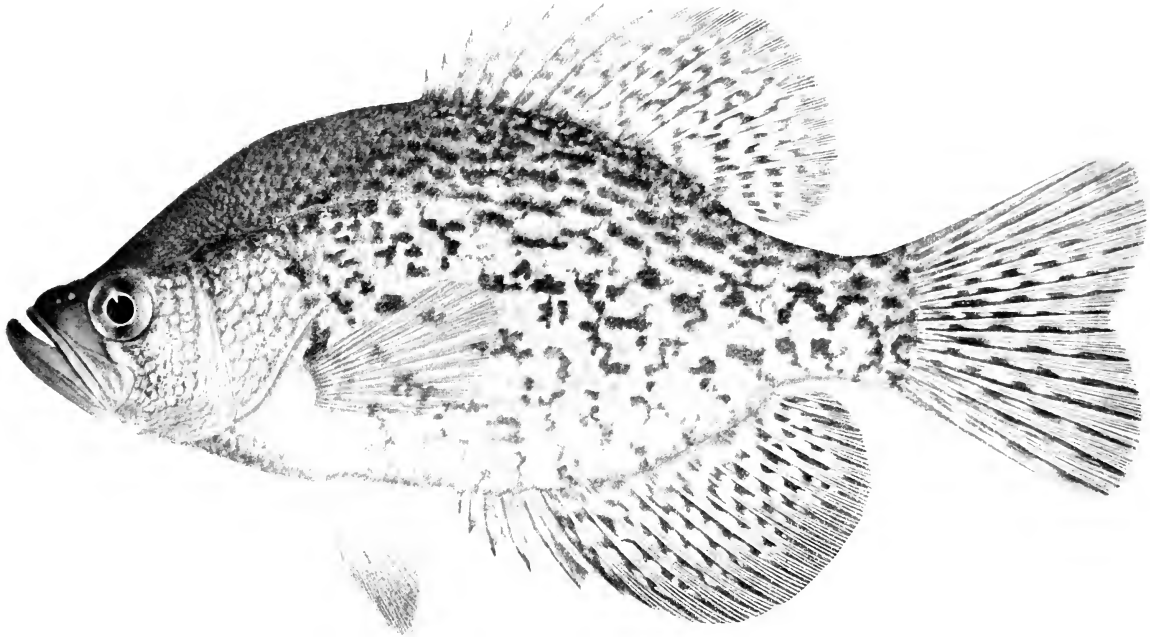
POMOXIS SPAROIDES (Lacépède)

(Plates 21 and 23)

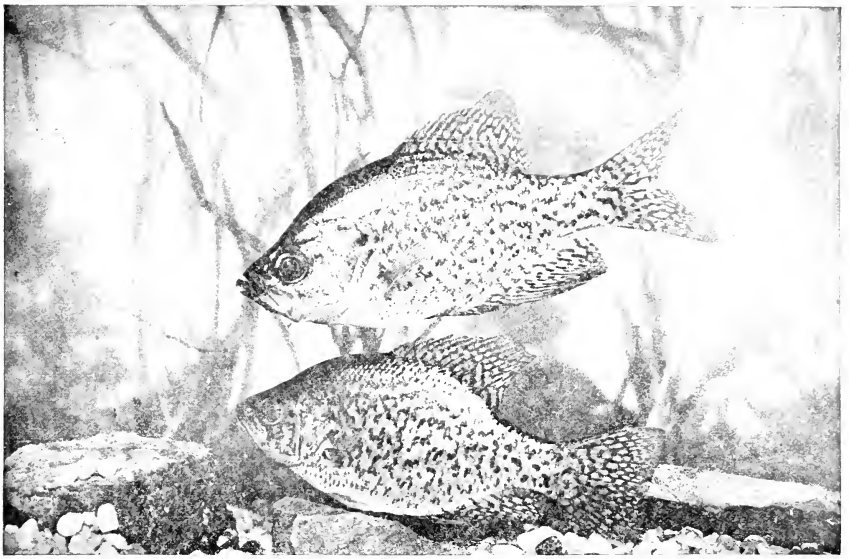
This fish is found through the Great Lakes region and south to New Jersey and Texas. Among the Great Lakes and throughout the upper Mississippi Valley it is an abundant and well-known species. As to choice of habitat, it prefers lakes, ponds, bayous and sluggish lowland streams. At Lake Maxinkuckee it is quite common, and is frequently seen and caught. Although a relatively shallow water fish it does not frequent the shore very much except on special occasions, but seems to inhabit the zone of 8 to 14 feet of water. For this reason only a few (12 or 13 specimens) were taken during the seining operation. It sometimes basks near the surface in relatively deep water. On April 29, 1901, a great number of fishes were noted splashing in the region of the deepest water of the lake. The fishes would be lying on the side and go under with a splash when the boat came near. On cautiously approaching the school it was possible to get close enough to recognize the species, and it proved to be the Calico Bass.

In Lake Maxinkuckee it is far more abundant than the Crappie, *Pomoxis annularis*. It is, however, usually mistaken for that species and called "Crappie" by most of the anglers who know it from this and other lakes of northern Indiana. There are a few who are able to distinguish the 2 species, and they usually speak of this as the Strawberry Bass, Paper-mouth or Tin-mouth. The first of these three names has reference, of course, to the color of the fish; "Paper-mouth" was doubtless given because of the great ease with which the mouth tears, releasing the hook and allowing the fish to escape; and the name "Tin-mouth" has reference to the thinness as well as the color of the jaws. Occasionally a visiting angler will speak of this fish as the "Silver Bass", or sometimes as the "Campbellite".

As a game-fish the Calico Bass does not hold a high rank, though there are many anglers who find that catching it is full of pleasure and satisfaction and not without excitement. It is a fish which can be caught any month in the year; in the early spring shortly after the ice goes off, it, along with other sunfishes, bites well from piers, and a number were caught near the Ice-houses



BLACK CRAPPIE, *Pomoxis sparoides* (Lacépède)



CALICO BASS (*Pomoxis sparoides*)

ROCK BASS (*Ambloplites rupestris*)

These photographs were taken from life at Lake Maxinkuckee by A. Radcliffe Dugmore for Jordan and Evermann's "American Food and Game Fishes," published by Doubleday, Page and Company.

about the end of April. Very good fishing is also had in October. We have records of good catches made on October 18 and 30, and on November 3, 4, 7 and 9; also in January, February, June, August and September. The largest catch of which we have a note was made late in October or early in November, 1894, and consisted of 42 pounds, representing not fewer than 100 fish. It is fair to say that this catch was made by a party of several persons.

It is said that the Calico Bass will bite readily at spawning time, but that only the males will do so. They will take a worm, small minnow, or a piece of fish. In the winter and late fall they bite readily at a small minnow, such as the straw-colored minnow (*Notropis blennius*), the blunt-nosed minnow (*Pimephales notatus*) or the skipjack (*Labidesthes sicculus*).

This fish will take not only a small live minnow, but it will take a dead minnow, a worm, a piece of fish or a grub. It is often taken with a small trolling spoon and we have occasionally taken it with a small artificial fly. And we recall one instance when it was taken in Lost Lake on the Harris floating meadow-frog.

Ordinarily during the summer months not many of this species are caught, but in September they begin to bite more freely, and by October, one who seeks them in their proper haunts is quite sure to meet with reasonable success. The species is usually taken by still fishing, though at times it may be gotten by trolling. During the summer months it frequents the deeper parts of the lake, coming on to the edges of the bars and into shallow water near shore in the night. In September and early October it remains about the edges of the bars where the water is 8 to 20 feet deep. Late in October it generally moves down into deeper water until the lake freezes over. It can most readily be taken at a depth of from 30 to 40 feet. The largest October catches that we recall were at a depth of 40 feet. About the middle of November, 1906, a great school of this species, averaging about 6 inches in length, collected under the Merchants pier at Culver. They presented a beautiful spectacle shining up through the water like a great flock of guinea fowl. When the lake freezes over, the Calico Bass leaves the deeper water and comes out upon the bars where the water is 6 to 25 feet deep. Its favorite haunts are the small channels between the bars, leaving more shallow ridges between. The cooling of the temperature has a markedly paralyzing effect upon them. When first seen under clear ice they attempt to swim away, but in a cramped fashion. They are unable to swim faster than one can walk and, instead of warming up and becoming more active, they soon become exhausted, give up trying to swim and lie on their

side among the weeds and appear to be actually panting. It is in the shallow channels that they are caught when fishing through the ice.

In fishing for Calico Bass one must be careful not to select too large a hook. For this lake the best size is No. 1 or No. 2 hook, and a hook with a long barb has advantages, as it is not so easily thrown out when the mouth tears, which it is very apt to do on account of its extreme tenderness.

While it is true that this fish will take several kinds of bait, it takes some of them only rarely or reluctantly. As already stated, it has been taken with the fly, and in Lost Lake with the artificial frog, but for lakes like Maxinkuckee such lures are not recommended. Trolling with a small spoon late in the evening or in the early fall is usually fairly successful. They will also now and then take a small live minnow that is being slowly trolled, but they are best taken by still fishing, and the best bait is a small minnow, the more silvery species, such as the Straw-colored minnow (*Notropis blennius*), the Red-nosed minnow (*N. rubrifrons*) or the satin fin (*N. whipplii*) being preferred. A small minnow should be selected, and 2 very small ones put upon the same hook will often prove quite attractive.

Sometimes the Calico Bass is a greedy biter, taking the hook much as does the straw bass, but after a short quick run it is apt to drop the bait unless it is well hooked. Usually it bites less vigorously than the straw bass, and does not make much of a fight until it is brought near the surface, when it turns upon its side and flaps quite vigorously until brought to net; and it should be mentioned that the landing net is an essential with this fish; for, owing to its delicate mouth it is not safe to attempt to lift it out of the water by the hook.

As a pan-fish the Calico Bass is far superior to the rock bass but not equal to the bluegill or yellow perch. Its flesh is white, flaky and firm, but rather coarser than that of the bluegill; it is, however, sweet, and is, by most persons who are familiar with it, highly esteemed.

The following, written by Professor Jared Potter Kirtland more than half a century ago, though placing somewhat too high an estimate upon the food value of this fish, is a reliable and interesting account of its habits.

"The 'Grass Bass' has not hitherto been deemed worthy of consideration by fish culturists; yet, from a long acquaintance with its merits, I hesitate not to pronounce it *the fish for the millions*. It is a native of our western rivers and lakes, where it usually resorts

to deep and sluggish waters; yet in several instances, where it has found its way into cold and rapid streams, and even small sized brooks, by means of the constructing of canals or by the hand of man, it has adapted itself to the change, and in 2 or 3 years stocked to overflowing these new locations. As a pan-fish for the table it is surpassed by few other freshwater species. For endurance and rapidity of increase it is unequaled. . . . .

"The Grass Bass is perfectly adapted to stocking ponds. It will thrive without care in very small ponds of sufficient depth. It will in nowise interfere with the cultivation of any number of species, large or small, in the same waters. It will live harmoniously with all others, and while its structure and disposition restrain it from attacking any other but very small fry, its formidable armature of spinous rays in the dorsal and abdominal fins will guard it against the voracious pike."

The operations of the United States Fish Commission and those of some of the state commissions have considerably extended its range by its introduction into waters which it did not previously inhabit.

Its spawning time is usually during the last half of June, though some individuals may begin spawning a little earlier and occasionally the spawning season will be prolonged into July. The place selected is on the tops and near the edges of the bars in 8 to 10 feet of water or shallower. The particular place selected is apt to be on a small ridge in a clean patch of sand surrounded by short Chara which abounds on most of the bars at these depths. It is known to spawn in considerable numbers on the bars off Long Point and it probably spawns on all such bars in the lake. The nest is usually somewhat circular in form and is about 8 or 9 inches in diameter. The nest is composed usually of coarse sand and fine gravel, with occasionally a few dead shells of *Viviparu contectoides*. So far as observed the nests are not very close to each other, but are usually separated by a distance of 5 or 6 feet, thus giving each nest or pair of fish from 6 to 8 square feet of space.

We have not, as yet, been able to make any satisfactory observations as to the number of eggs which this species lays or the period of incubation, nor are we aware that these facts have been determined by any one.

The Calico Bass reaches an average size of $\frac{3}{4}$ pound in the lake and rarely exceeds $1\frac{1}{2}$ pounds in weight. One 12 inches long weighed 1 lb. $1\frac{1}{2}$ oz., and one $10\frac{1}{4}$ inches long weighed $9\frac{1}{2}$ oz. The

greater number measured were 10, 11 and 12 inches long. Most of the stomachs examined were empty; one contained many flies.

Like the bluegill, the Calico Bass dies in considerable numbers in the spring.

Head 3; depth 2; eye 4½; snout 4½; D. VII or VIII, 15; A. VI, 17 or 18; scales 6-40 to 45-15, 6 rows on the cheek.

Body oblong, elevated, and much compressed; head long, its profile not so strongly double-curved as in the Crappie proper, the projection of the snout and the antedorsal region and the depression over the eye being less marked; mouth smaller than in the Crappie, the maxillary reaching about to the posterior edge of pupil, the mandible shorter than the pectoral; fins very high, anal higher than dorsal, its height 4 to 5 times in length of body.

Color, silvery-olive mottled with clear olive-green, the dark mottlings gathered in small irregular bunches and covering the whole body; vertical fins with dark olive vermiculations surrounding pale spots; anal marked like the dorsal; dusky opercular spot.

The Calico Bass and the Crappie resemble each other very closely and are not always differentiated by anglers and fishermen. They are, however, perfectly distinct and may be easily distinguished by means of the number of dorsal spines, the Crappie having only 5 or 6 while the Calico Bass has 7 or 8. The differences in coloration, particularly of the anal fin, is also an important diagnostic character.

44. ROCK BASS

AMBLOPLITES RUPESTRIS (Rafinesque)

(Plates 22 and 23)

The Rock Bass is one of our best known and most familiar fishes. Every angler in the upper Mississippi Valley began an intimate acquaintance with it during his boyhood days when a water-beech or iron-wood pole, a cotton line, a limerick hook and a can of fish-worms were all the outfit the boy found necessary to insure a goodly string of "red-eyes" and "pumpkinseeds". From Vermont to Manitoba, and southward west of the Alleghenies to Louisiana and Texas, this fish is found; "rock bass" in the north, "goggle-eye" in the south, and "red-eye" with the boys wherever he is known. This fish is found in all sorts of waters; it is abundant in all the Great Lakes and their tributary streams. In the small lakes of the upper Mississippi Valley states it is one of the most common species, and in the rivers, creeks and smaller streams it is equally common. It prefers clear, cool water and is therefore

not so abundant in sluggish lowland streams and bayous, or in the shallow, warmer lakes.

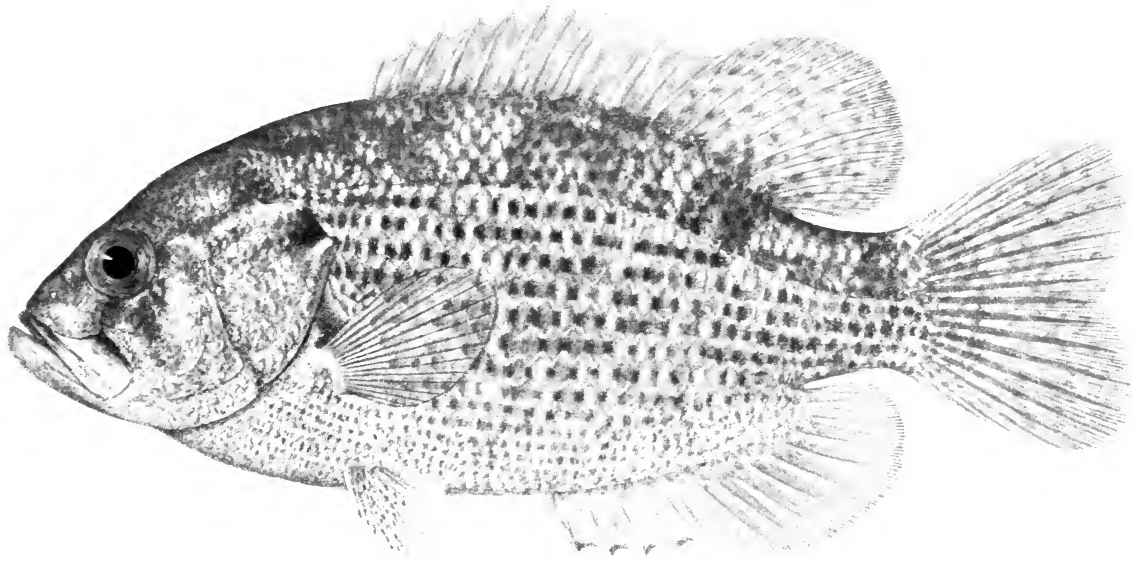
In Lake Maxinkuckee it is abundant and well known. People living about the lake, and most of the anglers who visit it, know this fish as the "goggle-eye" or "red-eye". The name "rock bass" is not so often heard and is used chiefly by those who speak by the book or who are from further north.

As a game fish the Rock Bass is, in most places, regarded with considerable favor, though at this lake it is usually regarded merely as a good fish to get when all the gamier species fail. It is a fish which can be captured at almost any time and with any sort of bait. They begin biting in the early spring as soon as the ice goes off, and can be taken at any time until the ice forms again; indeed, it is often taken through the ice. Perhaps August is usually one of the best months. They bit phenomenally in the latter part of April and the first half of May in 1901. In 1899, not many were taken in July, but during August many fine catches were made. Any one who cared to fish for redeyes seldom failed to get a good number. In 1900, perhaps the largest catches were made in August, but July fishing met with better success than in the previous year.

In the spring of 1901, from about April 28 to the middle of May, they bit almost everywhere in shallow water. One of the favorite places was off the Ice-houses, and here a considerable number of men, women and boys congregated with long cane poles and pulled out Rock Bass almost continuously. On April 28, 7 boys who had been fishing only a little time had 79, and the fishing continued in that manner for some time. These Rock Bass also bit well in various other places in the lake. Two men camping near Murray's and fishing from boats got considerable numbers. A favorite fishing place for them was the rock pile off Lakeview Hotel. The fishes hid among the crannies in the rocks and bit eagerly at worms. Most of those got here were rather small. A number were caught on set-lines about the same time.

The Rock Bass can be taken on any kind of bait. Perhaps the most attractive baits are small minnows, white grubs and angleworms, all of which are best used in still-fishing. Grasshoppers, pieces of mussel, pieces of fish, in fact, almost any animal substance, will prove effective. Trolling with live minnow, phantom minnow or spoon at times proves very successful, and they have been taken on the artificial fly and the artificial frog.

It is a voracious fish and will bite viciously even when its stomach is filled with crawfishes or other food.



ROCK BASS, *Ambloplites rupestris* (Rafinesque)

Though not one of the greatest of game-fishes, it nevertheless holds a respectable rank in that category. Its manner of taking the hook is full of energy, and the fight which it begins has in it the promise of better things, but it soon wholly or partially subsides and does not renew the fight until brought near the surface of the water, when it fights very prettily until landed.

Using light tackle and casting with the fly, the Rock Bass will afford the angler a great deal of genuine sport.

It can be taken at any time of day, and there are records of some very good catches made late at night and others early in the morning.

Although the Rock Bass is pretty generally distributed throughout the lake, it is usually found in greatest numbers about the patches of Potamogeton in 5 to 15 feet of water, and in water somewhat more shallow than the bluegill frequents. In our seining operations we usually found young Rock Bass in considerable numbers. The largest number taken at any one haul was 38. The great majority were young-of-the-year, and were found in greatest numbers in and about the patches of Scirpus and Eleocharis and also among the depauperate Chara and *Naias flexilis*. Young Rock Bass were also frequently raked up in winter near shore among weeds.

The Rock Bass in this lake reaches a length of about 12 or 13 inches and a weight of a little less than one pound. The great majority of those caught weigh ½ pound or less; occasionally one of ¾ of a pound is taken and still more rarely one weighing 14 or 15 ounces. The following are the measures and weights of individuals taken at various times: 11 inches, 13 oz.; 10 inches, 10½ oz.; 8 in. 6¼ oz.; 8½ in. 8½ oz.; 9 in. 8¾ oz.; 9¼ in. 9½ oz.

The Rock Bass is a voracious feeder, and may usually be found pretty well gorged with crawfishes, shells, insect larvæ, and occasionally minnows. Its diet differs with age and somewhat with the season.

Small examples 1.56 to 3.06 inches long raked up with Chara near the Inlet in December, 1904, nearly all contained insect larvæ. During the spring of 1901 the chief food of this, as well as of bluegills, was a species of Asellus which was very abundant in the Chara at that time. Beetles, minnows and a few leeches and crawfishes were also found in the stomachs examined then. Most of the large ones examined during the summer of 1906 contained crawfishes. One contained a mad tom, a spine of which had penetrated the walls of the stomach.

The Rock Bass is afflicted with parasites, perhaps to a greater

extent than any other species of this lake. Parasitic Copepods were abundant on the gills. Late in autumn the gills were frequently well crowded with small free-swimming Copepods. Distomids and Acanthocephali were frequently found in the stomachs, and leeches were frequently found attached in the axils of the fins.

The Rock Bass is one of the earliest spawners. They begin about the middle of May and are usually done by June 15. They come out into shallow water and make the nest among the rushes, or by a stick, chunk, stake, rock or any similar object. The nest resembles that of the calico bass, being made in clean coarse sand or fine gravel, and 8 or 9 inches in diameter. The eggs of the rock bass are about the size of small shot, and are very numerous.

The young Rock Bass is a quite handsome fish, the sides being beautifully mottled and clouded with irregular patches of brown. As it grows older the color markings become dark lines along the rows of scales and it becomes much less attractive.

The young seem to grow quite rapidly. Young of the year taken July 18, average 1.15 inches in total length.

Cold water has considerable influence in benumbing these fishes. Some large examples seen in shallow water near shore seemed to have lost the power of coordination; they had a tendency to swim on their sides.

As to the edible qualities of the Rock Bass, not much can be said in its favor. In cold running streams or waters where better fish are not common it will pass as a fairly good pan-fish, but in a lake like Maxinkuckee where so many better fish are found, it is not held in high esteem. Its flesh is white and flaky, but rather soft and insipid and sometimes tastes of mud. Next to the warmouth it is the poorest of the food-fishes of this lake.

Head 2.75 in length; depth 2 to 2.5; eye 3.5 to 4.5; snout 4; maxillary 2.3; D. XI, 10; A. VI, 10; scales about 6-39-12, 6 to 8 rows on cheek; gillrakers 7 to 10; cœca 7; vertebræ 14 + 18; body oblong, moderately compressed; head large, profile in adult somewhat depressed above the eyes; mouth large, the maxillary reaching middle of pupil; gillrakers developed only on lower part of arch; preopercle serrate near its angle.

Color, olive-green, conspicuously tinged with brassy, and with much dark mottling; the young irregularly barred and blotched with black and with very little brassy, the adult with a dark spot on each scale, these forming interrupted black stripes; a black opercular spot; dark mottlings on the soft dorsal, caudal and anal; eye more or less red.

The following are life color notes made on an example 8 inches long, caught at the Weedpatch September 12, 1907:

Back light olive mottled with darker; side olivaceous above, more brassy below, the olive of middle of side in 9 broken bars; belly white, dusted with brassy; breast and under part of head finely speckled with dusky; opercle dark; side of head brassy with a darker bar downward from eye; dorsal, anal and caudal olivaceous yellow, the dorsal and anal spotted with darker; ventral pale lemon, the tip of the first ray and all of last ray white; pectoral pale lemon.

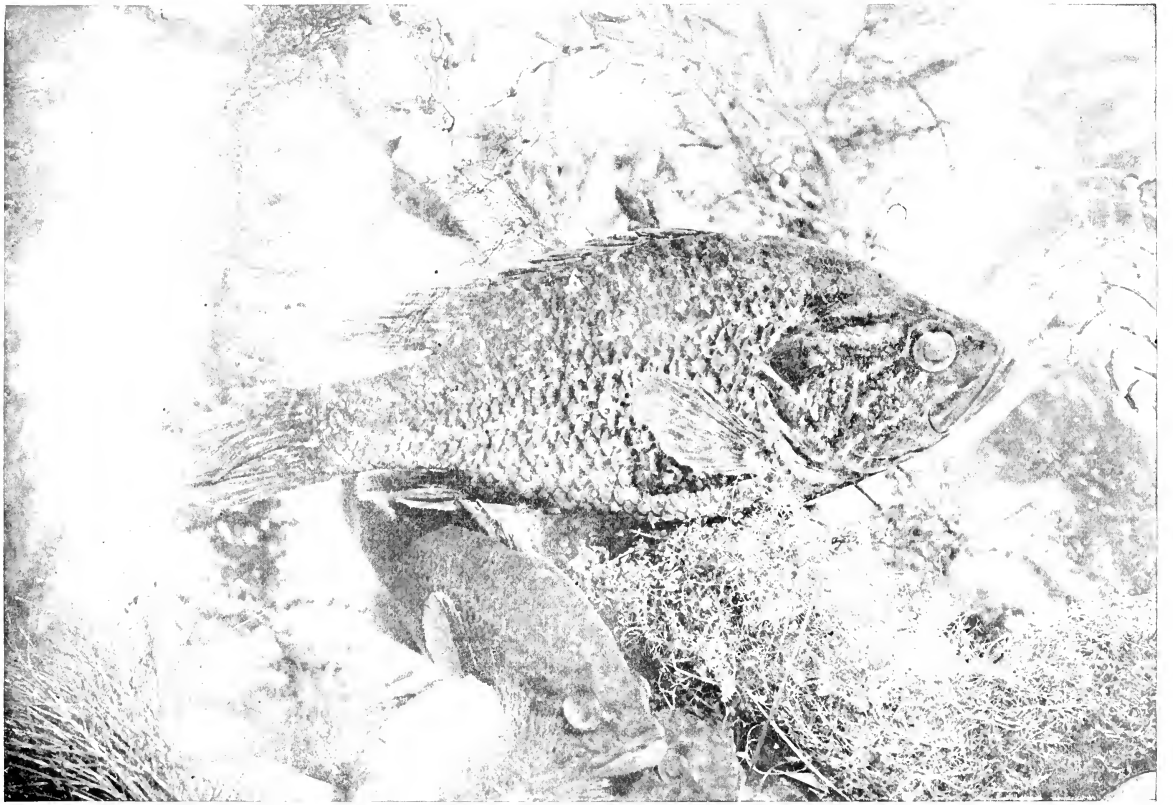
45. WARMOUTH

CHÆNOBRYTTUS GULOSUS (Cuvier & Valenciennes)

(Plate 24a)

The Warmouth is found throughout the eastern United States in suitable waters, chiefly west and south of the Alleghenies, from the Great Lakes, Iowa and Kansas, south to Florida and Texas. It is a fish of the warmer, shallower lakes, and the sluggish lowland streams, ponds and bayous. In the small shallow lakes with mud bottom and abundant vegetation, particularly among the spatterdock, Potamogetons and lily-pads, the Warmouth abounds. We know it from lakes such as those in northern Indiana, Illinois and Iowa, southward in the overflow ponds along the lower Wabash, Ohio and Mississippi, to the bayous and shallow lakes of Mississippi, Louisiana and Texas. It is not a common fish in Lake Maxinkuckee; this lake is too clean and there is not enough mud bottom.

In seining entirely around the lake between July 4 and July 27, 293 hauls were made, in only 3 of which were Warmouth taken. One of these was in the Outlet just above the railroad bridge where 6 were gotten. The other two hauls were between the Outlet and the Ice-houses, and only one Warmouth was gotten in each. A few were seined in Culver Inlet. Occasionally one is caught on a hook, but not often. Two or 3 were caught in the summer among the Potamogetons off the Gravelpit and 2 or 3 in Outlet Bay; and each winter a few are taken through the ice at these 2 places, minnows being the bait used. We have a record of only 6 or 8 so taken in the winter of 1899-1900. Although the Warmouth is uncommon in Lake Maxinkuckee it is rather abundant in Lost Lake, into which Lake Maxinkuckee empties. It is particularly abundant in the channel connecting the two lakes where from one to 10 were caught at each haul with a 15-foot seine. It loves to bask in the dense weeds along the edge of the lake, and it can be sometimes raked out in a bunch of tangled vegetation.



Warmouth Bass (*Chænobryttus gulosus*) Photograph by Dugmore

This fish is not well-known to many of the anglers who come to Lake Maxinkuckee. Only those who wet a line occasionally in Lost Lake or who fish through the ice there are apt to know much about it. Knowledge of it is therefore practically limited to the local fishermen who call it "Indian Fish" or "Mud Bass".

Its game qualities are not unlike those of the rock bass. It is most easily taken with a live minnow and it bites with considerable energy. It fights vigorously, after the manner of the rock bass.

As a food-fish the Warmouth is inferior even to the rock bass, though when caught in the winter its flesh is firm and sweet and entirely devoid of the flavor of mud which it may possess in summer. If it could be kept in clear, cold water its flesh would doubtless lose all its objectionable qualities.

The Warmouth, with its rich coppery color, is easily distinguished from the other fishes of the lake. It resembles the rock bass more than any other fish of the lake, and can be distinguished by the following description:

Head $2\frac{1}{3}$ to $2\frac{2}{3}$; depth 2 to $2\frac{1}{2}$; eye 4 to $4\frac{1}{2}$; snout 4 to $4\frac{1}{2}$; D. X, 9 or 10; A. III, 8 or 9; scales 6-40 to 46-11 or 12, about 40 pores, and 6 to 8 rows on cheek; gillrakers 8 or 9 besides rudiments. Body shaped very much as in the rock bass; head and mouth large, maxillary reaching posterior edge of orbit; opercular spot about as large as eye; dorsal spines low, the longest equal to distance from tip of snout to middle of eye; pectoral not reaching anal fin; ventrals reaching anus.

Color, dark olive-green, or sometimes rich brick-red and brassy, clouded with darker, usually with red, blue and brassy; a dusky spot on each scale; ventral fins mottled with dusky; a faint spot on last rays of dorsal bordered by paler; 3 oblique dusky or reddish bars radiating from eye; belly yellowish or brassy. Length 8 to 10 inches.

46. BLUE-SPOTTED SUNFISH; GREEN SUNFISH

APOMOTIS CYANELLUS (Rafinesque)

(Plate 24)

This beautiful little sunfish is found wholly west of the Alleghenies and from the Great Lakes to Mexico; it is usually abundant in all suitable waters from central Ohio and Indiana to the Rio Grande. It is not often found in lakes or large streams but in the smaller streams, brooks and ponds it is an abundant and well-known little fish.

It is very rare in Lake Maxinkuckee, and the statement by

Evermann and Jenkins in "Notes on Indiana fishes"* that it is "very common" in Lake Maxinkuckee appears to be no longer the case; only a few individuals were obtained in the two seasons devoted to the study of that lake, and not exceeding 6 or 8 were seen in Lost Lake. It is probably the rarest member of the family in these waters. On September 11, 1906, two examples, each about 2.5 inches long were seined in the Outlet of Lost Lake near the old mill-site. These are the only specimens recently obtained by us.

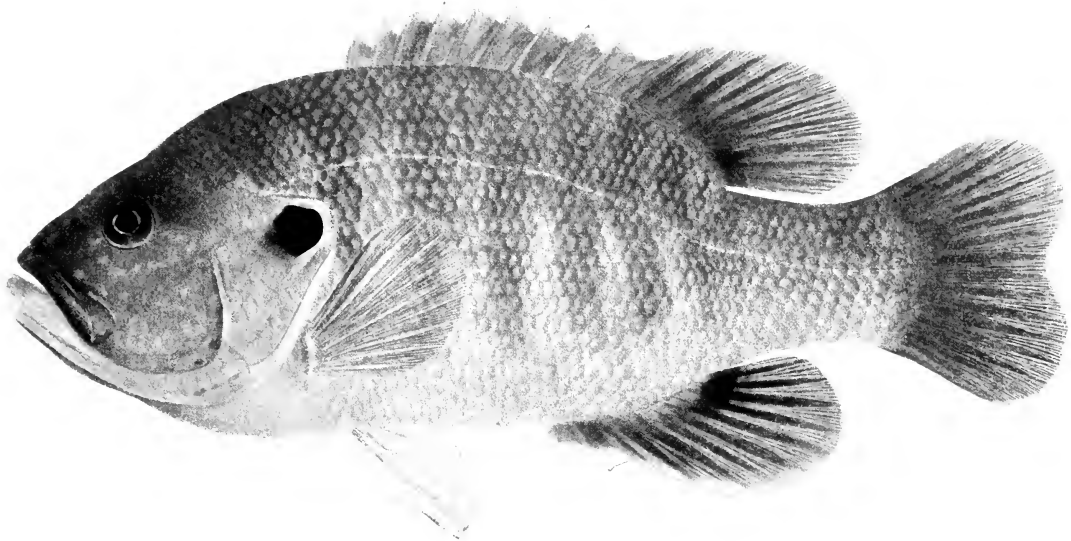
The Blue-spotted Sunfish does not attain a greater length than 6 or 8 inches and a weight of 4 or 5 ounces, but it is a sprightly little fish and excellent for the pan. Like the pumpkin-seed, it is, where common, a favorite with the small boy. It takes readily a hook baited with grub or angleworm, and would make a vicious fight for liberty if it were only larger.

A specimen at hand from Bruce Lake is quite different from the specimens of *Lepomis* and *Eupomotis* in the collection. It is characterized by the large number of scales, the large number of rows of scales on the cheek, the low fins and a conspicuous black spot on the posterior base of the dorsal and anal fins.

Head 3; depth $2\frac{1}{2}$; D. X, 11; A. III, 9; scales small, 6 or 7-45 to 55-16, 40 to 48 pores, 8 rows on cheek; gillrakers moderate, X + 13. Body rather elongate, moderately compressed, becoming stouter with age; head large, the snout projecting; mouth quite large, maxillary broad and flat, reaching middle of eye; a small supplemental maxillary above; lower jaw projecting; dorsal spines quite low; pectoral short, not reaching anal, $1\frac{1}{2}$ in head; ventrals not reaching vent.

Color variable, the prevailing shade green, with strong brassy luster on sides which becomes nearly yellow below; each scale usually with a sky-blue spot and more or less of gilt edging, forming pale lateral streaks, dusky or obscure vertical bars often present and the sides sprinkled with dark dots; vertical fins marked with blue or green, the anal edged with pale orange in front; usually a conspicuous black spot on posterior base of dorsal and anal fins, these often obsolete; iris red; cheek with narrow blue stripes; opercular spot smaller than eye, broadly margined with bronze, the black confined to the hard or bony part of the opercle, a character which readily distinguishes this from all other species of sunfishes.

* Proc. U. S. N. M. XI, 55.



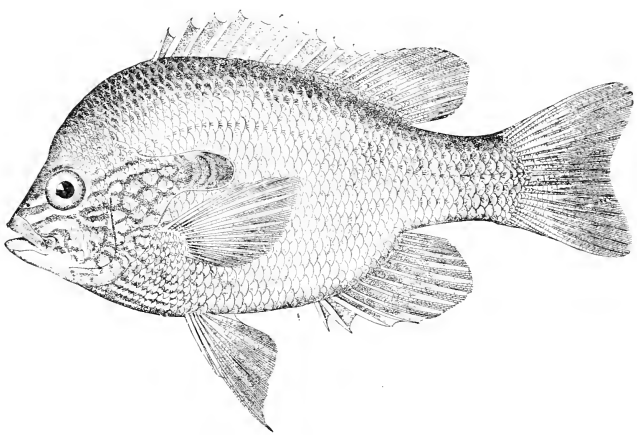
GREEN SUNFISH, *Apomotis cyanellus* (Rafinesque)

47. LONG-EARED SUNFISH

LEPOMIS MEGALOTIS (Rafinesque)

This is another of the small sunfishes that abound in all suitable waters in the Mississippi Valley and southwestward. From Minnesota and northern Ohio it ranges southward to Florida, Arkansas and Texas.

It is subject to great variation and has been described as new no fewer than 14 times. Although it occurs in lakes and large streams, it most delights in the smaller creeks and brooks. In Lake Maxinkuckee it is more common than the blue-spotted sunfish, but it is not by any means abundant, only a few examples having been obtained by us. In Lost Lake, however, it is more numerous and was frequently taken in the seine.



Long-eared Sunfish (*Lepomis megalotis*)

In these waters it does not seem to reach a greater length than 5 or 6 inches and a weight of 2 or 3 ounces. It is, however, a sweet pan-fish, and in game qualities it is not particularly different from the green-spotted sunfish and the pumpkin-seed.

Head 3 (without flap); depth about 2, varying with age; eye $3\frac{1}{2}$ to 4; D. X, 10 to 12; A. III, 8 to 10; scales 5-36 to 15-14, 31 to 40 pores, about 5 rows on cheek; gillrakers X + 8 or 9; pectoral $1\frac{1}{3}$ to $1\frac{1}{2}$ in head. Body short, deep, and compressed, the back very strongly arched in the adult, the profile steep, usually forming an angle above the eyes; mouth small and oblique, the premaxillary rather below the eye, the maxillary reaching middle of eye; gill-

rakers very short and soft, weaker than in any other species; dorsal spines very low, the longest little longer than snout, 3 in head; opercular flap in the adult very long and broad, with a broad or narrow pale blue or red margin, the flap half or more longer than the eye in the adult, much shorter in the young, its development subject to much variation.

Color, brilliant blue and orange, the back chiefly bluish; belly entirely orange, the orange on the sides in spots, the blue in wavy, vertical streaks; lips blue; cheek orange, with bright blue stripes; blue stripes before eye; soft parts of vertical fins with the rays blue and the membranes orange; ventrals dusky; iris red.

One of our most brightly colored freshwater fishes; extremely variable, the young often elliptical in form, and the size at which the characteristic ear-flap is developed varies greatly with different individuals.

As compared with the other sunfishes of the lake, most of our specimens are characterized by having the ventral fins very dark, almost black, and, although this feature is probably not enough to identify them with certainty, it is very helpful in making up a preliminary assortment of species.

48. BLUEGILL

LEPOMIS PALLIDUS (Mitchill)

(Plates 25 and 26)

The Bluegill is one of the most abundant and widely distributed of the sunfishes. It is known from the Great Lakes southward throughout the Mississippi Valley and to Florida and the Rio Grande. It is found in New York and Pennsylvania, the Carolinas, and west to Minnesota and Kansas. It occurs in quiet streams, but is, above all, *the* sunfish of the lakes, whether large or small, though it is decidedly more abundant in the smaller ones. It is very common in all the lakes of northern Indiana and of all the food fishes found in Lake Maxinkuckee, it is, next to the yellow perch, certainly the most abundant species.

In our seining operations along the shores we found it exceedingly abundant. In seining around the lake in July and August we sometimes used a 45-foot seine, but usually a 25-foot one, and occasionally one only 15 feet long. In covering the entire perimeter of the lake the seine was hauled about 612 times, and the Bluegill was the most abundant species caught. The total number caught exceeded 12,000. Occasionally a haul would be made without taking any bluegills but usually there were from a few up

to many in each haul; several hauls contained several hundred each, the largest number being 419. Most of those caught in this way were 1 or 2 years old; not many young-of-the-year were taken and not many adults. A good many 3 years old were taken, but by far the most abundant were those 1 and 2 years old. It is scarcely necessary to state that only a few of these fish were retained for specimens and that practically the entire catch was invariably returned to the lake.

The young-of-the-year are found in great abundance in shallow water near shore but, except when the smallest seine was used, they would pass through the meshes and we were thus unable to determine their number.

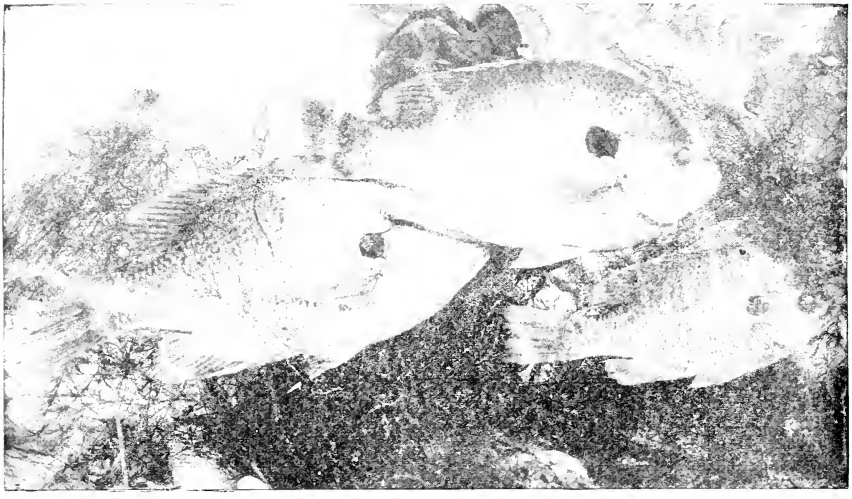
In Lost Lake the Bluegill seems equally abundant. More than 2,000 were caught in 100 hauls with a 25-foot seine. At Lake Maxinkuckee this fish is known almost exclusively as the "Bluegill"; Blue Bream, Blue Sunfish, Copper-nosed Bream, Dollardee, and the various other vernacular names by which it is known in other localities are never heard there.

In this lake the bluegills spawn during the last half of June, their spawning beds being usually located on shallow bars where the water is 4 to 8 feet deep. They clean off the rubbish from a circular area 6 inches to a foot in diameter and, like the pumpkinseed, will defend the nest with much bravery.

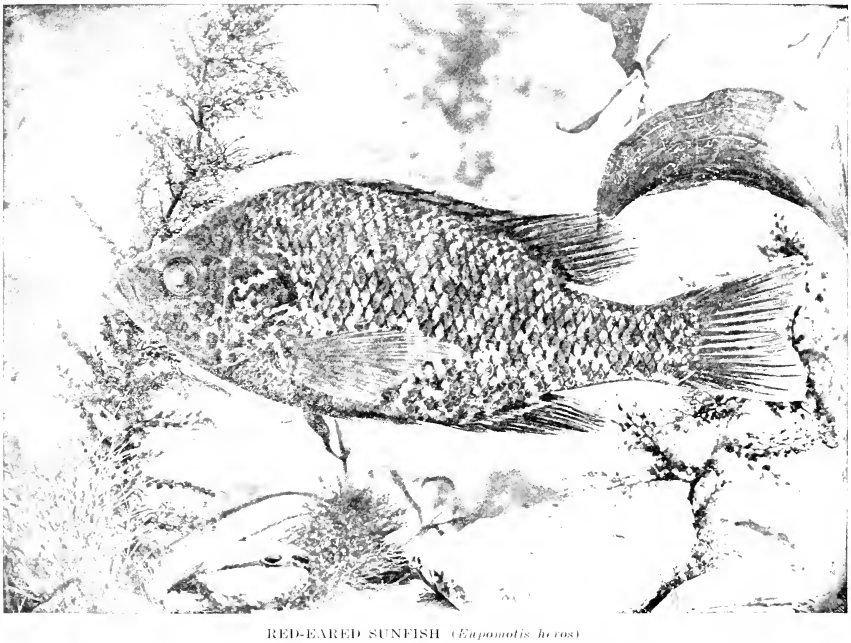
The Bluegill is the "gamest fish for its weight in the lake", so says one of the most observant and successful of the anglers who come to Maxinkuckee; and not many who have had experience with the large individuals in the clear, cold waters of this lake will be disposed to question the estimate.

In the first place, the bluegills of Lake Maxinkuckee are unusually large; they reach a length of 12 to 14 inches, a weight of a pound, and are broader than one's hand. Even their average size at this lake is from a half to three-quarters of a pound, while in Bass Lake, 10 miles west of Maxinkuckee, they do not average more than 2 or 3 ounces. Then the water of Maxinkuckee seems conducive to a high development of game qualities, not only in the Bluegill, but in all other fishes—the temperature, clearness, depth, and quality and quantity of food all seem most favorable.

This fish can be taken at any time in the year. Excellent catches can be made early in the spring, but during July and August the largest catches are probably made, it being no unusual occurrence in those months for two men in one boat to take 75 to 100 pounds in an afternoon. It bites well during the entire fall, also, though it is not fished for so assiduously after grasshoppers



BLUEGILL SUNFISH (*Lepomis pallidus*)



RED-EARED SUNFISH (*Eupomotis heros*)

These photographs were taken from life at Lake Maxinkuckee by A. Radcliffe Dugmore for Jordan and Evermann's "American Food and Game Fishes," published by Doubleday, Page and Company.

begin to fail. And in the winter time the Bluegill is taken in considerable numbers fishing through the ice.

The Bluegill can be taken with almost any kind of lure. Angleworms are probably the best, though grasshoppers are nearly as good. White grubs, small minnows and pieces of fish or clam are all good. The senior author has taken it also on small crawfish, with the fly, on the trolling spoon and with a small buck-tail.

It may be taken either by still-fishing or by trolling. The most popular method at Lake Maxinkuckee seems to be to fish from an anchored boat, using two long cane poles projecting over the stern at a divergent angle. A cork or float is placed upon each line, its position being determined by the depth of water, the hook being made to hang about a foot above the bottom. More expert or skilled anglers will use a rod and reel but will probably not catch any more fish.

The Bluegill can be caught in various places, as from the piers and elsewhere in shallow water near shore, from in and about the bulrush patches in water 2 to 5 feet deep, from the Vallisneria beds, or from the tops and slopes of the deeper bars where the various species of Potamogeton abound. Probably the best places are on the edges of bars where there are good growths of *Potamogeton amplifolius*. The most noted place in the lake for bluegills is the well-known "Weedpatch". Other good places are in the Potamogeton patches off the Gravelpit, off the Ice-houses, and at the Sugarloaf.

The Bluegill is a dainty biter, taking the hook slowly and deliberately, sucking it in rather than biting it. Not until after the bait has been sucked in and the fish starts away with it is the angler aware of what is going on; but when once securely hooked then the fight really begins, to continue without cessation or abatement of energy until the fish is landed. The Bluegill rarely jumps out of the water as does the black bass, but by turning his side toward the angler he is able to offer a resistance which makes the sport very fascinating.

Excepting the yellow perch, there is no other species in the lake which is equal to the Bluegill as a pan-fish. The flesh is firm and flaky and possesses a flavor of which one does not soon tire, and the size of the fish is the ideal one for a pan-fish.

As to feeding habits, the Bluegill appears to be by all means the most omnivorous fish of the lake. Its dietary never offers indeed such a violent juxtaposition of unrelated materials as exhibited by the shark, bowfin or goat; and does not so much remind one of a world's museum or valley of Hinnom as a biological

epitome of the lake. One is not likely to find as great an assortment of food articles in its stomach as in a shark's; but there is to be found in its stomach at various times bits of almost everything found in the lake. Morover, it is not generally in the habit of mixing its food, but generally feeds chiefly on one thing now and another at another time. It is choicy, indeed, after a fashion as to the quality of its food, insisting that what it eats be fresh and wholesome, but cheerfully eating whatever is set before it and asking no questions for conscience sake. This suggests that it would be as easy fish to rear, not easy in the sense that it would thrive in any place planted, but so far as food is concerned it would thrive in small, well-kept ponds, not demanding wide range or special crops of food.

A large number of stomachs were examined; more, probably than of all the other species of the lake put together, and the recital of the contents of different individuals one by one, while valuable as a matter of record, would be tedious reading. It will suffice to say here that the food of younger individuals appears to be mainly of an animal nature, consisting of various entomostraca, such as Cypris, waterfleas, Cyclops, Bosmina and various insect larvæ. The adult fishes eat also various mollusks, such as Physa and operculate mollusks, Sphærium and Pisidium. Among other occasional elements of their food are water mites, beetles and caddis cases with the larvæ. During the spring of 1901, they, along with the other sunfishes, seemed to feed almost exclusively on the common isopod of the lake, Asellus. On August 12, 1906, the stomachs of 21 specimens examined were all gorged with the tender tips of weeds, either one of the narrow-leaved Potamogetons or Heteranthera; they seemed to be wholly vegetarians at the time. Strangely enough, and much to the Bluegill's credit, we do not find among our records of the numerous stomachs examined, mention of a single fish.

So far as our examinations go, the Bluegill is quite free from animal parasites; its freedom from intestinal parasites is probably due in part to its abstinence from eating other fishes; carnivorous fishes in general appear to be more subject to such affections than others.

In spite of these advantages, however, the Bluegill is one of the most delicate fishes of the lake and succumbs quickly to various maladies. During the winter of 1900-1901, these fishes massed in immense numbers in Culver Inlet and most of the winter through could be seen packing that stream almost as close as they could be crowded. The reason of their crowding into this particular

spot was in all probability because of the warmer temperature of the water there. For some reason, partly perhaps because of subaqueous springs, and possibly because of exhaust pipes from the heating plant of the Military Academy, the water there was always several degrees warmer than that of the lake, and did not freeze at all.

It is barely possible that the bluegills which crowded into this inlet were unhealthy individuals, and had chosen the warmer waters out of a general sensation of discomfort or exceptional sensitiveness to cold; it was noted that all about the edge of the lake where springs ran in and raised the temperature of the water, that fishes which usually appeared more or less sick crowded about; at any rate, Saprolegnia soon broke out among the crowded fishes and in a short time wrought great havoc, and before long, fishes could be found dead and in all stages of disease. The fungus attacked especially the tail and eyes.

Even healthy bluegills exhibit in a marked degree the paralyzing influence of cold water. While cold water appears to benumb all fishes more or less, the greater number are able to swim away with reasonable speed when frightened. On December 21, 1904, some bluegills, as fine and large as are usually seen at the lake, were observed through the thin ice in Lake Maxinkuckee. Some simply stuck their heads down into the Chara and tried to hide; others tried to dart away, but appeared very numb, and moved with difficulty. If chased they soon tired, often showing their sides upward, and one soon lay down on its side and refused to move, although attempts of all sorts to frighten it were made on the ice above.

During the early spring the young bluegills of the year before, flock in rather large schools along shore. From April 26 to May 18 they were seen almost every day. The young frequently hide among Chara and weeds near shore in shallow water during the winter, and are among the most common fishes raked up with weeds through the ice.

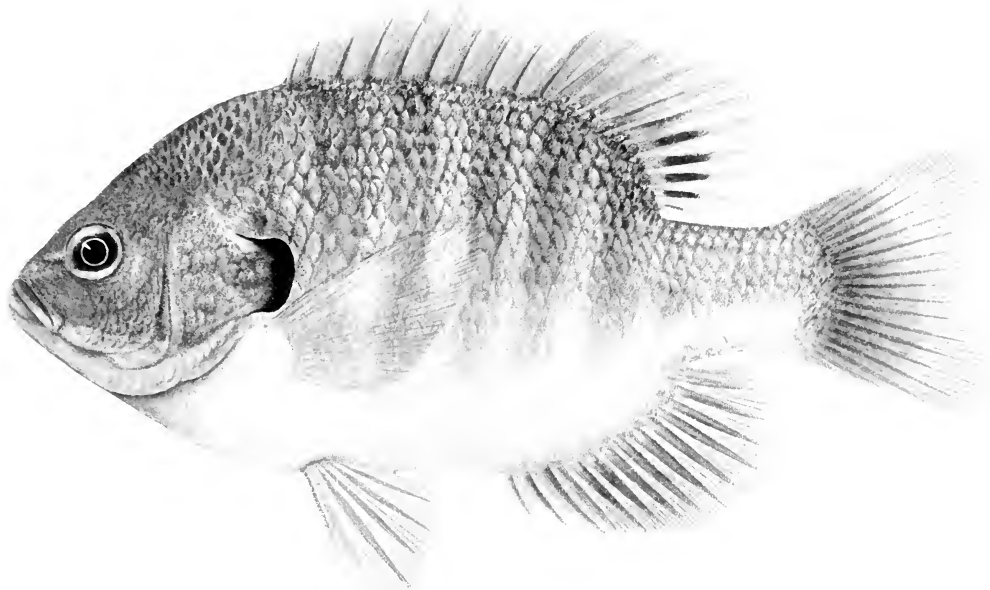
The Bluegill affords perhaps more sport and food to resident anglers about the lake than any other species. It bites all the year round, and is sometimes even taken on the set-line. One of the best times to fish for it is during the early spring, when large catches can be made fishing from piers with the ordinary bamboo pole and cork bob. The crowd of anglers who lined the shore by the Ice-houses from about the middle to the end of April, 1901, got goodly numbers of these fishes. On April 16, one fisherman caught 54; on April 18, another got 23. In general, catches of from 25 to 40 in a day or less seemed rather common about this time.

Later in the season they were generally caught from boats and frequently bit freely. About the end of August, 1903, one fisherman made a catch of 85, on worms. The next two days 2 men caught 56, and a few days after, they caught 42 in one day. Quite good catches were made late in September, 1906.

In addition to the Saprolegnia, there is a periodical occurrence every spring of some sort of malady which causes great mortality among this species. In the spring of 1901, this contagion broke out about May 19 and 20, when 16 of these fishes were found dead along shore between Knapp's and Farrar's. On May 24, 26 examples, all of good size, were found dead on the shore of Outlet Bay. On May 31, 40 large ones were found dead in a little strip on the southwest shore of the lake. On June 4, 34 of good size were found between the Fish Commission pier and Long Point, and on June 5, 73 dead ones were found on the north side of the lake between the old Vandalia pumping station and Lakeview Hotel. No certain cause could be discovered that would explain the deaths. The smaller fishes seemed exempt. There was a general impression among the dwellers about the lake that it was due to gorging on the great number of May-flies which appeared about that time.

The bluegills begin nesting early in June. Several nesting fishes were found in Lost Lake June 8, and they were quite dark in color. Their dark coloration may have been due to an abundance of pigment characteristic of the mating season, or to the dark waters of the lake; fishes of Lost Lake usually being considerably darker than those of the same species in Lake Maxinkuckee.

The nests were very close together, the rims nearly touching, and were found in black bottom in shallow water (4 or 5 feet) in rushes southwest of the Bardsley cottage. They were shallow, bowl-shaped depressions about a foot in diameter. They usually contained several small gasteropod shells and often a larger mussel shell, in the bottom. They were quite conspicuous. On June 12, four days after the nests were first observed, a visit was paid to the nests. The boat was anchored over a particularly large fine nest. The fish were very shy and on the first approach of the boat left in numbers. After some time they returned. The nest over which the boat was anchored contained a very large dark mass full of moving lively bright points—the eggs well advanced toward hatching. The parent Bluegill, a large fine one, came and stayed on the nest, moving its tail and fins. It would make dashes at and chase away the other bluegills which seemed to have nothing to do but visit; they seemed inquisitive. No such dark mass was found



BLUEGILL, *Lepomis pallidus* (Mitchill)

in any other nest, and it was thought that they were empty or deserted. A closer investigation revealed a sort of granular bottom, consisting of the eggs covered over by some silt raised by the current caused by the parent's fanning. On account of their being covered with silt the eggs were very inconspicuous. There was a constant restless watchfulness on the part of the parent fish. The bluegills did not look much worn by the labor of nest building, though some of the caudal fins were frayed. *Eupomotus gibbosus* nested with the bluegills, and elsewhere by itself nearer shore.

On June 15, several bluegills about 10 inches in length greatly distended with roe, washed up dead in front of the Fish Commission cottage. The eggs had a higher specific gravity than water, were very numerous, clear in color, and 21 to the inch.

The Bluegill apparently bites while guarding the eggs and young, and can be caught off the nest. This matter however requires further investigation.

Head about 3½, without flap; depth 2 to 2¼; eye 4 in head without flap; snout 4; maxillary 3½; D. X, 11 or 12; A. III, 10 to 12; scales 7-46-14, about 44 pores, 5 rows on cheek.

Body short, deep and compressed, the young slender, the adult more nearly orbicular; caudal peduncle rather slender, its least depth 2 in head; head not large, the projecting snout usually forming an angle above the eye; mouth quite small, oblique, the jaws about equal, maxillary not reaching eye; gillrakers moderately long, nearly round, bent slightly downward; dorsal spines strong and high, the longest about half head, usually longer than snout and eye; ventral fins reaching origin of anal; pectorals pointed, longer than head, reaching origin of anal; opercular flaps very short in the young, rather long and broad in the adult.

Color, rich greenish-olive on back, becoming paler on sides; belly sometimes coppery or brassy; top of head dark greenish; opercle and cheek bluish; opercular flap rich velvety black, without pale border, a small whitish spot near its base above; side sometimes with 3 or 4 more or less distinct broad darker greenish crossbars; fins all greenish, the pectoral palest, reddish at base; a large dark blotch near base of last rays of dorsal, and usually a similar blotch on anal; anal membranes darkish, a slight rosy wash along base of fin.

49. RED-EARED SUNFISH

EUPOMOTIS HEROS (Baird & Girard)

(Plate 25)

The Red-eared Sunfish is found from northern Indiana to Florida and the Rio Grande. It is an inhabitant of lowland streams and ponds. Although usually regarded as rare, it is not especially uncommon at Lake Maxinkuckee. Among the fishermen in general it is probably confused with the other sunfishes, although one of the fishermen of the lake pointed one out as "Green Sunfish" a name generally applied to *Apomotis cyanellus* where that species is well known. During the seining operations about the lake, in the 612 hauls, 75 specimens were taken, the maximum number in 1 haul being 8. Specimens were taken in 29 of the hauls. The shortest specimen obtained was 2.25 inches long, from which they varied in length to about 10 inches.

The habits of this species do not differ greatly from those of other members of the genus. Its food consists of worms, larvæ, small crustaceans, small mollusks and the like. Its parasitic enemies do not appear to be many. Only one example was examined with parasites; these were found in the region of the vent and resembled Gordius.

The spawning season of this sunfish is in May and June.

Little distinctive can be said as to its game qualities; they are essentially the same as those of the common pumpkinseed. It takes the hook readily if baited with angleworm, grub or cut bait. It takes hold cautiously but dashes away promptly and fights well for so small a fish. It is a delicious pan-fish.

Our specimens disagree in some respects from current descriptions of *E. heros;* the maxillary does not reach fully to the eye, the longest dorsal spine does not reach to the posterior border of the pupil, and the pectoral does not reach beyond the middle of the anal.

The following is a description of one of our specimens:

Head 3 in length; depth 2.3; eye 4.5 in head; snout 3.25; maxillary 3.3; mandible 2.6; preorbital 6.2; interorbital 3.25; dorsal X, 11, the spines very stout, the longest, (6th) 2.5 in head, longest ray 1.8 in head; base of dorsal 2.25 in length, its base extending over 25 rows of scales; anal III, 11, the spines, especially the third, very stout and much longer than the others, 2.5 in head; longest anal ray 2 in head; pectoral long, rather narrow and sharp, reaching somewhat beyond origin of anal, and contained 1.1 times in head; ventral rather acutely rounded, its stout spine 2.8 in head,

the length of the entire fin 1.6 in head, its tip reaching halfway between vent and origin of anal; caudal lobes 1.5 in head; scales 6-41-11, with 38 pores in the lateral line; scales on the cheek large, in 4 rows; membrane of dorsal and anal scaled at base.

Color in alcohol, brownish, of a nearly uniform tint all over the body, except the black opercular spot, the diameter of which is contained 1.2 times in the diameter of the eye; color in life pale olive-greenish, mottled with darker; cheek bluish but without lines; flap blue-black, with a red posterior border, silvery anteriorly above and below; some lemon wash.

50. COMMON SUNFISH

EUPOMOTIS GIBBOSUS (Linnæus)

This handsome little fish, also frequently known as the Pumpkin-seed and Butter-belly, is one of our best known fishes and is found in clear brooks and ponds from Maine westward to the Great Lakes and southward east of the Alleghenies to Florida. In the Mississippi Valley it is found only in the northern portion, being fairly abundant in Ohio, Indiana, Iowa, Illinois and northward, but it is said to be rare south of Virginia. At Lake Maxinkuckee it is fairly common; out of the 612 hauls made during the seining operations in and about the lake, one or more examples were taken in each of 144 hauls; 860 specimens in all were secured; the greatest number taken in one haul being 100.

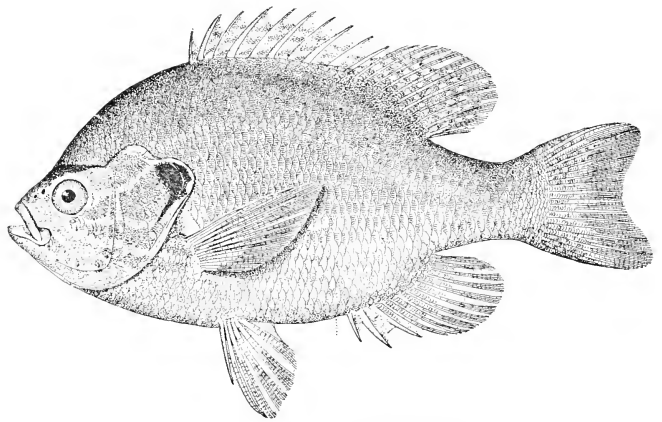
It is found in both lakes, also in the short stream connecting them. Favorite places which they frequent are the chutes and piers at the Ice-houses, Outlet Bay and the Outlet about the bridges, and under the piers at the numerous cottages. In such places as these they may be seen, sometimes in considerable numbers, resting quietly near some piling or other protection. Exceptionally fine examples are sometimes caught at the Weedpatch, the Flatiron and the Sugarloaf.

The Pumpkin-seed is one of the first, if not the very first, fish that the average country boy in the Eastern States and the Upper Mississippi Valley learns by name, and the ceremony of initiation into the art of angling usually consists in landing a Pumpkin-seed from a brook. It is one of those fishes which does not require a complete angler's outfit and an exhaustive study of bait. A pin-hook, a piece of string, any sort of pole, and a fishworm, are all that is necessary.

Although fairly abundant at Maxinkuckee and possessing some attractive qualities as a game-fish, the Pumpkin-seed is apparently

not caught in any considerable numbers by those who go a-angling. A few are taken about the piers by children and other amateur anglers, and one now and then by anglers who are fishing for larger game. The greatest number and the finest examples are doubtless caught by the long cane pole fisherman. The favorite places are about the various bars where the bluegills congregate.

They usually bite quite well during April and May. From April 16 to May 3, 1901, several people were fishing almost daily at the Ice-house piers, and many good Pumpkin-seeds were taken. One fisherman caught 26 on April 16, and 16 on the next day. On April 24, a small boy fishing from a boat took 10.



Pumpkin-seed Sunfish (*Eupomotis gibbosus*)

Although the Pumpkin-seed reaches maturity at a small size in Lake Maxinkuckee, good-sized examples are often taken. Perhaps 6 to 8 inches is the usual size, but larger examples are sometimes taken. A fine male 7.5 inches long weighed 5.75 ounces.

Those caught in Lost Lake were very dark, almost black in color, due doubtless to the dark color of the water and the bottom of that lake. All the fishes of whatever species from that lake seem in general to have a darker color than those of the same species from Lake Maxinkuckee.

The Pumpkin-seed is preeminently a boy's fish. It takes the hook readily, and promptly begins a fight which bears much resemblance to the way a small dog handles a rat; its movements are rapid, erratic, and uneven, at times quite vigorous, then again life-

less as if the fight were given up. Any sort of small bait will answer but there is nothing else so good as the common angle-worm.

As a pan-fish the Pumpkin-seed has no superior, and the mature roe nicely browned is a tidbit that is not easily excelled.

The food of the Pumpkin-seed is nearly the same as that of the other sunfishes. During the spring of 1901, the principal food was Asellus—the common isopod crustacean of the lake. They fed pretty largely also on small thin-shelled snails. Some contained minnows and darters. The stomach of one 7.5 inches long and weighing 5.75 oz. caught at the Weedpatch September 12, 1907, contained two leeches, fragments of Physa, a thin operculum of some snail and one Pisidium. An example 2.5 inches long caught August 3, 1906, contained what seemed to be fragments of a freshwater sponge, the sponge spicules being abundant; another 2.75 inches long contained insect larvæ, 2 ostracods (Cypris) and 1 water mite; another 3 inches long contained the opercle of a snail and a very small crawfish. Among other food elements (in early spring of 1901) were dragon-fly larvæ, minnows and one darter.

This species begins nesting early in June and continues nesting throughout the summer. Several nests were found in Lost Lake June 12. They were first found near the shore south of the Bardsley cottage and later others were found among those of the bluegills at the north end of the lake. Those near the shore were shallow, bowl-shaped affairs, worn out of the fibrous turfy bottom and containing no shells, pebbles or anything foreign or transported. They contained great numbers of small clear eggs which appeared to stick fast to the fibres projecting from the bottom of the nest. The fish behaves much as the bluegill, fanning the water over the eggs with its fins, and chasing away intruders. They are braver than the bluegill, do not nest so closely together, and do not flee at the approach of a boat.

Somewhat later, nests were found in the Outlet, just west of the railroad bridge and in Lake Maxinkuckee. On June 23, two small nests with the parent fish on were noted in the Outlet, and nests were still noted in July in the big lake. In these latter locations the nest consisted of a bowl-shaped depression scooped out of the sand.

On account of its bravery while on the nest, the breeding habits of this fish can be studied to good advantage. On July 7, 1901, the actions of the parent fish at a nest at the head of the Outlet

were observed for some time. The young were quite minute, transparent objects, the eyes being the most conspicuous part of them. They hugged the bottom quite closely, but were pretty active. Now and then one of them appeared to take a notion to leave the nest, and would swim up toward the surface. Quick as a flash the parent fish would snap it up, and it appeared at first glance as if it were devouring its young, but it was soon discovered that each time it had taken in a young fish it immediately went down to the bottom of the nest, head downward, and spat the young out into the nest near the ground.

In 1906, numerous nests were seen in shallow water near Chadwick's pier, with the parent fishes guarding, and two individuals were seen mating.

The nesting fishes appeared to be remarkably small; specimens only 2.5 inches in length were fully mature.

Young of this species were frequently caught while seining for minnows along shore. On June 19, 1901, examples 1.5 inches long were caught, probably young of the previous year.

Head 3 to 3.25 in length; depth 1.75 to 2; eye 4 to 4.5 in head; snout 4.5; D. X, 10 to 12; A. III, 10 or 11; scales 6-40 to 47, pores 35 to 45, 4 rows on cheek; body short and deep, compressed, the profile steep, convex, usually an angle above the eye; head rather small; mouth small, oblique, the maxillary scarcely reaching vertical with front of eye; dorsal spines rather high, the longest 2 to 2.5 in head, as long as eye and snout, the soft rays higher; pectoral long, as long as head; scales large; gillrakers short and soft, smaller than in any other sunfish except *Lepomis megalotis*, X + 8 to 10; pharyngeal teeth all bluntly rounded, paved, the bones very broad, somewhat concave. One of the most brilliant of our freshwater fishes, the colors somewhat variable. The following are color notes taken from a specimen 7.5 inches long (male) and weighing 5.75 ounces, caught at the Weedpatch September 12, 1907:

Back and upper part of sides with 8 vertical bars of dark blue green alternating with the same number of lighter golden bars; bars of each set, especially the latter, with scattered old-gold spots; cheek brassy or golden, with about 6 irregular pale blue oblique bars; opercle jet-black, edged with blood-red; belly rich orange or brassy; caudal and dorsal dusky with some iridescent green; anal pale wine; ventrals pale orange; pectoral pale; colors exceedingly brilliant.

51. SMALL-MOUTHED BLACK BASS

MICROPTERUS DOLOMIEU Lacépède

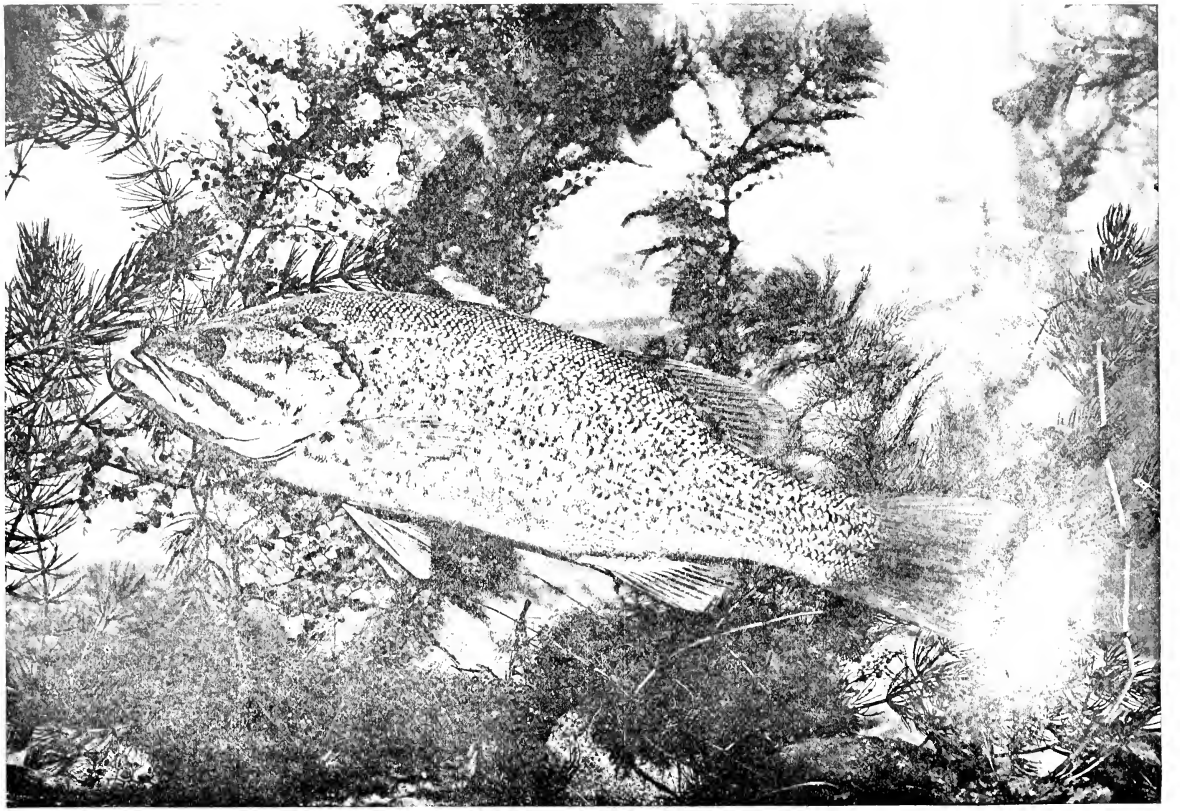
(Plates 27 and 28)

The Black Bass is found in most suitable waters from Lake Champlain westward to Manitoba and southward on both sides of the mountains from James River, Virginia, to South Carolina, and from the Great Lakes to northern Mississippi and Arkansas. It has been planted in many places where it was not native, both in this country, and in England, France and Germany, and has usually thriven wherever planted. It is a fish of clear running streams and of the clearer, colder lakes. In the southern part of its range it is confined to cool flowing streams, but in the north it is equally abundant in streams and in the larger, cooler lakes. It is absent, however, from many of the smaller, shallower lakes, such as Bass, Fletcher, Cicott, Manitou, and others in northern Indiana.

In Lake Maxinkuckee it is a very abundant fish. In the seining operations of 1899-1900, 1,127 specimens were taken, the maximum number secured in one haul being 62. In the summer of 1906, the young of this and the straw bass were phenomenally abundant; and people seining for minnows along shore were usually troubled by getting large numbers of young black bass and nothing else. While seining for minnows near Murray's over a hundred examples of this species were taken in two hauls.

Some idea of the rate of growth can be obtained from the following data: Numerous young of this species measured July 18 and 19, ranged in total length from 1.3 to 2.8 inches, the usual size being 2 to 2.25 inches. Others examined August 1, measured 1.7 to 2.7 inches, the usual size being about 2.3 inches. All these were probably hatched toward the first of June, as we have a number of fry, just hatched, taken from a nest June 1, 1901. They are each about one-third of an inch in length.

This is the fish most sought after by anglers who visit the lake. It can be caught almost the whole year round, and minnows are the best year-round bait. The best fishing, however, is early in August, and again in October and November. During the summer they are usually caught in rather shallow water. The best way to fish for them in August and early September is to use grasshoppers for bait, casting or trolling with a light oil line. In October and November, the best method is to troll with a live minnow, fishing deep by means of a heavy sinker. It is about the only



SMALL-MOUTH BLACK BASS (*Micropterus dolomieu*)

Photographed from life at Lake Maxinkuckee by A. Radcliffe Dugmore for use in Jordan and Evermann's "American Food and Game Fishes," published by Doubleday, Page and Company.

kind of black bass caught in July and August, the large-mouth not coming until September. Besides grasshoppers and minnows the spoon, spinner and fly are occasionally used. Rarely the crawfish makes a good bait. Generally one does not anchor, but trolls slowly with 75 to 100 feet of line out. Sometimes however, good catches are made while still-fishing. Sometimes they are caught through the ice; in the spring of 1901, just as the ice was going off there were 2 or 3 days when this was the principal fish caught; generally, however, it was the straw bass that was taken in winter.

The usual weight of this fish as got in the lake is from 2 to 2.5 pounds; 3-pounders are occasional, and the maximum size seems to be about 5 pounds. There is a record of an angler having caught one which weighed 7 pounds (April 7, 1900), but the fish may have been wrongly identified. A large number were measured, and a good number were measured and weighed. The following table gives the lengths and weights of 21 specimens of this species:

Length	Circumference	Weight
10 inches		9.25 ounces
9.75 inches		8 75 ounces
11.5 inches		10 5 ounces
12.5 inches		1 pound 1 ounce
12.75 inches		13 ounces
13 inches		1 pound 3.5 ounces
13 25 inches		1 pound 6 25 ounces
13.5 ounces		1 pound 6 75 ounces
14 ounces		1 pound 7.25 ounces
14.5 ounces		2 pounds
15.5 inches		1 pound 15 ounces
15.5 inches		1 pound 15 ounces
15 5 inches		1 pound 15 ounces
15 inches		1 pound 12 5 ounces
15.25 inches		1 pound 11.75 ounces
17 inches		2 pounds 8 ounces
17 5 inches		3 pounds
18.75 inches	12 inches	4 pounds
18.5 inches		3 pounds 2 ounces
19 inches	12 inches	4 pounds 8 ounces
20 inches		3 pounds (very lean)

The Black Bass exhibits some variations in color, though not so marked or striking as the straw bass. Some examples are irregularly spotted. A marked variation is brownish rather than greenish, with reddish eyes. Some of the fishermen speak of these as the "red-eyed bass".

By far the greater number of stomachs examined contained crawfishes, and the indications are that these form the chief food

SMALL-MOUTH BLACK BASS (*Micropterus dolomieu*)

SMALL-MOUTH BLACK BASS (*Micropterus dolomieu*)

The same individual fish as above, showing the interesting changes in color markings occurring within a brief time. Photographed at Lake Maxinkuckee by A. Radcliffe Dugmore for use in Jordan and Evermann's "American Food and Game Fishes," published by Doubleday, Page and Company.

of this species. Crawfishes, however, do not make very good bait as a usual thing. A few examples contained *Vivipara contectoides*.

The Black Bass begins spawning about the middle of May. The nest consists of a bowl-shaped depression in sandy or gravelly bottom. Most of those seen were in about 6 feet of water. The fish appear to bite rather well while preparing the nests and perhaps also while watching the nests. A fisherman was seen May 16 who reported that he had gotten 6 on the east side where they were preparing their nests. A few were caught during the nesting season and many were reported taken off the nests, but the reports could not be verified.

Besides being more gamy, the flesh of this fish is regarded as quite superior to that of the straw bass.

Head 2.5 to 3.5; depth 2.75 to 3; eye 5 to 6.5; D. X, 13 to 15; A. III, 10 to 12; scales 11-72 to 85-25, 67 to 78 pores, about 17 rows on cheek. Body ovate-fusiform, becoming deeper with age; mouth large, but smaller than in the large-mouthed black bass; maxillary ending considerably in front of posterior border of orbit, except in very old examples; scales on cheek minute, those on body small; dorsal fin deeply notched, but less so than in the other species, the ninth spine being about half as long as the fifth, and not much shorter than the tenth; soft dorsal and anal each scaly at the base. General coloration, dull golden green, with bronze luster often blotched with darker, especially on head; young with darker spots along the sides, which tend to form short vertical bars, but never a dark lateral band; 3 bronze bands radiating from eye across cheek and opercle; a dusky spot on point of opercle; belly white; caudal fin yellowish at base, then black, with white tips; dorsal with bronze spots, its edge dusky. In some waters the fin-markings are obsolete, but they are usually conspicuous in the young.

"The little-mouth has little scales,
There's red in his handsome eye,
The scales extend on his vertical fins,
And his forehead is round and high.

"His forehead is round and high, my boys,
And he sleeps the winter through;
He likes the rocks in the summer time—
Micropterus dolomieu."

52. STRAW BASS

MICROPTERUS SALMOIDES (Lacépède)

(Plates 1 and 29)

The Large-mouthed Black Bass is everywhere abundant in suitable waters from Canada and the Red River of the North, southward to Florida, Texas, and even into Mexico. It prefers lakes, bayous and other sluggish waters, and in the small lakes of the Upper Mississippi Valley it is most abundant in those of moderate or shallow depths. It is one of the best known game fishes and rejoices in a great number of vernacular names, among which may be mentioned bayou bass, slough bass, lake bass, cow bass, large-mouth black bass and Oswego bass. In the south it is absurdly called trout, green trout, chub and welchman.

At Lake Maxinkuckee it is very abundant and is the game-fish most frequently caught by anglers. It is caught the whole year round, and is the principal species taken in ice-fishing. During the seining operations in 1899-1900, 1506 specimens were taken, the greatest number secured at one haul being 100. In 1906, the young of this bass were exceedingly abundant, so much so that they crowded along the shores, and made up the larger portion of catches obtained by fishermen seining for minnows. On August 10 of that year people seining along the south shore of Outlet Bay with a common minnow seine got 150 young straw bass at one haul.

The Straw Bass is well distributed throughout the lake. During the summer the large ones are often seen near shore where they spend their time over the shallow weedy bars. They are also found on various bars out in the lake, the Weedpatch, the Flatiron and Sugarloaf, being favorite fishing grounds. With the approach of cold weather, after the water has cooled down considerably, they may often be seen in shallow water not far from shore. They come up to shore in considerable numbers at night when the weather begins to get cold. There appears to be a slight tendency in this fish to migrate down to Lost Lake during the winter, and to return to the larger lake in the spring, as occasionally schools of large fish may be seen—usually late at night or early in the morning—drifting down stream in September and October and coming up stream in the spring; and there are almost always during fall and spring good schools of young bass in the Outlet. This migration is relatively unimportant however, when it comes to considering the main mass of fish in the lake. The schools of fish in the Outlet are never so large nor continuous as to form what

might be called a run; the movement down the stream in autumn is an easy drifting, and the ascent in the spring has nothing in it of a purposeful run or migration. Ice-fishing during the winter is quite as good or better in Lake Maxinkuckee than in Lost Lake. Frequently in Lake Maxinkuckee great schools of large bass may be seen through the clear ice, that would cause the angler who has fished through relatively fruitless days in the summer-time to marvel at their size and abundance. These fish under the ice are pretty lively and swim before one at a good rate of speed, in this respect differing from many of the sunfishes.

Although the young Straw Bass are common along the shore of the lake during the summer time, they are also distributed all over the lake in the upper waters. On September 9, 1906, and on a few other occasions, thousands of them were seen far out on the lake sporting on the surface, swimming about in circles much like whirligig beetles, and with the dorsal fin sticking up out of the water. It was supposed that they were feeding on plankton at the surface. A towing was made near where they were feeding and the lake was found to consist mainly of Daphnias.

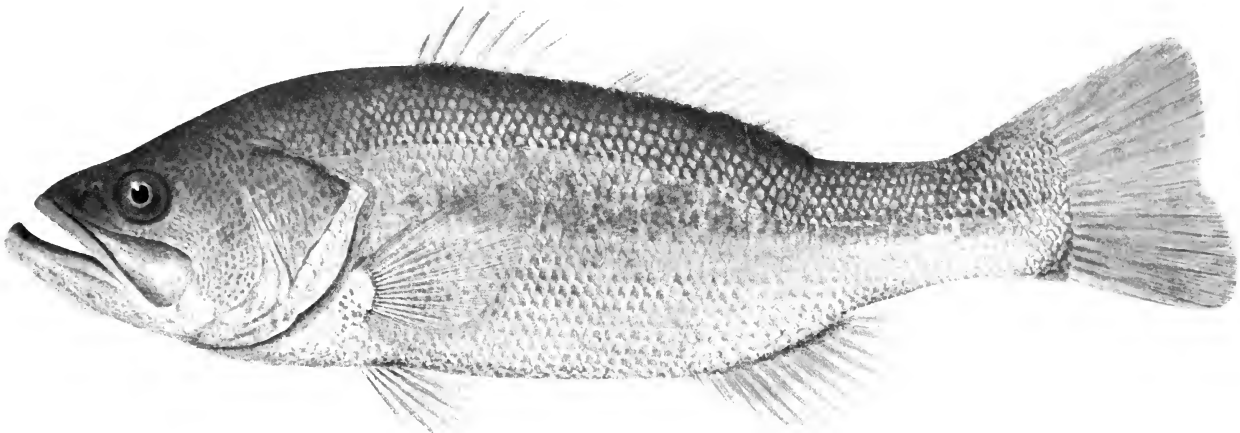
The food of the Straw Bass is quite varied, and so far as examined, appears to exhibit a much wider range than that of the black bass, changing with the size of the fish and with the season. Of 5 small ones examined July 23, 1906, one $2\frac{1}{2}$ inches long contained one copepod; one 3 inches long was empty; one $2\frac{1}{2}$ inches contained beach fleas; one 2 inches contained Cypris, great numbers of Daphnia and one Chironomus larva; and another 2 inches long contained entomostraca and a species of alga not identified; one $1\frac{3}{4}$ inches long taken November 16, 1904, contained insect larvæ. The young bass of somewhat larger size (about 3 inches long) are quite voracious, and frequently eat other fishes. On August 20, a small one caught at Long Point had a small skipjack not much shorter than itself halfway down. This, however, may have been an accident, as in seining where fishes are crowded they may snap at each other while gasping. On August 23, a young one was seen to dash from shore with a silvery fish, apparently a young bluegill, in its mouth. The fortunate bass was followed by a crowd of smaller ones, much as a flock of chickens chase one that has a choice morsel. On the next day precisely the same phenomenon was observed again. The food of the larger Straw Bass is quite as varied as that of the young. Of 3 examples, weighing about $1\frac{1}{4}$ pounds each, examined April 28, 1901, one contained 4 crawfishes, one had 2 darters and 4 crawfishes, and the third contained 2 crawfishes. Numerous others contained crawfishes, which seem

to be the most important element of their food. One example contained several darters; another 19½ inches long contained the spines of another fish; several contained *Vivipara contectoides;* one 5 inches long contained a backswimmer; and another, a medium-sized minnow. On August 7, 1906, a fisherman reported finding a young musk turtle in the stomach of a straw bass; another example contained a minnow, a johnny darter and several Sphærium shells; another contained a grasshopper—probably bait; and a large bass 19 inches long was found dead on shore with a good-sized bluegill lodged crossways in its mouth—a victim of its own greed. Although the bass bite eagerly in the winter, they appear to eat very little then; all the stomachs examined caught by ice-fishing being empty except for parasites.

The Straw Bass is the most abundant game-fish in the lake, and one of those most frequently caught. They are considered a good deal more loggy than the black bass and the flesh is coarser and not so finely flavored. The best season for catching the Straw Bass is in May and June, by trolling along the edge of bars; one observant fisherman claims that only males are obtained at that time. In fishing for the Straw Bass, almost all sorts of methods are used except fly-fishing, which is not much in vogue at Lake Maxinkuckee. In early summer the fish are caught on bars among the weeds in from 3 to 8 feet of water; later in the year they are often caught in deeper water; some were caught in 30 to 40 feet on October 17. Minnows are the best all-year-round bait—gray-back and blue-nosed chub, etc., for warmer weather, and shiners for cold weather. During late summer and early fall the grasshopper is favorite bait. Bass are also caught on the spoon, spinner, artificial frog, meat-rind, pork-chunk, etc. A few anglers are not ashamed to use the Dowagiac minnow, but the better sportsmen regard it as a barbarous device, fit only to be used by a clumsy fish-butcher.

This fish is the species most frequently caught by ice-fishers.

Just what might be considered a good catch at the lake depends upon the circumstances, the fisherman, the methods of fishing, etc. With the old methods of ice-fishing where there was no limit to the number of hooks, more could be obtained than in summer fishing. This varied greatly with the individual, as some men who fished a great deal through the ice got very few fish, and for a just comparison it would be necessary to have the records of the same person fishing both winter and summer, and having ample opportunity to fish the whole season through. One of the best ice-fishers got 21 Large-mouth Bass in one day (January 15, 1901); another,



LARGE-MOUTHED BLACK BASS, *Micropterus salmoides* (Lacépède)

hardly so good an angler, fishing after the ice had gone, got 13 one forenoon.

The true sportsman who comes to the lake, however, is little concerned with the number of fish he catches. He would wish for some probability—not quite a dead sure certainty—that he would get a strike from some big gamy bass. He would wish that bass so full of maneuvers and tactics as to test his skill to the utmost, and make the issue of the battle uncertain. He would like perhaps another boat in the distance, but not too near, to help tell the story of the fight, and to tell it as a disinterested spectator. And if a really big bass is landed, it is perhaps with a twinge of regret that he finds it necessary to take the fish along as a proof of his veracity instead of turning it loose with the hope that he or some one else may meet it again in battle.

During the autumn the young bass can be caught in the Outlet by the crude method of the old long cane pole and worm bait. On October 22, a boy was seen fishing from the railroad bridge with worms. He had caught 2 Straw Bass each about 5 inches long.

The Straw Bass begins spawning about the middle of May. On May 30, 1901, about a dozen nests were found. They consisted of circular depressions filled in with pebbles from about the size of a hen's egg down; some of them being finer, others of coarser, gravel, and they were from one foot to about $2\frac{1}{2}$ feet across in a depth of about 6 feet of water. The nests were found off Kreutzberger's, in front of the Palmer house and east of Lakeview hotel, also off the stone breakwater near the northeast shore of the lake. At the time the nests were found they were filled with little black young which looked much like carpet tacks scattered over the bottom. It is claimed by some of the fishermen about the lake that the bass will bite from the nest, and that during the nesting season it is easy for one who knows where the nests are to go from one to another and catch a number of fish.

The Straw Bass caught in the lake average from 3 to $3\frac{1}{2}$ pounds or less. The largest specimen, so far as verified records go, weighed 8 pounds. One fisherman in June, 1895, caught an 8-pounder which weighed $5\frac{1}{4}$ pounds when dressed. Another fisherman, fishing from a pier, caught one weighing 8 pounds and just 24 inches long; one man claims to have got one of $8\frac{3}{4}$ pounds. A great many fishes were weighed, and a number were both measured and weighed, occasional weights are 5, $5\frac{1}{4}$ and $6\frac{1}{4}$ pounds. The following table gives the weights and measurements of a number of Straw Bass taken at the lake:

Length	Circumference	Weight	Length	Circumference	Weight
$9\frac{1}{2}$ inches		8 oz.	19 inches	12 inches	4 lb. 8 oz.
16 inches		2 lb. 15 oz. female; plump	17 inches		2 lb. $12\frac{1}{4}$ oz.
$11\frac{1}{2}$ inches		12 oz.	$18\frac{1}{4}$ inches		3 lb. $2\frac{1}{2}$ oz.
$15\frac{1}{2}$ inches		2 lb. $\frac{1}{4}$ oz			
14 inches		1 lb. 8 oz.			
$17\frac{1}{2}$ inches		3 lbs.			
$17\frac{1}{2}$ inches		3 lbs.			
19 inches		4 lbs.			
17 inches		2 lbs.			
$12\frac{3}{4}$ inches		1 +			

The following table taken from Report State Fish Commissioners of Penn., 1897, p. 159, may be of interest for weights and measurements of smaller examples:

Inches	Weight of each Fish in Ounces
$5\frac{1}{2}$	$1\frac{1}{4}$.
6	$1\frac{3}{4}$.
$6\frac{1}{2}$	2, 2, $2\frac{1}{2}$, 2, 2, $2\frac{1}{2}$, 2, 2, $2\frac{1}{2}$.
7	3, 3, 3, 3, $2\frac{1}{2}$, 3, 3, $3\frac{1}{2}$, 2, 2, $2\frac{1}{2}$.
$7\frac{1}{2}$	4, $3\frac{1}{2}$, $3\frac{1}{2}$, 4, 4, $3\frac{1}{2}$, 3, 4, $3\frac{1}{2}$, 4, $3\frac{1}{2}$.
8	4, $4\frac{1}{2}$, 4, $4\frac{1}{2}$, 5.
$8\frac{1}{2}$	5, 5, $5\frac{1}{2}$, 5, 5, $5\frac{1}{2}$, 5, 6.
9	6, 6, $5\frac{1}{2}$, 7.
$9\frac{1}{2}$	7, 8, 7, 7, 8, 9, 7, 7.
10	10, 9, 7, 7, 8, 8, 8, 8, 7, 7, 8, 8, 9, 8, 8, 8, 10, 9, 9, 8, 10, 9, 8, 8, 9.
$10\frac{1}{2}$	11, 10, 9, 10, 10, 9, 9, 11, 11, 10, 11, 9.
11	11, 11, 11, 10, 11, 12, 10, 12, 11, 12, 11, 11, 12.
$11\frac{1}{2}$	12, 12, 12, 13, 13, 12.

The Straw Bass reaches a larger size farther south than here.

Mr. Willard Nye of New Bedford, has given us the following note:

"On or about February 20, 1902, I caught a female Large-mouthed Black Bass in the uppermost of a long chain of small lakes in Pasco County, Florida. The fish weighed $11\frac{1}{2}$ pounds, measured $26\frac{1}{2}$ inches in total length, $21\frac{1}{2}$ in circumference, and $7\frac{1}{2}$ across the mouth from side to side. The eggs were pretty well developed, but not ripe; the stomach contained one small fish too far digested to be identified. The fish was caught trolling with a phantom minnow of the blue-back variety, $3\frac{1}{2}$ inches long, which is the best bait for all sorts of fish in the fresh waters of Florida; even very small bass and sunfish will take this lure."

The large bass referred to jumped once entirely free from the water. Mr. Nye says that he has heard of other bass in Florida weighing as much as 12 pounds, but this is the largest he ever saw.

On another occasion he caught one not much shorter in length than this, but weighing only 5 or 6 pounds.

As to rate of growth in the lake, this is found to vary a good deal with individuals in the same waters. The young of the year were about 1 inch long on July 5, 1899, and in September and October, 1906, the smallest Straw Bass seen were about 2½ or 3 inches long and were supposed to represent the young of the year.

The Straw Bass about the lake seem to be quite free from parasitic copepods, leeches, etc. Internal parasites are not rare. During the winter of 1900-1901, nearly all the stomachs examined were empty of food but almost all contained a few distomids, one lot examined averaging about 8 distomids apiece. The young are sometimes afflicted with numerous parasites. Some examined July 24, 1906, contained a few distomids; a small one examined July 30, had one distomid; and of 3 small examples studied July 23, all contained parasites; one about 3 inches long, contained the usual distomids, the second 2 inches long contained 1 Acanthocephalus, and another 2½ inches long contained 4 different kinds of internal parasites.

Head 3 to 3½ in length; depth 3 to 3¼; eye 5 to 6 in head; D. X, 12 or 13; A. III, 10 or 11; scales 7-65 to 70-18, about 58 to 67 pores, 10 or 11 rows of scales on cheek. Body ovate-fusiform, becoming deeper with age, moderately compressed; head large; mouth very wide, the maxillary in adult reaching beyond the eye, shorter in the young; scales on body comparatively large; teeth sometimes present on tongue; gillrakers longer than gill-fringes; dorsal fin very deeply notched, its fifth spine 3¼ in head. General color, dark green above, sides and below greenish silvery; young with a blackish stripe along the side from opercle to middle of caudal fin; 3 oblique dark spots above and below lateral line; caudal fin pale at base, then blackish, and whitish at tip; belly white. As the fish grows older the black lateral stripe breaks up and grows paler and the color becomes more and more uniform pale dull green, the back being darker.

53. WALL-EYED PIKE

STIZOSTEDION VITREUM (Mitchill)

(Plate 30)

The Wall-eyed Pike is a species of wide distribution. It is found from Lake Champlain westward throughout the Great Lakes region and to Assiniboia. It is native also to the small lakes of New York and the Susquehanna and Juniata rivers, east of the

Alleghenies. In the Mississippi Valley it occurs in many of the larger streams and small lakes as far south as Georgia and Alabama. Though found in many streams, it is preferably a fish of the lakes, and it reaches its greatest abundance in the Great Lakes, particularly in Lake Erie. In different parts of its range it is known by different names. Among the Great Lakes it is called the Wall-eyed Pike, Yellow Pike, or Doré by the French-Canadians, and Pickerel in the places where the true pike (*Esox lucius*) is found. In the Susquehanna and Juniata rivers, and in the small lakes of northern Indiana, it is known as Salmon or Jack Salmon, names absurd and wholly without excuse. Southward in the Mississippi Valley it is the Jack. Elsewhere it is called Okow, Blowfish or Green Pike. In fish cultural books it is called Pike-Perch.

The Wall-eyed Pike is rarely seen in Lake Maxinkuckee, although it is not uncommon there. During the warmer weather they keep in deep water. When the weather first gets cold in the fall they come in to shore in some numbers at night, doubtless to feed on other fishes. Illegal fishermen who ply their work on dark nights and chiefly during the autumn and spring, sometimes get these fish. One man claims to have speared a two-bushel sack full of these fish early in the spring near the Inlet, where they had doubtless come to deposit their spawn. They do not appear to stay near shore or in shallow water during the winter, for they are not seen through the clear ice, and it is not known whether they go in schools like the perch does or not. From the fact that only one or a few are usually caught at a time, it would seem that they are rather solitary.

The Wall-eyed Pike is never caught in large numbers; usually only 1 or 2 are taken at a time. On October 27, 1900, one man caught 4 large ones one forenoon, and on the next day he caught 3. This would be regarded as exceptionally good luck. On November 3, 1900, 2 fishermen fishing together got 5, and on May 26, 1901, two men fishing together caught 4 in the forenoon and 7 in the afternoon; this would be regarded as quite remarkably good success. A very good fisherman who visited the lake for a week about October 16, 1905, got 10 of this fish in addition to a few of other species. Another sportsman who visited the lake had taken a particular fancy to this fish, and made it the special object of his search. He caught about 21 in 3 weeks and regarded himself as having been quite successful.

The Wall-eye bites almost any time during the year, but the best season is in June and during October and November. They are occasionally taken through the ice.

As to bait and manner of fishing, they take readily to both grasshopper or minnow, and are sometimes taken trolling with the spoon. They are usually caught slowly trolling with a live minnow, the hook being sunk with heavy sinker to a depth of 25 to 50 feet. They are regarded as one of the most desirable gamefishes of the lake. Perhaps one feels a greater pride in having landed a good-sized "salmon" than with any other fish, not excepting even the small-mouth black bass.

In many respects the Wall-eye is one of the most desirable of the fishes of the lake. The fact that very few are caught as compared with the bass, makes it difficult to compare them with that fish as many who have fished for bass never caught these. They are generally regarded by those who catch them as exceedingly gamy, making a good fight and affording a great deal of sport. As a food fish they are far superior to the bass, approaching their relative, the perch, in this regard, and greatly exceeding it in weight. They are the largest game fishes in the lake. The average weight is 3 to 5 pounds, and they are rarely seen under 1 pound in weight. They have been reported up to 8½ pounds and there is an account given by an old resident of the region of one obtained a good many years ago which weighed 11 pounds.

The Wall-eye does not weigh as heavily for its length as the bass; one 19½ inches long weighed 3 pounds, another 20 inches long weighed the same, and one 22 inches long weighed 3 pounds 12 ounces. We have the lengths of examples 8, 10, 12¼ up to 19 inches, measured but not weighed, and of examples from 2 to 6½ lb. weighed but not measured.

Dr. G. Brown Goode in his "American Fishes" has the following interesting remarks concerning the flavor of the pike-perch.

"Wherever the pike-perch is known it is very highly prized. In the Great Lakes region, *S. vitreum* ranks next in value to the white fish and lake trout."

He further says, "The flesh is hard, white, flaky and easy of digestion, and has a distinctive flavor of its own, which renders it especially available for boiling, though often stuffed and baked. Its capabilities are equal to those of fresh-caught cod or turbot."

Concerning its gaminess and method of capture he says:

"A correspondent of the *American Angler* wrote sometime ago to that journal that he had fished the streams and lakes of southern Wisconsin for twelve years, and had found no fish which afforded him better sport than the pike-perch. It will take the fly as readily as the brook trout or the black bass and while it will not fight as long as the bass, it furnishes the fly-fisher with a fair

amusement, and as a table fish is infinitely its superior. With a light rod, weighing from five to nine ounces, a four-foot leader, and a bass-fly, this fish may be readily taken. The angler should whip the white foaming water below a dam, on some frosty morning using a dark fly or cast upon the same water toward evening with a light fly. He will learn that there are new possibilities for him in the way of sport with a rod."

One of the most interesting historical notes concerning the lake relates to this fish. A resident of the place writes:

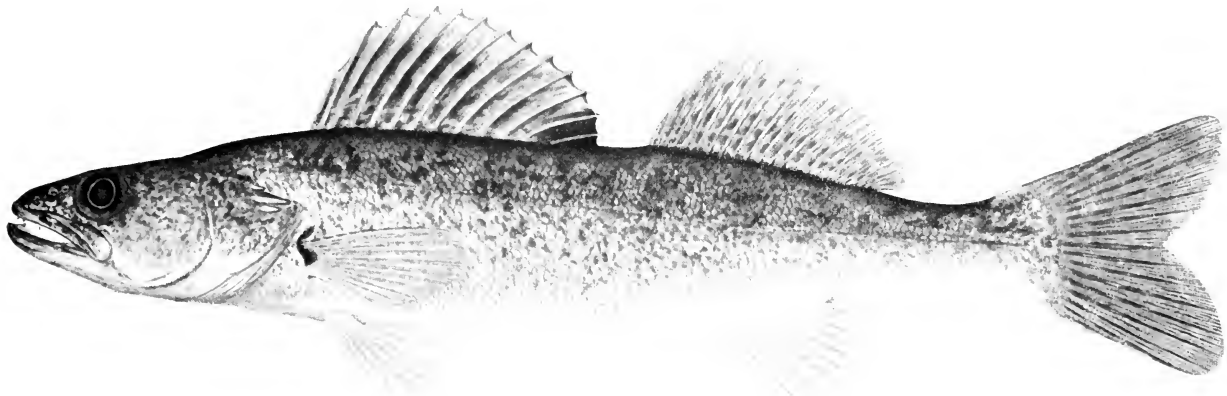
"As for the salmon (wall-eyed pike) they are a native to Lake Maxinkuckee, also to Yellow River, Mr. ——— tells me he speared them in both places 30 years or more ago. Other parties tell me the same. I met a Mr. Cobin at Rochester in 1892, and he told me that in 1838 or '39, he and Attorney Entline came by our lake on a return trip from Illinois, and found a band of Indians camping on a hill west of the lake and that the bucks were killing fish with clubs and bows and arrows; that he never saw the like of fish, and that the squaws were smoking and drying some for winter use."

The Wall-eye is one of the principal fishes planted in the lake; they have been planted in large numbers on several occasions; on May 14, 1902, 10,000,000 fry were planted in the lake.

A sudden chilling of the water seems to benumb these fishes even more than the other fishes of the lake. In the winter of 1900 (December 10) when the first skirt of thin ice was formed about the edge of the lake, a large Wall-eye was seen swimming along under the ice on its side. It was easy to kick a hole through the ice and take the fish out. It made very little resistance. On November 14, 1904, which was about the time the lake began to freeze, while rowing to the Weedpatch a fine Wall-eye was seen floating belly up. It was able only to flop feebly when lifted into the boat.

The nature of the food of the Wall-eye can be best judged by its sharp strong teeth. No other fish in the lake equals it in this respect. Nearly all the stomachs examined, however, were empty or nearly so; a few contained half digested minnows and some contained crawfishes or their remains. One specimen contained 6 crawfishes. It is claimed that this fish while being brought through warmer surface water during the process of capture gets sick and disgorges its food.

Nothing was learned of their spawning habits at the lake. Its habits are, however, well known in this respect, as it was one of the first fishes experimented upon by American fish culturists.



WALL-EYED PIKE, *Stizostedion vitreum* (Mitchill)

The following account of its spawn and spawning habits are given in Goode's American Fishes (Revised edition):

"The eggs are from 1 to 1½ millimeters in diameter and light golden yellow in color, and are adhesive like those of the sea-herring, clinging to stones, roots, and the stalks of water plants where they are deposited at a depth of from three to ten feet. They begin to spawn when less than a pound in weight, and each female deposits from two or three hundred thousand ova. This great fertility is serviceable, for no freshwater species is more subject to the fatalities incident to the spawning season. After storms the shores of lakes are said to be often bordered by windrows of the stranded ova of the pike-perch. Dr. Estes well describes the destructive inroads of sturgeon, catfish and suckers upon the spawning beds in Lake Pepin. He estimates that 'not one-fourth of the eggs remain to be hatched.' He quotes Dr. Estes as saying that 'Just as soon as the lake is well closed over with the ice, they leave the deep water and resort to the sand-bars where they remain until spring. It seems a fact that they select and take possession of the spawning beds fully three months before they are needed for use. I have carefully observed this habit for more than twenty-five years, and each year's observation is confirmatory. In the first place we do not take them on these bars in summer, and again two-thirds of all that are taken from the beginning of winter to spring are females, proving conclusively that they thus early select these bars as spawning grounds. I have often visited them as early as May (the spawning season in Lake Pepin is from the first to the fifteenth of April or even earlier) but failed to find the fish, while, from the closing of the lakes to March, they are often found in great numbers.'"

Dr. Goode further says that "The pike-perches are never taken in large numbers for use in commerce except during the spawning season, or immediately before it, and like the perch, they are in the finest condition when full-roed."

The Pike-perch is very free from parasitic copepods or fish-lice, although a few examples contained Ergasilus on the gills. One or two examples seen had leeches attached to the fins. They seem to be nearly or wholly free from distomids and Acanthocephali. They are, however, subject to infection with tapeworms to a remarkable degree, and nearly all of the individuals examined had the stomach and intestines swarming with multitudes of these parasites.

Head 3.6 in length; depth about 4.5; eye shorter than snout, 4.5 in head; D. XII to XVI-19 to 21; A. II, 12 to 14; scales 10-110

to 132-25, 83 to 95 pores; body slender, becoming compressed with age; the back somewhat arched; cheeks and upper surface of head nearly naked; dorsal spines high, more than half length of head; dorsal fins well separated, the interspace between them greater than diameter of eye; the last dorsal spine scarcely erectile; soft dorsal nearly as long as spinous dorsal; anal longer than high; pyloric cœca 3, rather long. Color dark olive, finely mottled with brassy, the latter color forming indistinct oblique lines; sides of head more or less vermiculated; lower jaw flesh-colored; belly and lower fins pinkish; spinous dorsal with a large jet-black blotch on the membrane of the last 2 or 3 spines, otherwise nearly plain; second dorsal and caudal mottled olive and yellowish; base of pectoral dusky, without distinct black blotch.

54. YELLOW PERCH

PERCA FLAVESCENS (Mitchill)

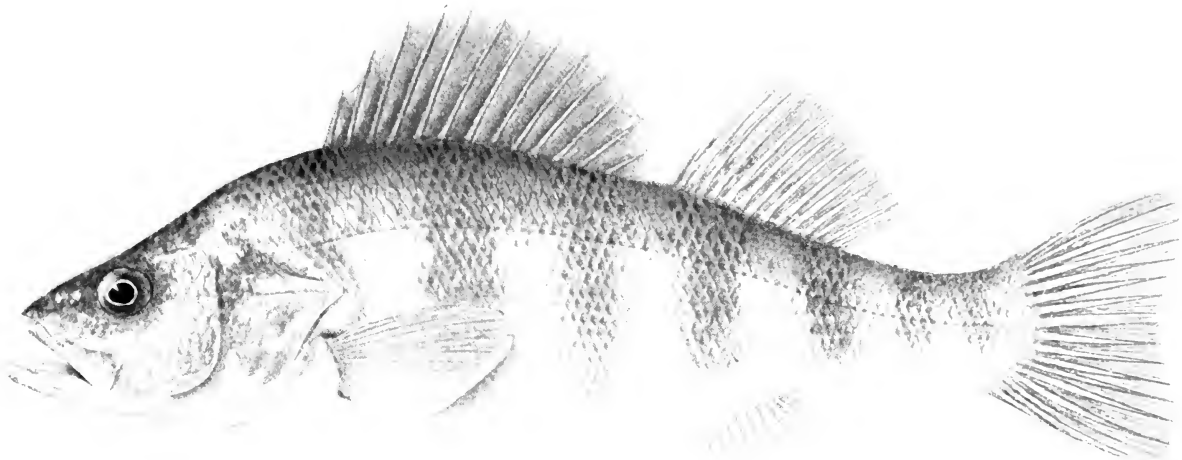
(Plates 31 and 32)

The Yellow Perch is found throughout the eastern United States, chiefly northward and eastward. It is abundant in the Great Lakes and in the larger coastwise streams and lakes from Nova Scotia to North Carolina; also in most of the small lakes in the upper Mississippi Valley, especially in northern Indiana, Illinois, Michigan, Wisconsin, Minnesota and Iowa. It is also found in some of the streams of this region, but is by preference a lake fish. It is not known from the Ohio River nor from the lower Missouri. In most of the New England lakes and those of New York it is an abundant and well-known fish.

At Lake Maxinkuckee the Yellow Perch is the most abundant and best known fish. It is simply called "perch" here, as there is no other perch present from which it is necessary to distinguish it. The Perch seem to be less abundant and of smaller size than formerly. During the seining operations of 1899-1900, the total number caught was 4544, one or more examples were caught in each of 282 of the 612 hauls, and the greatest number taken in one haul was 141.

Perch are found in abundance in all parts of the lake, though they live by preference in the shallower water and about the weedy bars. One of the pondweeds (*Potamogeton americanus*) of the lake is known as "perch weed" from the fact that Perch are frequently to be found in especial abundance where it grows.

In rowing about the lake this is the fish most often seen in the shallow water, and it is frequently seen in large schools under the



YELLOW PERCH, *Perca flavescens* (Mitchill)

clear ice. The Perch are quite lively under the ice and dart away at a good rate of speed.

There is no other fish of Lake Maxinkuckee so well known or held in such universal favor and esteem as the Yellow Perch. It is known to, and appreciated by, every one who comes to the lake, from the expert and professional angler to the casual visitor who only sees the fishes in the clear shallow water as he saunters along the shore. The angler does not disdain it because it will take the fly and possesses some qualities of gameness; the amateur likes it because it enables him to make good when better fish refuse to bite; the novice is pleased with it because he can usually catch more of it than he believed it possible for him to catch of any species; the women and children are delighted with it because all fish are good that come their way and they can catch them from the ends of the piers; it appeals to the farmer-fisherman with the long cane pole because it shares with the bluegill the honor of making up the bulk of the bushel of fish in the gunny-sack which he usually takes home at the end of the day's fishing. It appeals to everybody because it will bite when all else fails; because it is gamy enough to suit anyone except the most exacting, and because there is none more delicious.

The Perch can be caught almost every day in the year and by all manner of bait and methods of fishing. They can be caught trolling, still-fishing or casting, and can be taken in great numbers through the ice. In the matter of bait, they will take fishworms, mussels, minnows, the spoon, the fly, grasshoppers, cut bait, or probably anything else offered. The Perch is a fearless fish and by letting down a baited hook over the edge of the boat in clear water, one can look down and see these fish come up and take the bait. They usually take a small minnow with a dash and gulp and in such cases are caught deep. If cut bait is used, especially if it is large, they come somewhat with a dash and then nibble about the edges of the bait, frequently catching hold of it and shaking it as a terrier does a rat. In angling with the cork float, the characteristic "perch nibble" consisting of a rapid bobbing of the cork, separated by short intervals of rest and terminated by a long pull when the fish is hooked, is easy to learn and recognize. The Perch are usually in schools; often several perch, especially if they are small, can be seen wrestling with the same bait at the same time.

The Yellow Perch is known in various localities by different names, such as Yellow Perch, Red Perch, Ringed Perch or Ring Perch, and Raccoon Perch. Wherever it is found it is the perch

YELLOW PERCH (*Perca flavescens*)

Photographed from life at Lake Maxinkuckee by A. Radcliffe Dugmore for use in Jordan and Evermann's "American Food and Game Fishes," published by Doubleday, Page and Company.

par excellence. It is one of the most abundant and best known of freshwater fishes. Its usual length is 10 to 14 inches and its weight ½ to 2 pounds. Examples of 3 and 4 pounds, however, have been recorded. The largest examples of which we have a definite record are one of 4¼ pounds recorded by Dr. Goode, caught in Delaware Bay, by Dr. C. C. Abbott, and another reported to us by Dr. F. A. Lucas, taken at Morey's Hole, Massachusetts, and weighing 3 pounds and 2 oz. The Yellow Perch of Europe seems to grow much larger, examples of as great as 8 and 9 pounds having been recorded. The European perch is not so brightly colored as ours.

As a pan-fish we do not know of any better among American freshwater fishes. The senior author has experimented with the Yellow Perch and several other species, including both species of black bass, the bluegill, wall-eyed pike and rock bass, eating each for several days in succession, and has found the Yellow Perch the sweetest and most delicious of them all. One does not tire of it so soon as of the other kinds. Several other persons who tried the same experiment reached the same conclusion. In most parts of its range it is highly esteemed, and in many places it is of very considerable commercial importance. In the Great Lakes, the Potomac River and the small lakes in the upper Mississippi Valley, large quantities are taken, which always find a ready sale.

The diet of the Perch is exceedingly varied. In late autumn when they come near shore they subsist almost entirely on crawfishes, and these form the greater portion of their food the year round. They also were found to contain minnows, the larvæ of May-flies, dragon-flies and caddis-flies, and quite frequently small mollusks of various sorts, such as Physa and Sphærium. They also occasionally contain small worms, young of other fishes such as sunfishes, and one contained a stickleback. One was found dead choked on a Johnny darter.

The Perch of Lake Maxinkuckee seem to be quite free from diseases and parasites. One found dying on shore contained what appeared to be cysts in the liver; this was the only diseased one seen. A large number caught in the fall at the edge of Lake Michigan in 1903 were examined, and nearly every one had one or more white cyst-like objects imbedded near the eye, probably due to Myxosporidia, but no such phenomenon was noted at Lake Maxinkuckee. In some other lakes, particularly in New England, New York and Wisconsin, the Yellow Perch are frequently infested with tapeworms or other parasites which are found in the flesh. This condition is most apt to occur in ponds in which the water

becomes rather warm and foul in the summer or early fall and in which the fish are crowded. The presence of the parasites is usually only temporary and need cause no particular annoyance, and none whatever, if the parasites escape observation.

The spawning time of the Yellow Perch is early in the spring, soon after the ice has disappeared. The egg-masses are among the most remarkable among those of freshwater fishes. The spawn is in a single piece or mass, a "much-elongated ribbon-like structure, of a semi-transparent light grayish color. One end, corresponding to the anterior part of the roe, is larger than the other, and is bluntly forked. The spring is very long, but may be compressed lengthwise by virtue of an arrangement into regular transverse folds like the sides of a bellows or accordion. When deposited the eggs are in a loose globular form, and after being fertilized and becoming 'water-hard', their mass rapidly becomes many times larger than the fish which laid them. The length of the strings is from 2 to more than 7 feet, depending on the size of the fish. One fish in an aquarium at Washington deposited a string of eggs 88 inches long, 4 inches wide at one end and 2 feet at the other, whose weight after fertilization was 41 ounces, while the weight of the fish before the escape of the eggs was only 24 ounces.

A cavity extends the whole length of the egg mass, its walls being formed by the delicate membrane in which the eggs are embedded. The cavity is almost closed, small apertures occurring irregularly, which have the appearance of being accidental, but may be natural, in order to permit the circulation of water on the inside of the mass.

The egg-string is quite light and resilient or springy, the least agitation of the water causing a quivering motion of the whole mass.

The diameter of the egg is 1 13 inch. The quantity can not be easily measured, but the number is approximately 28,000 to a quart.

Head 3.25; depth 3.25; D. XIII to XV, 13 to 15; A. II, 7 or 8; scales 7-74 to 88-17, 54 to 62 with pores; back highest at origin of spinous dorsal, which is more or less behind insertion of pectoral; profile convex from dorsal to occiput, thence concave anteriorly, the snout projecting, a little longer than eye; mouth somewhat oblique, maxillary not quite reaching opposite middle of orbit; gill-rakers x + 15, the longest $\frac{1}{3}$ to $\frac{3}{4}$ length of branchial filaments; cheeks closely scaled throughout, the scales imbricated; opercular striæ and rugosities on top of head well marked; first anal spine longer than first dorsal spine; first dorsal spine inserted above

or a little behind base of pectoral; pseudobranchiæ quite small. Back dark olivaceous; sides golden yellow; belly pale; side with 6 or 8 broad, dark bars, which extend from the back to below the axis of the body; lower fins largely red or orange; upper fins olivaceous; the spinous dorsal dusky, usually with a narrow colorless triangle behind each spine, and with or without a distinct black spot on its anterior or posterior part.

55. LOG PERCH

PERCINA CAPRODES (Rafinesque)

(Plate 33)

The Log Perch is abundant almost everywhere in the Great Lakes and streams of the south and west from Quebec to Lake Superior and Iowa and south to Mississippi and the Rio Grande, chiefly in swift gravelly streams of some depth.

This species, represented by the subspecies *zebra* or the Manitou darter, was very abundant in the lake in 1899-1900. In the seining operations one or more examples were obtained in 143 out of the 612 hauls made—2,310 were obtained altogether, the greatest number taken in any single haul being 310. During the progress of the work after 1900, however, not so many were obtained. They ordinarily remain in shallow water near shore. They are often seen during April and the early part of May. The first one seen in 1901 was on April 6; this was found dead and was quite full of eggs. From this time on till early May these fishes crowded up in immense schools at the mouths of the various inlets of the lake. Large schools were noted at the mouth of the ditch by Farrar's, at the mouth of Aubeenaubee Creek, and even at the mouth of a tile by the depot grounds. When the fish were frightened they darted rapidly up stream. On April 11, 1901, 29 were caught with a dip-net at the mouth of Aubeenaubee Creek, and were measured. The longest was 4.25 inches long and the shortest 3¼ inches; the greater number were 3⅞ and 3¾ inches long. The females were quite plump, and contained large numbers of eggs. The eggs were rather pale in color, about 22 to the inch, and were very numerous; in one case the number of eggs in a single fish was estimated at 3,172. In darting up the streams they sometimes went with such an impetuous rush that some would get stranded on the shore. On April 29, a few were seen along the north shore and they were abundant where springs entered the lake. Although they are not ordinarily seen in small creeks, some were seen in the small creek on the north shore of the lake west of the Palmer House on

May 3. Quite a number were seen May 17, resting on the top of rocks in about 6 feet of water, and they were occasionally seen on rocks in the bottom through clear ice during the winter of 1904. A few were obtained while seining for minnows along Long Point and the Gravelpit in 1906. They are quite active during the winter, and not torpid as many fishes are.

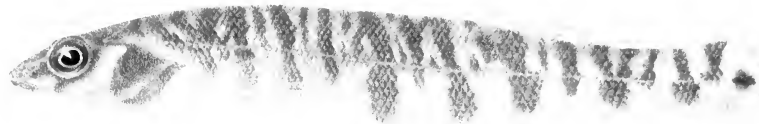
This fish subsists chiefly on small animals. Five examples from 2.5 to 3.75 inches long, captured August 3, contained the remains of insects or insect larvæ; of two 2.25 and 2.75 inches long, one contained several Bosminia, 1 Daphnia, Chironomus larvæ, and a beach flea, the smaller one contained 12 beach fleas.

The Log Perch is infested to some degree by trematodes which form small black spots in the skin, but it is not so susceptible to the attacks of these parasites as some of the other darters.

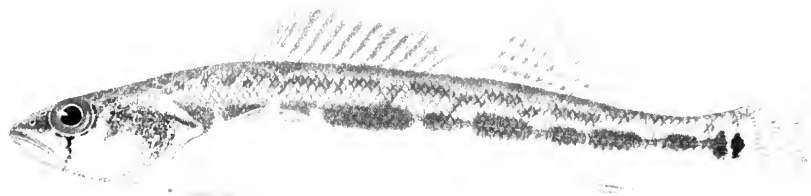
The Log Perch, although one of the largest of the darters, probably never exceeds 9 or 10 inches in length. It is scarcely large enough to be of any value as a food-fish. It will occasionally take the hook, but its small size precludes the exhibition of any considerable game qualities.

"The Log Perch is the giant of the family*, the most of a fish, and therefore the least of a darter. It may be readily known by its zebra-like colors. Its hue is pale olive, silvery below, darker above. On this ground color are about 15 black vertical bars or incomplete rings, alternating with as many shorter bars which reach only halfway down the side. The hindmost bar forms a mere spot on the base of the tail, and there are many dots and speckles on the fins. The body is long and slender, spindle-shaped, and firm and wiry to the touch. The head is flat on top and tapers into a flat-pointed snout which is squared off at the end like the snout of a pig, and this resemblance is heightened by the form of the small mouth underneath it. From this pig-like snout has come the scientific name *caprodes*. This is a translation of the older name of 'hogfish', which Rafinesque heard applied to it in his time and which is still used in the same regions. Percina reaches a length of 6 or 8 inches and it may readily be caught on a small hook baited with a worm. We often meet an urchin with two or three of them strung through the gills on a forked stick along with the 'red-eyes', 'stonetoters', 'hornyheads', and other 'boys' fish'. We find Percina usually in rapid and rather deep water. We rarely find them small enough for ordinary aquarium purposes; and the living specimen before us, though wonderfully quick and graceful in its movements, has shown little that is note-

* Except the rare *Percina nex*, described after the above was written.



LOG-PERCH, *Percina caprodes* (Rafinesque)



BLACK-SIDED DARTER *Hadropterus aspro* (Cope & Jordan)

worthy, save his courage, his fondness for angleworms, and a possible disposition to bury himself in the sand. There is something in the expression of his face, as he rests on his 'hands and feet' on a stone, that is remarkably lizard-like, suggesting the Blue-tailed Skink (*Eumeces fasciatus*)."—Jordan and Copeland, 1876.

Head 4 to 4.25 in length; depth 6.5 to 7; eye 4.3 in head; snout 3; maxillary 3.75; D. XV-14; A. II, 10; scales 9-90-9, the nape naked, the middle of the belly with a row of enlarged stellate scales which are finally shed leaving a naked strip; body elongate, compressed; head long and pointed, depressed and sloping above, the interorbital space rather broad and concave; mouth small, quite inferior, maxillary not reaching to the front of the eye; cheeks naked or with a few rudimentary scales; nape naked; opercles scaly; chest naked; fins rather low, pectoral somewhat shorter than head; caudal truncate.

Ground color yellowish, with about fifteen transverse dark bands from the back to about the lateral line, these usually alternating with shorter and fainter ones; a black spot at base of caudal; fins barred. Length 6 to 8 inches.

56. BLACK-SIDED DARTER

HADROPTERUS ASPRO (Cope & Jordan)

(Plate 33)

The Black-sided Darter is found from the Great Lakes region to the middle Missouri, northward to Minnesota and southward through Missouri, Indiana and Kentucky to Arkansas, and is especially common in the Ohio Valley, and is usually abundant in clear gravelly streams. It has not so far been found in Lake Maxinkuckee or any of its inlets; several specimens have, however, been taken from the Outlet of Lost Lake.

In the summer of 1906, one of the fishermen residing near the lake spoke of some queer fishes he had seen on several occasions while seining in the Outlet, and which he regarded as of no value for bait. It was thought from his brief description that the fishes mentioned were probably the blob (*Cottus ictalops*) no specimens of which had been obtained in the region.

The fisherman was therefore accompanied on his next seining trip (September 11, 1906) and a number of the fishes were secured. They proved to be darters of various species; among them were 11 which proved to be the Black-sided Darter. Associated with these 11 Black-sided Darters were 7 of its near relative, *H.*

scierus. On a later visit to the same place (October 7, 1907), two large fine darters were secured, one *H. aspro*, and the other *H. scierus*.

The separation of these two species was made with some difficulty, and the indications are that they intergrade; this indeed was suggested long ago by Jordan and Gilbert in their description of the subspecies *Hadropterus scierus serrula*. In nearly all the features in which this subspecies differs from the species to which it is assigned—the smaller scales, the naked breast, and relatively weaker serrulations of the opercle—it approaches the general type of *H. aspro*. So far as descriptions go it would be difficult to say whether the subspecies in question belonged to *aspro* or *scierus*. We have divided our specimens according to the presence or absence of stellate processes along the ventral line. This is a variable feature, as these structures differ both in number and degree of development. All other characters separating the species are equally or even more variable. The fishes identified as *H. scierus* seem in general to have the gill-openings more broadly united, although this is not invariably the case. The scales seem somewhat more regular along the dorsal line in *aspro* than in *scierus*. In *scierus* there are frequently small rudimentary scales intercalated along the sides of the dorsal fins, breaking up the diagonal series and making it difficult to follow them. This does not appear to be so pronounced in *aspro*.

The distinguishing character of the serrulate preopercle is qualified in current descriptions by the expression "more or less" and is said to vary with age. Our specimens of *scierus* vary considerably in this respect. None is so distinctly or closely serrulate as in the type; some are almost entire; some rather rough, the roughness being rather crenulate than serrulate, and the preopercle on one side may be considerably more roughened than that of the other side in the same specimen. A pretty constant difference between the species is the presence or absence of scales on the breast; however, one of our specimens which on account of the sum total of other characters we have placed with *aspro*, has the breast scaled; the mouths of our specimens average about the same in both species; they may average somewhat larger in our *aspro* lot; however, both the largest mouthed and smallest mouthed individuals in the collection belong to those identified as *aspro*. The dorsal fins are about equally separated in both species, or rather about equally close together there is usually hardly the width of a scale between them; the two specimens which have these fins farthest apart belong to the *aspro* series.

"The fine gentleman of the family is the Black-sided Darter (*Hadropterus aspro*). Him we may know by his colors.* The ground hue is a salmon yellow; the back is regularly and beautifully marbled with black in a peculiar and handsome pattern. On the sides, from the head to the tail, runs a jet-black band, which is widened at intervals into rounded spots which contrast sharply with the silvery color of the belly; or we may say that on each side is a chain of confluent round black blotches. Sometimes the fishes seem to fade out; these blotches grow pale and no longer meet, but in an instant they may regain their original form and shade. This latter change can be induced by the offer of food, and it is of course due to muscular action on the scales which cover the darker pigment. A male in our aquarium underwent almost instantly an entire change of coloration upon the introduction of a female fish of the same species recognized by him as his affinity. Although the two have been together for some weeks, the novelty has not yet worn off, and although his colors vary much from one hour to another, he has never yet quite reverted to his original hues. The form of the Black-sided Darter is more graceful than that of any other, and his movements have little of that angular jerkiness which characterizes his relatives. The fins of Hadropterus, like those of Percina, are long and large, the number of dorsal spines being about 14. A notable peculiarity in both species is the presence of a row of shields, or enlarged scales, along the middle line of the abdomen. These may help to protect that part from the friction of the stony bottom. They seem to be shed sometimes, but when or why this happens we do not know. Hadropterus delights in clear running water and may be found in most streams south and west of New York. It is especially desirable for aquaria, being hardier than any other fish as pretty, and prettier than any other fish as hardy, and withal with 'a way of his own,' as an Irish laborer, Barney Mullins, once said to us of Thoreau."—Jordan and Copeland, 1876.

57. DUSKY DARTER

HADROPTERUS SCIERUS Swain

No specimens seen in the lake; found only in Outlet Creek below Lost Lake.

Attention has already been called to the close relationship of this species and the preceding, and to the probability that they are connected by intermediate forms. This opinion is the result of an

* This is no longer the case since *H. scierus* and *H. maxinkuckiensis* have been described.

examination of the type of *H. sciurus* and a comparison of it with numerous specimens both of *H. aspro* and *H. sciurus*. The type of *H. sciurus* has faded so that little can be judged concerning its colors. It is still in a perfect state of preservation, though somewhat soft.

The mouth does not differ greatly in size from those of our specimens of both species. The maxillary extends almost to the vertical of the anterior of the orbit, and the statement in the original description "maxillary not reaching the eye by about the width of the pupil", evidently does not refer to the vertical from the anterior edge of eye, but to the width of the preorbital. The statement that the "spinous dorsal [is] separated from the soft dorsal by the length of the snout" is true only if the spinous dorsal is supposed to end at the base of the last spine; the membrane of the spinous dorsal is attached very nearly to the origin of the soft dorsal, there being barely more than the width of a scale between them. This is well shown in the very good figure of *Hadropterus sciurus* in Jordan and Evermann's Fishes of North and Middle America. As has been said, the union of the gill-membranes is a variable feature.

The following is a description drawn up from an examination of 5 Outlet specimens:

Head 4 in length; depth 6.1; eye 3.9 to 4.8 in head; snout 3.9 to 4.6; maxillary 3.5 to 4 in head, almost or wholly reaching to a vertical with anterior of eye; mandible 2.5 to 3; interorbital 5.1 to 5.5, preorbital 7.1 to 9.1; dorsal XI to XIII-11 to 13; scales 6 to 9-62 to 69-10, 5 to 7 rows of minute scales on cheek; 6 or 7 larger scales on opercle; 12 to 15 rows of scales before dorsal; no row of scales along median dorsal line, but a row along each side; scales small and crowded in front of dorsal, the scales in the lateral line somewhat smaller than the other scales of the body, thus breaking the alignment of the diagonal rows; small intercalated scales along base of dorsal, breaking up the regularity of the series; snout and interorbital space naked; occiput naked, this portion frequently transparent so that the outlines of the underlying brain can readily be seen; scales rather small, each scale with 2 or 3 fine concentric lines around the center, the whole margin of the scale, about ⅓ of the way to the center, rough, the roughness consisting of radiating faintly beaded ridges terminating in small stout spines which project from the entire free circumference of the scale, the scale somewhat irregularly beaded in front of the center; throat, chin and fin membranes naked; breast with minute embedded scales; one to 3 large stellate chevron-like scales be-

tween ventrals; median line of belly between ventrals and vent with from a few to 11 stellate projections, these projections varying in degree of development and finely granular at base, the granulations probably representing the beading of normal scales. Distance between dorsals very short, from one to a few scales in width; longest dorsal spine (one of the median spines, varying in different specimens) 1.8 to 2.2 in head, base of spinous dorsal longer than head, 3.75 in length and extending over from 21 to 30 rows of scales; longest dorsal ray 1.3 to 2.1 in head; base of soft dorsal 1.4 to 1.75 in head, covering about 15 rows of scales; pectoral rather acute, with 12 to 15 rays, length 1.2 to 1.4 in head, the tip not reaching tips of ventrals; ventrals 1, 5, acute, spine 3.3 in head, longest ray 1.4 in head, reaching about $\frac{1}{2}$ way to vent; caudal lobes 1.3 to 1.6 in head, the fin slightly emarginate, the lobes broadly rounded.

Color in spirits: Upper part of head to middle of eye dusky, rather coarsely punctulate; upper part of back with black bands of uniform width (about 2 scales wide) arranged in regular festoons; interspaces whitish or yellowish; under parts whitish, rather remotely punctulate under magnification, the punctulations somewhat more crowded along ventral line, especially near the vent, and still more so along the base of the anal fin and occasionally in spots along the caudal peduncle, causing these portions to be somewhat decidedly darker. A black band along middle of side, expanding at intervals forming a row of about 7 round confluent blotches, the largest of these being about 6 scales in width by the same distance along lateral line; dorsals and anal dark at base with irregular dusky mottling near margin; pectorals and ventrals somewhat dusky; caudal with a marginal and 2 submarginal dusky bands parallel with the edge of the fin and separated by similarly shaped paler interspaces.

58. MAXINKUCKEE DARTER

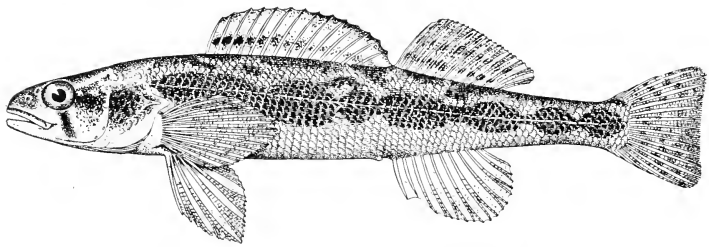
HADROPTERUS MAXINKUCKIENSIS Evermann

So far as general appearance and coloration go, the Maxinkuckee Darter very closely resembles *H. aspro* and *H. sciurus*. There are, however, a few diagnostic marks that enable one to distinguish it at once. The larger scales, the free gill-membranes, the smooth preopercle and the united dorsal fins are all diagnostic characters. The large mouth, with the maxillary extending backward to the vertical of the anterior edge of the pupil, is the most striking. In the color pattern, this fish differs from the species mentioned in having the caudal irregularly mottled instead of

barred. It also has a distinct black line projecting from the eye downward across the cheek, a feature sometimes hinted at by obscure markings in the other species, but never as distinct and broad.

Head 3.75; depth 6; eye 4; snout 4.2; maxillary 3.25; mandible 2.75; interorbital 6; pectoral 1.25; ventral 1.3; D. XIV, 13; A. II, 8; scales 7-61-10.

Body rather long, slender and subterete; caudal peduncle somewhat compressed, its least width one-half its least depth; head rather long, snout pointed; *mouth moderately large*, oblique, *maxillary reaching past anterior part of eye*, lower jaw included; premaxillaries not protractile; eye rather large, slightly above axis of body; interorbital moderately wide, nearly flat; gill-membranes free from each other and from the isthmus; opercle with a rather long flap and stout spine; fins rather large; distance from origin

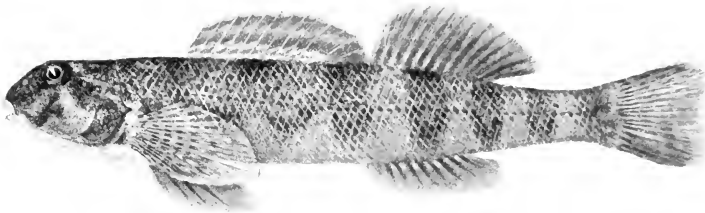


Maxinkuckee Darter (*Hadropterus maxinkuckiensis*)

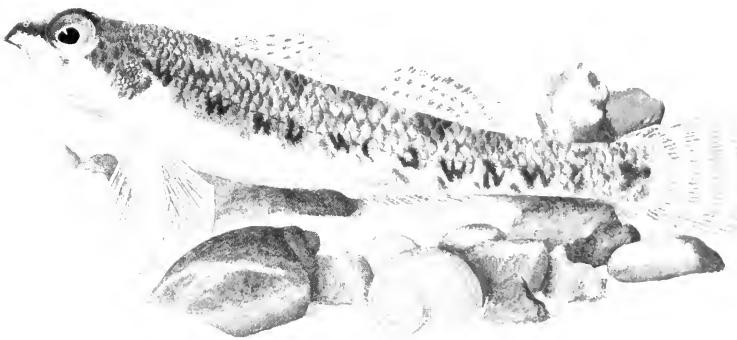
of spinous dorsal to tip of snout slightly greater than base of spinous dorsal or nearly twice base of soft dorsal; longest dorsal spine 2.25 in head; soft dorsal higher than spinous portion, 2 in head, the free edge gently curved; origin of anal under that of soft dorsal, its base 2.1 in head; caudal rounded or slightly emarginate.

Scales firm and strongly ctenoid; lateral line complete and straight, beginning over opercular spine; top of head and an oblong area on nape naked, space in front of spinous dorsal with small embedded scales; opercle with about 7 rows of scales; cheek with a few small, embedded scales; breast naked, except 2 or 3 partially embedded scales on median line; one large scale between ventrals; belly naked anteriorly, but with about 10 enlarged, stellate scales posteriorly; space between ventrals broad, equal to width of base of ventral; preopercle smooth.

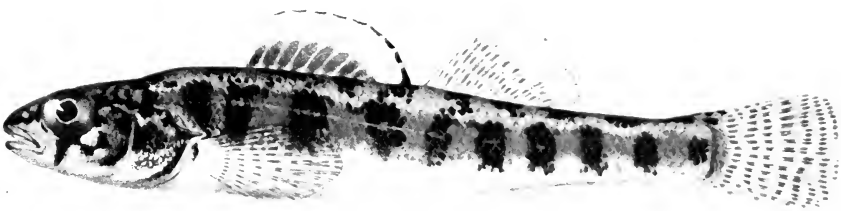
Color essentially the same as in *H. scierus;* mottled and ver-



GREEN-SIDED DARTER, *Diplesion blennioides* (Rafinesque)



JOHNNY DARTER, *Boleosoma nigrum* (Rafinesque)



IOWA DARTER, *Etheostoma iowæ* (Jordan & Meek)

miculated with light and dark brown or blackish, the middle line of back with about 9 large roundish dark confluent areas each surrounded by a wavy whitish line; middle of side with about 7 large, confluent dark spots, the anterior 2 largest and longest, the third small, the fourth large and the remaining 3 progressively smaller; under parts yellowish white; top of head dark; a narrow whitish line around upper, posterior part of orbit; a broad black line downward from eye, much more distinct than in related species; upper part of preopercle and nearly whole opercle dark, each dusted on lower part; cheek dusted with fine dark specks; an irregular pale area at anterior end of lateral line; spinous dorsal ashy, the first 3 spines black on the middle portion, the other spines dark but not so distinctly so, tips of last few spines dark; soft dorsal light brownish or grayish, crossed near the base by a series of dark spots and above by 2 series of whitish spots; caudal spotted or mottled with white and brown, not barred as in related species; anal white, dusted with brownish; ventrals whitish, with fine dark dustings; pectoral whitish, yellowish at base, followed by 2 alternating series of dusty and whitish spots.

This species is related to *H. scierus*, from which it differs chiefly in having the dorsal fins united, in having the maxillary reaching beyond front of orbit, in the larger scales, the free gill-membranes, and in the smooth preopercle.

Of this species we have but 2 specimens, the type, a specimen 3.5 inches long, taken in Aubeenaubee Creek about one-half mile from the lake, August 4, 1899, and another, the locality label for which has been lost, but probably from the same stream.

59. JOHNNY DARTER

BOLEOSOMA NIGRUM (Rafinesque)

(Plate 34)

This little fish is abundant almost everywhere in the eastern United States, and is especially common in small streams among gravel and weeds. At Lake Maxinkuckee it is not very abundant; occasional examples are seen lying on the bottom near shore or are raked up with weeds. During the seining operations 127 examples were obtained. One or more specimens were procured in each of 45 of the 612 hauls; the greatest number gotten in one haul being 12. Occasionally people seining along shore for minnows catch a few examples of this species.

Looked at from above while lying on the bottom, the Johnny Darter, with his slender body and spread fins, ready to go at a

touch, reminds one of nothing else so much as a drawn arrow. His long broad pectoral fins are the tense bow-strings, and at a touch he darts through the water like a shot shaft; his motion through the water resembles rather the leap of a frog than the swimming of a fish.

The black on his back is arranged in about 6 short transverse bars—one a little distance in front of the dorsal, one about the middle of the spinous dorsal, one between the two fins, one about the middle, one at the posterior of the soft dorsal, and one at the base of the caudal. These marks remind one of several other bottom-lying fishes—the black sucker, the blob, and one of the mad toms (*Schilbeodes exilis*). Looked at sideways—a view one never gets of him out in nature—he shows a very short blunt nose, even shorter and blunter than that of the green-sided darter. The ends of the dorsal cross-bars are visible as a series of dark blotches, and along the middle of the side is a row of blotches, irregular in size and shape, but in general more like W's than anything else.

The stomachs of several examples showed that this species feeds on small animals; beach fleas were found in an example 2 inches long, and another of the same size contained, in addition to the beach flea, a Chironomous larva, and a parasitic distomid.

In spite of their spiny armament, darters are frequently found in the stomachs of other fishes, and the Johnny Darter is quite effective for perch bait.

Head 3.75 to 4.5 in length; depth 5 to 7; eye 5 to 5.5 in head; snout 3 to 3.5; maxillary 3.5; D. IX-11 or 12 (VII to X-10 to 14); A. I, 7 to 9; scales 5-44 to 55-9, rarely 35 to 40; tubes of the lateral line sometimes obsolete on the last 4 or 5 scales; body fusiform, slender, not compressed, caudal peduncle slender, its least width 1.75 in the least depth; head rather short; snout a little longer than eye, decurved; mouth small, horizontal, maxillary reaching eye; premaxillaries protractile; lower jaw included; interorbital space rather wide; gill-membranes rather narrowly connected, free from the isthmus; fins moderate; origin of spinous dorsal nearer origin of soft dorsal than tip of snout; origin of soft dorsal somewhat anterior to that of anal; spinous and soft dorsals separated by a space $\frac{1}{2}$ to $\frac{2}{3}$ diameter of eye; longest dorsal spines about 2 in head; longest dorsal rays 2 in head; longest anal ray 2.5 in head; pectoral large, pointed, nearly as long as head, reaching past tips of ventrals; ventrals short, 1.3 in head, widely separated, the space between them as wide as base of either fin; caudal rounded. Scales rather large, strongly ctenoid; lateral line never complete, usually 15 to 30 pores with 2 or 3 interruptions then a few scattered ones,

the line thus broken in several places, chiefly posteriorly; region in front of spinous dorsal, cheeks and breast naked; opercles always partially, sometimes wholly, scaled; middle line of belly with ordinary scales, sometimes naked anteriorly; no enlarged humeral scale; opercular spine small.

Color in life: Pale raw umber above, tending to olive, and marked with dark brown along scale margins, darker and forming distinct cross-hatching in 7 blotches; about 13 irregular patches of dark brown or black cross-hatching along lateral line, separated from the markings of the back by a narrow line of whitish; nape and back mottled and colored by minute black dots fading to brown posteriorly; pectoral rays very faintly barred with brown; caudal fin more distinctly black-barred, showing plainest in the closed fin; a black line downward and one forward from eye.

The Maxinkuckee representatives of *B. nigrum* differ from typical specimens in some important particulars, the principal of which are the following: The less complete lateral line, the naked ante-dorsal region, the less complete squamation of opercle, and the smaller fins.

This description is based on 19 specimens 40 to 44 mm. long, taken on east side of Long Point in July and August.

The following is an interesting account of the habits of this little fish:

"We never grew tired of watching the little Johnny (*Boleosoma nigrum* Rafinesque). Although our earliest aquarium friend—and the very first specimen showed us by a rapid ascent of the river weed how 'a Johnny could climb trees'—he has still many resources which we have never learned. Whenever we try to catch him with the hand we begin with all the uncertainty that characterized our first attempts, even if we have him in a two quart pail. We may know him by his short fins, his first dorsal having but 9 spines, and by the absence of all color save a soft yellowish brown, which is freckled with darker markings. The dark brown on the sides is arranged in 7 or 8 W-shaped marks, below which are a few flecks of the same color. Covering the sides of the back are the wavy markings and dark specks, which have given him the name of the 'Tessellated Darter', but Boleosoma is a braver name and we even prefer 'Boly' for short. In the spring the males have the head jet-black, and this dark color often extends on the back part of the body so that the fish looks as if he had been taken by the tail and dipped into a bottle of ink. But with the end of the nuptial season this color disappears, and the fish regains his normal strawy hue. The head in Boleosoma resembles

that of Diplesion, but the habit of leaning forward over a stone, resting on the front fins, gives a physiogomy even more frog-like. His actions are, however, rather bird-like, for he will strike attitudes like a tufted titmouse, and he flies rather than swims through the water. He will, with much perseverance, push his body between a plant and the side of the aquarium and balance himself on the slender stem. Crouching cat-like before a snail shell, he will snap off the horns which the unlucky owner pushes timidly out. But he is often less dainty, and seizing the animal by the head, he dashes the shell against the glass or a stone until he pulls the body out or breaks the shell."—Jordan and Copeland.

60. GREEN-SIDED DARTER

DIPLESION BLENNIOIDES Rafinesque

(Plate 33)

Only 5 specimens of this handsome darter were secured; of these, one, an example 3.25 inches long, was secured down the outlet of Lost Lake near the old mill on September 11, 1906, and 4 others, ranging in length from 2.5 to 2.75 inches, were secured about the same place, on October 7, 1907. The markings of these specimens (in spirits) are quite contrastive, the dark markings being jet black; this being probably partly due to the black bottom of the stream in which they were found. The Y-shaped figures mentioned in current descriptions as occurring on the lower part of the side, are united in our specimens, so that the color pattern of that portion of the body resembles a series of arches, usually with a black spot underneath each arch.

The following description is from the largest of our specimens: Head 1.3 in length; depth 5.6; eye 3.2 in head; snout 3.1; mandible 4.2; interorbital space very narrow, 7.1 in head, the eyes being high up and close together; mouth small, horizontal, overhung by the blunt heavy snout; physiognomy peculiar, the profile being short and rounded, a condition best described by the expression "bull-nosed"; D. XII, 13; A. II, 9; scales 5-61-8. Body fusiform, elongate, but stouter than that of many of the darters; snout, occiput, throat and breast naked; gill-membranes broadly connected. Spinous dorsal quite low, the longest spine 2.3 in head; soft dorsal quite high, the longest ray 1.6 in head; anal about as long as soft dorsal but quite low; pectorals quite long and large, longer than head and reaching to tips of ventrals; ventrals quite large, about 1.1 in head, well separated at base and reaching about $\frac{2}{3}$ of the distance to the vent.

Color in spirits: Ground color pale straw-yellow, upper part of sides irregularly splotched with black, the splotches tending to form black spots along the dorsal line as follows: One small spot just behind occiput, a large one just in front of origin of spinous dorsal, an ill-defined one about the center and another about the end of the spinous dorsal, two similarly placed in regard to the soft dorsal, and one on the caudal peduncle; lower parts of side with a series of black arches, and small spots in the center of arches; belly unspotted; head dusky, irregularly blotched, a distinct spot above each eye and 3 blotches on occiput, these latter forming a sort of trefoil or fleur-de-lis mark; dorsals somewhat irregularly splotched; in the spinous dorsal there is a tendency for the black to aggregate in the membranes between the spines; in the soft dorsal this is definite, the interspaces between the rays being black and the intervals between the forks of the rays being dusky; caudal somewhat irregularly blotched, the blotches tending to form in bars; pectorals with spots arranged in bars; ventrals irregularly spotted; anal with a few dark dashes. In life this fish, especially during the mating season, is one of the most beautifully colored of our fishes; the bright colors which are removed by alcohol seem to be laid on over the ground colors just described. The following is given as the life colors:

Color olive green tesselated above; side with about 8 double transverse bars, each forming a Y-shaped figure; these sometimes joined above, forming a sort of wavy lateral band; in life these markings are of a clear deep green; sides sprinkled with orange dots; head with olive stripes and the usual dark bars; first dorsal dark orange brown at base, blue above, becoming pale at tip; second dorsal and anal of a rich blue green, with some reddish; caudal greenish, faintly barred; young and females more or less dull, but the pattern is peculiar.

All our specimens of both sexes were very dark in color, a feature probably associated with the black bottom of the stream from which they were taken. Many of the specimens died in the water and faded considerably; the unfaded alcoholic specimens have quite contrastive black and white markings. These specimens were quite badly infested with leeches, which were attached to the various fin-membranes; a number of the specimens had 2 leeches attached.

This species is so very like *H. sciurus* that the same general description will serve for both, by bearing in mind the few points in which they differ.

"One of the most simply beautiful of all fishes is the Green-

sided Darter (*Diplesion blennioides*). He is not like the *Etheostoma cœruleum*, an animated rainbow, but he has the beauty of green grass, wild violets, and mossy logs. As we watch him in the water, with his bright blended colors and gentle ways, once more, with Old Izaak, 'we sit on the cowslip banks, hear the birds sing, and possess ourselves in as much quietness as the silent silver streams which we see glide so quietly by us.' During the ordinary business of the year, Diplesion, like most sensible fishes and men, dresses plainly. It is not easy to get time for contemplation when the streams are low and food is scarce. Besides, a plain coat may ward off danger as well as facilitate attack. At all times, however, he may be known by these marks: The fins are all large; the back is covered with zigzag markings, while on the lower part of the sides are 8 or 9 W-shaped olive spots; these are more or less connected above, and sometimes form a wavy line. The eyes are prominent; the snout is very short and rounded; while the little inferior mouth is puckered up as if for saying 'prunes and prisms, prunes and prisms.' But when the first blue birds give warning by their shivering and bodiless notes that spring is coming on, then Diplesion puts on his wedding clothes and becomes, in fact, the Green-sided Darter. The dorsal fins become of a bright grass green, with a scarlet band at the base of each; the broad anal has a tinge of the deepest emerald; while every spot and line upon the side has turned from an undefined olive to a deep rich green, such as is scarcely found elsewhere in the animal world excepting on the heads of frogs. The same tint shines out on the branching rays of the caudal fin, and may be seen struggling through the white of the belly. The blotches nearest the middle of the back become black, and thickly sprinkled everywhere are shiny specks of clear bronze orange. In the aquarium Diplesion is shy and retiring, too much of a fine lady to scramble for angleworms or to snap at the "bass feed." She is usually hidden among the plants or curled up under an arch of stones or in a geode."—Jordan and Copeland.

61. IOWA DARTER

ETHEOSTOMA IOWÆ Jordan & Meek

(Plate 34)

The Iowa Darter is a common species in the upper Missouri Valley from Iowa and Nebraska north to Assiniboia, and eastward to Indiana. It is found farther northward and farther westward in the Missouri basin than any other darter. At Lake Maxinkuckee it is represented by a closely related species, the Aubee-

naubee Darter, which is there the most common of the darters except *Percina caprodes*. Not a great number were obtained during the seining operations, but nearly every rakeful of Chara brought up during the winter through the ice contained 1 or more of these fishes. This darter probably spends most of its time among the Chara and thus escapes the net. It prefers hiding under weeds to lying on open bottom, and is commonly not seen before being captured. In the short matted Chara found so abundantly in the shallow water of the lake, it is doubtless abundant. In the open places it may frequently be seen lying still on the sandy bottom, or occasionally darting to cover.

The Iowa Darter probably spawns late in April or early in May. Females taken April 27, 1901, were examined and found to be full of spawn. The ovaries of the specimen examined were each a club-shaped mass narrowed sharply behind, truncate and concave in front, its anterior margin adjusted in outline to that of the well-filled stomach, and surrounded by a firm membrane. The length of the fish examined was 50 mm., the length of the egg-mass 10 mm. The mature eggs, which may have been shrunken some, but probably little by the preservative, were bright yellow, 32 to the inch, and 115 in number in one ovary; probably about double that number in the whole fish. Mixed in with them was a large number of minute ova, probably representing the next year's product.

More than any other species of fish in the lake, except some of the minnows, this fish is affected with the affliction known as Diplostomiasis characterized by small round black spots in the skin, each indicating the cyst of a distomid which is said to reach its mature form in the stomachs of water birds.

The only food found in the stomachs examined consisted of insects and insect larvæ. These darters are occasionally found in the stomachs of other fishes. The bass sometimes eat them.

On comparing our Lake Maxinkuckee material with specimens of *E. iowæ*, from Creighton, Nebraska, and with current descriptions, the Maxinkuckee specimens appear to be less fully scaled on the cheeks and opercles.

The squamation of these parts is exceedingly various as regards degree of development as well as number of scales. The skin of these parts may be entirely smooth or naked; the scales in their simplest form are represented by raised tubercles, which are usually rather numerous and regularly arranged, which show well on a wet specimen by reflections. In a more developed stage they consist of embedded smooth circular scales which bear some re-

semblance to pores, and which show best when the specimen is somewhat moist. Finally we have the more or less fully developed ctenoid scale, more or less free at the posterior margin and inclined to curl up, which is best seen on the specimen when somewhat dry.

A specimen taken at random from our reserve series had the scales on opercles and cheek 34-19, well developed and ctenoid. The number found in the best developed of our specimens in this respect, out of a series set aside for their special development in this particular, was 23 on the cheek, and 11 on the opercle, from which it varied to 8 on the cheek and 3 on the opercle, and the scales on the cheek are always imbedded and hard to make out. There is no correlation between the number of scales on the cheek and those on the opercle.

62. AUBEENAUBEE DARTER

ETHEOSTOMA IOWÆ AUBEENAUBEI Evermann

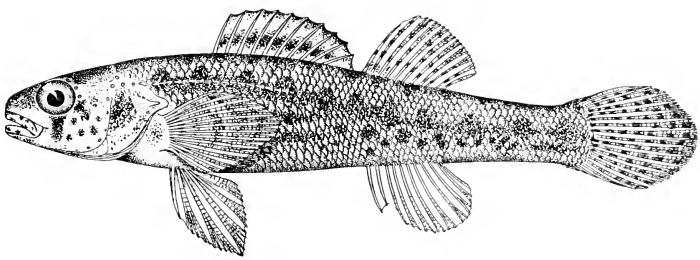
In making a critical study of the large series of darters which in our preliminary studies were regarded as two distinct species, *E. iowæ* and *E. aubeenaubei*, and now greatly augmented by later collections, we find that the two extremes are connected by intergrading forms. In so far as the squamation of the cheeks, which is one of the most important features, is concerned, they vary from one extreme, the type of *E. aubeenaubei*, with wholly naked cheeks and opercles, to a form with these parts moderately well scaled; although none of our specimens seems to be so distinctly or heavily scaled on these parts as the specimens of *E. iowæ* in our reserve series, from Creighton, Neb.

The typical *Etheostoma aubeenaubei* differs from typical *E. iowæ* in the almost naked cheek, the less complete scaling of the opercle, the somewhat longer maxillary, more oblique mouth, the general coloration and much closer approximation of the dorsal fins.

In a series of 30 specimens examined critically in regard to the points above enumerated, the number of scales on the cheek varies from none to about 15 which could be definitely counted, or, in some examples, to a good many small scales difficult to make out satisfactorily. The scales on the cheek vary from none through 2, 3, 5 to 15 or more, often imbedded and difficult to make out. The squamation appears to proceed from above downward; when these parts were only partly scaled the scales were on the dorsal portion. The length of the maxillary varies from 3 through

various intermediate values to 4.4 in head, and the end varies from reaching to the anterior edge of the pupil, and the tip of the upper jaw was on various levels, from the lower edge of the pupil to the lower edge of the orbit. The number of scales covered by the space between the spinous and soft dorsals varies from 1 to about 4, and the space varies from 2 in eye through many intermediate values to a trifle larger than the horizontal diameter of the eye. Among our specimens is one which has the spinous and soft dorsals continuous, the membrane being quite high throughout. The dorsal formula of this specimen is XI, 10, and the cheeks and opercles are naked.

The color pattern is extremely variable; full notes on colors of specific individuals are given below; the following general remarks will serve to call attention to the great diversity:



Aubeenaubee Darter (*Ethcostoma aubeenaubei*)

A dark line downward from the eye and a dark heart-shaped occipital spot (which is so frequent among fishes in general), appear to be always present. The color pattern of the caudal fin also appears to be constant, at least so far as general effect is concerned, though a study of more material might show a number of variations in detail; it consists of a series of dark blotches, arranged in irregular broken zig-zag bars. These probably vary somewhat in number and position, their irregularity making it difficult to correlate them, giving thus a semblance to uniformity. The unit of the pattern usually consists (in small, and presumably young, individuals) in its simplest form of a pair of parallel lines like the arithmetical sign of equality—a bar on each side of the rays, the whole making an elongate blotch from 2 to 4 times as long as wide, followed by a colorless space of about equal length. Where the rays fork there are likely to be three parallel lines; in the next stage of development a row of dots is intercalated between the parallel lines; these finally close up to form an entire line, and finally the whole

space between the lines becomes colored, making a solid rectangle. In its simplest form the soft dorsal is colored similarly to the caudal, but in most cases it is also more or less densely punctulate with exceedingly minute and quite close punctulations on the membranes between the rays. The spinous dorsal varies greatly in coloration and may be simply blotched, something after the fashion of the caudal, or may also have a distinct black bar at the margin, at the base, or both places. It is probable that the latter difference is sexual and is accentuated during the breeding season. Of two individuals contrasted in this particular, that with the ornate dorsal proved to be the male, and the other the female.

The color pattern of the body is also an exceedingly variable feature. In one extreme the back is a sort of uniform olivaceous brown above, with a very faint diffuse paler streak along below the dorsal line, this general brown color breaking up below into irregular blotches leaving the belly colorless except for a few large irregular blotches along the base of the anal fin.

In addition to this general color there may be vague dusky bars across the side, varying greatly in distinctiveness. They may be so dim as to tease the imagination or in the extreme form they may become so decided as to be the first feature to catch the eye, and remind one strongly of the colorations of Perca or Percina. In one set of examples these were distinct short blotches on a pale olivaceous yellow background so that the fish bore some general resemblance to *Boleosoma nigrum*. On a single example they were a series of elongate lateral dashes, so that the fish looked considerably like *Percina caprodes*. It was thought at first that this was a sexual difference, but on examining two individuals representing each extreme of color pattern both proved to be females full of spawn.

Head 3.6 to 4 in length; depth 4.32 to 6; eye 3 to 4 in head; snout 3 to 4; maxillary 2.66 to 3; dorsal VII to IX-10 to 12; anal II, 6 to 8; scales 4-50 to 60-7. Body moderate in length, short and stout, somewhat compressed; head long, snout blunt pointed, not greatly decurved; mouth moderate, slightly oblique, maxillary reaching eye; gill-membranes scarcely connected, free from the isthmus; premaxillaries not protractile; caudal peduncle compressed, rather long; dorsal outline abruptly arched at nape; fins moderate; distance from snout to origin of spinous dorsal slightly greater than $\frac{1}{3}$ length; dorsals well separated; spinous dorsal rounded, the longest spines about 2.5 in head; soft dorsal also rounded, the longest rays about 1.9 in head; pectoral rather long, 1.3 in head, the tip reaching tips of ventrals; anal small, the rays

about equalling those of soft dorsal; first anal spine stronger and somewhat longer than the second; scales strongly ctenoid; top of head naked, nape densely scaled; cheeks and opercles only partially scaled, sometimes naked; breast naked; median line of belly with ordinary scales; ventrals close together, the space separating them scarcely as wide as base of fin; lateral line incomplete, usually 20 to 30 pores. Color of male, in life, light yellowish brown above, with broad bars of pale olive brown; side with alternating blotches of bright vermilion and pale bluish green, the vermilion following the margins of the scales and giving the effect of cross-hatching, the green bars deeper and more distinct below lateral line on the caudal peduncle but anteriorly they are most distinct above middle of body; a small clear vermilion spot at base of pectoral; opercle golden and greenish iridescent; dorsals and caudal with series of dark spots on membranes; other fins pale; a dark line downward from eye and one forward. Color of female in life, light olivaceous above, side with about 10 rather distinct, irregular vertical green bars or blotches, narrower than the interspaces, which are rusty straw-color; caudal barred with white and 5 light brown bars; pectoral similarly barred but more faintly; spinous and soft dorsals with small brownish spots in irregular series, the spinous dorsal narrowly green-edged; back olivaceous, with about 8 indistinct greenish blotches alternating with the green lateral bars; head light brownish; under parts whitish; a small darkish spot on base of last dorsal spines.

There is considerable variation in the coloration, some showing considerably more red than others. We are not now able to recognize *E. aubeenaubei* as a distinct species. If distinguishable at all, it must be merely as a subspecies of *E. iowæ*, with which it seems to intergrade. Typical specimens of the Aubeenaubee Darter were found only in Aubeenaubee Creek.

This discussion is based upon numerous specimens each about 36 to 44 mm. long collected on Long Point, August 11, 1900, and several from Aubeenaubee Creek.

63. RAINBOW DARTER

ETHEOSTOMA CŒRULEUM Storer

This gaudy little fish is generally abundant in gravelly streams of the Mississippi Valley. At Maxinkuckee it is not very common in the lake itself, only a few having been obtained. They were more common in the Outlet, particularly near the railroad bridge, where there was a pebbly bottom and swift current. Here several

could be observed, especially in the spring. Here they live in the crevices between some boards which form a dam. They may also be found about the wagon bridge. One was captured near Farrar's on July 6, one was caught at Long Point June 2, 1901, and another was found under a board in shallow water near Murray's, November 12. They are also found in the outlet of Lost Lake, 3 being obtained about 2 miles down the outlet on Nov. 7, 1907. These, like the other fishes obtained in the vicinity, were very dark, almost black.

"Gayest of all the Darters, and indeed the gaudiest of all freshwater fishes, in the Rainbow Darter (*Etheostoma cœruleum*). This is a little fish, never more than 3 inches long, and usually about 2. Everywhere throughout the northern parts of the Mississippi Valley it makes its home in the ripples and shallows of the rivers and in the shady retreats of all the little brooks. The male fish is

Rainbow Darter (*Etheostoma caeruleum*)

greenish above, with darker blotches, and its sides are variegated with oblique bands alternately of indigo blue and deep orange, while the expanded fins are gorgeous in scarlet, indigo, and crimson. The female, as is usually the case when the male of the species is resplendent, is plainly colored—a speckly green, with no trace of blue or orange. When the war of the rebellion broke out there were some good people who were anxiously looking for some sign or omen, that they might know on which side the 'stars in their courses' were fighting. It so happened that in a little brook in Indiana, called Clear Creek, some one caught a Rainbow Darter. This fish was clothed in a new suit of the red, white, and blue of his native land, in the most unmistakably patriotic fashion. There were some people who had never seen a Darter before and who knew no more of the fishes in their streams than these fishes knew of them, by whom the coming of this little "soldier fish" into their

brooks was hailed as an omen of victory. Of course these little fishes had really 'always been there.' They were there when America was discovered and for a long time before, but the people had not seen them. The warblers lived, you remember, in Spalding's woods at Concord, but Spalding did not know that they were there, and they had no knowledge of Spalding. So with the Darters in Spalding's brooks. Still, when the day comes when history shall finally recount all the influences which held Indiana to her place in the Union, shall not among greater things, this least of little fishes receive its little share of praise? The Rainbow Darter is a chubby little fish, as compared with the other Darters. In its movements it is awkward and ungraceful, though swift and savage as a pike. One of the mildest of its tricks, which we have noticed, is this: It would gently put its head over a stone and catch a water boatman by one of its swimming legs, release it, catch it again and again release it, until at last the boatman, evidently much annoyed, swam away out of its reach. It will follow to the surface of the water a piece of meat suspended by a string. It is more alert in discovering this than a hungry sunfish or rock-bass, and it can be led around like a pet lamb by a thread to which is fastened a section of a worm."—Jordan and Copeland.

Head $3\frac{3}{4}$ in length; depth $4\frac{1}{4}$; eye 4 to $4\frac{1}{2}$ in head, little shorter than snout; D. IX to XII-11 to 14; A. II, 7 or 8; scales 5-37 to 50-16, usually 5-45-10, pores 18 to 35; body robust, rather deep and compressed, the back somewhat elevated; head large, compressed; mouth moderate, terminal, oblique, the lower jaw somewhat included, the maxillary reaching front of orbit; opercular spine moderate; gill-membranes not connected; palatine teeth in one row; cheeks naked or nearly so; opercles scaled; neck and breast usually naked; fins all large; dorsal fins usually slightly connected; anal spines subsequal or the first a little the longer; caudal rounded; pectoral nearly or quite as long as head. Males olivaceous, tesselated above, the spots running together into blotches, back without lengthwise black stripes; sides with about 12 indigo-blue bars running obliquely downward and backward, most distinct behind, separated by bright orange interspaces; caudal fin deep orange, with deep blue in front and behind; soft dorsal chiefly orange, blue at base and tip; spinous dorsal crimson at base, then orange, with blue edgings; ventrals deep indigo; cheeks blue; throat and breast orange; females much duller, with little blue or red, the vertical fins barred or checked; young variously marked; no dark humeral spot. Length $2\frac{1}{2}$ inches.

64. LEAST DARTER

MICROPERCA PUNCTULATA Putnam

This pigmy among fishes is common in clear, cold, weedy streams and ponds of the Northwestern States from Indiana, Michigan and Minnesota, south to Arkansas. It is not well known except to collectors and naturalists as it usually escapes observation on account of its small size. It is occasionally found in Lake Maxinkuckee, usually in the neighborhood of Norris Inlet, where several specimens were raked up through the ice. It is still more abundant in Lost Lake, and is quite frequent in the Outlet between the lakes. Specimens were taken in the outlet of Lost Lake at various places, some of them a mile or so below the lake. Those raked up in Lake Maxinkuckee were associated with the Iowa darter, from which they could be distinguished at once by their smaller size, comparatively larger scales, absence of lateral line, and general coloration.

Least Darter (*Microperca punctulata*)

This interesting little fish most delights to dwell where the water is cold and quiet and the bottom of that loose material which accumulates on the floors of small lakes and sluggish streams from the disintegration and slow decay of aquatic vegetation. In such situations the water is apt to be vegetable stained to the appearance of very weak coffee, and the vegetable débris black in color and with a specific gravity but little greater than the water which permeates it. Here the Least Darter is at home quietly resting on the surface of the unstable mass and ever ready to burrow in it on the least alarm. A favorite place for these pigmies was in the Outlet well down toward Lost Lake.

We have in our collection 81 specimens, ranging in length from [illegible] to 1.44 inches. Of these, 21 were obtained in Lake Maxinkuckee at various places, 47 in Lost Lake, and in the outlet of Lost Lake. The 4 specimens in our reserve series were obtained in Lake Maxinkuckee in 1890. All appear to be adult.

The following is the description of a specimen 1.31 inches long raked out of the weeds near Norris Inlet, December 12, 1901:

Head 3.6 in length; depth 5; eye 4 in head, snout shorter than eye; mouth moderate, the cleft reaching to anterior of orbit, and somewhat oblique, upper lip on a level with lower margin of orbit; under jaw somewhat the shorter; D. VI-8; A. I, 5; scales 10 in transverse series, 36 in longtudinal series; no lateral line, but the head with a well marked series of mucous pores in 2 rows, beginning each side near tip of snout and passing up over eyes and terminating a little above top of gill-cleft, each giving rise to a short branch projecting upward along the posterior margin of the occiput; body rather deep and compressed, resembling that of the yellow perch or species of Etheostoma; fins rather high but with a narrow base, the slender ventrals reaching beyond the origin of the anal; pectorals reaching to vent.

Ground color yellow, each scale more or less punctate with rather large punctulations so that each scale stands out distinctly, giving the whole fish a checquered appearance; punctulations gathered into a row of about 10 small elongate dots along middle of side; a dark line downward from eye; upper fins checked and barred; caudal finely barred; lower fins plain.

The Least Darter varies considerably in intensity of coloration, but the pattern remains about the same. The specimens obtained in the outlet of Lost Lake are generally considerably darker than the others. These fishes are affected, to a very slight extent however, by the immature trematodes which produce small round black spots in the skin.

THE MAMMALS

Introduction

Very few local lists of the mammals occurring in the different counties of Indiana have ever been published; even brief published notes and references are rare, and as a consequence, the geographic distribution within the State of the species found within its borders has not been carefully worked out. Indeed, data are wanting for the correct identification of several of the forms inhabiting the State.

During the survey of Lake Maxinkuckee no special effort was made to collect or study the mammals native to the region, any observations made or notes taken having been entirely incidental to the regular work of the survey, except with those species whose habits bring them in relations more or less direct with the life of the lake. Among these are, of course, the muskrats, minks, otters and coons; and observation of the habits of these naturally led to recording any chance observations concerning the other species of the region. No trapping was done by us, except on one occasion when a few deer mice were caught. The present list is therefore far from complete, especially as to the bats and mice and others of the less conspicuous species, but it is believed it may prove useful and interesting. It will serve as a nucleus around which additional data may be gathered and it will prove helpful to the cottagers about the lake who take an interest in nature and who wish to know the animals that they meet.

Great changes have doubtless taken place as regards the abundance and species of mammals of this region since the country was first settled. The deer, wolf, wildcat, fox, otter, and beaver were doubtless then abundant, and most of the species were more common than now. Many of these are now practically exterminated, and others, as the wolf and otter, are found only very rarely and in the wilder region west of Maxinkuckee and in the Kankakee marshes. Such species as the muskrat, rabbit and coon have probably not been seriously affected by civilization, albeit they are hunted and trapped incessantly.

Besides the 30 native species listed in this paper, at least 2 introduced species—the common rat (*Epimys norvegicus*) and the house mouse (*Mus musculus*) are all too common.

None of the native mammals is so abundant as to be a pest and none should be killed except the rabbit for food, the muskrat for its fur, and the mink and weasel for their fur and in the interest of the poultry yard. The bats, moles, and shrews, are useful and

interesting and should never be killed; and the squirrels should be protected at least until more abundant.

In nomenclature and sequence of species we have followed Miller's "List of North American Land Mammals in the United States National Museum, 1911," Bull. 79, U. S. Nat. Mus., 1912, except in the name of the Wildcat, for which we have adopted *Lynx rufa* Schreber, following Dr. Allen (Journal of Mammalogy, Vol. I, No. 2, p. 91).

LIST OF SPECIES

1. COMMON OPPOSSUM

DIDELPHIS VIRGINIANA Kerr

According to old settlers the Opossum used to be common as far north as northern Indiana, but disappeared from there many years ago. In recent years they have been returning northward and are now tolerably common throughout the northern part of the State. About 1887 an old trapper near Fort Wayne caught one and reported that it was the first he had seen for 20 years. No more were seen in that region until about 1900, when they began to be captured occasionally. In October, 1903, three were captured in Walley's woods southwest of Lake Maxinkuckee and three others were trapped at Norris Inlet. It was not seen by us at the lake until the summer of 1906, when on August 5, an adult example was found dead on the lake shore just north of the Outlet. On October 30, 1906, another was seen in the possession of a boy at Culver, who reported the capture of three on the previous night. One is reported to have stayed under the Barr Cottage on Long Point during the winter of 1906-7. About September 3, 1907, boys living in Culver got an old Opossum with a number of young in her pouch. They did not count the young, but let her go.

The northward movement of the Opossum seems to have been general over the State. They are occasionally taken in Marshall and adjoining counties. They are frequently seen at Fort Wayne, Indiana, a few being captured every winter.

2. COMMON MOLE

SCALOPUS AQUATICUS MACHRINUS (Rafinesque)

The Mole is very common about this lake. Its burrows may be seen in all suitable places. The loose, sandy soil is particularly well adapted to their habits. They are usually abundant on Long Point, also along the railroad, in the fields and open woodlands about the lake, in the Academy grounds, and in fact in all situ-

ations in the country where the conditions are favorable. Their burrows are often seen along the railroad, and frequently they are seen to pass from one side of the track to the other, passing under the rails between the ties. Several of their burrows were noted in various places about the lake in September and October, 1913.

Several were caught during our stay at the lake. When a captive mole is released it does not attempt to escape by running away but at once begins to dig or burrow, and in an incredibly short time it has sunk into the ground and entirely disappeared.

The popular prejudice against the mole based on the belief that it is injurious to vegetation is entirely unjustified. Moles are insectivorous in their habits and do not eat garden plants or vegetables at all. The only possible harm they cause is the slight injury they sometimes do to lawns by their burrows. This, however, is infinitesimal in comparison with the great good done by ridding the fields, gardens and lawns of noxious worms, insects and larvæ.

3. MOLE SHREW

BLARINA BREVICAUDA (Say)

On account of its nocturnal and underground habits the Mole Shrew is not often seen and is therefore not very well or generally known even to those living in localities in which it is really common. It is probably not uncommon about Lake Maxinkuckee. We have records of 10 specimens, of which nine were found dead as follows: One in road south of Arlington, in August, 1899; one on lake shore October 20, 1900; one south of Arlington, October 9, 1906; one at ice-houses, October 22, 1906; one on Long Point, October 29, 1906; one on Long Point, September 25, 1907; one in road on Long Point, October 13, 1907. One was caught in a trap on west side of lake, November 1, and another on Long Point, October 22, 1906. One was caught by a cat, October 3, 1906.

Special search would no doubt have enabled us to find many more specimens of this curious little creature.

The stomach of the one caught October 22, contained many parasites resembling tapeworms. The one found October 29 was lying at the edge of the water and was covered with leeches.

Why these little creatures are so often found dead is not well understood. It has been suggested that the fetid odor of this animal, particularly the male, causes it to be rejected by animals which would otherwise prey upon it, and that those found dead are individuals which have been caught by hawks or owls and dropped

after discovering the disagreeable odor possessed by the little animal which the hawk or owl at first thought would prove a delicious titbit.

The carnivorous, bloodthirsty nature of the Mole Shrew has been noted by many observers. On two different occasions we put a Mole Shrew in a box with a white-footed mouse and in each case the shrew killed and ate the mouse. Others have recorded similar experiences. One observer records the fact that a Mole Shrew ate three times its own weight of meadow mice in 24 hours.

4. LITTLE BROWN BAT

MYOTIS LUCIFUGUS (LeConte)

The Little Brown Bat is quite common about the lake. They first appear early in April and remain out at least until November. We have definite records of April 10, June 23, September 17, October 9, and November 1.

On still evenings from May to October, just as the twilight deepens and objects at a distance become indistinct, these little creatures come out from their hiding places and may be seen circling in and out among the cottages and trees, and now and then out over the lake in their search for food. Rarely are they seen before sundown, but on moonlit nights we have seen them out over the lake as late as eleven o'clock.

5. TIMBER WOLF

CANIS OCCIDENTALIS (Richardson)

The Timber Wolf or Big Gray Wolf was doubtless very abundant throughout the wooded portion of Indiana in the early days. It still occurs in some numbers in the more wild regions. Mr. Anton Meyer tells us that he got a few pelts each winter up to 1905-6, from the region northwest of Plymouth toward the Kankakee marshes. During a visit to Starke County in 1906 we heard statements to the effect that large wolves are occasionally seen and heard in the vicinity of Knox. Dr. Hahn in his "Mammals of the Kankakee Valley" states that the reports of the occurrence of the Timber Wolf in that region are conflicting and that it may be that only the Prairie Wolf is found there. Mr. Meyer, however, states positively that he gets pelts of two different species, a "large gray timber wolf" and a "smaller prairie wolf."

6. PRAIRIE WOLF

CANIS LATRANS Say

The Prairie Wolf, or Coyote as it is more commonly known in the West where it is abundant, is not known to occur in the immediate vicinity of Lake Maxinkuckee. It is a species of the prairies, occurring in some abundance in the prairie counties in the northwest corner of the State, particularly in Benton, Lake, Newton, Jasper and Starke counties. Dr. Hahn records a large number from these counties. He also states that a pack of moderate size was seen near Leesburg, Kosciusko County, in the winter of 1906-7. On May 16, 1906, two examples, a male and a female, were killed near McCoysburg, Jasper County, by Mr. Charles W. Bussel, who forwarded them to the U. S. National Museum. This place is about 25 miles southwest of Lake Maxinkuckee. Mr. Anton Meyer of Plymouth, Indiana, already quoted, informs us that he usually gets a few small prairie wolf pelts each winter, chiefly from Starke and Jasper counties. As the prairie of this portion of the State reaches Lake Maxinkuckee it is quite probable that this wolf occurs there. Dr. Hahn expresses the belief that the Coyote has doubtless increased greatly in numbers in recent years in the northwestern portion of the State and that its range is gradually extending eastward.

7. RED FOX

VULPES FULVA (Desmarest)

Formerly common throughout the State but now not often seen. A few burrows believed to be those of Foxes were observed in Walley's woods and near the outlet, southwest of the lake. The only Foxes actually seen by us about the lake were a family of three young and their mother found April 18, 1901, in a den in Green's field southwest of the lake. The old one was shot, and the three young taken as pets. One of them promptly escaped, but the other two were kept for several weeks when a second one escaped. The remaining one for some unknown reason became paralyzed in its hind legs. It was permitted to go about as best it could, and finally took up its residence among the bushes in Green's marsh. Here the dog would occasionally go to tease it, but the young fox was always able to keep the dog off. Late in the summer it disappeared and was not seen again.

On the morning of October 16, 1913, as the senior author of this report was coming up the Kankakee River from the Warden's Island, a fox was seen standing on a soft maple tree that leaned out

almost horizontally from the bank over the river. As our boat approached the fox watched us a moment then turned about and disappeared among the bushes on shore.

8. RACCOON

PROCYON LOTOR (Linnæus)

The Raccoon appears to be somewhat common, especially in the large stretch of heavy woodland east of the lake. It also occurs west of the lake as well as north and south of it, as evidenced by its depredations in the cornfields at roasting-ear time, and, later in the year, by the piles of shells it leaves from its feasts on fresh-water mussels, a habit it shares with the muskrat. In the spring of 1901 they were often heard at night—a shivering call not unlike that of the screech owl. In January, 1904, one was caught near Monterey and another was taken east of the lake in November. In 1906 one was seen on east side, October 30. On September 7, 1907, five young Coons about two-thirds grown were got from a tree on the east side. The old ones escaped. Five days later three others were caught.

Mr. S. S. Chadwick says that the largest coon he ever saw weighed 18 pounds; this was in Pennsylvania.

In the Delphi Journal was recently noted the capture of a coon near Russiaville, Howard County, Indiana, which weighed 34 pounds.

Raccoon tracks were seen on the south shore of the lake east of the Farrar cottage October 5, 1913. Raccoons are said to be common along the Kankakee. In 1912 their pelts brought $1.50 to $2.00 each. One trapper at Maxinkuckee secured two raccoons in the winter of 1911, two in 1912, and one in 1913. The pelts sold for $1.00 to $2.50 each. Another secured about 12 in 1911-12, worth $1.50 to $2.75 each, 16 in 1912-13, worth $1.50 to $3.00 each, and eight in 1913-14, which he sold at $1.50 to $2.50 each.

9. WEASEL

MUSTELA NOVEBORACENSIS (Emmons)

The Weasel is generally common throughout Indiana. It is not rare about Lake Maxinkuckee, although it is not often seen.

August 3, 1899, one was found freshly dead at the edge of the lake near Green's pier. An adult male was killed August 19, 1901, on Long Point, where it had taken up a temporary residence under the floor of a tent. Another fine large example was found dead near the railroad, south of the lake, in December, 1904. In the

winter of 1912-13 one trapper got two pelts which he sold for 20 cents each.

About July 15, 1902, Mr. S. S. Chadwick saw a weasel chasing a rabbit. The rabbit came out upon the road on Long Point, turned back toward the lake, and then ran south. Just then a Weasel came along on the rabbit's trail. When it reached the road and saw that it was being watched it stopped a moment, then, not at all frightened, started on after the rabbit. Losing the trail the weasel came back and hunted about until it was recovered, then again followed it by scent just as a dog would. The rabbit appeared greatly frightened, its eyes popped and shining. The Weasel was very quick and alert.

It is said to occur in limited numbers on the higher ground back from the Kankakee River.

10. MINK

MUSTELA VISON LUTREOCEPHALA (Harlan)

The Mink is not common in the immediate vicinity of Lake Maxinkuckee, but it is said to be more plentiful a few miles to the westward and along Yellow and Tippecanoe rivers. One was killed in February, 1898, near the Winfield cottage; others were obtained about the lake December 18, 1899, January 19, 1900, and November 9, 1900. On April 5, 1901, a skull of a female mink was picked up near Lost Lake. A few were trapped in the winter of 1903-4; three at Norris Inlet in October, and one at the icehouses December 14. On December 17, 1901, a mink dragged three ducks from the ice on the lake to a hole under a stone wall on Long Point.

In the winter of 1906-7, a mink track was observed on the shore at the Shady Point cottage. The mink had gone south toward Murray's until opposite the Gravelpit when it went out on the ice several rods to an open place where it evidently fed for a time, after which it returned on the ice to the shore and then followed the lake shore on south nearly to Murray's, where it was found under the edge of the ice and killed. It was in some respects an abnormal mink, the head and shoulders being unusually heavy, the body short and thick like that of a coon, and the color jet black. The pelt sold for $3.50.

On September 7, 1907, a very large mink was seen in Outlet Bay between Chadwick's Hotel and the north end of the icehouses. It was watched for some time and was evidently feeding. It would dive and remain under a few seconds, then come up not far from

where it went under. After remaining at the surface a minute or two, swimming and turning about in a narrow area, apparently eating what it had brought up, it would dive again. Often the entire length from nose to tip of tail could be seen just above the water surface. When it dived it humped its back, going under head first, the entire length of the tail (except the tip) which seemed to be quite long, often coming entirely out of the water.

After feeding for more than 20 minutes it swam to its burrow on shore near the steamer slip. What it was feeding on was not determined.

In July, 1907, Dr. J. T. Scovell found a family of young minks on the Tippecanoe River, below Delong. They were on a mass of drift in the stream. They were moving about on the drift from one part to another. As the boat approached, the two old minks swam out toward it, and as the boat floated by they made a wheezy noise which they continued until the boat was some distance below them when they returned to the drift, into which the young had disappeared.

11. SKUNK

MEPHITIS MESOMELAS AVIA (Bangs)

The Skunk or Polecat is not common in this region, but it is apparently becoming more frequent. We saw none in 1899 and 1900, but that the country was not wholly deprived of this interesting animal was on several occasions made evident by the presence of the well-known diagnostic odor.

On September 16, 1906, the mangled remains of one were found on the railroad track near the Gravelpit; it had evidently been run over by a passing train. On September 20, 1907, a freshly skinned skunk was seen in the possession of a hunter at Culver. The skin was 22 inches long, and the tail 10 inches. The roots of the hairs show through the skin so that the skin looks black under the black parts and white under the white dorsal stripe.

12. BADGER

TAXIDEA TAXUS (Schreber)

Never more than very rare in Indiana and now probably extinct in this part of the State. In 1893, Mr. S. D. Steininger, then of La Grange County, reported that the Badger has been found in Elkhart, La Grange, Steuben, De Kalb, Noble and Kosciusko counties; that four had been caught in La Grange County within the last 10 years, the last in 1887; that three were caught in the

northeast part of Elkhart County in 1888, and a black one in Noble County in 1880. Various old residents say that it was formerly found in Marshall County.

13. OTTER

LUTRA CANADENSIS LATAXINA (F. Cuvier)

The Otter was formerly not uncommon in this region, but it is now very rare. One was caught on the Tippecanoe River just below Delong about 1895. Mr. Anton Meyer, a fur buyer of Plymouth, Ind., tells us that he gets 10 or 12 Otter skins each year, chiefly from the Tippecanoe and Yellow rivers.

14. WILD CAT

LYNX RUFA Schreber

The Wild Cat or Lynx was probably not uncommon in this country up to about 1850. They are now rarely seen. We have unauthenticated accounts of their occurrence west of Lake Maxinkuckee as late as 1870, or later. Dr. Hahn records the killing of one near Oxford, Benton County, in 1905.

15. MICHIGAN WHITE-FOOTED MOUSE

PEROMYSCUS MANICULATUS BAIRDII (Hoy & Kennicott)

This species is not as abundant as the Common White-footed Mouse. It does not appear to venture into woodlands or swamps, but seems to prefer dry, open situations such as the edges of fields and grassy pastures. Its general distribution is more northern than that of its near relative *P. leucopus noreboracensis*. It is very abundant in the sand dunes that border Lake Michigan. At Maxinkuckee it is probably not uncommon, though we have seen only three examples. One was found dead on the railroad track November 3, 1904. Another captured at the Gravelpit October 29, 1906, gave the following measurements: Length 118 mm.; tail 48; hind foot 9; ear 10; girth 55. A third example was captured November 3, 1906, in a cornfield east of the lake.

The young of this mouse differ from the adult in being drab in color instead of yellowish-brown. On one occasion when trapping these mice for specimens it was observed that they were quite seriously infested by fleas. The examples thus afflicted could usually be recognized at once by their having the hair gnawed or scratched out from about the root of the tail.

This mouse can be distinguished from its more common relative

(the Common White-footed Mouse) by its smaller size, smaller ears and feet, and shorter tail, the tail being more thickly hairy and more sharply bicolor. The adult is yellowish-brown, with a sooty dorsal band; belly white; feet not quite white; tail bicolor. Length 4¾ inches, tail 1½ inches.

16. COMMON WHITE-FOOTED MOUSE; DEER MOUSE

PEROMYSCUS LEUCOPUS NOVEBORACENSIS (Fischer)

This is the common wild mouse of Indiana. At Maxinkuckee it is abundant not only in the fields and woods but also about the cottages around the lake. Any old pile of wood, boards, logs or brush, stack of straw or hay, or shock of fodder, is almost sure to contain at least one family of these beautiful and interesting little animals. They may also be found in almost any old dead tree, whether in open woods or dense forest, in which there are natural hollows or deserted woodpecker holes.

Several examples were trapped in July at the cottage occupied by us on Long Point. A male was captured October 20, 1906, at the pond below Farrar's woods.

These mice feed largely upon beechnuts of which they often store up considerable quantities for winter use. We have on various occasions found more than a pint of beechnuts stored in a hole in some old tree, evidently by these mice. They do not hibernate, but remain quite active during even the most severe winters. Their tracks may be seen in abundance in the snow. They also feed on small snails and other small, delicate mollusks such as Physa, Limnæa and Sphærium. We have frequently found shells, with the apex bitten off, in and about the nests of these mice.

They breed probably several times each season, as we have seen young as early as March and as late as November. The number of young produced in a litter ranges from four to six. We have frequently caught old females with the young hanging to the teats and carried them many rods before the young dropped off.

On two occasions when one of us put a shrew (*Blarina brevicauda*) in a box with a Deer Mouse the shrew killed and ate the mouse.

The Deer Mouse is readily distinguished from related species. It attains a length 6.5 inches including the tail which is 3 to 3.25 inches long. In color it is yellowish brown, grayish, or fawn-color; belly and feet pure white; tail less distinctly bicolor than in the Michigan White-footed Mouse.

17. FIELD MOUSE; MEADOW MOUSE; VOLE

MICROTUS PENNSYLVANICUS (Ord)

The Meadow Mouse is abundant in all suitable situations about the lake. The extensive areas of semi-marshy grassy land supply an ideal habitat for this noxious but interesting little animal. Wherever there are meadows or marsh ground covered with grasses there these mice will be found, their labyrinthine runways forming an intricate network under the dead grass where their nests are numerous and usually quite conspicuous. These runways are very common in the low marshy meadows such as are usually submerged during the winter and spring, during which time the mice must retreat to higher ground. They do not hibernate but continue very active throughout the winter. In the spring when the snow melts away their runways that were under it become quite conspicuous.

This species is very destructive to grasses and other cultivated crops. When the corn is cut and left in shocks in the field these mice establish themselves in nearly every shock, building a nest near the center and feeding destructively upon the corn. The amount of damage done in this way to the average field of corn is very considerable and far in excess of that done to the poultry yard by the hawks which, if not destroyed by the farmer, would do much to hold the Field Mice in check. The Marsh Hawk, Sparrow Hawk, Pigeon Hawk and Cooper's Hawk, as well as the various owls all prey on these mice.

On October 24, 1904, a Meadow Mouse was found on the lake shore, beheaded, possibly by some bird of prey. November 1, 1904, a cat was seen with one. December 11, 1904, one was seen near a muskrat house in Norris Inlet marsh.

18. PINE MOUSE

PITYMYS PINETORUM SCALOPSOIDES (Audubon & Bachman)

Probably not common. We know of only one specimen taken at the lake. It was secured November 29, 1913, and sent to the National Museum where it was identified by Mr. N. Hollister.

19. MUSKRAT

ONDATRA ZIBETHICA (Linnæus)

The Muskrat is a familiar and well-known animal throughout North America wherever there are marshes, ponds or streams. Among the hundreds of small lakes and smaller ponds in northern Indiana there is probably not one that is not the home of one to

several pairs of these interesting rodents. At and about Lake Maxinkuckee it is quite common, albeit not often seen except by the few elect who know when and where to look for it. In the autumn and early winter, especially in the evening and early morning, they may be seen swimming about or heard splashing among the weeds near shore. It is at this time that they begin to build their houses, and day by day those who pass along the shores of the lakes or about the ponds and marshes may notice the increase in size of the piles of Chara and rushes of which they build their winter homes. These homes or houses are built almost anywhere along the shore in shallow water or even well out in small shallow ponds wherever there is suitable building material conveniently at hand. Every Scirpus patch is likely to contain one or more of these houses. On the west side of the lake we usually found one in a small pond by the side of the railroad just north of the Assembly grounds, two or three in the edge of the lake between there and Culver, one near the Winfield cottage, one or more in Outlet Bay, two or three between Long Point and Murray's, six or more from Murray's to Norris Inlet, a score or more about Norris Inlet, several along Aubeenaubee Creek and perhaps a dozen in the northeast corner of the lake and along Culver Creek. A great many are seen each year about Lost Lake and along the Outlet throughout its entire length, even to Tippecanoe River. Each of the marshes and ponds west of the lake has its share of nests and each old kettle hole that is not too dry will have one or more.

While these are the usual places where the muskrats build their houses, now and then a house is found in some quite unusual and unexpected place. Among them are the cross-timbers under the piers at the cottages about the lake. December 24, 1900, a completed nest was found resting cosily on cross-timbers under the pier at the Lakeview Hotel. Though not large this nest was compactly built. It was composed almost wholly of Chara and was a foot or more above the surface of the water. November 2, 1904, another nest was found in a similar situation on cross-timbers at the distal end of the Culver depot pier. This nest was quite large and composed chiefly of Chara. When disturbed the owners of these nests would drop quietly into the water and swim away.

Toward the last of October, 1904, a nest was found on the seat of an abandoned boat near Murray's. This nest was newly built and consisted chiefly of Chara and Scirpus stems. Later, when the lake froze over it was deserted. Still another nest was found on the top of a tree that had fallen into the lake, and yet another on the boughs of a broken tree that extended into the water.

The most interesting and unique situation selected by a muskrat for its house ever seen by us was a large dry-goods box which a duck-hunter had anchored in Outlet Bay for use as a blind from which to shoot ducks. The box was anchored some distance from shore with the open side toward the shore. Bushes with leaves still on were stuck in the lake about the box to aid in concealing the gunner and his boat, a half-inch manila rope being used to hold the box at anchor. On visiting the blind one morning in October more than a peck of fresh wet Chara was found in the box. The amount was increased each night for the next few days until it consisted of more than a bushel of material, almost wholly Chara. One morning the box was missing and the next day it was found on the east side of the lake where it had evidently been drifted by the wind. An examination of the anchor rope disclosed the fact that it had been gnawed in two by the Muskrat itself which thus set its own home adrift.

The materials which the Muskrat uses in constructing its winter houses are chiefly various aquatic plants such as Chara, water lilies (both white and yellow), Potamogeton, Myriophyllum, Ceratophyllum, Scirpus. Typha, Iris, and the like, and our observations lead us to believe that they utilize at least some of this material as food. Along with these various plants will often be found stems and sticks of various sizes. In Lost Lake some of the houses contain a considerable proportion of mud.

During the summer the muskrats appear to subsist almost wholly on vegetable matter. In the early fall they sometimes make foraging trips to nearby gardens where they commit depredations on the carrots, parsnips, beets, turnips and other succulent vegetables. They also eat the seeds as well as the stems and roots of the yellow and the white pond lilies. They gnaw the bark from the roots and stems of Swamp Loosestrife (*Decodon verticillatus*) and the Buttonbush (*Cephalanthus occidentalis*). Later in the fall and during the winter animal food enters more largely into their menu. We have found them feeding on dead coots and ducks that had drifted ashore or which, wounded by some gunner, had escaped among the weeds and sedges fringing the lake. They also feed on turtles of various species which they find dead or which they themselves may kill. On several occasions we have found partly devoured turtles under circumstances which left no doubt as to what had been feeding on them. December 11, 1904, several dead painted turtles and a few musk turtles were found near Norris Inlet lying on their backs on the snow or ice, with the flesh wholly or partly devoured, and Muskrat tracks leading to and from

them and all about. The most important element of the winter food of the Muskrat, however, is the freshwater mussels or Unionidæ. At various places along the shore, wherever an object projects out into the water, such as a log or pier, or fallen tree-top, there will be found in autumn or early winter a pile of mussel shells where muskrats have been feeding. These piles are frequently of considerable size, containing sometimes a bushel or more of shells. September 24, 1907, one of these piles on Long Point was examined. It was off shore several feet and in water 18 inches deep. About one-half of the shells were examined critically and counted. There were 532 shells, representing 4 species as follows: *Lampsilis luteola*, 358; *Unio gibbosus*, 167; *L. iris*, 6; and *L. multiradiata*, 1.

During the fall these operations are probably confined to mussels which they find in shallow water near shore. In winter, however, when ice-cracks form and extend well across the lake, the Muskrats go far out on the ice, dive through the cracks and bring up mussels which they eat sitting on the ice. At such times they get mussels at considerable distances from shore. In the first days of January, 1905, a broad crack formed in the ice from Long Point to the Norris boathouse. On January 4, a Muskrat was seen at the edge of this crack about 1,000 feet from shore eating mussels. It would dive through the crack and after a little while reappear with a mussel. Sometimes it dived five or six times before securing one. It would then sit up on its haunches, holding the mussel in its paws and, by much clawing and chewing, finally succeed in opening the shell and removing the meat, which it usually licked out quite clean. In some cases the muskrat failed to get the shell open. Usually the shells are but little or not at all broken; even the hinge still holds and the shells are scarcely injured. It is our observation that the Muskrat, by inserting its claws or teeth between the valves succeeds in cutting or tearing loose the adductor muscles so as to permit the valves to spring open. Another Muskrat was observed further out on the same crack, a long distance from shore, and the ice along the crack between the two was pretty thickly strewn with shells. The Muskrats apparently do not care so much for mussel-gills filled with eggs or glochidia, as these are usually rejected. The stomach of a Muskrat examined at Washington, D. C., late in the spring was found well-filled with mussel remains. Muskrats also feed to a considerable extent on fish, crawfish and frogs. We have on more than one occasion found partly devoured fish at their feeding stations, and remains of fish, frogs and crustaceans in their kitchenmiddens. We have never

seen a Muskrat catch a live fish, but have no doubt they do so. They certainly pick up freshly dead fish which they chance to find.

At Lake Maxinkuckee the Muskrats raise at least two litters, and probably three, each season, the first litter being born about the first week in May. About the middle of June, 1901, young muskrats about half-grown were seen swimming about or sitting on their haunches on shore eating bits of lily roots. These were probably of the first litter. On June 15, 1903, a nest with five young was found in a pile of brush on marshy ground on Long Point. The young were evidently not more than a few days old, as their eyes were not yet open. On May 31, 1901, we caught one about one-third or one-half grown on south shore of lake. September 5, 1906, saw two young not more than half grown. On another occasion, a young one was seen on the shore near the Culver depot pier and was almost caught before it took alarm. On another occasion, a young one was seen to dive in shallow water south of Green's pier. Upon wading out to where it dived a hole was seen in the bottom out of which the Muskrat soon came and was captured. From these data it is evident that at least two litters per season are raised in this vicinity.

In the early winter, after ice has formed some distance out from shore, Muskrats are often seen swimming under the ice. They move along quite rapidly, and present a peculiar appearance, a bubble of air at each nostril expanding and contracting as they breathe, and a number of small bubbles on the fur giving them a silvery color. Apparently the Muskrat before diving fills its lungs with air, portions of which it exhales and rebreathes again. During the time the air remains as a bubble at each nostril it is purified through its contact with the water and rendered fit for breathing again. This peculiar habit would seem to account for the ability of the Muskrat to remain under water so long. On one occasion (in December, 1904) when standing on the ice a peculiar sound was heard beneath our feet. Upon investigation it was found to be caused by a Muskrat gnawing at the under side of the ice. The sound was like that made by a rat gnawing under a floor.

At times the Muskrats make various noises. September 5, 1906, two half-grown young were observed chasing each other and singing a long, shivering note, followed by mewings and squeakings and other noises or calls. The shivering, singing noise was heard on other occasions.

The Muskrat is the most valuable fur-bearing animal in the Maxinkuckee region; indeed, it is the most valuable in the State. Considerable numbers are trapped each year about the lake, the

best grounds being Norris Inlet and Lost Lake together with the Outlet. We have been unable to obtain complete figures of the catch, but have enough to show that it is important. In the winter of 1896-1897 one trapper secured between 60 and 70 skins. One who trapped only at Norris Inlet in the fall of 1900 had secured 30 pelts by November 9, and another at Lost Lake had 50 by the same date. Up to November first, 1903, two men trapping chiefly at Norris Inlet had secured 103 pelts. They got 28 one night. Their entire catch for the winter was 264 Muskrats, 4 mink and 3 opossums. The muskrat pelts brought them 10 to 15 cents each. The prices now are much higher, ranging from $1.50 to $3.50. Black pelts, which constitute a small proportion of the catch, bring much higher prices.

It has long been suspected that the Muskrat is the intermediate host of certain parasites which are concerned in the production of pearls in the Unionidæ or freshwater mussels. The Muskrat stomachs and intestines examined by us at Lake Maxinkuckee did not enable us to demonstrate the truth of this theory. One stomach examined contained no parasites of any kind. Another examined at Washington, D. C., contained a few parasites but none that could be identified with the distomid which induces pearl-formation. A species of parasite, *Monostoma affine* Leidy, closely related to the distomids was described from the gall-bladder of the Muskrat. It is the intention to examine a considerable number of stomachs at the first opportunity with a view to determining the facts in this matter.

20. JUMPING MOUSE

ZAPUS HUDSONIUS (Zimmermann)

This is another northern animal whose range southward reaches northern Indiana. It is frequently reported from this part of the state, particularly from the vicinity of Yellow River. It is also said to be seen occasionally about Rochester a few miles southeast of the lake. Our only definite records for the lake are a weather-worn skull found on Long Point in 1906, and one found dead near the ice houses on the west side of the lake August 26, 1906. This example gave the following measurements: length of body, 80 mm.; tail 108 mm.; ear 5 mm.; hind foot 28 mm.

21. PORCUPINE

ERETHIZON DORSATUM (Linnæus)

According to accounts given by old settlers in Indiana, the Porcupine was at one time not rare throughout the northern part

of the State. It was not uncommon for the inquisitive cow or the dog to come home with its nose full of spines of the Porcupine. It was the custom to hold the afflicted animal and pull out the spines with pincers, as they stuck very tightly, while the suffering creature announced to the neighborhood the discovery it had made that day. Troubles like this caused the settlers to wage a war of extermination on the Porcupine, with the result that it is now rarely or never seen. We have only one record of its recent occurrence in this vicinity. According to Mr. S. S. Chadwick one was killed a short distance west of Culver in the fall of 1887.

22. GROUNDHOG

MARMOTA MONAX (Linnæus)

The Woodchuck, Marmot or Groundhog as it is usually called in Indiana, is fairly common in most parts of the State. It most delights in the more hilly districts covered with open forests or grassy meadows, particularly those near fields of red clover. It is not rare about Maxinkuckee. One or more pairs can usually be found on the hillsides about Lost Lake, others in or at the edges of the fields along the Outlet, several north and east of the lake, and a few in most other suitable situations. In 1900 one had its home in a burrow under one of the buildings on Long Point. In the fall of 1904 some burrows were observed in the middle of a level field, the holes going vertically downward several feet. This is rather unusual, as the Groundhog almost invariably selects a hillside or bank in which to dig its burrow.

In May and early June, 1901, five were shot in Green's field near the Gravelpit, two of which were old females, and three were young. About the last of June, 1901, a half-grown young was caught near Lost Lake. When pursued it ran until overtaken, when it turned and showed fight. August 25, 1906, several were noted in fields near the railroad south of the lake. They sat up erect and watched us go by. September 13, 1906, one was killed near Lost Lake. September 22, 1907, several burrows, evidently of this animal, were seen along fences between the lake and the tamarack swamp, and on September 25, one was seen near the Gravelpit. On September 15, 1913, we saw one that had just been killed near the lake, and on October 7 one was seen south of the Gravelpit. It is said to occur in the high ground back from the Kankakee River.

In the early spring, soon after the first warm days have come and the only remaining reminders of the passing winter are a few snow banks in protected places or occasional little flurries of snow,

and when the first green blades of grass are just peeping through the matted dead grass of the previous year on warm hillsides and along fence-rows, the first Groundhog of the season is apt to be seen. He will most likely be found out in the open in some old meadow, preferably a clover-field, and near his den. Here he appears early in the afternoon when the sun shines warm on the hillside. He comes out not only to feed upon the young and tender stems and leaves of the clover and other early spring plants, but he also delights to lie in the warm sunshine or to sit upright near his burrow looking about over the fields and renewing his acquaintance with the scenes which have remained only as a memory since he went into winter-quarters the previous fall. Later in the spring and in summer and fall, if you should be abroad in the early morning when the sun is just showing and the dew still hangs heavy and sparkling on the tender new grass, you will almost certainly be rewarded by seeing one or more Woodchucks in any cloverfield you chance to pass. Then they come out for their morning repast of red clover stems and leaves, and the tender shoots of windflower and cinnamon fern. At this time they will be quite busy. When done feeding they will return to their burrows where they probably sleep until one or two o'clock when they reappear, not so much for feeding as to bask in the warm sun or to look about over the country. Again late in the evening, between sundown and dusk, they come out again to feed. Then they usually remain out until nearly dark when they are apt to retire to their burrows. They are, however, to some extent nocturnal and may remain abroad well into the night.

The Groundhog is a pretty strict vegetarian, his food consisting chiefly of red clover and the tender stems of grasses and other plants. He will sometimes do damage to the young corn plants and will on occasion, feed upon the leaves of pumpkin, squash and bean vines. They will sometimes visit the kitchen garden and do more or less damage to the cabbage heads and celery. They have also been known to visit apple orchards near their burrows and feed upon such fruit as they could find on the ground. The only real damage they do that is serious is that done to the clover-field; all the rest is only occasional and may be regarded as negligible, except perhaps the inconvenience caused by the holes they make in the meadows and fields.

Dr. Merriam has observed that in the fall the Woodchucks tend to leave the burrows in the open fields and go to those in the woods in which they spend the period of hibernation, and our observations lead us to the same conclusion. Certain burrows in Walley's and

other woods which appeared to be deserted during the summer showed evidences of being used early in the fall and those in the fields had the appearance of having been abandoned in September or early October.

On May 3, one was observed sitting at the mouth of his burrow, which was under a large stump. One of us slipped up from the opposite side, and, looking over the stump, watched him for some time at very close range. He was very quiet and seemed to be looking out across the field. When a small object was dropped upon his nose he quickly turned his head sidewise and looked up with an expression of curiosity, if not astonishment, on his face. Not until the observer moved did he become frightened, when he quickly disappeared in the burrow.

The Woodchuck produces three to six young in a litter, usually about the last of April. We have some evidence indicating that two litters may be produced in one season. On September 10 a young Woodchuck not more than one-third grown was seen on an open hillside where it was feeding on fresh grass. When chased it ran quite swiftly. When overtaken it would change its course from time to time. Finally when tired out it crouched down in the grass, apparently attempting to hide from its pursuers. Its small size suggested that it was born not earlier than the middle of July or later.

The Groundhog as yet possesses little or no economic value. Its pelage is coarse and contains little fur. The hide is tough and ought to make a good quality of leather. The flesh is abundant in quantity, sweet, palatable and very nutritious; it ought to be more extensively utilized as an article of food.

23. STRIPED GOPHER

CITELLUS TRIDECEMLINEATUS (Mitchill)

This gopher is an intrusion from the prairie fauna to the westward of Maxinkuckee. It appears to be gradually extending its range eastward. Thirty years ago it was very rare or entirely unknown in Indiana except in the prairie counties along the western border of the State. During 1883-1885 the senior writer of this report had exceptional opportunities to become quite familiar with all parts of Carroll County, which lies some 50 to 80 miles south and a few miles west of Maxinkuckee, and in those years he saw a total of only three or four pairs of Striped Gophers within its borders and they were all in the extreme western part of the county where the land is largely prairie. During many years of almost continuous residence in that county (1858 to 1885) the species

was never seen east of the Wabash River, but recently it is said to have appeared there. In Vigo County it was common from 1886 to 1891 and has so increased in abundance since then as to have become a serious pest.

In 1899 when our field work began at Lake Maxinkuckee the Striped Gopher was rare in that region; in fact, only one or two pairs were seen during that season. They had their home at the Gravelpit and were observed most frequently in August. In 1900 they were more numerous. Besides the colony at the Gravelpit, one or more were seen occasionally further south along the railroad, several about the sandy hills southeast of the lake, and now and then one was noted on Long Point. In 1904 they had still further increased. On July 3 one was found dead on the railroad near Murray's where it had evidently been killed by a passing train, and several others were seen at the Gravelpit. One or more were seen on Long Point, and in the autumn of 1906 several were observed there. In 1907, soon after corn-planting, these little rodents were found to have increased greatly in numbers about the Gravelpit. They became very destructive to the young corn in a field nearby. They would pull up and eat the young plants. One individual was seen to pull up 20 stalks. The owner of the field shot 20 of them in May and early June. Many of them were old ones while others were small and apparently young of the year. The gophers of this colony had their holes or burrows in and about the Gravelpit. The colonies on the sandy farms south and southeast of the lake had also increased considerably in numbers, as had also that on Long Point. One was caught by a cat on Long Point in June of that year. In 1910 it was learned that they were becoming more and more abundant every year. Several were seen on Long Point. Observations made in the fall of 1913 indicate that they are still increasing. On September 17, one was seen at the Gravelpit, and one or more were noted near Murray's on October 4 and 6. On the farms south, southwest and southeast of the lake they are getting to be a pest. They are probably now found west, north and east of the lake in suitable situations, but we have not observed them there, as our field work has not recently extended into those regions.

The Striped Gopher feeds upon young corn, wheat, oats, grass and other tender plants, also upon grain and other seeds of various kinds. It is very prolific and, once it has secured a foothold in any locality, it is quite certain to become a serious pest sooner or later unless drastic measures are taken to hold its numbers in check.

24. GROUND SQUIRREL

TAMIAS STRIATUS (Linnæus)

The Ground Squirrel or Chipmunk is an interesting and familiar little animal in all suitable situations in Indiana. Every farmer's boy in the State knows it well. Wherever there are open woods or pastures and old decaying trees, rocky ledges overgrown with vines, fallen timber and brush piles, and Virginia rail fences that have not been well kept, there the Chipmunk is quite sure to be found. Though still abundant in most parts of Indiana they are less so than formerly. At one time they were so numerous as to be regarded as a serious pest and bounties were paid for their scalps.

About Maxinkuckee they are still rather common and may be seen almost anywhere about the lake and on adjoining farms. Nearly all portions of the lake shore are favorable. Wherever there are old trees on the north, east and south sides, there you may find Chipmunk families. The old oaks at the southwest corner of the lake and those on Long Point have never, since our acquaintance with the lake, been without their Ground Squirrels. The open woods between the two lakes and Walley's woods are also favorite situations. A visit to any of these regions would almost certainly be rewarded by a glimpse of a pair or more of these merry creatures.

On Long Point several pairs usually have their homes, and from May or June until late in October they may be seen chasing each other along the fences or sitting at the root of some hollow old oak where they often remain chirping hours at a time. During the winter of 1900-1901, one had its home under the cottage in which we lived. During the fall it was seen daily gathering nuts, seeds, and grain which it stored for winter use. On bright sunny days it worked persistently from early morning until evening, usually stopping in the middle of the forenoon and again about two o'clock in the afternoon to sit on the south steps of the cottage or at the root of a gnarled old oak near by, where it would keep up an almost incessant chirping for an hour or more. Toward evening it generally disappeared, not to be seen again until 7 or 8 o'clock next morning. On dark and gloomy days it sometimes failed to appear. On November 27 it went into winter quarters and was not seen again until the twentieth of March following when it was seen scurrying about as lively as ever. From that date on it and others were noted occasionally on bright sunny days until warm weather, when they might be seen every day, usually near the edge of their

burrows or other safe refuge into which they would scamper, on the slightest alarm, with a rapid succession of sharp chipping noises. During the summer and early fall they are ever in evidence and are not easily frightened. As fall comes on and seeds and nuts mature, these interesting little animals become more active and very busy laying up their winter stores, stopping now and then to bask in the sun, their crammed cheek-pouches giving them a comical, mump-like appearance. At this time of the year they have a call or note quite different from the sharp chipping noise usually heard in the summer, it being a succession of hollow clucking sounds, most interesting when heard at some distance through the autumn woods. A little later, toward the last of October, when frosts are frequent and the days are chill, they may be seen only on those days that are bright and sunny, usually sitting in the sun on the root of some old hollow tree, chipping merrily. Still later, as cold days become the rule, only the brightest days tempt them out; then they sit quietly where the sun shines warmest, chipping not at all or only now and then very mildly.

Following are some of our notebook records:

1899.—October 3, still out and busy gathering food. 1900.—October 18 and 19, noisy about and under our cottage; October 22, noted; 24th, one seen going under cottage; 25th, the one belonging to our cottage was quite noisy for a while; 26th, 27th and 30th, still out and noisy; November 3, 5, and 6, seen; 27th, seen for last time. 1901.—March 20, the one under our cottage came out today and scurried about as lively as ever. October 19-21, very common on Long Point; at least 20 between our cottage and the end of Long Point, all very busy garnering their winter stores, but mixing a good deal of play with their work. 1902.—June 19, two seen on Long Point; 22d, one at tip of Point and several elsewhere. 1904.—October 18, several seen; 19th, on early morning trip around the lake saw only one; October 20 and 21, one or more were seen on Long Point; November 5, one seen. 1906.—September 17, several seen on east side, all chipping merrily; 25th, caught one in trap on Long Point; 30th, a very bright colored one seen. 1907.—September 26, one heard and another seen on east side; 29th, one heard at Walley's birch swamp; October 4, one seen on Long Point filling its pouches with ragweed seeds which it skillfully gleaned from the standing weeds; 10th, one seen on Arlington coal bin, and another with very full pouches basking on a rock near the Duenweg cottage. Loud gunshots fired at coots near by did not frighten it; 14th, one heard clucking near the birch swamp.

In some sections of its habitat the Chipmunk is said to be mi-

gratory, but our observations lead us to believe it to be non-migratory in Indiana.

The Chipmunk feeds chiefly upon nuts and seeds of various kinds. In regions where beech trees are found their delicious nuts constitute its principal food. Hickory nuts, particularly the thinner shelled species, hazelnuts, acorns and corn are also highly prized. In the spring they may do some damage to the corn fields by digging up the newly planted grains; but this is infrequent and apt to occur only when the field borders on open woods. As already recorded, on October 4, we observed a Chipmunk going from one ragweed to another, stripping off the seeds and cramming his pouches with them; from which it appears that they are of some value as weed-seed destroyers.

On the whole, the Chipmunk is a harmless and very cheery little creature which, in moderate numbers, does little or no harm and adds much to the attractiveness of any region.

25. RED SQUIRREL

SCIURUS HUDSONICUS LOQUAX Bangs

The Red Squirrel, Pine Squirrel, Chickaree or Boomer, as it is variously called, is a northern species which is gradually extending its range southward in Indiana. Until within the last decade it was rare or wholly unknown in most parts of the state south of Logansport, though it was not uncommon in the more northern counties. On December 24, 1889, one was shot near Kewanna which is about 12 miles south of Maxinkuckee. It was regarded as a rarity in that region. About 1900 one was seen near Frankfort, about 70 miles south of Maxinkuckee, the first ever noted in that county. We have learned from Mr. Sidney T. Sterling of Camden, Carroll County, that it has recently appeared in that county.

When we began our investigations at Lake Maxinkuckee, the Red Squirrel was not common. In 1899 only one was seen, in September, near old Lake Manitou. On September 24, 1900, a young one, just able to crawl about, was found on the ground in Farrar's woods. It had probably fallen from the nest. It was taken home and fed and soon became quite tame. It was not caged but was permitted to run about the room, and soon became quite playful and mischievous. One of its favorite positions was a seat on one's shoulder where it soon called attention to itself by a gentle nipping of the ear of the person on whose shoulder it was sitting. One or more were seen October 1, 14, 19, and 30. In 1904, they were

quite numerous; several were noted October 19 and 27 and at various times thereafter until January 3, 1905, when we left the lake, until August, 1906, from which month until November 14, many were seen.

On September 13, 1907, and at various times thereafter until the middle of November, one or more were seen on any day when we cared to look for them. One was seen September 27, 1908. On September 8, 1913, one was observed for some time on the grounds of the Chadwick Hotel, and again on the 17th. One seen in Walley's woods October 7, 1913, and on September 30, two were shot in the same woods; one (a male) weighed 7 ounces, the other (a female) 6¼ ounces. According to Mr. S. S. Chadwick they have continued to increase up to the present time. Their favorite haunts about Lake Maxinkuckee are the heavier woodlands at the south end of the lake, Walley's woods, the timbered areas on the east side and the groves north and east of the Academy grounds. Only rarely have we seen it on Long Point, while on several occasions we have observed it on the Tippecanoe River near Delong.

While the Red Squirrel is a merry playful little animal, there is little else to commend it to one's favor. While its principal food consists of nuts and seeds of various kinds, it is very destructive to birds' eggs and even young birds. It is also popularly thought to drive the fox squirrel out of regions which it formerly occupied, and there is probably a basis of fact in this belief. On account of its small size it is not much hunted for food, although it makes a delicious stew.

26. GRAY SQUIRREL

SCIURUS CAROLINENSIS LEUCOTIS (Gapper)

Formerly the Gray Squirrel was very abundant throughout Indiana and southern Michigan. Forty to fifty years ago squirrel hunting was an avocation in which nearly every farmer and farmer's son, as well as many of those who dwelt in the villages and towns engaged, and a poor marksman indeed was he who did not return from a morning in the woods with the old muzzle-loader and anywhere from 6 to 20 squirrels. To be regarded as a real expert shot, however, it was necessary to be able to "bark" the squirrel, that is, to kill it simply by shooting through the bark of the limb on which the squirrel happened to be sitting without actually hitting the squirrel. There were in every community a number of such expert squirrel hunters. In southern Michigan a large proportion of the Gray Squirrels were *black!* while in middle Indiana a black squirrel was not often seen. In the Maxinkuckee region

this squirrel is now a very rare species. Mr. Chadwick says he knows of only two or three having been killed near the lake in the last six or seven years. The only one ever seen by us in that region was observed May 9, 1901.

27. FOX SQUIRREL

SCIURUS NIGER RUFIVENTER (Geoffroy)

Although formerly quite common in central and northern Indiana, the Fox Squirrel was never so abundant as was the Gray Squirrel when the country was new. But as the forests were cleared away, farms opened up, and open woodlands and pasture lots became more and more common features of the country, the Gray Squirrel became practically extinct while the Fox Squirrel was more nearly able to hold its own, albeit, even this species is far from being as abundant as formerly. In the region with which the present paper deals the Fox Squirrel was very rare until recently. None was seen or heard of in 1899. In 1900 one was seen in Walley's woods on September 28, and one near Delong the next day. The first of these was killed by some one in October. Several were killed by a local hunter in the fall of 1902. In 1904, Fox Squirrels were occasionally seen. Two were killed November 29; one was seen in the Assembly grounds; on December 15 a large oak on Long Point was cut down and was found to contain two Fox Squirrels, probably young of the year, but fully grown. In the fall of 1905 three or four were seen on Long Point. In 1906 two were killed south of the lake September 12; two days later one was seen in Farrar's woods, and on September 17 another was noted on the east side of the lake. In the autumn of 1907 one or more were observed in Green's woods. Doubtless it is no less frequent in open woods east of the lake.

The Fox Squirrel prefers the open woods and is rarely seen in heavy, dense forests. Wherever there are large old trees with hollow limbs or trunks on the borders of cornfields, there these squirrels are apt to take up their homes if there be any in the neighborhood. Unless disturbed the same pair will occupy the same tree for several years, probably until they die or are killed.

These squirrels feed upon all sorts of nuts and are very destructive to the farmer's corn. In January, 1908, Mr. A. M. Evermann observed Fox Squirrels near Burlington (56 miles south of Maxinkuckee) feeding upon the seeds of the cocklebur, *Xanthium strumarium*. The squirrels would strip the burs from the plants and carry them to a nearby log on which they would sit on their

haunches while they gnawed the burs and removed the seeds. At the time the ground was covered with snow.

So far as we have been able to learn this habit of the Fox Squirrel had not been previously observed.

28. FLYING SQUIRREL

SCIUROPTERUS VOLANS (Linnæus)

Wherever there are, about the lake, large old trees with hollow trunks or limbs, one or more pairs of Flying Squirrels are likely to be found. Striking such trees with an axe or maul will often induce the squirrels to come out, especially if the tree is of proper size and springy enough to vibrate well in response to blows. When striking the tree is stopped, the squirrels usually return quickly to their nest. By such devices as this, one is apt to discover that the Flying Squirrel is a much more common animal in the neighborhood than the number seen otherwise would indicate. On account of its quiet, unobtrusive ways and its nocturnal habits it is not often seen except by those who know its ways.

These squirrels usually make their nests in holes in old dead or decaying trees; they may utilize a hollow limb, a decayed and hollowed-out portion of the trunk or a deserted woodpecker hole. Late in the fall, after the cottagers have left the lake and the cottages have been closed for the winter, these resourceful little animals sometimes take up their residence in the loft, cupboard or some suitable box in the cottages. There they build their nests and dwell cosily until the warm days of returning spring tempt them to return to a hole in some scraggy old oak near-by, where they will spend the summer.

Occasionally, in the evening twilight or on moonlight nights, a Flying Squirrel may be seen sailing in a gentle downward curve from one tree to another, the start being made from well toward the top of one tree and the place of alighting at a much lower point on the other. There is something ghost-like in this gliding flight; it is so unlike that of any other of our native creatures; there is not only an entire absence of fluttering wings, but perfect silence.

While in their nests these squirrels do more or less squeaking. On the night of September 21, 1903, one or more were heard in trees in the Arlington hotel grounds. On November 27, 1904, the accidental burning of two cottages on Long Point ignited some of the surrounding trees, one of which contained a family of Flying Squirrels. They did not leave their nest until fatally burned, when

they leaped to the ground. On August 19, 1906, while riding along a road west of the lake a squeaking sound attracted attention to the base of a small scrub oak at the roadside. On examining the place four young Flying Squirrels were discovered. They were quite small and wholly naked. A storm had probably blown them from their nest which was a large, globular affair, made of fibrous material, situated in a crotch of the tree. While we were only a few feet away, one of the parent squirrels, presumably the mother, came down the tree and, taking the young in her mouth, carried them, one at a time, back to the nest.

On April 16, 1890, one of us found a nest containing two young Flying Squirrels, south of Terre Haute. The nest was in a woodpecker's hole about 20 feet from the ground in a maple. Upon striking the tree the mother squirrel came out of the hole and flew to another tree near-by, where she remained watching. Breaking the snag at the hole the two young were removed and placed on the ground. After a little time the old squirrel flew back to the snag and seemed much disturbed by the changed appearance of things. She looked all about and, finally discovering the young on the ground, she came down, and taking one in her mouth, carried it to the top of the snag from which she then flew with the young in her mouth to another tree about 30 feet away. She ran up that tree to a height of about 50 feet where she found a knot-hole in which she placed the little one. In a moment she reappeared and flew back to the snag for the other. In the meantime I had stationed myself near the young. After several advances and retreats she finally came and seized the young in her mouth when I caught her in my hand. When released she returned to the knothole with the young squirrel. These dates (April 16 and August 19), are of interest in showing so wide a range in the breeding season of the Flying Squirrel.

On December 16, 1890, a family of six Flying Squirrels was found by Mr. J. M. Beck near Burlington. They were all full-grown. On Thanksgiving day, several years ago, Prof. U. O. Cox, then of Farmland, Indiana, found 15 Flying Squirrels in a small rotten stump a little higher than a man's head.

It is remarkable the number of Flying Squirrels that can be discovered in any wood by knocking on the old dead snags or trees, particularly in the spring. We have found them in old oaks, beeches, maples, ash, willows, sycamores and hickories, as well as in various old buildings. They seem to breed chiefly early in the spring, about sugar-making time. A second or third litter may be produced later in the season.

Flying Squirrels make very interesting pets. Several years ago one of us had two which were kept as pets for several weeks. They had the freedom of one room in the house. During the day they lay curled up in a box provided and made comfortable for that purpose. At night, particularly before midnight, they would come out to play about the room and to accept the nuts and other food offered them. One night a drawer containing a number of bird-skins was inadvertently left open. One of the squirrels got into it, ate one of the skins and as a result died of arsenic poisoning.

29. BEAVER

CASTOR CANADENSIS CAROLINENSIS Rhoads

The Beaver was at one time pretty common in the northern part of Indiana. There still exist vestiges of one or more beaver-dams in the Outlet between Lost Lake and the Tippecanoe River.

30. RABBIT

SYLVILAGUS FLORIDANUS MEARNSII (Allen)

The Rabbit or Cottontail is an abundant and well known animal of the Maxinkuckee region. The large areas of uncultivated swamp-land, abounding in tall grasses, sedges and small brushy shrubs, the tamarack and other swamps, and the considerable tracts of timber, often with heavy undergrowth, give a wide choice of location and refuge. In all these, Rabbits are usually quite abundant. Although apt to be found almost anywhere, there are choice places where they are particularly common. Among these are the thickets, fields, and Farrar's woods at the south end of the lake; the shores of Lost Lake and the woods and fields from Green's to Walley's and beyond; the fields, swamps and prairie westward to Manitou and Houghton lakes, including the tamarack swamp; and the low ground along Aubeenaubee Creek on the east side.

The following records made by us serve to indicate to some extent the abundance of Rabbits in this region. They are by no means complete, but simply show the observations of one or two persons for portions of each of several years. During the fall of 1899 up to January 21, one man who hunted only occasionally and only in the immediate vicinity of the lake, killed 76 Rabbits. In the fall of 1900 one hunter had killed 56 by December 31. In 1901 they were said to be plentiful in February and on December 10, one hunter shot 19. On January 2, 1903, hunters obtained 21 in the vicinity of Mud Lake near the head of Aubeenaubee Creek; December 14, four hunters got 20 and on December 30, one got 8. In 1904, 7 were killed December 8, 24 on December 13, and 2 on

December 22. In 1905 two were gotten November 27. In 1906, two on January 22, one seen July 21 and 29, and October 9, several on the east side on October 31, 2 on November 13, one on the 14th and 4 gotten on the 20th. In 1907, a half-grown young one was seen September 11 and another September 20; another not more than one-third grown was seen September 22. On November 17, 1909, two gotten with ferrets under the Farrar cottage, were sent to the U. S. National Museum. In the fall of 1913, they did not seem to be very common. On September 17 a half-grown young one was seen on Long Point, and again on October 4.

In this region the Rabbit is hunted rather persistently every fall and winter from October to February and the total number killed is great; nevertheless the animals are so prolific that the supply usually keeps up pretty well. During some years it is less abundant. The season of 1908-9 was a period of scarcity. Generally these periods last only for a single season, and the next season is one of usual abundance. They are in best condition in November to January and these are the principal months when they are hunted. Unfortunately a few local pothunters have been using ferrets, a method which affords no sport, is entirely unsportsmanlike, gives the Rabbit no chance, and which cannot be too severely condemned.

In this region the Rabbit breeds at least twice each season. The first litter is produced early in the spring, usually in May, and the young are half or two-thirds grown by the first or middle of July. The second litter is probably produced in July or even as late as September, as we have seen half-grown and one-third-grown young September 11 and 22. Heavy rains in the spring frequently flood the breeding grounds, with the result that many of the first litters are drowned. This was particularly the case in 1902 when there were unusually heavy rains in May and June, flooding all the lowlands. That many young Rabbits were drowned is evidenced by their scarcity in the fall and winter following.

Here, as elsewhere, the Rabbit causes some damage to young fruit trees by gnawing the bark. The damage is greatest during the winters of heavy and long-continued snows which cover up other vegetation on which they would feed. The Lake Maxinkuckee region, however, is not much given to orchards or horticulture and the injury wrought by Rabbits is therefore not serious.

The Rabbit as an article of food is becoming more highly appreciated in recent years and there is also an increasing market for its fur. With proper laws providing adequate protection a large and valuable catch can be made every year.

THE BIRDS

Introduction

The scope of the investigation as originally planned included as careful study of the vertebrate animals of the lake as time and facilities at command would permit. It soon became evident, however, that no very satisfactory progress could be made with those groups without consideration of the plants and of the various groups of invertebrate animals of the lake. It also became more and more apparent as the work progressed that no hard and fast line could be drawn between the species directly related to the lake and those only indirectly so related, or those thought to bear no relation.

Many illustrations could be given of the ways in which various species of purely land animals and plants are related ecologically to purely aquatic species inhabiting the lake. Mention will here be made only of the birds.

The larvæ of certain dipterous insects of the genus Chironomus are exceedingly abundant at the lake and constitute a very important part of the food of the fishes, particularly of the young. We discovered also that several of the birds feed upon the adult insects. In September and October, when the larvæ complete their metamorphoses and the adult insects emerge from the water, the air and the trees about the lake become filled in the evening and on quiet days with vast swarms of these mosquito-like insects. The air becomes vocal with the constant humming of the millions on the wing. They are everywhere,—in the air from the ground to a height as far as the eye can see, thickest perhaps at a height of 15 to 30 feet; on the sides and roofs of the cottages, on the fences and on bushes; and on the trunks, limbs and leaves of the trees. There were literally billions of them. Then it is that many species of birds which had not been thought to bear any intimate relation to the lake have a veritable feast. Among the birds which we saw feeding upon the insects were the nighthawks, swallows, yellow-billed cuckoos, yellow-rumped warblers, red-headed woodpeckers, and even song sparrows. And along the shore vast quantities of casts of Chironomus larvæ had been washed up and upon these were feeding phalaropes, snipes, plovers, and even rusty blackbirds, redwings, and crow blackbirds.

But the story does not end here. After the nuptial flight of the Chironomi has been made, these insects, myriads upon myriads of them, return to the surface of the water upon which they lay their eggs, and there fall a prey to various species of fishes, from the

tiny top-minnow to the bluegill, yellow perch, and large-mouthed black bass. And the eggs laid by those which succeed in escaping all their enemies furnish enormous quantities of food to the multitude of little fishes hatched during the previous summer, while the eggs that escape hatch sooner or later, and in their new form as Chironomus larvæ, supply even greater quantities of delicious food to the fishes of somewhat larger growth, and also to the turtles and young waterdogs in the water, and to various species of birds that feed along the beach. But even this is not all the story. The millions of midges, after having accomplished their only purpose in life by laying billions upon billions of eggs, die, and their dead bodies, falling upon the surface of the lake or upon the land, are eaten by the fishes, birds, small insectivores, or other animals.

The total number of species of birds noted by us in the immediate vicinity of Lake Maxinkuckee is 175. Doubtless if we could have been at the lake oftener during the spring migrations, the number would have been considerably increased. Only one of us was at the lake during an entire spring, and his time was then so largely taken up by other and more important investigations that little opportunity was left for noting the birds except those associated directly with the lake.

Of the 175 species, at least 50 are very directly and closely related ecologically to the fishes and other life forms found in the lake. At least 23 other species are more or less directly so related. Of these 73 species many feed directly upon the fishes; a yet larger number feed directly upon the food of the fishes, and still others feed upon insects, plants, etc., which in turn serve as food for other species upon which the fishes feed directly. All of these 73 species are closely associated with the lake itself; they are either strictly aquatic birds, such as ducks, coots, gulls, terns, and the like, or shore birds such as herons, snipe, plover, bitterns, and similar species; or else swallows and the like which fly over and about the lake, feeding upon the insects found there. Then there are the birds of prey, the hawks and owls, some of which prey directly upon the fishes, while others prey upon aquatic birds, such as the ducks and coots.

As a matter of fact, it is doubtful if there is a single species of bird frequenting this lake or its vicinity that does not exert some influence, however small, upon the life forms of the lake itself. This would be true of any body of water and the birds found about it.

The number of aquatic and shore birds in the present list is

remarkably large. The total of their influence upon the life of the lake must be very great, indeed.

There is probably no other lake in Indiana, if, indeed, in the Mississippi Valley, where ducks are so abundant as to species and individuals as at Lake Maxinkuckee. At least 21 species of ducks are known to visit this lake, and several of them in great numbers. The physical characteristics of the lake, its location, and the abundance of wild celery and other suitable food, all combine to attract the ducks during their migrations and to hold them for many days, especially in the fall and early winter.

In the spring the ducks begin to appear just as soon as any open water is found in the lake. This will usually be in narrow strips along the shore, particularly at the south end where the water is shallow and where the ice melts readily. Soon after the ice has left the lake they appear in great numbers.

In 1901, the only spring for which we have many records, the first arrivals were noted March 2. The next day a great many were observed. On the 4th, 8th and 9th, several large flocks were seen, although the ice was not yet off the lake and there was very little open water so that the ducks had to rest upon the ice. On the 12th the largest and most numerous flocks were seen, usually flying over the lake, but sometimes finding the open water where they alighted. After that date they continued to be noted almost daily in considerable numbers until the last of April. They were noted as abundant on April 26. On the 27th only a few were seen and at no time after that date were they numerous, although a few were seen almost daily until May 18. After that date only a few scattering ducks were observed. There were 5, probably all little bluebills, that remained in the east and southeast parts of the lake at least up to July 10 when Mr. Clark left the lake. One of these seemed to be crippled and it may be that all of them were birds which were unable, on account of gun-shot wounds, to continue their northward migration. A single canvasback was also seen July 10 in the southwest part of the lake. It and a pair of the little bluebills acted as if they had nests somewhere on the shore, and it is not unlikely that a few ducks that have recovered from wounds nest at the lake each season. Our fall and winter records are much more complete. Our earliest fall record is for August 21, 1906, when several ducks were seen at some small ponds north of Twin Lakes, a few miles north of Maxinkuckee. On August 31, 1908, a good many wood ducks, several mallards, and a few coots were reported from some small ponds just west of Maxinkuckee. It is usually not until well in September, however, that

ducks are seen. For each of several years the first were noted as follows: In 1899, the first flock was seen September 29. In 1900, on September 3, two flocks seen flying south. In 1906, on September 11, they were said to be common at Lake Manitou, near Rochester, and the next day a flock was seen at Maxinkuckee. In 1907, the first flock was seen September 23. In 1913, on September 4, two were seen flying from Lake Maxinkuckee toward Lost Lake. Usually by the middle of October, sometimes the first, they are abundant, although, in 1913, they were not yet very common at the end of October when our stay at the lake ended.

In 1899, they were noted as scarce on October 12, but five days later a large flock was seen at night, which was very foggy, on shore at Long Point. They were believed to be mostly little bluebills.

In 1900, a flock was noted October 16 and others on the 19th. Two small flocks seen flying over on the 26th, and several others were noted on the 28th, and again on the 29th when there was much shooting. Our only October record for 1903 is one for the 15th to 29th, during which fortnight two market hunters camping on Long Point are said to have killed a great many ducks, mostly little bluebills. They used blinds and decoys, a method of pot hunting which should be made unlawful. It is said that these pot hunters received $6 a dozen for the ducks they killed.

In 1904, ducks were reported to be numerous as early as October 8, but there were not many on the 18th. On the 21st and 22d good-sized flocks were seen flying over. On the 25th there were a good many birds on the lake and a cottager from Peru was seen pursuing them in a motor boat; two days later he was caught in the act and, pleading guilty on two counts, was fined $72.00, including costs. On the 29th there were a good many ducks on the lake, mostly little bluebills but some canvasbacks, and there was a good deal of shooting.

In 1906, a few were seen far out on the lake on October 9, and on the 13th there was much shooting on the lake, unlawfully continued long after sunset. We have no other note until October 28 when a flock was seen flying south. The next day there were many on the lake and there was a good deal of shooting. On the 30th they were common, two hunters getting 15. They were plentiful on the 31st.

In 1907, two or three flocks were seen on October 7, chiefly on Lost Lake. Others were seen on the 13th, 14th and 15th. On the 19th there were thousands on the lake. Many were noted on the 21st, mostly little bluebills, whistlers, canvasbacks and redheads.

November is the month of greatest abundance. Practically all that come from the north have arrived by the end of November and few, if any, have left. Our notes are quite full for this month in 1900, 1904 and 1906, and show that ducks were quite abundant throughout the month in each of those years.

December is second only to November in the abundance of ducks. While there will normally be few or no new arrivals, there will be some departures for the south, and the numbers throughout the month will not differ greatly from those of November.

In 1899, ducks were abundant and there was excellent shooting at the beginning of the month. In 1900, they were abundant and continued so throughout the month. In 1901, they were very abundant at the beginning and continued so; little bluebills, canvasbacks, fish ducks, butterballs, mallards, ruddy ducks and redheads all being common. In 1902, they were quite abundant. In 1904, up to December 8, one cottager on the east side had killed 60 ducks, mostly bluebills, canvasbacks and redheads.

The ducks remain at the lake usually so long as there is open water and abundant food. This usually extends well into January. Our only personal observations in January were in 1901. By the first the lake was entirely frozen over with the exception of 2 or 3 open pools. One of these was east of the Deephole and was only about 15 feet across. Another was off the Van Schoiack place and was even smaller. Still another, and the most important one, was at the Weedpatch, and was about 15 feet across. All these pools as long as they remained open were literally packed with ducks and coots, and many were often seen sitting on the ice. By the 27th nearly all had gone, and none was seen after January 31.

The best hunting is usually from about the middle of October until the middle of December, November being the best month. The open season for ducks in Indiana is from September 1 to April 15. This covers practically the entire period of their presence at the lake, and affords them no protection whatever. Spring shooting should be eliminated entirely. The birds should be protected then, not only because they are *en route* to their breeding grounds, but because they are not in prime condition as an article of food. The open season also begins too early in the fall. Many, indeed, most of the ducks arriving in the fall are young birds, more or less immature and so unsuspicious that they fall an easy prey to the pot-hunter. The closed season should be extended to the first of October.

The most abundant species of duck visiting Lake Maxinkuckee

is undoubtedly the Little Bluebill (*Marila affinis*), and the second in abundance is the Canvas-back (*Marila valisineria*). Following these come the Redhead (*Marila americana*), the Mallard (*Anas platyrhynchos*), the American Merganser (*Mergus americanus*), the Ruddy Duck (*Erismatura jamaicensis*) and the Butterball (*Charitonetta albeola*). The remaining fourteen species are each less common.

The state law regarding hunting water-birds is not as well obeyed at Maxinkuckee as it should be. The most serious offenders are those who have launches or motor-boats of one sort or another. Not all those having such boats violate the law, but several of them do. They not only chase or pursue the ducks with their launches, but do it after sundown, and even without any sort of hunting license.

The Lake Maxinkuckee Association should have their patrolman made a special game warden and then see to it that he be active and fearless in enforcing the law against all pot-hunters.

In nomenclature and sequence of species we have followed the third (revised) edition of the Check-List of North American Birds, issued by the American Ornithologists' Union in 1910.

List of Species

1. HOLBŒLL'S GREBE

COLYMBUS HOLBŒLLI (Reinhardt)

The only definite record we have of this species was made October 12, 1913, when a single individual was observed in the lake 150 to 200 yards or more east of Long Point. Its larger size, long slender neck, and white color at once attracted our attention as indicating a species different from the horned grebe or pied-billed grebe. Considerable time was devoted to observing it. It was evidently feeding, as it dived very frequently, remaining under several seconds and usually coming up not far from where it went under. Occasionally it would stand up in the water and flap its wings.

This species of grebe feeds on small mollusks, crustaceans and small fishes.

2. HORNED GREBE

COLYMBUS AURITUS Linnæus

This little grebe is not common at Lake Maxinkuckee, but a few may be seen in the spring and again in the fall. We have observed it in April and June; also in October, November, Decem-

ber and January. It is evidently a spring and fall migrant. Dates on which we definitely recorded it are as follows: In 1899, on September 30 when two were shot at Long Point; in 1900, on September 14, on October 17 and 18, on November 1, 3, 4, 8 and 12, and December 8, all off Long Point; in 1901, on January 2, April 19, June 11, September 30 and October 8; in 1902, on October 19; in 1904, on October 23, 25, 26, 27, 28, 30 and 31, and on November 2, 3, 5, 9, 11 and 15; in 1907, on October 15 and 22; and in 1913, on October 3, 6, 17 and 20. It may have been seen at other times but at the distance observed and in the condition of plumage could not be positively distinguished from the more common pied-billed grebe.

Though it is said to breed at some of the small lakes in northern Indiana we have never found its nest here, nor have we seen the species in mid-summer. June 11 is the latest date in spring on which we have seen it, and the earliest date in the fall is September 14. From then on until the lake freezes over it may be observed almost any day. A few usually linger until the last open spaces in the lake begin to close, then they disappear. The latest date on which it has been recorded is January 2 when one was seen in an open pool in the ice near the Weedpatch.

The Horned Grebe is a solitary bird, rarely seen in flocks. Sometimes 2 or 3 may be together, and on rare occasions as many as 5 or 6, but usually only 1 or 2 may be seen. Occasionally they may be found mixed in with a flock of coots, the grebes sometimes surrounded by the coots; at other times on the edge or outskirts of the flock. They prefer to stay near shore and in the nooks and coves and protected corners of the lake, although at times they may be seen out in the open, exposed places.

These innocent birds are frequently shot in pure wantonness by irresponsible boys and others who, seeing them near shore, cannot resist the foolish desire to shoot at any bird seen on the water. Doubtless they are sometimes mistaken for ducks by the ill-informed. Dead grebes are often found along the shore.

An examination of a number of stomachs showed that their food consists chiefly of vegetable matter, with an occasional small fish, mollusk or crustacean. No food or game fish was found in any grebe's stomach. The only species found were skipjacks (*Labidesthes sicculus*), graybacks (*Fundulus diaphanus*), and some of the Cyprinidæ. The stomach of one examined November 3 contained vegetable fibers and possibly a few feathers. Another examined November 9 contained only a small quantity of feathers. They are, therefore, entirely harmless and should be protected.

They are very quiet birds, seldom uttering any note, although on one occasion (September 14), when one was surprised near the shore of Lost Lake, it uttered a succession of short, quacking cries as it scurried to deeper water in which it dived.

Like its relative, the pied-billed grebe, the Horned Grebe is an expert diver. Usually when approached it swims slowly away, but when close-pressed it never takes flight but dives. It can remain under water quite a time and usually comes up at some remote unexpected place.

The Horned Grebe, when in full plumage, is a very handsome bird, especially when the sunlight glints on the rich color of the head.

The only other species occurring at the lake that at all resembles the Horned Grebe is the helldiver. The two are readily distinguished, however, even by the novice, by the difference in the bill, that of the Horned Grebe being more slender, straight and rather acute, while that of the helldiver is stout and somewhat hooked. The difference in the length of the bill is considerable, that of the helldiver being about an inch, while that of the Horned Grebe is over three inches.

3. HELLDIVER

PODILYMBUS PODICEPS (Linnæus)

This curious little grebe is known by many different names, among which may be mentioned Pied-billed Grebe, Thick-billed Grebe, Carolina Grebe, Pied-billed Dabchick, Dabchick, Dipper, Didipper, Didapper, Helldiver, Water-witch, and Devil-diver. At Lake Maxinkuckee it is known to those who know it at all, as the Helldiver. Most of these names refer to the ease and quiet mystery with which it disappears under water when approached. Every one who has ever spent any time about a lake or stream has often seen these curious duck-like birds and has been mystified by their elusive movements.

From the horned grebe the Helldiver can readily be distinguished by its short, stout, broad bill in contrast with the slender, straight, sharp bill of the former. At Maxinkuckee it is much more common than the horned grebe. It is seen in considerable numbers in the spring and more abundantly in the fall. A few remain throughout the summer and breed among the Scirpus patches about Lost Lake or in the marshes of Norris Inlet. A pair evidently nested in Lost Lake in 1908, as two immature young, unable to fly, were seen there September 6.

A few dates on which it was definitely observed may be given:

In 1900, almost daily from August 28 to December 8; in 1901, from April 15 to 28, and on December 18; in 1903, on September 21; in 1904, on October 31 and November 1; in 1906, on August 29, September 14, October 5, 6, 9, 11, 15 and 30, and November 8; in 1907, from September 7 to October 14; in 1908, on August 24 and September 6; and in 1913, from September 6 to October 26. Specimens were examined on October 27 and November 14, 19, and 20, 1900; April 15 and December 18, 1901; October 5, 6, 9, 11, 15, 30 and November 8, 1906, and October 10, 1913.

The nest is usually a little semi-floating island made of decayed and decaying rushes, reeds and grass mixed with mud and various sorts of débris gathered from the bottom or from the nearby shore. The nest will be fastened more or less securely to reeds or rushes or other aquatic plants which have been pulled down and piled upon until the nest rises two or three inches above the water. The eggs number six to nine or ten and are a dirty yellowish or bluish white. During the day the grebes cover the eggs with decaying vegetation and trust to the heat of the sun to incubate them. At night it is said the rubbish is removed and the bird sits upon the eggs.

The Helldiver remains late in the fall, even until compelled to leave by the freezing over of the lake. They appear in spring as early as April 15 and are common for about 2 weeks. During the summer only rarely is one seen until about the last week in August when they reappear. They are most common from about the tenth of September to the first of December. The latest date on which any was observed was December 18.

This bird is solitary in its habits though now and then 2 or 3 or even more may be seen together. We have observed small flocks of as many as five, particularly in Outlet Bay, at Norris Inlet, and in Lost Lake. Like the horned grebe the Helldiver delights most in the shallow water near shore, especially over mud bottom, and in the vicinity of patches of vegetation. Rarely is it seen far out on the lake. To find it one should look in the nooks and coves and other protected places. Here it swims about quietly, never uttering a sound, and escaping when approached, usually by diving and not coming up until some distance away. Sometimes when one of these birds is approached quietly and slowly, it will settle down quietly in the water, leaving only its bill and nostrils projecting. It normally rides much higher in the water than the coot, nearly all its body being above the water-line.

A favorite resort for the Helldiver was in Outlet Bay. There one to 5 or 6 could be seen any day in late summer or during the fall, swimming about quietly, now and then diving for food. Some-

times they associate with the coots or the little bluebills, but they are usually quite exclusive and stay apart.

There is always a feeling of mystery about this curious little bird. Not only is its coming unheralded and unobserved but likewise its departure. And while it tarries with us its actions are elusive and phantom-like.

On one occasion in the fall of 1906, a Helldiver was cornered in a small shallow cove in Lost Lake where the water was scarcely deep enough to cover it when it attempted to dive, which it did when gradually approached with the boat. When the grebe attempted to dive it would strike the bottom and immediately come up again and, seeing the boat so near, it would give vent to a sort of surprised sneeze and dive again. It did this several times until finally it got by the boat and escaped to deeper water.

The feeding habits of the Helldiver are interesting. Its food consists chiefly of small mollusks, crustaceans, vegetation and small fish. Usually when securing food it simply dives, picks up what it desires from the bottom, sometimes swimming along on the bottom searching for choice bits. Surface-swimming minnows it may occasionally capture without diving. But it is when a school of small surface-swimming fishes comes near that its method becomes rather more exciting. On December 4, 1900, a Helldiver was seen near the shore so close that its movements could be carefully observed. It was keeping in touch with a large school of skipjacks (*Labidesthes sicculus*) on which it was feeding. It would dive, swim rapidly under the school, then rising to the surface, seize one of the fish, the skipjacks the while leaping out of the water and scurrying excitedly about in their efforts to escape. On December 8, a Helldiver was caught on a set-line hook baited with a small minnow.

Although this bird feeds largely on fishes, the species it preys upon are skipjacks, graybacks and various Cyprinidæ, none of any value as a food fish but useful only as food for the Helldiver, or for other fishes. An examination of many stomachs did not reveal a single food or game fish of any kind. It is frequently shot by hunters or boys who sometimes mistake it for a duck, but more often in pure wantonness. Many grebes found dead along the shore, especially in the fall, were examined that we might learn what we could regarding their food, with the result set forth above.

Although sometimes eaten it is not esteemed as an article of food, the flesh being rather rank in both odor and flavor.

It is therefore clear that the Helldiver is as innocent as it is attractive and should not be molested in any way.

4. LOON

GAVIA IMMER (Brünnich)

The Common Loon or Great Northern Diver is not a very common spring and fall migrant at this lake. We have noted it in the spring on the following dates:

May 20, 1885; March 28 and 29, April 3, 4, 6, 7, 8, 11, 15, 16, 18, 19, 21, 24, 28 and 29, May 9, 27, and 31, and June 8, 10, and 14, 1901; and April 23, 1909. In the fall we have observed it on the following dates: September 23, October 10, 17, and 18, November 7, 12, 13, 20, 21, 22 and 23, and December 2, 4, 6 and 17, 1900; October 20, November 2, and December 21, 1902; October 27, 1904; October 15 and November 5, 1906, and October 11 and 28, 1907. The extreme spring dates are March 28 and June 14, and those for the fall are August 8 and December 21. Though our fall records are the more numerous, it is probably no less common in the spring. Between the extreme spring and fall dates given, one or more, usually a pair, may be seen on the lake on almost any suitable day. It does not nest at this lake although it probably did so formerly, as it is still said to do at some of the lakes in northeastern Indiana.

The Loon is never seen in flocks; it occurs singly, sometimes in pairs, or, very rarely, 3 or 4 together. It does not frequent shallow water near shore but most delights to stay well out in the open water far from shore.

Its behavior in the water is interesting. On April 24, four were seen far out on the lake flapping their wings, raising their bodies out of the water, and stretching their necks. Then they would swim around one another, at the same time bowing, making strange sounds, and preening their feathers. Sometimes, particularly in muggy weather, or when the sky is lowering and rain is approaching, they utter the wild, delirious laughter for which they are famous. There is nothing else like it, so wild and wierd and startling in its explosive suddenness.

The Loon is the prince of divers. There is probably no other bird of our inland waters that dives so promptly and so gracefully on approach, or which will remain under water longer or swim farther than the Loon. It is difficult to put a Loon to flight; they almost invariably depend on diving as the proper method of escape. Rarely is one seen on the wing, but occasionally one has been seen usually flying low over the lake.

The Loon is one of our largest birds. One examined October 28, a young bird, was 29¾ inches long and weighed 6 pounds, 12¾ ounces.

The food of the Loon doubtless consists chiefly of fish. It is not often, however, that any food can be found in their stomachs. Two were examined May 20, one November 5, one October 15, and one October 28, but nothing identifiable was found in the stomach of any. One good observer at this lake states that he saw a Loon chase, capture and devour a helldiver, and he believes they prey upon other water birds such as they can capture. He observes that ducks, coots, etc., always give the loons a wide berth; but it may well be that the Loon is the one that keeps away.

The Loon is a much persecuted bird. No sooner does one appear on the lake and come under observation than some one in a rowboat or a motor-boat begins to chase it. And during the hunting season many thoughtless gunners take a shot at any Loon within reach. Fortunately the Loon is so prompt in diving that it is usually under water before the shot reaches it.

While the Loon doubtless eats a few fish the damage it does in this way is so slight as to be negligible, and such a picturesque bird should receive full protection and encouragement to remain as long as it will at the lake when on its spring and fall migrations.

5. HERRING GULL

LARUS ARGENTATUS Pontoppidan

The Common American Herring Gull is a spring and fall migrant at this lake. In the winter and spring it has been noted January 10, 21, 25 and 28; March 7, 8, 9, 13, 20, 21, 27, 28, 29 and 30; April 1, 3, 4, 5, 10, 11, and 25; and May 21. In the fall it has been recorded on October 12, 20 and 25; November 4; and December 6, 12, 14, 15, 18, and 21.

As will be observed from these dates, this gull is most common in March and December; it is therefore a very early spring migrant and a very late migrant in the fall. They are sometimes seen in the middle of winter when the lake is wholly or partly covered with ice. Those seen December 19, 1900, were standing on the ice, as were also those seen December 6 and 12, 1904. Those that came early in March sat around on the ice or swam in the open places. Those seen in January were doubtless arrivals from the north, tarrying for a few days on their way south.

They apparently do not feed while at the lake and the stay of any individual is usually brief.

Although this gull is a fish-eating bird it is a useful scavenger and should be protected.

6. RING-BILLED GULL

LARUS DELAWARENSIS Ord

In general appearance and habits much like the herring gull, and, though smaller in size, not readily distinguishable at a distance except by the trained ornithologist.

This is a regular migrant in Indiana, and winter resident on Lake Michigan, and perhaps elsewhere in the State.

A flock of 6 seen September 28, 1900. In the spring of 1901 one or more were noted April 4, 5, 6, 14, 15, 18, 19, 22, 23, and 24. Several were seen April 7, 1885. Rarely were more than 2 or 3 seen at any one time. They were usually seen flying, but occasionally they were observed on the water. When flying, they circle about, often uttering their peculiar harsh cry. The one seen April 6 was found dead.

Like the herring gull this species is chiefly a scavenger and should be protected.

7. BONAPARTE'S GULL

LARUS PHILADELPHIA (Ord)

This handsome little gull is a common species throughout North America, not only on the coasts but in the interior. Its flight is light and graceful as that of a tern. Like the two preceding species it is with us only as a spring and fall migrant. On Lake Michigan it is sometimes a winter resident. At Lake Maxinkuckee it is seen most often in the fall. Several were seen and two specimens secured April 7, 1885. In 1899, examples were seen September 1, 2, 3, 21 and 29, and on November 1. In 1900, it was seen September 3; in 1904, November 4; in 1906, September 9; and in 1913, September 12, and October 11, 12, 21, 22, and 25. The largest number seen at one time was 11 on September 12, 1913.

In their migrations these graceful birds tarry at the lake only a few days, during which they are usually seen circling about over the water, now and then alighting for a short time. They are most frequently seen in the north end of the lake and particularly on rainy or stormy days in September and October.

8. FORSTER'S TERN

STERNA FORSTERI Nuttall

Spring and fall migrant, not often seen at Maxinkuckee. Examples were seen by us on the Wabash River, near Terre Haute, April 28 and May 19, 1888, and several specimens were taken at Lake Maxinkuckee by Mr. A. B. Ulrey in 1895.

We have no positive record based on our own observations.

9. COMMON TERN

STERNA HIRUNDO Linnæus

This little tern is seen at the lake only rarely as a spring and fall migrant. We have observed it on the Wabash near Delphi, where we saw perhaps a dozen flying up the river May 2, 1884. We have examined a specimen shot near Adams Mill on Wild Cat Creek, Carroll County, Indiana, October 28, 1898. Our first experience with this species at Lake Maxinkuckee was on May 11, 1885, when one specimen, a fine male, was obtained by Sam J. Huntsinger from a considerable number seen on the lake that day. One was seen September 3, 1913, flying over the south part of the lake.

10. BLACK TERN

HYDROCHELIDON NIGRA SURINAMENSIS (Gmelin)

Rather common in spring; noted most frequently between April 27 and May 30 (1901). Not abundant every day, but some days in considerable flocks, flying, wheeling and dipping in graceful evolutions and giving fine effects as the sunshine catches different parts of the plumage. Sometimes they are noisy, giving vent to sharp cries. Sometimes associated with them in their flights are bullbats, which, in their movements and general build, considerably resemble the terns while in flight.

This species is often seen also on the larger rivers in the state, especially on the Wabash at Delphi and Terre Haute where we have frequently noted it in the spring. It is said to breed abundantly in the Kankakee and Calumet marshes.

In 1899, this species was frequently seen in August and September. In 1900 a flock of about 17 was seen July 24, following a heavy rain in the morning, which raised the lake 2½ inches. On the next day 10 were seen flying over the lake. One more seen on next day, and several on 29th. On August 7, six or seven were seen, and on August 9, four adults were seen. Two days later 12 to 15 were observed and again on 23d, 27th and 30th, after which date no more were noted. On August 27, a large flock of 18 was seen.

In the spring of 1901, it was seen at the lake on April 10, 13, 14, 15, 16, 17, 27, and May 30, also June 8. On April 27 a flock of about 80 was observed swimming on the lake. During the entire month the species was quite abundant. In 1903 it was noted September 21.

In 1904 the Little Black Tern was common on the lake during

September 19-21, flying about in flocks of 4 to 6. The first noted in 1906 were seen July 29; others may have been present earlier but our notes do not mention it. This one sat nearly all day on a stake in the lake in front of the ice houses. Another was seen September 13. In 1907, one or more were noted September 8, 9, 10, 12, 22, 24, 25, and 30. On September 24, 11 were observed in the north end of the lake flying against the wind. In 1910, several were seen May 30, and more than a dozen on July 4.

On September 21, 1913, a flock of 12 appeared at the lake and they were noted almost daily thereafter until October 2, after which none was seen. They frequented the north end of the lake and were often observed resting on a floating piece of timber in the lake off the ice-houses. They would sometimes remain there for an hour or more at a time, then they would circle about over the lake, now and then striking at a school of skipjacks or other small fish at the surface, sooner or later returning to the resting place where they would again remain for some time.

This graceful little tern is one of the most interesting and attractive birds that visit this lake; usually quiet, but sometimes uttering a sharp cry, as if of alarm or anger; sometimes skimming low over the lake, now and then striking the surface where a school of skipjacks is swimming, at other times, particularly when a storm is approaching, circling high in air. All these terns are fish-eating birds, but they prey chiefly upon the small surface-swimming fishes such as the skipjack and the grayback minnow. They do no harm and add much to the attractiveness of the lake.

The fact that this tern is seen about the lake in every month from April to September suggests that it may breed in this region.

11. FLORIDA CORMORANT

PHALACROCORAX AURITUS FLORIDANUS (Audubon)

The Cormorant is one of the rarest migrants at Maxinkuckee. Our only records are as follows: September 20, 1900, one seen flying over the lake; October 8, 1900, 3 were seen perched on a tree at Long Point; another seen on Long Point, October 19, 1907; and 3 seen flying over the lake September 20, 1913. On October 16, 1913, one was seen on the Kankakee River near Hebron, some 10 miles west of Lake Makinkuckee.

Although the Cormorant is a greedy fish-eating bird, its rarity at Lake Maxinkuckee precludes it from exerting any appreciable influence on the fish-life of that lake.

12. FISHDUCK; MERGANSER

MERGUS AMERICANUS Cassin

The Fishduck, American Merganser, or Sawbill, is not common at the lake. Several were seen in a narrow, open strip of water near the Farrar cottage, April 7, 1885. One of these, a female, was killed; it gave the following data: Length 23 inches; wing 10; tail 5; bill $2\frac{1}{2}$; tarsus $1\frac{3}{4}$; stretch 31; weight $2\frac{1}{4}$ pounds. At that time the ice was still on the lake, there being only an open strip around the shore, usually widest at the mouths of the inlet streams. In this open water ducks were rather common, mergansers, butterballs, baldpates, and little bluebills being among the species noted.

According to Mr. S. S. Chadwick, who has observed the waterfowl of this lake for many successive years, the Sawbill is the last to arrive in the fall and the first to leave in the spring.

In 1900, one or more were noted on each of the following dates: November 2, 3, and 18; and December 5. In 1901, on January 2, March 7, and December 6 and 18; and in 1904, on December 15, when one was shot from an open pool in the ice in which were mergansers, little bluebills, canvasbacks, a horned grebe, a few coots, a pair of hooded mergansers, two golden-eyes, and, perhaps, a few others.

The stomachs of several examined were all practically empty. It is well known, however, that this duck, as its name indicates, feeds largely on fish. Its flesh is therefore rank and fishy and not esteemed as food. The young birds are not so objectionable.

The comparative rarity of this magnificent duck at the lake prevents it from doing any appreciable harm to the fishes of these waters and justifies all efforts that may be put forth for its protection.

13. RED-BREASTED MERGANSER

MERGUS SERRATOR Linnæus

The Red-breasted Merganser or Sawbill, is not a common duck at this lake. Our notes contain only half a dozen references to it.

One or more were seen October 21, 1900; several on December 5, and again December 6, 1900, when 4 or 5 were killed; a few on January 2, and one on March 8, 1901; and 2, one of which was shot, on November 28, 1904. This example weighed 2 pounds, 2 ounces, and the œsophagal enlargement was packed full of small fishes, chiefly skipjacks, but with a few log perch and a few small minnows.

14. HOODED MERGANSER

LOPHODYTES CUCULLATUS (Linnæus)

Occasional in winter. One was shot on November 21, 1900, 2 on December 9, 1901, both very fat, and 2 on December 15, 1904, a male and a female. They were both shot while in one of the open pools in the ice. A few were noted December 2, 1902, and 1 on March 9, 1903.

This and the two preceding species are, of all the ducks, perhaps the most destructive to fish life. In Alaska and elsewhere in the West, where there are salmon streams, these fish ducks destroy great numbers of salmon fry. Fortunately the fishes on which they feed at Maxinkuckee are unimportant species, and these ducks are not sufficiently abundant, nor do they remain long enough, to do much damage.

15. MALLARD

ANAS PLATYRHYNCHOS Linnæus

The Common Mallard, or Greenhead, is one of the abundant ducks, particularly in the fall. We have only the following spring references: March 3 and 31 and April 1, 4, 6 and 11, 1901.

In the fall we have noted it on various dates from September 22 to January 3. From October 1 to December 30 it is usually quite common. When on the lake they are usually seen some distance from shore or else in solitary pairs in secluded nooks or coves. Single individuals or pairs are often seen in protected places about Lost Lake. Formerly the Mallard bred at this lake but apparently few, if any, do so now. At night they come near shore or resort to the land, where they feed on seeds or stems of land or swamp plants.

In the open pools left in the lake when it freezes over, the Mallard is one of the ducks most often seen. The ice about the pools is often covered with muddy tracks made by mallards that have returned from their nocturnal feeding grounds in the marshes.

The Mallard is the most alert of all the ducks. When approached in the open they will take wing long before one is within shooting distance. When come upon suddenly, they are up and away with a loud, quacking noise. They have the loudest voice of any and are the most noisy. They are particularly noisy on quiet, foggy or muggy nights, and their frequent quacking is almost identical with that of their domesticated kin.

On November 14, a female Mallard was caught in a steel-trap set for muskrats.

Four examples measured and weighed gave the following data:

November 1, a female, weight 2 pounds, 5½ ounces.

November 1, a male, weight 2 pounds, 5½ ounces.

December 2, a male, 22½ inches long, weight 2 pounds, 7 ounces.

December 2, a female, 19½ inches long, weight 2 pounds, 2¼ ounces.

The Mallard is primarily a vegetable feeder. The stomach of one examined November 30 contained bits of a fine-leaved Potamogeton; two examined November 1 contained stolons of wild celery. Others examined contained seeds of various plants, particularly smartweed.

16. BLACK MALLARD

ANAS RUBRIPES Brewster

The Black Mallard or Black Duck is not common. Seven were seen September 18, 1899, several on November 3 and 4, and 3 or 4 on Lost Lake, November 15, 1900, and a female was shot December 7, 1900. A fine flock was seen in a marsh near the tamarack swamp early in the spring of 1901, and several were seen flying over Long Point, October 23, 1906. It is not known to breed here.

17. GADWALL

CHAULELASMUS STREPERUS (Linnæus)

The Gadwall or Gray Duck is rare at Maxinkuckee. Our notes contain no definite records of its occurrence, but it undoubtedly does occur here occasionally as a migrant.

18. WIDGEON; BALDPATE

MARECA AMERICANA (Gmelin)

Apparently rare; several seen in the lake near Farrar's, April 7, 1885; none noted recently. A spring and fall migrant.

19. GREEN-WINGED TEAL

NETTION CAROLINENSE (Gmelin)

A spring and fall migrant, apparently not common. One obtained October 31, 1902, and several seen two days later; a fine plumaged male shot October 22, 1907; length 13 inches, weight 11 ounces; another (a female) shot October 25, 1907.

20. BLUE-WINGED TEAL

QUERQUEDULA DISCORS (Linnæus)

A beautiful little duck, but rare at Maxinkuckee. Our only record is of a fine male, secured May 11, 1885, by Sam. J. Huntsinger. It measured: length 16 inches; wing 7.75.

21. SHOVELLER

SPATULA CLYPEATA (Linnæus)

Apparently one of the rarest ducks of this region. Our only record is of a female shot November 17, 1906.

22. PINTAIL

DAFILA ACUTA (Linnæus)

The Pintail or Sprig is not common, and is seen only as a spring and fall migrant. On October 26, 1900, Mr. Chadwick saw several on the lake and on March 2, 1901, 6 were shot and others were seen. On December 12, 1904, one, apparently a young male, was shot; this was 22½ inches long and weighed 1 pound, 12 ounces.

On the Kankakee marshes northwest of Maxinkuckee this duck is more abundant.

23. WOOD DUCK

AIX SPONSA (Linnæus)

This, the most beautiful of all our ducks, was formerly abundant as a summer resident at Maxinkuckee and throughout Indiana. Scarcely was there a small lake or pond that did not have at least one pair during the breeding season and a flock of a dozen or more in the fall. But now it is very rare. Several were seen March 20, 1901; a hunter got 4 on October 3, 1899; and one seen in an open pool January 2, 1901. Undoubtedly the Wood Duck is more abundant on the Kankakee, a few miles west of Lake Maxinkuckee, than any place else in the state. The heavily timbered swamp land along that river furnishes an ideal breeding ground for these ducks. During a day in October (the 16th) 1913, spent on the Kankakee the senior author saw perhaps a hundred examples of this beautiful duck.

This stretch of the Kankakee is the last remaining considerable breeding ground in Indiana not only of the Wood Duck but of several other species of birds. The region is unique in its biological interest and general charm and should be set aside as a state park or reservation.

24. REDHEAD

MARILA AMERICANA (Eyton)

The Redhead is one of the most abundant ducks at the lake. Though a spring and fall migrant, we have no spring records. We have noted it October 4, 9, 12, 24, 25, 27, 28 and 31, November 1, 3, 4, 5, 7, 8, 9, 10, 11, 12, 14, 19, and 30; and December 14 and 29. They usually arrive from the north early in October and are abundant until in December. They are often seen associated with the little bluebills, canvasbacks and coots; most often, perhaps, with the canvasbacks, which it much resembles, but from which it can readily be distinguished even at a distance by its high forehead.

It is often seen in Outlet Bay, coming in near shore on fine mornings and quiet afternoons to feed on the wild celery which there abounds.

It is a stout, heavy bird, a good diver, usually not very timid, and feeds chiefly on water vegetation of various kinds, such as wild celery, pondweed, and the like. As an article of food it is scarcely inferior to the canvasback. Several were weighed with the following results: 2 pounds, 9¼ ounces; 2 pounds, 7 ounces; 1 pound, 14 ounces; 2 pounds, 6¼ ounces; 1 pound, 15¼ ounces; 2 pounds, 3 ounces; and 2 each of 2 pounds, 5½ ounces.

On November 12, 1906, one hunter got 12, and another got 6.

25. CANVASBACK

MARILA VALISINERIA (Wilson)

The Canvasback is one of the most abundant as well as most interesting and valuable of the many species of ducks visiting the lake. A flock was seen March 24, 1901; one bird on June 10 and one on July 7, 1901, evidently a cripple left behind. From early October until the lake freezes over, the Canvasback is very common. Our records are most numerous in November, and that is doubtless the month of their greatest abundance. Next to the little bluebill the Canvasback visits the lake in greatest numbers. They begin to appear in the fall as early as October 25 and by the middle of November they have reached their maximum which is maintained approximately for 2 or 3 weeks, after which the numbers diminish. A good many remain, however, until compelled to leave by the freezing over of the lake. In 1901, several remained as late as January 9 and 10 when only one small open space was left.

The Canvasback is the most unsuspecting and unprepared of

the ducks, the most easily baffled by any sudden emergency. When they first arrive in the fall they are quite unsuspicious and many fall an easy prey to the early gunners. Soon, however, they become more wary, but never do they learn wisdom as do most other ducks. More Canvasbacks than any other species were found frozen fast in the ice in January. When a flock composed of several species was frightened the Canvasbacks were usually the last to take flight, and even then they rose not in a definite decisive way, but slowly, hesitatingly, and at a long winding slant. While feeding on the lake the Canvasbacks are most often associated with redheads, little bluebills and coots; usually the Canvasbacks and redheads would be somewhat segregated from the coots and bluebills. Favorite feeding grounds are in Outlet Bay, along the east side of Long Point, off the Gravelpit, and about the south end. They at first frequent those parts of the lake where the wild celery is found. When it has all gone, and they have become somewhat more wild, they will be found farther out on the lake, particularly about the Flatiron and Weedpatch, where the broad-leaved pondweeds abound.

Opportunity was afforded to examine the stomach contents of several Canvasbacks. Most stomachs were empty or nearly so. One contained only a tapeworm. Several of those obtained when the pools froze over, contained little or no food, except fragments of pondweed leaves. Those examined earlier in the fall had been feeding chiefly on the stolons or winter-buds of Vallisneria. Those examined later contained fragments of the bases of the leaves of Vallisneria and some pondweed. No fish or other animal food was found and it is not believed they feed to any extent upon anything except vegetable food.

Three obtained December 9, 1901, were very fat; one weighed 4 pounds, the other two 6 pounds. In the fall of 1902 they were quite common and many were killed. One hunter, shooting from a blind, November 5, 1911, got 15. During the season he got 12. Another got 51, and still another, 9, in the first week of November, 1904.

26. BIG BLUEBILL

MARILA MARILA (Linnæus)

The Big Bluebill, Greater Scaup Duck, Scaup Duck, or Big Blackhead, is apparently not common. It may be really more abundant than it appears, as it is difficult to distinguish it in mass from the little bluebill. Our notes record it on March 31, April 1 and April 7, 1901; October 31, 1902, when 3 were gotten, and

November 1, 1902; and on November 9, 1906, when a female 17 inches long, and weighing 4 pounds, 1½ ounces was taken.

Usually no distinction is made between this and the smaller species; they are both locally called bluebills.

27. LITTLE BLUEBILL

MARILA AFFINIS (Eyton)

The Little Bluebill, called in the books Lesser Scaup Duck, Little Blackhead or little Raft Duck, is known at Maxinkuckee simply as the Bluebill. It is the most abundant and, in many respects, the most interesting species coming to that lake.

Our note-books contain records of this species as follows:

1885.—April 7, the senior writer shot a fine male in an open strip of water near the Farrar cottage. Length, 17¼ inches; wing, 8½; tail, 3¼; tarsus, 1¼; weight, 24 ounces. Several others were seen. April 18, a young male in immature plumage was received from the lake.

1899.—October 16, a good many noted.

1900.—October 17, one seen; 18th, a flock of 12 seen; 20th, a dead one found; 21st, a flock on Lost Lake; November 7, three or 4 flocks seen; 9th, good many in the south end of lake, 2 hunters got 5 in the forenoon; found one dead on shore at south end; 11th, 15th, and 20th, many; hunters after them in motor boats; found one dead at Norris Inlet on 20th; 22d, abundant; 26th, got one; December 2, good many; 8th, many, some flying quite near Mr. Clark while he was taking temperatures at the Deep Hole; 12th, plentiful; 13th, very many far out; 14th, abundant; 15th, large flock in Outlet Bay; 16th, big flock on lake; 2 were caught on the ice; 19th, many on lake; 28th, a flock scared up from beach on Long Point; 29th, one got.

1901.—January 1, abundant in the open pool near the Deep Hole; 2d, one shot in north ice pool, and one caught on the ice; 3d, two males and one female in ice-pool, eating small mollusks; February 7, one tried to alight near the ice houses where ice was cut. March 24, flock seen at south end. April 1, a hunter got 3 females on east side of Long Point; 4th, many, some flying over; 5th, noted; 6th, one gotten; 8th, noted; 9th, many, mostly hugging the west shore in front of Shady Point both morning and evening; 10th, a large flock, mostly Little Bluebills, near shore all day in front of Shady Point; one found dead at Norris Inlet; 11th, many near shore; 12th, largest number yet seen near shore, the whole lake off east side of Long Point nearly black with them; one hunter

got 6, another 1; stomachs contained shells and pebbles; 13th, hunters after them; 15th, a wounded one at south end; 16th, 17th, and 18th, some on lake, chased by a launch; 19th, 24th, and 25th, a good many scattered over the lake, some quacking; 26th, 27th, 29th, and 30th, good many except on last two days. May 2 and 3, a few noted; 4th, a big flock seen flying southwest, low over the lake; 5th and 6th, some seen; 7th, quite a large flock in Outlet Bay; 8th, 9th, 10th and 11th, some noted; 14th, noted every day; 16th to 20th, noted every day; 27th noted; one seen on shore on east side; 30th, a good flock seen; 31st some still on the lake, a dead one found on southwest shore. June 15, one seen in Norris Inlet swimming and making a sort of quacking noise; 19th, a flock of 5 seen; 25th, a flock of 5 seen. July 10, four seen, acted as if nesting.

1902.—February 2, one seen in lake off Chadwick's pier, where the ice company had cut off 2 or 3 acres, leaving open water. March 9, plentiful. June 19, abundant; 20th, a flock of 25. October 30, one adult and one young killed. November 1 and 2, two seen near Chadwick's pier. December 6, one got; 12th, many; 16th, caught two on the ice; 17th and 18th, got two; 21st, noted.

1903.—March 9, noted as plentiful. August, an old bird and 6 young still unable to fly were noted at south end of lake. October 15, abundant; many killed by pot hunters who sold them at 6 for a dollar.

1904.—October 10, two flocks seen; 25th, many on the lake; 27th, perhaps even more abundant, probably 1,000; saw at least 150 flying over at one time in the evening; 28th, still abundant; 30th and 31st, flocks seen flying and many more on lake. November 2, some noted; 5th, a hunter got 3; 6th, great many on lake; 10th, a dead one, partly eaten, found at Long Point, stomach contained white ball-like masses composed mostly of Chara; 11th, a hunter got 2; 16th, another got 2; 17th, several seen flying. December 1, a hunter got 1; 2d, another hunter got 2, length, 15½ and 16 inches, weight, 30½ and 28½ ounces, respectively; they had been eating Vallisneria; 3d, a wounded one caught on Long Point; 4th, noted; 6th, one got on ice near ice-houses and one found dead near the depot; one found dead at south side, stomach empty; 10th, one got; 11th, large flock near Knapp's pier; 14th, 2 found dead; 15th, several shot and one caught on ice; 16th, several seen, 2 shot; 23d, 2 or 3 flocks noted.

1906.—September 12, a few seen. October 12, a flock of about 20 seen; November 2, one found dead; 9th, two got, one measured 17 inches and weighed 19¼ ounces; 10th, got two; 12th, three

gotten; 14th, got two, one 17½ inches long and weighing 2 pounds, the other 15½ inches long and weighing 24½ ounces; 15th, an immature bird found dead; one, probably a cripple, was seen from time to time all summer about the lake.

1907.—October 21, several flocks seen; 25th, common, hunters got two; November 2, one found dead on east shore.

1909.—April 23, this and other ducks said to be quite plentiful.

1913.—Up to the time of our leaving the lake (October 20 and November 9), few, if any, Little Bluebills had returned; none was actually observed.

The records given above show that the Little Bluebill is one of the first ducks to appear in spring. It returns with the first open water and by the time the ice is off the lake it is usually present in great numbers. Our notes record it as early as March 9, and as abundant in April. It remains well into June, and flocks have been noted as late as June 25. Occasionally a few remain throughout the summer, but in all probability most, if not all, of these are cripples which were unable to resume the northern flight with their fellows. Some of these may mate and breed in the marshes at Norris Inlet or about Lost Lake. In August, 1903, an old bird and 6 young, still unable to fly, were seen at the south end of the lake. In the fall of 1906 an old nest with fragments of shells about it, evidently duck eggs and believed to be this species, was found in Overmeyer's woods near the lake.

In the fall they begin to return about the first of October; in 1906 a few were seen September 12. By the middle or twentieth of October they are usually abundant, but the maximum is not reached until early in November. Fully a thousand were present October 27, 1904. They remain until scarcity of food or freezing up of the lake compels them to seek other feeding grounds. At times they are so abundant as to appear like a solid mass covering considerable areas of the lake.

When unmolested and in calm weather, they usually stay not far from shore and in rather shallow water where they feed upon the wild celery. They mix quite freely with the coots with which they appear to be on the best of terms. They delight, perhaps more than any other duck, to gather in great flocks, hence the name Flocking-fowl which Audubon says was in his day applied to them in the lower Mississippi valley. During fair days in the fall they may be seen in great numbers near shore at Lake Maxinkuckee, diving and feeding in shallow water, 3 to 15 feet deep, all the time keeping up rather low, subdued conversations quite unlike the quacking of the mallard; it is more conversational, like that of the

coots. At these times they present an interesting and attractive sight. The play of colors when the sunshine glints on the purple-black heads of the males as they bob up and down on the passing waves, makes them conspicuous objects easily recognizable from other ducks. In stormy weather, or when disturbed, they move farther out on the lake or seek the quiet protected places. When far out on the lake they often appear as a long black line. At night, especially in foggy weather, they frequently come ashore.

Sometimes they remain in winter even after the lake is frozen entirely over. This was the case in 1901 when the lake froze suddenly. Then these ducks were seen in considerable numbers walking about on the ice.

Six examples of this duck that were weighed and measured gave the following data:

Date	Sex	Length in inches	Weight	
			Pounds	Ounces
April 7, 1885	Male	17¼	1	8
December 2, 1904	Male	15½	1	14½
December 2, 1904	Female	16	1	12½
November 9, 1906	Female	17	1	3¼
November 14, 1906		17½	2	0
November 14, 1906		15½	1	8½

A good many stomachs of Little Bluebills were examined. The results of these examinations and our observations lead us to the conclusion that their food consists chiefly of small mollusks (principally *Vivipara contectoides* at this lake) and vegetation. The stomach of one shot December 1, 1901, contained about 1,000 very small shells, probably the young of Vivipara. While the wild celery lasts they feed largely on it; later they will eat bits of Potamogeton leaves, Chara and even Myriophyllum and Ceratophyllum. We have no evidence that they ever feed on fish.

The Little Bluebill does not rank with the redhead and the canvasback as an article of food. However, during the early part of the fall when it is feeding on the wild celery, it is quite delicious.

28. RING-NECKED DUCK

MARILA COLLARIS (Donovan)

This little duck, known variously as Ring-billed Blackhead, Marsh Bluebill, Ringbill, and Ring-necked Scaup Duck, appears to be rare at Maxinkuckee. The difficulty of distinguishing it cer-

tainly from the little bluebill at a distance, whether on the water or on the wing may, however, indicate it to be less abundant than it really is.

Our only records are as follows: Several were seen April 6 and 7, 1885, and one was obtained on each of the following dates: March 21, 1901; November 29, 1902, 4 shot by one hunter; November 11, 1904; November 12, 1904; and November 12, 1906. Nothing distinctive was observed as to its habits. It can usually be known from other ducks by its broad bill and gray speculum, and the orange-brown ring around the neck in the male; the female has no collar and the head and neck are brown.

29. GOLDEN-EYE

CLANGULA CLANGULA AMERICANA Bonaparte

The American Golden-eye or Whistler is a rather common spring and fall migrant, but never abundant. Our note books show the following records:

In 1900, November 15, a flock seen; 20th, common; 21st, a fine but immature male shot in front of Shady Point, and two others (both females) got near same place; found them very good eating; 26th, seen; 28th, a flock seen; 29th, another young male shot in front of Shady Point. December 3, saw 2 or 3, and found a dead female on beach at south end of lake; 4th, a hunter using decoys got one female; 6th, noted a small flock off Long Point; 14th, a small flock near shore; 28th, one seen flying.

In 1901, January 3, one found dead frozen in ice; 19th, heard flying; March 4, a flock seen; 8th, a few seen; 12th, noted; 31st, noted off Long Point, a fine male shot. April 11, one got; 14th, one seen; 15th, one seen at Norris Inlet.

In 1903, March 9, several seen.

In 1904, October 24, a pair seen off the ice houses; 29th, a flock passed over, whistling loudly. November 3, one found dead on shore; length 17 inches.

In 1906, November 1, a flock flying over; 2d, found one dead; 14th, noted.

In 1907, October 21, heard flying over; 24th, saw four.

The most considerable flocks were seen and heard in the fall, but none was noted in October, 1913.

These ducks fly very swiftly and attract attention by the loud whistling noise made by their wings. When on the lake they are rather unsuspicious and may often be seen near shore. Several specimens were obtained at different times by shooting from shore.

As a food bird it is very good, ranking in this respect with the butterball and the bluebill. It apparently feeds largely on vegetation and the smaller mollusks.

30. BUTTERBALL; BUFFLE-HEAD

CHARITONETTA ALBEOLA (Linnæus)

This pretty little duck is quite often seen in small flocks of 5 to 10, in spring, autumn and early winter. We have the following spring records:

In 1885, April 7, several seen in south end of the lake near the Farrar cottage. The lake was then covered with ice except a narrow strip along the south shore. In 1901, March 22, two seen; 28th, a small flock on lake; 31st, several good flocks on each lake. April 6, one shot; 11th, four shot, two of them females; 14th, a pair noted off Shady Point. Our fall and winter records are as follows: In 1900, November 9, two or 3 good-sized flocks seen; 20th, common, a hunter got one male and 4 females; 26th, a flock seen near shore, a hunter got a female under the McSheehey pier; 29th, a few seen; 30th, 15 to 20 seen. December 5, a large flock noted off Long Point; 10th, some near shore south of Shady Point; 14th, a few drakes in splendid plumage; 28th, one drake and 3 ducks noted, uttering a strange quacking sound just before rising to fly. In 1901, January 1, several huddled with bluebills and coots in small open pools; 2d, several fine drakes in an open pool near the Weedpatch, were first to leave when approached; 3d, one found dead on the ice, and one seen in an open pool. December 16, one caught on ice. In 1902, December 1, two got; 2d, one secured; 19th, one secured. In 1904, October 25, a pair in south end of lake. November 5, one seen off Long Point; 12th, one shot; 14th, a flock flying; 16th, a pair collected; 19th, two seen on Lost Lake, a hunter got one on Lost Lake and one at south end of Lake Maxinkuckee. December 4, four noted east of Long Point; 5th, several seen flying; 11th, 8 seen in southeast part of lake. In 1907, September 10, a small flock seen; 12th, 4 seen near the icehouses. November 1, a flock observed flying; 10th, one collected.

This species seems to be most common in November and December, during which months small flocks or single individuals may be seen on almost any day. When on the water they are most often seen singly or in pairs. They come near shore to feed in shallow water. Their food at the lake appears to consist chiefly of small mollusks and vegetation and, to some extent, small fishes.

In the winter of 1900-1901, when the lake was frozen over ex-

cept a few small open pools, these little ducks huddled together in the pools along with coots and other ducks, and one was found frozen in the ice.

The Butterball deservedly ranks high as a food bird, especially in the early fall when it is fat.

31. OLD-SQUAW

HARELDA HYEMALIS (Linnæus)

The Old-squaw or South-southerly is a rare duck at Maxinkuckee. On December 1, 1900, about 4 p. m., when crossing the lake from the east side, a flock of five was seen flying almost directly overhead and very low down so that their colors could be plainly made out. In February, 1895, Prof. S. B. McCracken of Elkhart obtained 2 specimens (both females) of this duck near Burnetts Creek, Carroll County, Ind., about 30 miles southwest of Lake Maxinkuckee. About November 18, 1911, Mr. S. S. Chadwick shot a fine male at Lake Maxinkuckee. He says he has seen this species occasionally but never secured but one specimen.

32. RUDDY DUCK; WIRETAIL

ERISMATURA JAMAICENSIS (Gmelin)

This curious little duck has been noted by us at the lake but twice in spring. On March 30 and 31, 1901, one was observed on the lake near the Long Point shore. In the fall, however, it is not at all uncommon. Our earliest fall record is October 12 (1906), and our latest January 4 (1901).

From the middle of October until the freezing of the lake compels them to leave, they may be seen almost daily. They are usually seen singly, either wholly by themselves or with a bunch of coots; rarely are they associated with other ducks, except in midwinter when one or more may be found with the miscellaneous lot of ducks and coots that come together in the few remaining open pools, when the lake is nearly frozen over. One was seen sitting on the ice on Lost Lake November 16. When approached, it was not able to rise from the smooth ice and fly away, but slipped along on the ice as best it could. On January 2 (1901), one was caught on the ice near an open pool; when cornered it showed itself quite game and fought with energy and no small amount of skill.

Of all our ducks these are the most cunning. If domesticated they would make very interesting pets. They are by no means stupid, as some writers have asserted. They are quite intelligent and alert, much more so even than the canvasback. At Lake

Maxinkuckee this duck is sometimes called the Brown Teal; also Dipper Duck, probably on account of its skill as a diver; and as Sprigtail, because of its stiff tail feathers; a name, however, which belongs properly to the Pintail, a very different species. In California it is often called Wiretail, which is a much more appropriate name.

They are only moderately esteemed as an article of food, being somewhat inferior to the whistler and the butterball.

Of the many stomachs examined by us the majority were empty. In one case the stomach contained a quantity of seeds of some leguminous plant, probably Lespedeza, and some small gravel. The round-headed bush-clover, *Lespedeza capitata*, is abundant about this lake, and it is not improbable these ducks come ashore at times and feed upon its seeds. No fish of any kind was found in their stomachs.

Our definite date records are as follows: In 1900, October 27, one shot by a hunter who called it a "Brown Teal". November 7, a flock seen; 8th, several observed among coots near shore, one quite red and in excellent plumage; 16th, one on ice on Lost Lake; 28th, a young male found dead on shore near the Gravelpit. In 1901, January 2, one caught on the ice; 3d, one wounded in pool, found dead and frozen the next day. March 30, one seen near shore at Shady Point; 31st, a few noted on lake. In 1904, October 25, a wounded one found and another one reported; November 13, a dead one found south of Shady Point; length 14 inches; weight 15 ounces; 19th, a dead one found under a telegraph wire near Arlington; stomach empty. December 15, two seen, one collected. In 1906, October 12, a wounded one seen; 16th, one shot; 17th, found one dead; November 2, twenty found dead between Long Point and Norris Inlet, with them one golden-eye, one little bluebill, and a few coots; 5th, found seven dead between the Gravelpit and Long Point; 8th, found two dead off Assembly grounds; 12th, found one dead; 15th, another dead; 18th, two found dead. In 1907, October 25, several seen in Outlet Bay, one secured.

It was at first thought that the ducks found dead had been killed by gunners who were at that time quite active on the lake, but an examination of the birds disproved this theory, as they showed no wounds of any kind. Nor had they starved, as was suggested; every one was found to be fat and in excellent physical condition. Nor did it appear that any parasite had caused their death. It is true that a few contained a good many intestinal parasites, particularly tapeworms, but they could scarcely have had anything to do with the death of the birds which, as already stated, were fat

and plump, in no case emaciated. Moreover, if their dying were due to starvation or disease of any kind, it is improbable so many would have died at approximately the same time.

No reasonable explanation of this very unusual phenomenon has as yet been suggested, and it must, for the present at least, remain an unsolved mystery.

33. GREATER SNOW GOOSE

CHEN HYPERBOREUS NIVALIS (J. R. Forster)

This goose appears quite rare at Lake Maxinkuckee. The only record we have is of 10 to 20 seen by Mr. S. S. Chadwick, November 6, 1902. They were mixed in with a large lot of Canada Geese which he estimated at 1,200 to 2,000 birds. They were on the lake all day but all left that night.

34. CANADA GOOSE; WILD GOOSE; HONKER

BRANTA CANADENSIS (Linnæus)

Twenty to forty years ago Wild Geese were very abundant in Indiana during the spring and fall migrations. For several days in the spring, hundreds of flocks representing thousands of birds could be seen wending their way northward. The first flocks were usually seen during the "February thaw", with an occasional one in January, but the great flight came in March and early April. In the fall the flights were even greater. They usually began late in October and continued toward the last of November, with an occasional belated flock in December. Although the flights now are as nothing compared with those of two or three decades ago, the number of geese seen by us at Lake Maxinkuckee was surprisingly large. Because of the popular interest in this fine bird, we give our records with considerable detail.

In the spring of 1899, the Wild Geese were first noted on March first and several flocks were observed during March and April. In 1901, a flock was reported January 22. Others were noted March 3, 10, 12, 13, 15, 16, 17, 22, 23, 24, 25, 28 and 29 and on April 1, 4, 6, 7, 8, 11, 14, and 25. A good many were seen March 3; two flocks were noted on the 10th; on the 12th several flocks, one of them quite noisy, and some of them resting on the ice which still covered the lake; a flock reported on 13th and another on the 15th flying southwest and honking; on the 16th a flock alighted in the lake, on the 17th a large flock was seen flying northwest, and on the 22d a large noisy flock stopped on the lake but soon left, going

north; on the 23d a flock was seen in an open pool in the lake, another on 24th late in the evening heard going north; on 25th a flock seen on the lake, and on 29th several were killed. On April 1 a flock heard and another seen in the lake; on the evening of the 4th about 100 were seen in the lake off the Maxinkuckee road. They moved slowly southward until near Fulton's pier. Now and then they would flap their wings and occasionally a honk could be heard. At 5:40 p. m. they all rose, honking, and flew south in a long east-and-west-line. On April 6 (in the afternoon), a flock of seven was seen flying low eastward from the lake; on the 7th a noisy flock alighted in the southeast part of lake, another flock seen and heard on 8th; on 11th two large flocks, one west of the lake in the morning flying about as if desiring to stop and honking a good deal, the other in the afternoon east of the lake, both finally leaving, going northeast; on 14th a very large flock seen leaving the lake, honking and going south; on 25th several heard both morning and evening. In the spring of 1902, the first flock (of 10) was seen March 3, coming from the northwest and going on southeast without stopping; on 13th a flock of 20 or 30 on the ice, leaving in the evening, going west; on 20th fully 200 seen on the lake, with many ducks; on 23d many geese and ducks on the lake; no more seen until April 2 when 13 were noted going northwest.

For 1903 we have but one record, March 7, when several hundred were seen on the ice. Our fall records are as follows: On October 17, 1900, a flock of 8 seen flying southwest and calling; November 7, about 5 p. m., two large flocks (of 50 and 60 each) seen flying high across the lake from northeast to southwest and honking loudly; about same hour another and larger one was seen flying south across the lake; on 9th, a flock of 5 flew over, one of which was shot; on 10th, a very large flock seen going south at 5:30 p. m.; and on 19th a few were seen. Our only record for the fall of 1901 is December 9 when one flock was seen. They were evidently scarce this fall. In 1904 our first record is for October 27 when a flock was seen and another heard at night. Two days later another was heard and seen; others seen on October 30 and 31 and still others on November 15.

In the fall of 1907 they were unusually abundant, from October 19, when a flock of 50 was seen flying south, to October 31 when at least 15 large flocks were noted. This was perhaps the most remarkable flight of Wild Geese that we have ever observed at Lake Maxinkuckee. The flocks were each regularly arranged in systematic V-shaped order, all were going in a general southerly direction and with much honking. They were rather common

in the fall of 1913. On October 19 the first of the season, a flock of 20, was seen. Another large flock seen on 22d, honking as they flew.

Usually the geese do not stop, or if they do, they do not tarry long. Sometimes they alight in the open lake, or, when the lake is frozen, they stop for a few hours in the open pools. At times they remain in the lake until evening when they go to nearby wheat fields where they remain until morning, when they resume their migration.

35. TRUMPETER SWAN

OLOR BUCCINATOR (Richardson)

A flock of five was seen on the lake November 19, 1900, and again the next day. On March 31, 1901, a flock was heard flying over early in the morning. On November 11, 1904, a flock of 36 alighted in the lake and remained three days, when they left, going southward.

There are few sights in the bird world more impressive than that afforded by a flock of these magnificent birds whether a-wing or swimming on the lake. Their flight is in a long line much like that of geese. On a bright day the great white objects are almost brilliant in the sunlight; and even when the sky is overcast still they are easily seen and are notable bodies against the darker background. When swimming the head and neck are held in a graceful curve and every movement is with a stately dignity.

They are quite alert, always on the *qui vive*. Upon the approach of a boat the necks are stretched to their full length, and the great birds loom up immensely against the distant horizon or background. To approach a flock cautiously and see this sudden accession of tallness of the whole white squadron is a sight worth traveling a long way to witness, and too fine and wonderful to spoil with a gun.

The Trumpeter Swan breeds from the Rocky Mountains to the western shore of Hudson Bay and from the Arctic Ocean to about latitude 60°. It formerly bred as far south as northern Indiana, and on the St. Clair flats in Michigan. It winters from southern Indiana to Texas and from southern British Columbia to southern California.

The whistling swan (*Olor columbianus*), although occurring in the Mississippi Valley during its migrations, has not been observed at Lake Maxinkuckee.

The swans feed chiefly upon vegetation and small mollusks and are not in any way detrimental to fish-life.

36. BITTERN

BOTAURUS LENTIGINOSUS (Montagu)

This interesting bird, also known as Great Bittern, Stake-driver, Thunder-pumper, and Indiana Hen, is a fairly common summer resident at Lake Maxinkuckee. It arrives early in April and remains until about the last of October. Our spring records are April 15 and May 2, 1885; April 14 and May 1, 1901; and April 23, 1969. Following these dates it was seen almost daily. In 1899 it was observed daily or whenever visits were made to localities which it frequents, during July, August and September, and it was frequently noted in October. In 1900 it was seen as late as October 28. In 1903 one was noted September 21. In 1906, a dozen or more were seen September 6 along Outlet Bay. In 1907 one or more were noted October 21 and 28. And one was killed August 31, 1908.

The Bittern is a bird of the marshes and most delights in those bordering lakes. At Maxinkuckee its favorite haunts are the great marsh about Norris Inlet at the head of the lake, the Scirpus patches off the Gravelpit, the narrow strip of marsh fringing Outlet Bay, and, most of all, the splendid marshy borders of Lost Lake and the Outlet to below Walley's. In these situations Bitterns may be seen any day during the spring, summer and fall. It may often be seen stalking sedately about on the sedgy flats or skulking mysteriously among the tall Typha and other aquatic plants.

It doubtless breeds at this lake, though we have never found a nest. It does not breed in colonies as do most of the herons, and its nest is not easy to discover. It is placed by preference in the more impenetrable swampy places and on the ground or a mass of decaying vegetation. The eggs are brownish-drab or isabella color, unspotted.

37. LEAST BITTERN

IXOBRYCHUS EXILIS (Gmelin)

This pretty little bittern is seen rather frequently about the lake throughout the summer. It has been noted every month from April to October. They doubtless breed in the patches of reeds and cattails that border the lake, but we have not found any nests. The birds are solitary and wholly quiet, and are rarely or never seen except when frightened. Then they rise and fly in a rather awkward manner for a short distance, then drop among the reeds where they conceal themselves. Their protective coloration serves

them well; indeed, they are even more difficult to discover than the larger species. Following are our records of definite dates on which we observed the least bittern about Lake Maxinkuckee:

1899.—Noted in July, also on August 4 and September 11.

1901.—May 25, one near the Outlet; 26th, one on Lost Lake; 29th, one seen on the flat at north end of Lost Lake; 30th, one near the Outlet; 20th, one at the Outlet; June 3, two near the Outlet; 20th, one at the Outlet, 22d, one at the Inlet.

1902.—June 24, remnants of a nest near the water in a clump of grass and button-bushes in Green's marsh.

1903.—September 21, one noted.

1906.—July 30, one seen at Inlet.

1907.—September 9, one scared up in front of Chadwick's in afternoon, flew just west of the steamboat slip where it alighted in the rushes; 14th, one on Chadwick's lot in morning.

At the Goose Pond, 9 miles south of Terre Haute, the least bittern formerly nested in considerable numbers. The senior author was wont to visit this interesting pond on Decoration Day each year. Then the woods about the pond were full of migrating warblers, and the pond itself was in its most attractive condition. Pond turtles and water snakes were abundant, resting on broken-down patches of cattails and Scirpus and basking in the warm sun. Great patches of white waterlilies were at their best, the fragrance of the beautiful flowers filling the air. And, most interesting of all, the little bitterns were there in abundance and the nesting season was at its height.

We are told that this beautiful pond is no more. It has been ditched and drained and converted into cultivated fields, more's the pity. There will now be more corn and cabbage and hogs, but less of nature and beauty and the appreciation thereof.

38. GREAT BLUE HERON

ARDEA HERODIAS Linnæus

Our definite dates are as follows:

1899.—July 26, one seen.

1900.—July 24, one seen flying southward over Lost Lake. A Great Blue Heron, probably this same individual, had been seen previously on several occasions by others. Messrs. Young and Knowlton saw a flock of 14 west of the lake, August 24, and one with a broken wing seen on outlet stream below Lost Lake. September 18, one seen below Lost Lake; 27th, one seen flying over

Lake Maxinkuckee. October 16, three seen on outlet below Lost Lake; November 14, one seen at Norris Inlet.

1901.—April 2-6, eight seen; May 31, two seen near the outlet in the morning, and one at the south end of the lake; June 10, one seen flying and heard in evening; 11th, one alighted at edge of lake near Murray's; 17th, one at south end of the lake; 26th, one on shore near Norris Inlet.

1906.—October 8, 9, and 18th, one seen each day about Lost Lake.

1907.—September 30 and October 1-3 and 5, one noted about Lost Lake.

1913.—September 19, one seen flying; 21st, one below Walley's; 27th, one seen; October 25, several seen near Lost Lake.

It may be seen from these records that the Great Blue Heron is not a very common bird at Lake Maxinkuckee. Rarely is more than a single individual seen at a time. This is partly due to the solitary habit of the bird, but partly also to the fact that not many visit this lake. An inspection of all the marsh places about the two lakes and all the shore would probably rarely disclose more than three or four of these magnificent birds. This is, no doubt, partly due to the fact that there are no suitable nesting places about the lake.

No nest has been observed anywhere in this vicinity. Just where those nest that do come to the lake is not known to us. Many years ago (1883-85) there was a considerable heronry of this species in the northern part of Carroll County, near Idaville, and another one of more than a hundred nests in a maple swamp near Cutler, in Carroll County, about 50 miles south of Lake Maxinkuckee. And a few years earlier a few pairs nested each year in the tops of some large cottonwood trees near where the senior writer spent his boyhood days.

39. GREEN HERON

BUTORIDES VIRESCENS (Linnæus)

This is the most common heron of the region. It is found in a greater variety of places than any other heron about the lake. It occurs in the wet, sedgy plains as do the two bitterns; it is also found about the edge of the lake. It perches much more frequently than the other herons, and, like the kingfisher, is particularly fond of sitting on the limbs of trees overhanging the shore. When frightened, it flies off with a loud startled squawk. It is the noisiest of our herons, and frequently gives vent to a loud sneeze-like

call. Its flight is heavy and awkward, and the method of alighting on a tree is ludicrous. It drops its legs down preparatory to alighting and leaves them dangling in a peculiar manner some time before reaching the tree.

The birds usually come early in the spring and remain until late in the autumn. They were seen at various dates every year spent at the lake. They probably nest somewhere in the region, but no nests were found. They nest, generally, throughout the state, their favorite nesting places being low dense woods, the water beech being one of their favorite trees in which to nest. They also nest in orchards. The nests are flat platforms built loosely of coarse sticks, and sometimes found in small colonies. The young remain in the nest till of good size, and a little before they leave are fierce-looking little creatures. Upon shaking the nest they catch hold of the boughs with chin and feet, climbing about somewhat after the manner of a parrot. The young attempt to escape capture by ejecting the contents of the crop upon the would-be captor. The Green Heron is more tolerant of civilization than any of the other herons and is often seen in orchards and about farmhouses and about the lagoons in public parks.

Our notebooks contain the following references to the Green Heron:

1899.—Noted frequently during July and August.

1900.—Two noted July 17 and one July 18.

1901.—May 13, one seen at edge of lake north of the Winfield cottage; 15th, one at south end of lake, 23d, one toward south end of lake; June 8, one seen at Long Point; 10th, one heard; seen frequently from this date on to the end of summer.

1902.—June 19-20, one at Long Point.

1904.—November 12, one seen between Murray's and Farrar's.

1906.—July 30, several seen at Norris Inlet; August 19, several seen in the dune region southwest of the lake.

1907.—Noted on September 9, 12, 22, 24, 25, and 26, in various places about the lake.

1913.—September 3 and 4, one seen at Long Point.

40. SANDHILL CRANE

GRUS MEXICANA (Müller)

A pair were seen by the senior writer on the prairie west of Culver on April 6, 1885. It is said that they used to be common in that region where they were sought by hunters. None has been observed about the lake in recent years.

41. VIRGINIA RAIL

RALLUS VIRGINIANUS Linnæus

Apparently rare. Our only record is of one seen October 15, 1907, standing on a log in a small pond west of the railroad track. It walked along skulkingly, apparently disliking to get in the water which it finally did, however, and disappeared in the rushes.

The Virginia Rail probably breeds at the lake, but we have never found its nest there. The nest should be looked for among tufts of reeds or grasses in or close to shallow water. It is usually composed of dead vegetation and is rather compactly built. The eggs are cream or buff, sparsely spotted with reddish-brown and obscure lilac. They usually number from 6 to 12 and measure about 1.25 x .92 inches.

42. CAROLINA RAIL; SORA

PORZANA CAROLINA (Linnæus)

The Sora is probably a common summer resident in the tall grasses and sedges along the Outlet and about Norris Inlet. They are not often seen, as they almost never fly, even when chased, but they spend their time skulking through the grass. They are very noisy, particularly when frightened, and one individual can give the impression of a whole swamp full of them. In 1901 the first was seen April 23, and they were heard or seen quite frequently from that time on, chiefly in Green's marsh, along the Outlet, or in the adjacent marsh. On May 31, 1901, a nest with 10 eggs was found in the Norris Inlet marsh. About June 6, after a heavy storm, a small downy young, much like a small chicken, was found dead on Long Point. On June 8, an old bird was seen leading her young along the south shore of Outlet Bay, very much like a hen leads her brood. One seen by the Outlet July 24, 1906, was quite tame and suffered us to approach within about six feet of it when it skulked away through the sedges. Another was seen on the same day, which came squawking down to the water's edge and really appeared to be swimming in the shallow water. The latest date on which we have noted this rail at Maxinkuckee was December 11, 1900, when one was seen at Norris Inlet marsh.

The nest of the Carolina Rail is poorly constructed of grass and weeds, placed on the ground in a tussock of grass on boggy ground where there is a good growth of taller grass or weeds. The eggs are dark cream or drab with reddish-brown spots, most numerous at the larger end. They measure about 1.26 x 0.90 inches.

43. YELLOW RAIL

COTURNICOPS NOVEBORACENSIS (Gmelin)

Apparently rare, although from the habit of these birds remaining concealed in the tall sedges, it is difficult to say how common it really is. The only specimen seen by us was brought in by a house cat March 3, 1901, and was caught in Green's marsh.

The finding of this beautiful rail in northern Indiana and at so early a date is of especial interest.

44. FLORIDA GALLINULE

GALLINULA GALEATA (Lichtenstein)

This bird seems to be a rare migrant, or perhaps summer resident. The only record is of one seen in the flat along the Outlet west of the railroad May 7, 1901. These birds skulk through the tall grasses much as the rails do and are probably less rare than records indicate.

This bird is known to breed in the State. A nest with five well incubated eggs was found May 31, 1890, at the Goose Pond, 9 miles south of Terre Haute. It was placed about 6 inches above the water on a pile of broken stems and leaves of Green Arrow-arum (*Peltandra virginica*), in a bunch of that plant. The eggs measure about 1.81 x 1.22 inches and are creamy or brownish buff in color, rather thickly spotted and blotched with brown and umber.

45. COOT; MUD HEN

FULICA AMERICANA Gmelin

The Coot or Mud Hen is by far the most abundant of the water fowl at Lake Maxinkuckee. After it come the little bluebill, canvasback, redhead, mallard, butterball, ruddy duck, merganser, and whistler, about in the order named. The Coot is not only the most abundant species, but it is in many respects the most conspicuous and most interesting. Because of these facts, and the further fact that it is economically the most important species of the water birds that frequent this lake, it seems worth while to give our records of its presence in some detail. This we will do for each of the years in which we made observations.

1885.—Our only observations in 1885 were made on April 6 and 7 when the senior author made a brief visit to the lake. The ice was still on the lake, the only open water being a narrow strip along the south shore. In this strip there were perhaps a hundred Coots.

1899.—A few were noted in August but unfortunately the exact dates were not recorded. September 21, beginning to arrive; 22d first large flock, about 100, seen, three killed; 28th, increasing in abundance; 29th, a great many came last night, about 500 in one flock seen off Shady Point this morning; 30th, very abundant, many shot. October 1, abundant and becoming wilder; 2d and 3rd, abundant; 4th, abundant, close in shore, the weather being fine and favorable; 5th, abundant, gunners out early, killing several; 12th, less plentiful; 16th, some noted. November 1, one hunter got 11.

1900.—September 16, saw several, the first of the season, near Shady Point; they doubtless came last night; 17th, several seen; they seem quite tame, probably young birds; 18th, a few noted; 22d, one near Shady Point and about 200 reported in south end of lake in afternoon; a gunner got 4; 23rd, several seen; 26th, about 4 p. m. A great many seen east of the Deep Hole; as they flew, six distinct flocks totaling 194 birds were observed, although only a small proportion left the water; 28th, many on east side of lake at 4 p. m.; 30th, many off the Gravelpit. October 1, pot-hunters in motor boat bombarding the Coots all afternoon; 2d, on both lakes; 5th, noted; 8th, abundant; 10th, many; 12th, common; 13th, several flocks on west side and a good deal of shooting; 17th, saw 300 to 400; 18th, very numerous in afternoon in front of Shady Point; 21st, pot-hunters in launches pursuing coots and ducks; 24th, noted; 25th, many and very noisy; 26th, one hunter got 12; 27th, another hunter got 34; 28th, one found dead. November 5, many seen; 7th, about 1,000 a short distance off Shady Point, a few horned grebes among them; 8th, abundant in front of Shady Point, from which they were scared by a passing train at noon; three inches of snow; Coots most abundant, then little bluebills, redheads, ruddy ducks and helldivers,—no sprigtails; in the afternoon, while a strong wind was blowing from the northwest and some snow was falling, the coots and ducks came in near shore, the coots and a few helldivers nearest, while the ducks remained out along the line where the more quiet water protected by Long Point from the northwest wind joined the unprotected portion; 9th, in a trip along the shore from Long Point to Norris Inlet a great many coots were observed, all pretty well out from shore; two hunters in the forenoon got 7 coots, 5 little bluebills, and one redhead, while two others got 36 coots and ducks; 10th, one hunter got 6 coots, 2 others got 50, and 2 other pot-hunters in a launch bombarded the coots and ducks all afternoon until dark; 11th and 12th, many on lake; 14th, two pot-hunters in a launch got 12 coots,

one little bluebill, and one helldiver; 10th-15th, many off Shady Point and Arlington; 15th, two hunters got 2 each; the coots came in near shore in the forenoon; 18th, noted; 19th, many on lake; 20th, many on lake, found 3 dead; 21st, not so numerous near shore, but many far out; 22d, still abundant; a good deal of shooting; 23d, many coots and ducks, mostly well toward east side; much shooting all day; 26th, still abundant but mostly far out; 27th, common; 28th, common, very noisy in morning; 29th, much less abundant; 30th, noted. December 1, 2, 3, 4, and 5, good many noted each day; 6th, today and yesterday in a thick flock not far from Outlet busy diving and seeming to find a good deal to eat; feeding voraciously in the forenoon; often one comes up with a bit of food and another grabs it; they were somewhat noisy and kept pretty well out of range; 8th to 15th, noted as plentiful each day; one hunter got 170, another got a large number, one man on skates caught 10 on the ice; a large number, perhaps 400 to 500, were on the ice and many persons participated in the slaughter; 17th, still a good many; 18th, only a few left; one man got 27 coots and several ducks, catching most of them on the ice; found 10 dead on the ice; many people out picking up dead birds and those frozen in the ice; 19th, a great many have been killed, not many left; 23d, a few off Knapp's pier; 27th, none seen for several days; 28th, a few seen flying off Long Point.

1901.—January 1, a good many coots, together with butterballs and little bluebills in a small open pool; 2d, caught one on the ice; they can run swiftly on quite slippery ice, flapping their wings to help them; many in a pool in south end of lake; when watched or approached, they get out on the ice ready to run; 3d, four in pool near the Weedpatch; when diving for food they remain under 9 to 16 seconds; 4th, one still in the pool after all but canvasbacks have left; 5th, two seen; 7th, two seen, one dead at the pool; 8th, 9th, and 10th, one or more noted in the pool. March 24, and 29, several seen; 31st, one seen in north end of Lost Lake and one seen flying south of Shady Point. April 1, one at north end of Lost Lake; 2d, two in Lost Lake; 3d and 4th, three near the Deep Hole; 5th, one at north end of Lost Lake; 6th, three in north end of Lost Lake; three killed by a hunter; 7th, fifty or more near the south end east of Farrar's; a sick one found, died soon; 10th, a good flock near the Inlet; one found dead; 15th, a flock near the Inlet; one found dead. May 16, a few seen. December 9, common.

1902.—October 19, many on the lake and feeding near the shore; many in Outlet Bay and another flock east of Long Point;

21st, many, three shot; 31st, one shot. November 2, abundant, especially south of Arlington; 3d, many in south part of lake. December 1, three shot; 2d, one killed; 17th, four got.

1903.—September 21, fifty to 100 seen.

1904.—October 20, several flocks seen; one shot in Outlet Bay; 21st, many noted, in straight east-and-west line; 23d, noted; 25th, about 2,500 in Outlet Bay, not fewer than 10,000 on entire lake; one flock of 236 counted near Outlet early in the morning; some shooting, perhaps 200 killed; remains of about 100 noted at Green boathouse near Norris Inlet; 26th, apparently as many as yesterday, many near shore at noon in Outlet Bay; 27th, a good many in Outlet Bay; some shot near ice-houses; one found dead on north shore; 28th, many on lake, appearing much frightened, scattering in all directions even when a muskrat swims near them; feeding and diving busily; some redheads among them; two dead coots found; 29th, many in Outlet Bay, quite near shore, others well scattered over the lake; stomachs of three examined contained bits of Chara, Ceratophyllum, and small Potamogetons; 30th, a good many, well scattered; 31st, many, but not so much crowded in Outlet Bay, better scattered over the lake. November 1, common, three hunters got 103; 2d, one hunter got 9; two found dead; 3d, a good many scattered over the lake, a few near shore at Long Point in the morning; two found dead; 5th, many on lake, a good many near Long Point and west shore; 6th, many on lake, some near shore; 7th, common; 8th, three found dead; 9th, a number very near shore near Chadwick's pier, wading in shallow water, 3 canvasbacks among them; many coots scattered over the lake, with several canvasbacks and bluebills; one dead coot found on south shore of Outlet Bay; 10th, good many near shore in Outlet Bay and east of Long Point; much shooting; 11th, a great many, well scattered; in morning some near west shore; a good deal of shooting; two boys on Long Point got 6 in morning and 17 in afternoon; 12th, duck hunters shot several coots by accident (sic), not even picking them up; 13th, some in Outlet Bay and many elsewhere; near shore in mid-forenoon, some actually walking along shore; two seen appropriating food canvasbacks brought up; 14th, many; 15th, a good many noted, well scattered; one boy got 6 in morning; 16th, as numerous as yesterday; one hunter at Long Point got 3; 17th and 18th, a good number scattered over the lake; 19th, pretty abundant, scattered over Outlet Bay and entire lake; near shore at Arlington in morning, some calling; good many killed during the day; 20th, still abundant; 21st, abundant, some near Knapp's pier in morning; 22d, same conditions as yesterday; 23d

to 25th, well scattered; 26th and 27th, less abundant and well scattered; 28th, rather plentiful but well scattered; some near Knapp's pier. December 2 and 3, quite a number scattered over entire lake, some in Outlet Bay; 4th to 8th, quite a number in Outlet Bay and elsewhere in lake; 9th, apparently not so many; 10th, still common; 11th, a few in Outlet Bay, a good many on main lake; one dead at Inlet eaten by muskrats; 12th, common; 13th, in long rows in open places; 14th, not so many in the few open places; 15th, a good many in pools and on the ice; many shot and let lie; 16th, a few in a round open pool; 3 or 4 shot off Farrar's, the rest scattering over the lake; 17th, two scared up from the round pool.

1905.—January 1, two seen in pool.

1906.—September 9, a flock of 5 seen at south end of the lake, the first of the season; after this date they gradually increased in number. October 5, one found dead; 6th, rather large flocks now, gunners busy in morning; 7th, a dead one found; 9th, a hunter got 4; 10th, much shooting; 11th, much shooting; two boys got 14; one found dead; 12th, many on lake; hunters got good many; 13th, a flock off Knapp's pier; much shooting, even after sunset; 15th, heard strange cackling notes, believed to be made by coots; 16th, considerable shooting; 18th, two found dead; 28th to 30th, many; two hunters got 10 on 30th and 6 were found dead; 31st, good many near shore; one man got 6. November 2, several found dead on shore; 3d, noted; 5th, found 5 dead on east side; 8th, seen; 10th, got one; 11th, seen; 12th, got 2; 13th, a good many noted; 15th, a big flock at south end.

1907.—September 8, five seen in forenoon well out toward middle of lake; seen again in afternoon; 10th, about 200 arrived last night; 12th, about 200 to 300 seen near the Weedpatch, 45 in one flock; 13th, about 200 in two flocks at south end; 20th, a flock of 100 or more east of Long Point; reported as common in the other parts of the lake; 21st, a man got 16, crippling 3 others; 22d, a flock of about 500 off Long Point in morning; quite a number in many detached flocks, one of about 242 near shore between Green's and Murray's; some shooting; one dead by Green's pier; 23d, noted; 24th, noted off Long Point early in morning, perhaps 500 or more; those near shore allowed near approach; some shooting; 25th, many large flocks off Long Point, 400 to 500 feet off shore, rather wary, swimming rapidly; 26th, a few flocks east of Long Point, 500 to 1,000 feet out; not so many as yesterday; quite a number in Outlet Bay; two dead near Norris Inlet; 27th, a flock of about 50 swimming northwest about 1,000 feet off Chadwick's pier early in the morning; no others seen early; do not seem to be

feeding much; 28th, a few off Chadwick's pier in Outlet Bay; 29th, a number of large flocks off Murray's; 30th a good many flocks noted; a good deal of shooting even before sunrise and after sunset. October 1, a few seen in morning off Murray's, also in Outlet Bay, where there was some shooting; one seen in Lost Lake, busy feeding; 2d, a good many, especially in Outlet Bay and off Murray's, some shooting; 3d, some in Outlet Bay and some shooting early in morning; 4th, some off Murray's and in Outlet Bay, two men got 17; 5th, thousands present, most abundant off Arlington, quite tame; 6th, abundant; 7th, many, especially off Murray's; 8th, many near shore, feeding; one hunter got 3; one dead near ice-houses; busy feeding off Merchants' pier at a Vallisneria patch; 9th, a good many on lake, busy diving and feeding; they are more frightened by passing train than by hunters; 10th, abundant, rather near shore; good deal shooting; one hunter got 10; 11th, much shooting, one hunter had 10; saw wounded one on Lost Lake; 12th, much shooting; coots pretty well scattered but feeding, keeping near shore; a few in north end of Lost Lake; 13th, many but well scattered, a few shot; 14th, much shooting; some in Lost Lake; 15th, many feeding very near shore, a few ducks among them; much shooting at south part of lake, hunters got over 125; 16th, abundant, much scattered, much shooting; several dead ones found; 17th, many, scattered; 18th and 19th, a good many, considerable shooting; 21st, many, much shooting; 22d, well scattered, some near shore in Outlet Bay and off Long Point; one man got 3; 27th and 28th, abundant in Outlet Bay; 31st, abundant and wild, 2 men got 5. November 1, abundant, one man got 2; 4th, common near Chadwick's pier; 5th and 6th, good many near shore.

1908.—September 6, first ones arrived last night; 3 seen on Lost Lake, quite tame; in afternoon saw some off Long Point.

1909.—April 23, Mr. Chadwick reported the coots have been rather plentiful this spring.

1913.—September 13, first noted; two seen in morning in Outlet Bay and 40 later in the day; 14th, several, perhaps 50, in Outlet Bay and near Norris Inlet; 15th and 17th, noted; 21st, many, four big flocks; 23d, a large flock below Green's pier, diving and feeding; 24th, in big flocks; 25th, large flocks in a long row below Arlington; 26th, in large flocks, some shooting; 27th, probably many on lake, but only a few near Long Point; 28th and 29th, many off Long Point and elsewhere along west side; 30th, noted. October 1 to 3, common; 4th, many; gunners after them by 6 a. m.; 5th, a fair flock noted; 6th, many and much shooting; 8th to 12th, noted; 13th, good deal shooting, some hunters got 12; 14th, a few

seen; 15th, a large flock seen; 16th to 26th, common, and some hunting; 27th, abundant; 28th, many; 29th, plentiful; 30th, abundant and a good deal of shooting. November 1, common.

An examination of the above detailed data shows that the coots appear in the spring very soon after the ice goes off and that they remain until about the last of April when they leave for further north. They usually appear about the last days of April and remain approximately one month. In the fall they make their appearance usually in the first days of September. Occasionally a few may be seen in August, but they generally appear between the 6th and 15th of September. By the last of September they are present in large numbers and remain so until the lake freezes over or until persecution by the gunners drives them away.

On October 25, 1904, the total number on the lake was estimated at 10,000. In the winter of 1900-1901, several remained until only one small pool was left open. The last was seen January 10.

The coots always migrate at night; one never sees flocks either arriving or departing, or rarely sees them flying except when they have been scared up. When flying they do not rise directly from the water like a duck but at a low angle or incline, their feet working frantically, as do their wings, as they rise out of the water, striking and kicking the water for some distance until they have got too high to touch it.

They frequently have the curious and foolish habit of rising out of the water and flying close by the boat which has disturbed them.

They are, at Maxinkuckee, as thoroughly a water bird as any species of duck with the one exception already mentioned. We never saw them walking on the shore as mentioned by Cooper, but observed that they might be found in any and all parts of the lake, though they were most apt to occur in large numbers nearer shore than most other water birds. The helldiver and grebes, as a rule, came somewhat nearer shore than the coots; and small flocks of butterballs and whistlers and solitary ruddy ducks were disposed to stay near shore. Bluebills would usually be a little farther from the shore than the coots, while the redheads, mallards, and canvasbacks would be still farther out. However, it often happened that nearly all, or quite all, of these species would be mixed together in a single flock, the coots and bluebills constituting the shore side of the miscellaneous group.

When the coots first arrive in numbers in the fall they are not wild, but quite tame and unsuspicious, frequently coming near the

shore. One of their favorite feeding grounds is off Arlington station; another is in Outlet Bay where they can be easily observed from the Chadwick Hotel. In each of these places they remained day and night unless disturbed, or when those parts of the lake were made rough by winds, when they would fly to some protected corner of the lake.

The depth of the water over these feeding grounds varied from 4 to 25 feet, and the bottom everywhere was well covered with various species of Potamogeton, Myriophyllum, Nitella, Tolypella, Vallisneria, Naias, Chara, and other kinds of plants. Chara and Nitella grew in the more shallow water, and Tolypella in the deepest, while the tapegrass or wild celery (*Vallisneria spiralis*) grows in all depths from 2 to 24 feet.

Watching the coots from shore with a pair of good field-glasses was an extremely fascinating pastime. There is, of course, no doubt about the Coot's ability to swim well. This they do quite as well and as gracefully as most ducks.

They are also very noisy or loquacious, keeping up their calls and conversations during all hours of the day and night. They are particularly noisy when feeding. In the spring they have a peculiar call much resembling that of the cuckoo or raincrow.

And contrary to some observers they are expert divers. They dive habitually and regularly when feeding, with the greatest ease and grace, also when wounded, to escape their pursuer. The Coot dives with greater abruptness than any duck we have observed. The body turns very quickly and is usually in a nearly vertical position before entirely submerged. There is, of course, great irregularity in the frequency of their diving. The character of the weather, whether they are disturbed or not, the success of their dives, and the extent of their hunger, are factors determining the frequency. Ordinarily, however, one dive follows another very quickly, so that when watching a flock of a dozen or more, one or more individuals can be seen going down and others emerging at any moment.

The maximum depth to which they can descend was not definitely determined; but they reach bottom certainly in as much as 25 feet. In front of our cottage was a buoy marking a 25-foot hole, and we have often seen Coots close to this buoy diving and bringing up food from the bottom. Usually, however, their choice feeding grounds are in depths between 1 and 18 feet.

The length of time the Coot remains under water varies greatly, and is probably determined chiefly by the depth to which they dive

and the readiness with which acceptable food is found. The longest time any individual was observed to remain under water was 16 seconds, and the usual time in water 4 to 10 feet was about 9 seconds.

The Coots feed most industriously when the surface of the water is smooth and the air balmy. They feed actively also on calm, moonlit nights. On quiet mornings and again in the afternoon they gather on favorite grounds near shore and feed industriously until disturbed.

During the early part of the fall they were most apt to feed near shore, doubtless because they were less timid and also because their favorite food was found in shallow water. Later, as a result of their being hunted and disturbed by gunners and others, they became more wary and would not ordinarily approach or remain so near shore. The depletion of the inshore feeding grounds also doubtless has much to do with causing them to seek food farther out in the lake.

We soon discovered that the early arrivals were feeding on the wild celery (*Vallisneria spiralis*), but at first we were not sure what part of the plant they ate. We had read in the botanies and the ornithologies that the great delicacy of the flesh of the canvasback duck is due to the fact that it feeds on "the roots" or the "leaves" of the wild celery. If a brisk breeze should spring up after the Coots had been feeding diligently for a few hours or a day or two, great quantities of wild celery plants would be washed up on the shore. Upon examining these plants, we were not able to discover that the roots or leaves of many of them had been removed. Nearly all of the plants seemed intact and perfect so far as these parts were concerned. One interesting part of the plant, however, we were unable to find on any of the plants washed ashore, namely, the modified stolon or so-called winterbud, which many, perhaps all, of the Vallisneria plants form late in the summer. This is a short stem somewhat smaller than a lead pencil, about one-half to two inches long, somewhat enlarged at the distal end, white in color, very tender and crisp, and having quite a pleasant flavor. We soon found it was upon these winter buds that the coots were feeding, apparently exclusively, and they doubtless, during the early fall, constitute the principal food of the Coots that frequent this lake.

Later in the fall, after the supply of winter buds has become practically exhausted, the Coots, bluebills, redheads, and canvasbacks begin eating the bases of the wild celery leaves, and as choice

food becomes more and more scarce they eat other parts of Vallisneria, and other plants which at first they reject. In fact, when occasion requires, the Coots seem to be able to eat almost any aquatic plant, and various kinds of animal food such as snails, small crustaceans, and the like. There is no evidence that they eat fish. Most of the stomachs examined in the fall contained Chara, some contained bits of fine-leaved Potamogeton (probably *P. pectinatus*), also Ceratophyllum and Naias. Several stomachs examined October 12, 1906, contained a quantity of finely comminuted light green material, probably leaves of Vallisneria. One examined April 7 contained some vegetable fibers and leaves of *Potamogeton lucens* mixed with white sand. Sixteen were examined September 9, and Naias was found to constitute the bulk of the food. Two contained bits of Potamogeton and Ceratophyllum, two had some small seeds like clover mixed with some fine gravel. One examined November 4 contained fine fiits of Naias and a few small shells of *Viripara contectoides*.

On January 3, 1901, the lake was frozen over excepting one open pool near the Weedpatch, in which were several coots along with a number of various species of ducks. At this time food was particularly hard to get and the birds were disposed to rob one another. Generally when one dived the others watched for his coming up. They were able to see him some moments before he reappeared, and, hurrying to the spot where they thought he would emerge, would be on hand ready to appropriate for themselves as much of the food brought up as they could get possession of. Not only would the coots rob each other but the ducks also robbed the coots. Whenever a Coot came up with an unusually great amount of food, the little bluebills and even the canvasback drake would be on hand ready to help themselves. In this way the coots fed not only each other but various ducks as well. It was observed that the ducks did very little robbing of each other. Usually a considerable mass of vegetation was brought up each time. In this particular place the principal food seemed to be one or more species of Potamogeton, *P. pectinatus* predominating. The birds often came up with long stems hanging over their backs. Quite often the plant brought up looked like Chara, but of this we were not sure. It is certain the plants they were getting here were not their favorite food, but such as they could utilize when necessary when better food was not to be had.

Following is a tabular statement of the food found in a number of coots examined.

Date	Number of stomachs examined	Contents
April		
7	1	White sand, some vegetable fibers, and some leaves of *Potamogeton lucens*.
October 29	3	Bits of Chara, Ceratophyllum and small Potamogeton.
November		
2	2	Chara; opercula of *Viviparа contectoides*, fragments of shells.
3	1	Chara; opercula of *Viviparа contectoides*, fragments of shells.
3	1	Fragments of *Naias flexilis robustus*.
8	2	Fine pieces of Naias, fragments of *Viviparа contectoides* and perhaps other mollusks.
12	1	Chara.
28	1	Chara.
December		
8	1	Chara.
October		
9	4	Ceratophyllum.
12	7	Fine green matter, probably Vallisneria.
September		
21	16	Chiefly *Naias flexilis robustus*, with some Potamogeton, Ceratophyllum, 2 contained some small seeds like clover, mixed with gravel in crop.
October		
10	1	*Naias flexilis robustus*.
31	1	All vegetable matter but not specifically identifiable.
November		
4	1	Naias in fine bits, and shells of *Viviparа contectoides*.

The Coot averages a little more than one pound in weight. Following is a record of 28 examples weighed by us:

Date	No.	Weight	
		Pounds	Ounces
November 12	1	1	3
	2	1	7 1/2
	3	1	8
	4	1	7
	5	1	11 1/2
	6	1	12
	7	1	3
	8	1	3
	9	1	11 3/4
September 21	10		15 1/4
	11	1	6
	12		14
	13	1	2
	14	1	3 1/2
	15	1	2
	16	1	5 1/2
	17		15
	18		15
	19	1	1 1/2
	20	1	2 1/4
	21	1	4
	22		15 1/4
	23		14 1/2
	24		14 1/2
	25	1	1 1/2
	26	1	3
	27	1	8 3/4
	28	1	5

The Coot is not generally held in high esteem as an article of food. Those who have put themselves on record in the books are almost unanimous in the opinion that it is worthless for food. As a matter of fact, however, the Coot is scarcely inferior to most species of ducks. Coots, particularly young ones, skinned and fried, or even old ones parboiled, then baked, are quite as delicious as any duck. It is, however, doubtless true that the delicacy of flavor, not only of the Coot, but also of the canvasback and other ducks, is largely determined by the kinds of food they have been eating. The wild celery (*Vallisneria spiralis*) is sufficiently abundant in Lake Maxinkuckee to give the Coot frequenting it a delicate flavor which has received high praise from all who are familiar with it.

Beginning soon after their arrival in the fall the coots are hunted relentlessly until the constant persecution or the freezing over of the lake compels them to leave. Soon after they come in numbers certain local pot-hunters and temporary cottagers, and people from various parts as far away as Terre Haute, Indianapolis and Logansport, who come to the lake for a few days shooting, begin to bombard the coots from early morning until late in the evening. Unfortunately not all of these are sportsmen; in fact the majority of them are not. Many of them are mere pot-hunters or butchers who possess none of the instincts of the true sportsman and who continue to pursue the birds as long as they are in sight. The methods of these pot-hunters are reprehensible in every way. They shoot everything in sight whether edible or not, including coots, helldivers, grebes, tern, and loons. The Coot has a particular fascination for them, though few of them make any use of it; they simply kill or cripple the coots, helldivers and grebes in pure wantonness and leave them to float ashore and decay. Some of these pot-hunters use naphtha or gasoline launches (contrary to the law), and keep up their fusilade until after sundown (also unlawful); and some of them have been known to pursue the fowl on Sunday, in violation of the law.

On October 25, 1900, the remains of about 100 coots were found in a pile at the small green house at the south end of the lake. The next day one hunter shot 12 coots, and on the following day two pot-hunters got 34. On November 9, two other pot-hunters from Indianapolis, men who ought to know better, killed 36 coots and ducks, and the next day they got 50. They did their bombarding from a small launch.

Fortunately a few of these pot-hunters have been caught and fined heavily. Public sentiment in favor of fish and game protec-

tion is growing, thanks to the interest and activity of the Lake Maxinkuckee Association and a number of appreciative citizens and visitors, and it is hoped and believed that the fish and game laws will hereafter be better observed.

The Coot breeds at this lake in very limited numbers; indeed, in most seasons it is not believed that any do so. Formerly a few pairs nested each season about Lost Lake or in the Norris Inlet marshes. The nest is made of dead reeds and grasses placed on the ground near the water, on a tussock, or on a mass of floating vegetation. The reeds or flags on which it rests are broken down and the nest sometimes rises and falls with the water. The eggs are clay- or creamy-white in color, uniformly and finely dotted all over with dark brown or blackish specks. The full nest complement usually numbers from 6 to 15 and the egg measures 1.77 to 2.00 inches long by 1.40 to 1.45 in the shorter diameter. Their nesting season in this part of the State is in late May and early June.

46. NORTHERN PHALAROPE

LOBIPES LOBATUS (Linnæus)

The only example of this species ever observed by us at Lake Maxinkuckee was seen September 21, 1913. It was at the water's edge on Long Point, where it was feeding. It appeared to be feeding on insects in or at the edge of the water. It was very tame and permitted very near approach so that it could be carefully observed. When approached too near it would wade out into the water, and if further pressed, it would swim away a short distance, then rise and fly out over the lake in a short circle, then come back and alight behind us on the shore.

This bird remained on this stretch of shore all day but by the next morning it had gone.

47. WOODCOCK

PHILOHELA MINOR (Gmelin)

This bird seems to be quite rare; indeed, almost unknown at the lake. It is significant that although hunting and game are matters of considerable interest in the region, one never hears of this bird being taken. We have only two records for this species at the lake: A pair were seen April 6, 1885, by the senior author in a marshy prairie just west of Culver, and about August 10, 1900, Dr. Scovell saw one on the west shore of the lake.

Those seen on April 6, 1885, were evidently mating. One of the birds, presumably the male, would rise high in air by a kind of

rapid spiral flight, then return to the ground with a sort of booming sound. Then the act would be repeated, accompanied by a peculiar note hard to describe. This was just before dusk of a warmish spring day, and the performance was repeated many times.

There are a few places near the lake that would furnish almost ideal retreats for this bird. One of the best is a rather deep gully on the east side which is known locally as "the canyon" and which has patches of soft marshy bottom. Another is Green's marsh, and still others the marshy ground at the south end of the lake. The bird is not rare about the lakes of the adjacent county of Kosciusko.

48. WILSON'S SNIPE

GALLINAGO DELICATA (Ord)

This bird, known here as Jack Snipe, is much more common than the woodcock, which it resembles considerably in general habits.

Our records are as follows: Sept. 29, 1899, one seen on Long Point; about April 7, 1901, 8 or 10 killed by a local hunter; April 3, 1902, one seen; Oct. 21, 1902, one seen in Green's marsh; October 31, Mr. Chadwick says he has seen them in Green's marsh for a month; Nov. 1, 1902, one seen; Nov. 2, one or more heard in Green's marsh; Oct. 20, one seen in Green's marsh; Nov. 3, 1904, 3 seen, and one or more seen along west side of lake on Nov. 9, 13, 15, 20 and 21 following; Oct. 13, 1906, one seen in Hawk's marsh; Oct. 31, 1907, one seen at Norris Inlet; Apr. 23, 1909, one heard.

In 1913, it was first noted on September 29; 30th, one shot on Long Point. October 3, one seen near the Chadwick cottage; 5th, 6th, and 7th, three seen near Chadwick's; 8th, one on Long Point; 9th, one at Norris Inlet; 10th, 11th, 12th, and 13th, one noted near Holbrunner's; 14th, one found dead under a telegraph wire, stomach contained one angleworm; 16th, 17th, and 21st, seen on Long Point; 22d, two on sandy shore near Holbrunner's; 23d, noted in same place; 26th, two seen; 28th, several seen.

The Jack Snipe is usually seen alone, or sometimes 2 or 3 together, on the lake shore. They are one of the most interesting and delicious of American game birds, and there is none more erratic or eccentric. When frightened they rise with a cry and start off with a swift, zigzag flight that tests the skill of the sportsman. They are usually found in low marshy situations. They lie close and are rarely seen until they are up and away.

At Maxinkuckee they occur only as spring and fall migrants. Their food consists chiefly of worms which they find in the soft marsh ground.

Among their favorite places at Lake Maxinkuckee may be mentioned Green's marsh, the narrow marshy border of Outlet Bay from the wagon bridge to the tip of Long Point, the Scirpus-covered shore from Shady Point south to Murray's and east to beyond Farrar's, and the Norris Inlet region. From the first of April to the first of May and again from the last days of September until the last of November, one or more can usually be seen in any of these localities. Within these dates and in these places we rarely failed to find them if we cared to look for them. They are, however, much less abundant than they were a few years ago before ditching, draining and clearing up the land so greatly reduced their suitable feeding grounds.

49. SEMIPALMATED SANDPIPER

EREUNETES PUSILLUS (Linnæus)

Apparently not common. Noted August 12 and at other times in August and September, 1899; on July 17 and 18 and August 7 and 11, 1900. Usually seen in pairs and most frequently along the shore at south end of lake.

50. YELLOWSHANKS; GREATER YELLOWLEGS

TOTANUS MELANOLEUCUS (Gmelin)

Not very common, and only as a spring and fall migrant. In 1899, it was noted August 4 and September 23. In 1900, a pair, believed to be this species, was seen on July 18, at the south end of the lake; one was seen October 2, and on the 24th, eleven were seen flying over and calling loudly; they were heard again in the afternoon at Norris Inlet; and on the 31st, one was noted flying over the lake. In 1901, one or more were heard March 7. In 1902, one was heard flying over Lost Lake. In 1906, several large flocks thought to be this species were seen by Mr. Clark near Warsaw. One noted October 4, and one on Long Point on the 11th; noted again on the 28th. In 1907, on September 10, heard, and reported by Mr. Chadwick to have been heard several times this fall; 29th, one seen flying high and calling loudly; November 2, one seen flying over. In 1913, one seen at noon September 7 on Long Point; 24th, a flock of five seen; October 15, heard by Mr. Clark.

From this record it appears that this species may be seen at

the lake only for a brief period in spring, and again from the middle of the summer until at least the first part of November. October is probably its month of greatest abundance.

The Greater Yellowlegs is one of our most interesting shore birds. It is a stately bird and may often be seen wading along the margin of the lake feeding upon small mollusks, crustaceans and fishes. It is a rather wary bird. Spying the gunner while yet at a long distance, it utters three or four rapidly repeated loud and shrill whistling notes, which serve as a signal to its feathered associates, when they all take wing and are off; for which reason "Tell-tale" is one of its vernacular names.

51. SPOTTED SANDPIPER; PEET-WEET

ACTITIS MACULARIA (Linnæus)

This little bird is one of the most common and characteristic shore birds at this lake. It arrives early in spring and remains until late in October. We have records for April 21 and 30, and May 1, 1901; also for August 19 and September 16, 1906, September 27 to 30, 1907, and October 1, 10, 11, 12, and 13, 1907. Between these extreme dates they could be seen at any time when suitable portions of the beach were visited. On almost any day during the summer and fall one or more may be seen running rapidly for short distances along the water's edge, especially on sandbars in sequestered places, stopping at intervals to balance themselves with the peculiar teetering motion for which they are so well known, and to utter the characteristic call "peet-weet." When approached this bird takes a low flight, usually out over the lake, circling back to some point only a short distance down the shore from where it started. It feeds assiduously along the shore, picking up small crustaceans, mollusks, insects, and other small bits of animal matter, dead or alive. In this way this bird acts to some extent as a scavenger, as do many other shore birds, doing much to keep the beaches clean.

This Sandpiper breeds at Maxinkuckee. Its nest is a simple affair, a mere depression in the sand, usually where there is some rubbish or drift material, often at a considerable distance from the water. It may be composed of a small quantity of dead vegetation, but is at best a mere makeshift of a nest. The eggs, usually 4 in number, are creamy, buff or clay in color, blotched, spotted and dotted with blackish-brown. They measure about 1.31 by .91 inches.

52. KILLDEER

OXYECHUS VOCIFERUS (Linnæus)

One of the most conspicuous and interesting summer residents, although not abundant. It is one of the first birds to arrive in spring, and one of the last to leave in the fall.

Our definite date records are as follows:

1899.—Seen almost daily throughout July and August. September 11 and 17, several seen on these dates and subsequently.

1900.—September 22, a large flock at Lost Lake; 27th to 30th, several seen and heard. October 2, noted; 6th, abundant and calling at Fletcher Lake north of Logansport; 21st, 24th, and 27th, several seen and heard.

1901.—March 1 and 3, heard; 13th, heard and 3 seen; 17th to 19th, seen or heard; 23d to 26th, seen and heard. April 2, heard and seen below Lost Lake; 3d, seen calling on Green's marsh; 4th, one heard at Lost Lake; 6th, one heard west of lake; 9th, one at the tamarack swamp; 26th and 28th, heard at Lost Lake. May 4 and 29, heard at Lost Lake.

1902.—March 4, one seen flying over lake and calling; 10th, one seen by Mr. Chadwick.

1904.—October 21, seen; 24th, some heard calling over by the tamarack swamp. November 6, seen and heard at Lost Lake; 12th, seen flying and heard over by Lost Lake.

1906.—Seen off and on and no doubt present all summer. September 5, constantly calling; 6th, seen. October 4 and 10, several seen and heard calling; 11th and 12th, seen along shore; 25th, one shot near Outlet Bay; 27th, one found dead under telegraph wires.

1907.—September 12, three seen flying high and calling; 14th, a good many noted along railroad between the lake and Logansport, and many along the Wabash near Terre Haute; 23d, seen north of lake toward Twin Lakes. October 4, one heard at Hawk's marsh, flying and calling; 10th, heard very early in morning.

1913.—September 4, two on Long Point at 4 p.m.; 14th, 21st, 25th, and 28th, one or more seen or heard each day; 29th, a flock of 8 or 10 seen and heard; 30th, four seen on Long Point. October 3 to 9, seen and heard every day; 13th, several seen in morning and heard at 9:40 p.m., a fine still moonlit night; 15th, 21st, and 22d, one or more noted each day.

During the spring and especially during the summer the killdeers are usually seen singly or in pairs; in the fall they gather

up in small flocks. They frequent low ground, old pastures and sandy beaches. Among favorite places where these birds were quite sure to be found may be mentioned the sandy shore at the northwest end of Lost Lake and the tip of Long Point.

53. PIPING PLOVER

ÆGIALITIS MELODA (Ord)

Only one example of this species has been noted by us at this lake. On September 23, 1913, one was observed on Long Point, feeding at the water's edge. It was quite tame and permitted near approach. It remained four days, on each of which it was closely observed. It was last seen on the evening of the 26th, and probably left that night.

54. BOB-WHITE

COLINUS VIRGINIANUS (Linnæus)

Formerly the Quail was an abundant permanent resident about Lake Maxinkuckee. The environment was favorable; the many copsy tangles about the lake afforded good protection at all times and the weedy fields supplied abundant food. Even as late as 1899 Quail were fairly numerous. During the late summer and early fall several fine flocks were seen, one good-sized covey making Long Point its feeding ground. In the fall very good shooting was had and many good bags were made. In 1900, they were somewhat less abundant but a number of good flocks were seen. They did not last long, however. Before the open season began (Oct. 10) more than a score of quail had been killed in the vicinity of the lake by local lawbreakers, among whom were several more or less prominent residents of Culver, who ought to have been prosecuted to the full extent of the law.

The next year, Quail were much less common. A few were seen or heard throughout the season. In 1902, they were still more scarce. By 1904, they had become very rare, indeed. In 1906, none was seen or heard; the pot-hunters had succeeded in practically exterminating them. In 1908, they had increased somewhat in numbers. One fine flock of 20 or more was seen August 24. In 1909, a covey of 11 was seen March 1 south of the old Manitou lake bed. In 1913, a good-sized flock of third-grown young was seen at the north end of the Gravelpit on October 5; one was heard near the Outlet on the 8th and 11th, and on the 28th a flock was seen.

This valuable bird appears now to be increasing in numbers in the Maxinkuckee region. With proper protection it will soon become abundant.

Public sentiment in this region needs educating. Every violator of the game law should be prosecuted whether he be a transient visitor or local business man or town official.

55. RUFFED GROUSE; PHEASANT

BONASA UMBELLUS (Linnæus)

This is now a rare bird about Maxinkuckee.

Our definite records are as follows:

1899.—October 12, two seen on Long Point. November 7, one shot; 15th and 27th, one seen. December 2, three seen; 20th and 22d, two got.

1900.—November 10, one shot in a swamp thicket in field between Murray's and Farrar's; 15th, one shot; 25th, one seen in tamarack swamp. December 18, two seen, one got; 28th, one got.

1901.—January 1, one hunter got three. April 7, one seen among dead leaves at swamp south of Farrar's; 11th, one heard drumming east of lake. December 30, noted; 31st, Mr. Chadwick saw 10 to 12.

1902.—January 2, Mr. Chadwick saw 2 near Mud Lake; 15th, four seen; 22d, eight to 10 seen.

1904.—October 4, one flushed at tamarack swamp; one seen on Long Point.

1906.—September 17, one seen south of lake. October 7, heard one drumming near tamarack swamp, where one was flushed later; one heard drumming in Culver's woods on east side; 13th, one seen in Hawk's marsh; 14th, one heard drumming on east side; 16th, one flushed in Farrar's woods; 31st, one seen on east side. November 14th, one seen south of lake; 17th, one seen south of lake.

1907.—August 15, Prof. W. S. Blatchley saw one in Walley's woods, dusting. October 5, one seen in Farrar's woods. November 15, one got south of lake.

The Ruffed Grouse, or Pheasant as it is usually called in Indiana, was at one time an abundant bird in this part of the State. The heavy woods, tamarack swamps, and thickets occupying the old kettle holes, furnished a peculiarly favorable environment, and in such situations will it be found today, if at all. When our observations at the lake began in 1899, pheasants were much more

numerous than now. Favorite places, where one or more might be flushed at any time were the swampy thicket at the edge of an old field between Murray's and Farrar's, the old kettle holes in Walley's woods, the heavy woods northeast of the lake, and the tamarack swamp west of the lake.

In the spring of the year, particularly in April, and again in October, they could be heard drumming. One was observed fighting off a black snake which was trying to get its eggs. The snake was shot and the grouse after a moment of astonishment, feigned lameness and hobbled slowly away.

Only the most rigid enforcement of a closed period of several years can save this splendid game bird from extinction. With proper protection it can again become an abundant bird in this region where there yet remain many very favorable situations.

56. PRAIRIE CHICKEN

TYMPANUCHUS AMERICANUS (Reichenbach)

At one time a common species in the prairie west of the lake, but now very rare. On April 6 and 7, 1885, one or more were seen. On February 9, 1901, one flew over Long Point, and two weeks later they were heard calling. One seen southwest of the lake October 12, 1913.

In 1910, the Indiana State Legislature made it unlawful to kill prairie chickens at any time prior to 1915. The wisdom of this law is already evident. In all the prairie parts of the State prairie chickens are reported to have increased greatly; in many places they are very abundant. During our recent visit to Lake Maxinkuckee (September 2 to October 31, 1913), we did not visit the region west of the lake but we were told that prairie chickens are now quite plentiful there.

57. WILD TURKEY

MELEAGRIS GALLOPAVO SILVESTRIS Vieillot

In all probability now wholly extinct in this region, as it is in most parts of the State.

The late Mr. James Green, long a resident on the west shore of the lake, told us that he saw wild turkeys near the lake many years ago. On one occasion he observed a flock on Long Point. When they were frightened they attempted to fly across the lake to the east, but a portion of the flock found the distance too great and, falling into the water, were caught.

58. PASSENGER PIGEON

ECTOPISTES MIGRATORIUS (Linnæus)

The Wild Pigeon, formerly abundant throughout Indiana during the spring and fall migrations, is now probably extinct. None has been seen about Lake Maxinkuckee since 1885. On April 6 of that year the senior author saw 6 or 7 in Farrar's woods at the south end of the lake. These are the last he has seen in the State or elsewhere.

59. MOURNING DOVE

ZENAIDURA MACROURA CAROLINENSIS (Linnæus)

The Dove is quite common in the region of the lake, and apparently remains during mild winters. Although it is often seen in late winter (December 3, 1900, December 13, 1904, January 4 and 6, 1905), it is usually not often noted until in February or March, and it is not until a few warm days have come that one hears its cooing. In the spring they are usually seen in twos or threes. In the spring of 1901 the first was noted February 11, in willows by Long Point. From this time on they were seen quite frequently. The first one was heard cooing March 19, and thereafter they were heard often. Nests were found in various places; two were noted in trees near Green's marsh, one 10 feet up and the other 30 feet up. They nested still more abundantly on the brush piles in Green's marsh, and also occasionally on the ground of the same region. On April 26 a nest with two eggs was found on a brush pile, and April 8 a new empty nest was found in a similar situation, the dove in leaving the nest feigning lameness. May 10 young birds were seen just able to fly. They were heard cooing in July. One was noted October 19, 1904. In autumn they usually flock together more or less. On August 12, 1900, a flock of about 20 was seen on ground northeast of the lake. On September 14, a very large flock was seen just south of Kewanna. On December 3, 1900, another flock of about 20 was seen. They often pass the winter in cornfields. In 1906 they were heard cooing throughout the summer, and seen quite frequently from July 20 to October 30, when they were frequently seen along the railroad track.

In 1907, they were quite common and were noted almost daily from September 11 to October 7, the period of observation. One large flock was seen near Delong October 7. In 1913 they were noted practically every day from September 3 to the last of October.

60. TURKEY VULTURE

CATHARTES AURA SEPTENTRIONALIS Wied

The Turkey Buzzard, as it is invariably called in Indiana, is not common so far north in the State as Maxinkuckee. One was seen by us at Lapaz Junction, 18 miles north of the lake, September 18, 1900. On December 10, 1904, two were seen on Tippecanoe River, four miles south of the lake. A flock of six or seven were seen on Yellow River near Twin Lakes September 23, 1907. On October 15, 1913, seven were observed on the Kankakee River west of Lake Maxinkuckee, and five days later one was seen near Kewanna, 10 miles south of the lake.

In Carroll County, 25 to 40 miles south of Lake Maxinkuckee, the Turkey Buzzard is a common summer resident, breeding in all suitable places, remaining late in the fall but rarely or never all winter.

61. MARSH HAWK

CIRCUS HUDSONIUS (Linnæus)

Not common; but one or more may be seen at almost any time in the summer and fall flying over the marshes about the lake, perhaps most frequently about Lost Lake and Norris Inlet. In the fall, after the gunning season has begun, these hawks are often seen searching the shores for wounded ducks and coots.

The Marsh Hawk doubtless breeds in this locality though we have never found its nest.

Our definite records are as follows:

1899.—Occasionally seen in August and September.

1900.—July 22, one seen on the outlet of Lost Lake near Walley's woods. September 28, one near Walley's. November 7, one at Outlet; 10th, one southwest of lake.

1904.—October 28, one flying over Green's marsh. December 6, one in marsh at north end of Lost Lake eating a Microtus; 10th, one along outlet below Lost Lake, latest date on which observed.

1906.—Occasionally seen during the summer flying low over the marshes. July 19, one near Lapaz Junction. August 3, a fine example that had been winged was caught at Hawk's marsh; 23d, one at Lost Lake.

1907.—September 13, one seen flying from Green's across the lake; 22d, one flying about over Outlet Bay.

1913.—September 3, one near Norris Inlet in morning; 6th, one at 8 a. m. flying east across Outlet Bay; 29th, one flying east over Long Point. October 9, one at Norris Inlet; 12th, one over Green's marsh.

62. SHARP-SHINNED HAWK

ACCIPITER VELOX (Wilson)

Occasionally seen, usually in fall or early winter. Probably a summer resident.

We have only a few records. In 1900, one was seen on September 28, October 25, and December 6. In 1907, one was seen entering Green's woods September 29.

63. COOPER'S HAWK

ACCIPITER COOPERI (Bonaparte)

Apparently rare. Our only record is of one seen November 1, 1902, north of the Academy grounds.

64. RED-TAILED HAWK

BUTEO BOREALIS (Gmelin)

Seen nearly all the year round, but most common in spring. The greatest number were seen in March (24th and 31st,) 1901, when they were abundant, flying and circling about, quite noisy and giving vent almost constantly to their shrill, well-known calls. This is perhaps the most familiar hawk of the region. An old nest was noticed high up in a large tree in Overmeyer's woods, where hawks were often seen in the spring, doubtless preparing to use the nest again. Our definite records are as follows:

1900.—August 26, two or three seen by Mr. Knowlton near old Lake Manitou west of Culver. September 21, one heard in morning near Murray's; 28th, a large black hawk, believed to be this, seen by Mr. Clark; 30th, one seen near railroad between lake and Delong. October 8, one seen. November 25, one seen by Mr. Clark near the tamarack swamp. December 3, a large black hawk, probably this, seen flying over the lake; 6th, one seen.

1901.—January 20, one seen. February 2 and 3, a large whitish hawk, thought to be this, seen flying at a distance; 20th, seen; 24th, heard. March 8, one seen on east side; 11th, one near Norris Inlet; 12th, one near the Gravelpit and another flying high; 17th, seen and heard; 24th, several seen flying and heard calling; 31st, one seen soaring; heard calling near the lake. April 2, seen; 7th, one observed flying southwest of the lake; 9th, one near the tamarack swamp; 15th, one flying over Lost Lake marsh; 18th, one flying over Green's field; 19th, one at Long Point; 26th, one at Lost Lake.

1904.—October 18, one at Lost Lake outlet; 24th, one seen. November 25, one in Walley's woods. December 19, one seen.

1906.—August 31, one seen at Twin Lakes.

1907.—September 22, one seen in afternoon at the tamarack swamp much annoyed by crows; 29th, one seen rise from the road near Walley's.

65. RED-SHOULDERED HAWK

BUTEO LINEATUS (Gmelin)

Not common; our only record is of one noted April 2, 1901.

66. BALD EAGLE

HALIÆETUS LEUCOCEPHALUS (Linnæus)

Occasionally seen, usually in winter. First noted November 12, 1899, when one was seen flying at south end of the lake. October 21, 1900, one noted flying over the lake hunting for crippled coots and ducks. Another was seen January 4, 1901, flying low over the lake; one on Lost Lake January 12, 1902, and another November 14, 1904, seen flying over south end of lake. During February and March, 1905, four bald eagles were frequently seen on Long Point. One had not yet attained the white head and tail. They frequented an old oak near the Barr cottage, where they were often seen. After one of them was killed the others disappeared. One was seen October 5, 1907.

The Bald Eagle is said to breed in Starke County, just west of Maxinkuckee.

67. PIGEON HAWK

FALCO COLUMBARIUS Linnæus

Probably quite rare. Our only record is of one seen by Mr. Clark September 15, 1913, believed to be this species.

68. SPARROW HAWK

FALCO SPARVERIUS Linnæus

Not common, but occasionally seen. We have the following records: September 27 October 25 and December 6, 1900; April 4 and 7, June 11 and December 31, 1901; November 15, 1904; August 31 and November 13, 1906; September 23, 1907; and September 11 and October 14, 1913. Seen oftener in the fields and along the roads some distance back from the lake than in its immediate vicinity. One or more could usually be seen any day from early spring to late fall on the road from Culver to Burr Oak. When the winter is mild it probably remains through the year. The Sparrow Hawk was observed preying on English sparrows about the grist mill at Culver.

69. FISH HAWK

PANDION HALIAËTUS CAROLINENSIS (Gmelin)

The Osprey or Fish Hawk is seen only rarely at this lake. We have noted it as follows: September 21, 1899, one seen on Long Point. A few days later an Osprey, probably this one, was found dead at the south end of the lake. It had been shot. August 30, Mr. A. Radcliffe Dugmore (now Major Dugmore of the British Army) saw one, and October 4, 1900, one was shot. November 4, one seen. April 23, 1901, one seen searching for fish in Lost Lake. December 12, one seen on Long Point. September 25, 1907, one seen flying over Long Point, then hovering over Outlet Bay into which it dropped, evidently for fish, but failed to get any; then it flew high over the water toward Long Point where, after hovering and swooping some, it returned to near the Outlet where it skimmed low over the water, and finally disappeared down Lost Lake. October 11, 1907, one seen flying low over the lake. October 19, 1913, one seen flying east across Outlet Bay.

The Fish Hawk has the same habit as the marsh hawk of searching the shores and marshes for wounded birds.

70. LONG-EARED OWL

ASIO WILSONIANUS (Lesson)

A male in fine plumage taken by Mr. E. E. Slick and the senior writer December 30, 1890, in the large tamarack swamp near Kewanna, a few miles south of Lake Maxinkuckee. We never saw the species in the immediate vicinity of the lake.

71. SHORT-EARED OWL

ASIO FLAMMEUS (Pontoppidan)

Apparently rare. One seen December 27, 1902, two miles southwest of the lake near a tamarack swamp.

72. BARRED OWL

STRIX VARIA Barton

Not common. One shot on Long Point November 29, 1899, another December 10, 1901, and another heard on Long Point October 17 and 18, 1902.

73. SCREECH OWL

OTUS ASIO (Linnæus)

The most common owl about the lake. One or more pairs make their home among the old oaks on Long Point; others are constant

residents in the grove on the hill at the Outlet, and still others appear to stay in Farrar's woods at the south end of the lake. Wherever there are old oaks or other large trees with deserted woodpecker holes or hollow trunks or limbs suitable as nesting places or as hiding places during the day, one or more screech owls are apt to be found. They also sometimes take up their residence in the lofts of cottages or in barns or stables, where they are very useful and effective in destroying the mice which infest such places.

At Long Point and on the Outlet hill could be heard almost any night in spring or autumn the peculiar well-known shivering note of the Screech Owl, also at various other places such as in Green's, Walley's, and Farrar's woods, and at various places on the east side. During the nesting season they often become quite bold and will make dashes at anyone who comes near them in the twilight, snapping the bill and uttering a short tremulous cry.

Our definite records are as follows:

In 1899 it was frequently heard at night in July, August and September. On October 12, one was seen on Long Point. In 1900, one heard on Long Point August 14, October 4, November 3, and another near Lost Lake November 10. In 1901, seen or heard January 22 and 23, April 16, May 28, June 10, 15, 16, and 23. In 1902 one heard on Long Point October 19. In 1904, noted on October 18, 23, and 31, November 2, 4, 6, 9, 11, 15, 18, 19, and 21, and December 21. In 1905, one seen on Long Point January 1, August 6 and September 8, and one in December. In 1907, seen or heard September 20 and October 16. In 1913, one was seen or heard on Long Point, September 23, and October 8, 9 and 14.

74. GREAT HORNED OWL

BUBO VIRGINIANUS (Gmelin)

Not at all common. As a result of the cutting away of the forests and the ignorant shortsighted destruction of these useful birds, the owls are much less common than formerly. We have only a few records for this region. In 1899 one was seen November 29. In 1900, one heard October 26. In 1901, one heard March 20 and another in Farrar's woods April 13, when it came within a few rods of the observer and hooted several times until crows drove it away. It returned, however, in the afternoon and hooted again. In 1904, one was heard October 21. In 1906, on November 7, one seen south of lake. In 1907 one heard November 3.

75. SNOWY OWL

NYCTEA NYCTEA (Linnæus)

This magnificent owl is a rare winter visitor to Lake Maxinkuckee. On November 22, 1905, one was killed on Long Point. It had been seen several times flying about and across the lake. When shot it was attempting to fly from shore with a coot in its talons. Another was shot a few days later, and in February following a third example was seen flying across the south part of the lake.

76. YELLOW-BILLED CUCKOO; RAIN-CROW

COCCYZUS AMERICANUS (Linnæus)

Rather common throughout the summer. Frequently heard on Long Point, especially in muggy weather preceding a rain. Noted on the following dates: July to September 20, 1899; July 17, 18, 19, August 18, 23, 27, and September 19, 1900; May 17, 18, 23, 24, and 27 and June 1, 3 and 9, 1901; June 19 and 20, 1902; September 12 and 13, 1907; August 27, 1908; and September 12, 21, 22, 25, 29 and October 3, 1913. During the last days of September and the first days of October, 1913, one or more yellow-billed cuckoos were seen feeding on Chironomus insects that had just emerged from the water at Long Point.

The black-billed cuckoo was not positively identified but it in all probability occurs here.

77. KINGFISHER

CERYLE ALCYON (Linnæus)

The Kingfisher is one of the most interesting birds about the lake. Although never abundant, its constant activity and its far-reaching note at once command attention, and dull indeed must be the cottager or chance visitor at the lake who has not been attracted by this assertive bird. In the economy of the aquatic life of the lake the Kingfisher is one of the most important factors. These birds have their favorite perches, usually an old dead tree, tall stake, or some limb near or extending over the surface of the water, which they will frequent for days, or even weeks, at a time. From this station they watch the water for any unsuspecting fish that may come too near the surface. They are always on the *qui vive* and may often be seen dropping into the water after some fish that has been observed. Usually the attacks are failures and the bird returns to its post, soon to repeat the performance, perhaps with better success. The bird usually strikes

the water with a splash; sometimes two individuals strike at the same fish and, failing, one chases the other away, uttering its characteristic scolding note. Now and then the bird will change its base and go to some distant tree where it will remain sometime, returning, however, sooner or later to its regular station.

The kingfishers appear quite early in the spring, even before the ice goes off the lake, and they remain until very late in the fall, at least until the lake begins to freeze over. Indeed, in mild winters, or when there is open water at the Outlet, one or more will probably tarry all winter.

In 1899 a pair remained all season about the tip of Long Point, and another pair frequented the lake immediately in front of the Arlington station, using the trees nearby as resting and outlook stations. They were often observed to catch fish. One or more pairs nest each season in the cliff at the Gravelpit.

In 1900, they were noted all summer and fall, even as late as December 30.

In 1901, one was observed almost daily about the Outlet from January first until March 24, after which several were seen throughout the summer.

In 1902, they were present in their usual numbers during the season. In 1904, they were noted almost daily during October and November, the period of observations. In 1906, they were noted almost daily during the season. In 1907, our observations covered September and October when they were noted almost daily; and in 1913, they were present during September and October, a pair using a small sycamore tree near the Chadwick hotel as their observation station.

78. HAIRY WOODPECKER

DRYOBATES VILLOSUS (Linnæus)

Not uncommon; seen every month in the year; probably resident throughout the year. Often seen or heard tapping on some limb or tree trunk, much more rapid than that of the redheaded woodpecker, but less clear and sonorous.

Definite date records are as follows:

1900.—September 30, one noted near Delong; October 12, 13, and 14; November 11, 20, and 22; and December 8, 13, and 30, one or more seen or heard, often quite noisy.

1901.—January 7, 11, 20, and 27; February 1, 7, 10, 13, 15, 16, 20, and 26; seen or heard. April 7, two seen and heard tapping responsively, the tapping exceedingly rapid, not so sonorous as that of the redhead; one seen tapping on a dead aspen stub; 13th

and 18th, one seen near Delong; 19th, several noted in various places about the lake. May 7, one on Long Point; 13th, one at the willows near the wagon bridge across the Outlet, where it was often seen.

1902.—June 20, one seen in Chadwick's yard.

1904.—January 3, one noted on east side. October 18, 23, 24, 25, and 30; November 1, 3, 4, 5, 15, 18, 19, 24, and 25; December 10, 12, 13, 19, 21, and 30, seen or heard or both, often noisy.

1906.—October 6 and 13, and November 12, seen and heard.

1907.—September 29, first seen today, in swamp at side of railroad across from the birch swamp. October 5, 13, and 15, seen in Farrar's woods, Walley's woods, and near Chadwick's.

1913.—September 14, three seen, 2 flirting. One noted on 28th and one October 4.

The Hairy Woodpecker is evidently less common than the downy, especially near the lake. A little distance from the lake, particularly in Walley's woods and along Tippecanoe River near Delong, it was more often seen.

79. DOWNY WOODPECKER

DRYOBATES PUBESCENS MEDIANUS (Swainson)

Much more common than the last; seen or heard calling or pecking all the year round, usually in small trees. In bright weather one finds them more in open places, and when colder they take to more sheltered situations or deeper woods. They are more tolerant of civilized conditions than any other of the woodpeckers and are frequently found in orchards or trees along the streets of towns or cities, industriously pecking away, too busy to notice a quite near approach of people. Probably as common but not generally so evident during the summer as in the fall and winter.

Among our definite records the following may be given:

1899.—Not often noted, but doubtless common.

1900.—July 19, seen at south end of lake. September 18, noted at Lapaz Junction. Noted at various places about the lake September 30, October 3, 12, 13, 14, November 10, 11, 20, 22, 24, 26, and 28, and December 1 and 6.

1901.—Noted January 6, 11, 20, 27 and 28; February 7, 11, 13, 14, 18, 20, 21, and 23; March 12, 17, and 20; April 7, 13, and 18; May 7 and 13; and December 30.

1902.—Noted in Chadwick's yard June 19 and 20, October 20, and November 2.

1904.—One seen in tamarack swamp, October 24.

1906.—Noted October 25, 28 and 31, and November 12 and 13.

1907.—Noted September 11, 13, 22, and 29, and October 14, 17, 21, 28, and 30; and November 1.

1913.—Observed or heard September 4, 11 to 15, 21, 23, and 29, and October 8, 12 and 28.

80. YELLOW-BELLIED SAPSUCKER

SPHYRAPICUS VARIUS (Linnæus)

Apparently only a fall and spring visitant, and not often seen, although its presence is evidenced by transverse rows of holes in the linden and apple trees of the region. The senior author saw 3 or 4 at the lake April 6, 1885. One was noted on a trip to Delong, September 30, 1900, one thought to be this species was heard October 27, and another was noted east of the lake November 2. In the fall of 1913 one was seen near Chadwick's on Long Point September 5, 6, and 28.

81. RED-HEADED WOODPECKER

MELANERPES ERYTHROCEPHALUS (Linnæus)

One of the most common and cheery birds of the region, delighting in the vicinity of cottages and farm dwellings about which are found old trees; frequenting also the borders of woods adjacent to fields or other open ground. It is a permanent resident and may be seen in any month of the year. During the winter of 1900-1901, throughout which the junior writer was at the lake continuously, the Redheads could be seen any day, and a few probably remain every winter. They are, however, not so abundant in winter as in summer, and, when the weather is particularly severe, they seek the more protected places such as are afforded by the timbered strips bordering the streams, and the denser forests.

With the return of warmer days they are more in evidence. In the spring-time they are very active, flying about from tree to tree, uttering their call notes, of which they have several quite distinct from each other. They then do a great deal of hammering on dead limbs and upon the roofs of houses. They evidently select limbs, shingles or other objects with considerable discrimination with regard to the sonorous effect of their tattooing. Certain shingles or boards in the roofs of buildings are used daily for a fortnight or more. One bird discovered that the end of a stove-pipe that projected from one of the cottages gave particularly fine results and it was utilized with unusual frequency, and apparently to the bird's great satisfaction.

Ordinarily one would not suppose that the redheaded woodpeckers bear any direct relation to the aquatic life of lakes and streams, but that they do bear such a relation was determined by us in the fall of 1913. In the last days of September and the early part of October, certain species of Dipterous insects of the genus Chironomus, particularly the species *Chironomus meridionalis*, appeared about the lake in untold millions. They completed their metamorphoses and came out of the water in numbers innumerable, swarming through the air and literally covering the trunks and limbs of the trees and shrubs and the sides of houses, fences, and even the ground. They were particularly abundant on Long Point where we observed them daily. They were most in evidence in the late afternoon and evening and we were surprised to see feeding on them several species of birds which we had not previously known to do so. The following birds were observed feeding actively, chiefly on the flying insects, but sometimes picking them from the trees and bushes: Redheaded Woodpeckers, song sparrows, yellow-billed cuckoos, barn swallows, yellow-rumped warblers, nighthawks, crow blackbirds, and rusty grackles. One of the most active species was the Redheaded Woodpecker, which usually caught the insects on the wing.

This illustrates strikingly the futility of attempting to draw a line between the birds that sustain a relation to aquatic life and those which are supposed to bear no such relation.

82. RED-BELLIED WOODPECKER

CENTURUS CAROLINUS (Linnæus)

Perhaps the rarest woodpecker of this region. In the fall of 1899 two or three were seen in the Tippecanoe River bottoms near Delong, and again on September 30, 1900. It was noted about the lake October 27, November 2, 11, and 14, and December 11, 20 and 31, 1900; on October 25 and 30, November 2, and December 12, 1904; also on October 7 and 31, 1906.

It was rarely observed on the west side of the lake. It was most often seen in the bottom land along the Tippecanoe River near Delong, and on the east side of the lake.

83. YELLOWHAMMER; FLICKER

COLAPTES AURATUS (Linnæus)

Quite common about the lake and in the neighboring fields and woodlands. Probably a permanent resident but rare in winter; our notes record it for every month except January and Febru-

ary. It frequents the open places and is seen often on the ground. One or more pairs could be seen at any time on Long Point or in Farrar's and Walley's woods.

Like the redheaded woodpecker, the the Yellowhammer often beats a tattoo on the shingles or metal roof of a house.

84. WHIPPOORWILL

ANTROSTOMUS VOCIFERUS (Wilson)

The Whippoorwill does not seem to be at all common in the region of the lake, although conditions seem suitable. They are probably more common on the east side where there are stretches of rather dry, but dense, woodland. One was heard on April 25, 1901, and another was seen east of the lake May 3, 1901. Not heard at all during the summer of 1906.

85. NIGHTHAWK

CHORDEILES VIRGINIANUS (Gmelin)

The Nighthawk or Bullbat is a common spring and fall migrant in this part of the state. They appear in considerable numbers in May and early June, when they may be seen evenings and on gloomy days circling about over the lake much like the black tern with which they sometimes associate, skimming and dipping, evidently after the insects on which they feed. In June they all leave for farther north and none is seen again until about the middle of August (August 18, 1900). By the last week in August they are quite abundant, and large numbers may be seen circling about over the lake and meadows. By the first week in October all have departed for the south; our latest record is October 3.

86. CHIMNEY SWIFT

CHÆTURA PELAGICA (Linnæus)

Common throughout the summer. Our definite records are as follows:

1902.—June 19, one seen circling about Long Point, and again noted on the 20th.

1907.—September 30, a number seen at Delong late in the evening, and the next day a like number at the lake.

1913.—September 13, 15, 21, and 29, many noted, and on October 9, 3 or 4 were seen flying over Lost Lake.

In 1882, the senior author found a nest of the Chimney Swift in a hollow hickory snag near Burlington, Indiana.

In 1883 and again in 1884 a pair built their nest on the inner side of the door of the outhouse at the Vandalia station at Camden, Ind. This outhouse was in daily use but the ticket agent gave instructions that the birds should be disturbed as little as possible. The birds entered the building through a hole cut in the gable. When anyone entered the building the bird would usually leave the nest, but when care was used, she sometimes remained on the nest. A brood of young was raised each year.

In late summer and early fall the chimney swifts gather up in great numbers in the evening and roost in some chimney of the neighborhood. One such roost was in the chimney of the Baptist church on North Sixth Street in Terre Haute, at least from 1887 to 1891. A similar roost was in the chimney of the Methodist Church in Flora, Indiana, where the birds were observed in great numbers every fall from 1899 to 1903, and perhaps later.

87. RUBY-THROATED HUMMINGBIRD

ARCHILOCHUS COLUBRIS (Linnæus)

Not common. In 1899 they were noted through August and September. On July 22, 1900, two were noted below Lost Lake, one (a female) at a hickory tree, from which it was evidently securing sugar. The last one seen this year was on September 28, at work on the flowers of Nabalus. In 1901 the first was seen along the road north of Green's marsh May 14, and on June 2 one was seen working at the blossoms of *Scrophularia leporella* which seems to be one of their favorite flowers. In 1906 they were noted occasionally, when it was observed that they were fond of hovering over the flowers of the touch-me-not which grew along the edges of the lake. The last one of 1907 was seen September 13 in Farrar's woods. In 1913, one was seen in the afternoon of September 4, near Norris Inlet.

88. KINGBIRD

TYRANNUS TYRANNUS (Linnæus)

Rather common summer resident. In 1900 they were particularly abundant. On August 24 of that year a very unusual sight was observed on Long Point. The day was threatening and a storm was approaching, when a flock of about 50 Kingbirds appeared and alighted in the trees on the point. They remained together until the storm abated when they scattered. The first arrivals in the spring appear at least as early as May 2, and the birds have been noted as late as September 19.

89. CRESTED FLYCATCHER

MYIARCHUS CRINITUS (Linnæus)

Apparently not common summer resident. Noted July 8, 1899; July 17, 1900; June 19 and 20, 1902; and August 9, 1906. Usually a pair could be seen at the edge of Walley's woods next the railroad. One was seen in the woods on the opposite side of the track, with a cast-off snakeskin which it was evidently intending to use in its nest.

90. PEWEE

SAYORNIS PHŒBE (Latham)

The common Pewee or Phœbe is one of the most domestic and sociable little birds among the summer residents. They are among the first arrivals in the spring and among the last to leave in the fall. Our earliest spring record is March 14 (1902), and the latest date when observed in the fall is October 16 (1906). In 1901, they arrived on March 19.

Several pairs nest in the porches of the cottages and a pair can always be found at the bridge across the Outlet. They begin nesting early in April. The nest at the Outlet bridge contained eggs May 13, and the young birds left the nest June 25.

91. WOOD PEWEE

MYIOCHANES VIRENS (Linnæus)

A fairly common summer resident; a few to be seen in suitable places at any time between May and October.

Noted July 8 and October 2 and 3, 1899; up to September 29, 1900; June 19 and 20, 1902; October 23, 1904; July 25, 1906; September 11, 12, 13, and 29, 1907; and September 4, 5, 6, 9, 10, and 13, 1913. A pair nested in a tree in Chadwick's yard in 1906.

92. ALDER FLYCATCHER

EMPIDONAX TRAILLI ALNORUM Brewster

A rare summer resident. One seen on Long Point August 4, and another in Farrar's woods September 13, 1907. Others noted September 15, 28 and 29, 1913. No specimens were collected and the identification is subject to verification.

93. LEAST FLYCATCHER

EMPIDONAX MINIMUS (W. M. & S. F. Baird)

A rare summer resident. Noted in July and August, 1899, and July 20, 1900.

94. HORNED LARK

OTOCORIS ALPESTRIS (Linnæus)

A not very common spring and fall visitant, or probably resident from fall to spring; apparently not present in summer. Our records are as follows: September 29, 1899, a flock of 12 seen flying over the lake. October 19, 1900, two seen flying southwest over the lake and calling, and on November 9, several seen flying. April 9, 1901, two seen in a road west of lake; February 20 and 21, three seen; March 1 and 7, other seen; November 4, 1906, one seen west of lake.

95. BLUE JAY

CYANOCITTA CRISTATA (Linnæus)

One of the most common and conspicuous birds about the lake; heard or seen nearly every day in the year, and by all means the most noisy bird in the region. They are most noisy in autumn, mingling their various calls with the sound of dropping nuts. They were noted as particularly noisy October 4, 1904. They become very noisy whenever they find an owl. They have many voices and probably mock other birds. A very common call is one that sounds precisely like that of a red-tailed hawk. They have one really musical call, "linnet," "linnet," usually heard in the spring, and low confiding chats during the courting season. Some old nests were found in the woods along the east side of Long Point. In 1906 they were heard or seen almost every day about the lake. August 5, one appeared to be trying to mock a catbird; and on September 17 one was heard trying to warble.

96. COMMON CROW

CORVUS BRACHYRHYNCHOS Brehm

Crows are a rather common permanent resident. In summer they rarely or never come very near the lake shore. Almost every day a few may be seen flying at some distance, in the vicinity of the cultivated farms lying back from the lake, or on fine mornings their far-off cawing may be heard. It is probable that they breed in the forest back of the lake. In the winter the birds are often seen walking about on the ice picking up any bit of dead fish that they may find. Where ice-fishing was carried on the fishermen frequently left dead bait-minnows or sometimes small perch they had caught, on the ice near the holes through which they had fished. The crows soon found these and ate them, picking into the sides and eating the stomach first.

Although in some parts of the State the crow is regarded as a nuisance and is accused of eating sprouting corn and roasting-ears, it does not appear to be so abundant here as to become an economic factor of importance.

97. BOBOLINK

DOLICHONYX ORYZIVORUS (Linnæus)

A rare summer resident. Noted August 5, 1899, when three or four were seen in a meadow west of Culver where they were evidently nesting. Several were seen May 10, 1901, one near the Outlet and four or five near the Arlington station. It probably breeds in some numbers in the meadows west of the lake.

98. COWBIRD

MOLOTHRUS ATER (Boddaert)

Not rare as a summer resident; arrives about the middle of April and remains until the last of October.

Of all the birds that are summer residents at Maxinkuckee the Cowbird is the only species which does not mate. These birds remain in flocks throughout the summer and small flocks may be seen at almost any time. We have noted considerable flocks on April 18, June 7, September 23, and October 15, 24, 25 and 30.

99. REDWINGED BLACKBIRD

AGELAIUS PHŒNICEUS (Linnæus)

One of the most abundant and interesting summer residents. They arrive from the south usually in the first week in March, the males preceding the females by a few days, and remain until the last of November. We have records of first arrival as follows: March 4, 1899; March 9, 1900; March 8, 1901; March 6, 1902; and March 5, 1903. Our latest records for the fall are November 29, 1900; November 21, 1904; and November 6, 1907.

During the time between early March and late November they are much in evidence and may be seen in numbers in all suitable situations. They may usually be found in abundance about Norris Inlet, Green's marsh, the Outlet, Lost Lake, and in the marshy ground along the creek below the little lake. In September and October, 1913, they were unusually abundant and fed to some extent on Chadwick's roasting ears. On September 21, a flock of 2,000 to 3,000 was seen in the evening flying southeast below Walley's. They nest in the cattails, tules, brushes and tall grasses in all these places. The nesting season begins early in May (May 10,

in 1901); young birds have been observed leaving the nest May 24, and fresh eggs have been seen as late as June 24 (1902), when 15 nests were found on an area not exceeding one acre in Green's marsh.

These birds are, of course, more or less musical at all times during their stay, but it is in the fall that they are most noticeable as musicians. Then they gather up in great flocks and on bright sunny days hold their "campmeetings." The first of these in 1900 was held on August 7 and thereafter for two months or more they were quite frequent. These meetings are in the nature of concerts or choruses and are remarkable in many ways. The birds select a prominent tree, usually isolated from others, in the top of which they congregate and remain for hours pouring forth their soul in song. Sometimes they move to another tree or group of trees and continue the chorus.

100. MEADOWLARK

STURNELLA MAGNA (Linnæus)

A fairly common summer resident; sometimes arriving as early as February 6 (1901), and remaining until October or November.

101. ORCHARD ORIOLE

ICTERUS SPURIUS (Linnæus)

Summer resident but not common; noted only in April, May, July and August, in Academy grounds, about Murray's, on Long Point, and in nearby orchards.

Our definite dates are as follows: August 3, 1899; July 19, 1900; April 30, and May 5, 7, 9, 15, 21, 23, and 27, 1901.

102. BALTIMORE ORIOLE

ICTERUS GALBULA (Linnæus)

Summer resident, arriving late in April and remaining until in September. One of the most cheery birds of summer, frequenting the maples and other trees about the cottages. Its brilliant colors and musical note attract attention throughout the summer and its beautiful pendent nests may be seen in the late fall and winter when the leaves have fallen from the trees.

We have definite records as follows: July and August, 1899; July 17 to August 27, 1900; April 29, 1901, first heard, first seen next day, and almost daily from then on until late in the summer. A fine long nest was seen at the north edge of Green's marsh, and the young were frequently heard inside. Another nest near

Chadwick's. Two nests noted in 1902. Seen and heard July 28, and August 15 and 23, 1906.

103. RUSTY BLACKBIRD

EUPHAGUS CAROLINUS (Müller)

This beautiful blackbird is probably a rather common spring and fall migrant, although we have no spring records.

In 1899, a considerable flock was noted October 15. In 1904, 3 or 4 birds were seen October 23. On November 1, 1912, a fine male in perfect plumage, unable to fly, was captured in Chadwick's garden on Long Point. It was brought into the house where it was kept for an hour. In this time it fully recovered except for a slight wing injury. It was then let loose among the trees where it seemed quite able to take care of itself. On the same day a flock of perhaps a hundred blackbirds, believed to be this species, was seen at a distance in Green's marsh. In the fall of 1913, rusty blackbirds were noted on September 27, and October 6, 7 and 9, only a few individuals, however, at any one time. On Oct. 6, a fine male was observed at the water's edge on Long Point feeding on the casts of Chironomus larvæ that had washed up on the shore in great quantities. It was very busy feeding on the casts and upon water bugs and other small insects on the shore, and so intently was it engaged that it allowed us to approach it quite closely. Several others were observed in the trees nearby. The next day several rusty blackbirds were seen picking adult Chironomus insects from the limbs and trunks of the trees on Long Point on which many hundreds of the millions that filled the air had alighted.

104. BRONZED GRACKLE

QUISCALUS QUISCULA ÆNEUS Ridgway

The common Grackle or Crow Blackbird is moderately abundant as a summer resident; most often seen about the marshes. Arrives as early as March 24 and remains at least as late as October 23.

In September and October, 1913, they were particularly abundant. On September 3 and 4 at least 50 were seen feeding in Chadwick's yard, and they continued to frequent the yard in considerable numbers for some weeks. They fed to some extent on acorns that had been freshly crushed by people stepping on them. On September 24, they were very abundant and the majority were more or less bob-tailed and unable to fly well on account of their moulting condition.

Forty and fifty years ago the crow blackbirds would settle down in the cornfields when the corn was in milk and in a few hours do great damage to the crop. So great was the destruction that farmers found it necessary to be on the *qui vive* and drive them from the fields whenever they appeared.

With the clearing of the land, particularly with the reclamation of the wooded swamps in which these birds found their most congenial nesting sites, plus the continuous war of destruction that was waged against them, the crow blackbirds are now so reduced in numbers as to do practically no damage anywhere. And now that the swamps are largely gone they find their best nesting sites in the pine and other coniferous trees planted about the farmers' yards.

105. PURPLE FINCH

CARPODACUS PURPUREUS (Gmelin)

A rather rare spring and fall visitor. One heard November 22, 1900. February 13-24, 1901, a flock seen along the lake shore feeding on rose hips. November 9-11, 1904, a flock of several seen near the railroad station at Culver, seven on a telegraph wire and others in a pine tree. September 22, 1907, one noted west of the lake. September 6, 1913, saw and heard one flying northwest in front of Chadwick hotel, and on 11th, saw and heard six to eight flying over in the morning, going northwest.

A beautiful bird and a delightful songster.

106. ENGLISH SPARROW

PASSER DOMESTICUS HOSTILIS Kleinschmidt

This disreputable bird is all too common, but fortunately it has not yet become established in numbers about the cottages around the lake. In the town of Culver, at the Academy, and about the icehouses, it is abundant. Common about many of the farmhouses of the surrounding country.

Recent study of the European sparrow by a German ornithologist led him to recognize several distinct forms for which he proposed subspecific names. The form occurring in England and the United States, he described as *Passer domesticus hostilis*.

107. CROSSBILL

LOXIA CURVIROSTRA MINOR (Brehm)

A rare spring and fall visitant. Noted on November 22, 1900, October 31 to November 6, 1906, the latter record being of a flock

of six seen on the ground along the waterfront on Long Point, picking among the shells and at intervals uttering call notes. They were quite musical and very tame, allowing one to approach quite near.

108. GOLDFINCH

ASTRAGALINUS TRISTIS (Linnæus)

The Goldfinch, Thistlebird or Wild Canary, is one of the common cheery birds at the lake in the spring and fall and sparingly during the summer. In May they come in some numbers and may be seen in small flocks about the farms back from the lake or along the railroad. The males are then in their richest plumage of yellow and black. They do not nest until late spring or even summer. Then an occasional nest may be found perhaps in a willow near the lake or in some low bush at the edge of a marsh. The Goldfinch, however, is oftenest seen in October, after the males have moulted and taken on the winter plumage, the more modest coat which the females wear at all times. Then these birds may be seen in open places in small flocks about the lake, in orchards, along the railroad, and other suitable places, feeding upon seed of various kinds, such as thistles, milkweed, and the like.

They appear to feed to a considerable extent on the seeds of the milkweed, ragweed and evening primrose, also the dandelion, thistle and sunflower.

Occasionally they remain quite late in the fall; large flocks were seen as late as December 23, 1904.

In 1906, it was noted nearly every day during our stay at the lake from July 23 to October 14. On July 28 it was first heard singing the canary song. On August 19 they were beginning to flock, and their singing was heard throughout the autumn. In 1913, they were noted almost daily during the entire period of our stay at the lake—September 3 to November 1.

109. SNOW BUNTING; SNOWFLAKE

PLECTROPHENAX NIVALIS (Linnæus)

A rare and infrequent winter visitant. A flock of 12 to 15 seen by Mr. S. S. Chadwick on a road five miles southwest of the lake January 12, 1902, and six seen by him at his house on Long Point four days later. A flock of ten seen on Long Point November 1, 1906. The character of Long Point had been changed by the removal of the grove of trees, and millet had been sown. The Snowflakes evidently found the millet and the flock increased daily for several days until it finally numbered 50 to 60 individuals.

While on the ground feeding they scatter over considerable area but when frightened to wing they form a compact flock which circles about some time with musical cries, and then alight a little distance away. In flight they present a very pretty scene, reminding one not a little of a whirling flurry of snow. They were usually quite fearless or unsuspicious, rarely taking flight until approached quite closely. They even paid no attention to gunshots only a short distance away on the lake shore. They remained until the 15th.

On October 22, 1913, three appeared on Long Point. They were seen again the next day. On the 24th only one was seen, but two were noted on the 25th, after which they were not again seen.

110. VESPER SPARROW

POOECETES GRAMINEUS (Gmelin)

A moderately common summer resident, arriving early in April and remaining until late in October; nesting on the ground in the fields; noted at various times from April 11 to October 15. Frequently seen in public highways and easily known by the white outer tail feathers.

Our definite dates are as follows: September 18 and October 15, 1899; March 27, April 11 and 20, and June 6, 7, and 18, 1901; July 3, 1904; October 13, 1906, when 40 to 50 were seen in a weedy field south of the lake; September 22 and 23, 1907, when 15 to 20 were seen west of lake; and September 14, 25, 28, and 30, and October 5, 14, and 19, 1913.

111. SAVANNA SPARROW

PASSERCULUS SANDWICHENSIS SAVANNA (Wilson)

A rare summer resident; noted only once, October 24, 1904, on road between the lake and the tamarack swamp.

112. GRASSHOPPER SPARROW

AMMODRAMUS SAVANNARUM AUSTRALIS Maynard

This little bird, one of the most dainty and attractive of the sparrows, is probably rather common in the meadows about the lake. As its haunts lie outside of the zone of constant observation, and as it is not conspicuous either to sight or hearing at any great distance, records concerning it are rather few. About the only region suitable for it west of the lake is Green's clover field, and whenever this was passed during the summer, the Grass-

hopper Sparrow was usually seen and heard. It was noted August 5 and October 16, 1899. It was heard and seen May 5, 11 and 17, and throughout the summer of 1901. It often stays near the fences or margins of fields. It usually chooses a stone or a stump or other elevation as a perch while singing its shrill grasshopper-like song. It doubtless breeds in the region. The first one heard and seen in 1901 was on May 5, and they were noted whenever the clover field was visited after that.

The Grasshopper Sparrow is probably not one of the aboriginal species of the lake region, but has apparently come in after the clearing up of the forests. It is one of the meadow birds which, originally dwellers of the open plains, extend their range with the removal of the forests, taking the place of the vanished forest birds. Its life is subject to many vicissitudes, as the hay is sometimes cut during its nesting season, the nests destroyed, its whole landscape rendered unfamiliar, and the birds driven away to other fields.

113. LECONTE'S SPARROW

PASSERHERBULUS LECONTEI (Audubon)

Only one example of this pretty and interesting little sparrow has been observed by us at Lake Maxinkuckee. On the morning of September 29, 1913, one was seen on the north side of Long Point in a patch of Bulrush (*Scirpus validus*). When disturbed it would run rapidly along the shore among the rushes. When too closely pressed, and only then, it would fly a short distance, alighting again among the rushes and at once running some distance, so that it was often difficult to locate. It remained on this section of shore all day where it was observed by us several times. It was also seen the next day, but on the next it was not seen.

This species is probably more common than the above record would indicate; its quiet, elusive movements render it difficult to see.

114. LARK SPARROW

CHONDESTES GRAMMACUS (Say)

A rare summer resident; seen occasionally along the railroad or the roadside at the edge of fields. Our notes contain no definite records.

115. WHITE-CROWNED SPARROW

ZONOTRICHIA LEUCOPHRYS (J. R. Forster)

Common spring and fall migrant. First seen in 1899, on October 15; in 1900 on September 28 and 30, and on October 3, 12,

and 14; in 1904, on October 25; and in 1913 on October 10. Most frequent along fence rows and the borders of fields.

Much less common than the white-throated sparrow.

116. WHITE-THROATED SPARROW; PEABODY BIRD

ZONOTRICHIA ALBICOLLIS (Gmelin)

A common spring and fall migrant; arriving in April and May in the spring, and in October in the fall. October 15, 1899; May 1 and 13, 1901; April 21, 1902, large flocks west of lake; October 18, 21, 23, and 25, 1904; October 14, 1906; October 13, 1907; and October 4, 5, 11, 12, 15, 16 to 21, and 24, 1913.

This interesting sparrow, so well known in New England and other Eastern States, is not so well known in Indiana, although quite common as a migrant. Its rather plaintive song, which has been variously interpreted as saying: "*I, I, peabody, peabody, peabody*," or "*Hard Times, Canada, Canada, Canada*," may be heard both in the spring and in the fall; we have heard it at Maxinkuckee most often in the fall, perhaps because our opportunities have been best at that season.

117. TREE SPARROW

SPIZELLA MONTICOLA (Gmelin)

This is one of the interesting and cheery little birds that come down from the north in the fall and spend the winter with us. In October and later, as one wanders along the edges of fields joining woods or thickets, these birds may be seen in considerable numbers, feeding on seeds of various kinds of weeds and flying up into the bushes and smaller trees at one's approach. On cold, quiet, sunny days their song may often be heard. They are often associated with snowbirds or juncos.

In 1900 they were first observed November 11, after which date they were seen regularly until April 4, about which time they left for the north. In 1904 they arrived on October 24, and in 1906 as early as September 16. In 1913, they were first seen October 20. Just before leaving in the spring they perch high in the bushes or smaller trees and break out into a very musical little song, quite different from their winter twittering.

118. CHIPPING SPARROW

SPIZELLA PASSERINA (Bechstein)

A fairly common summer resident; often seen about the farms. In 1899 noted in July and August; in 1900 noted July to Septem-

ber; in 1901 it was first seen April 3, after which it was frequently seen and heard. In 1902, it was noted June 19 and 20.

It is a domestic liitle bird and may be seen about the cottages, and farmhouses, where its nests, constructed largely of horsehairs, may be found in the shrubbery.

119. FIELD SPARROW

SPIZELLA PUSILLA (Wilson)

Tolerably common summer resident. Noted July 8, 1899; September 30, 1900; March 31, and April 6, 7, 8, 9, 11, 13, 14, 15, 17, 18, 22, 24, 26, and on to May 28, 1901; October 24, 1901; August 16, 1906; and September 22, 1907.

120. SLATE-COLORED JUNCO; SNOWBIRD

JUNCO HYEMALIS (Linnæus)

Abundant in flocks during winter, usually on upland, associated with tree sparrows. Our earliest fall records are: October 8, 1899; October 25, 1900; October 21, 1901; October 19, 1902; October 14, 1906; October 12, 1907; and October 4, 1913. Our latest spring record is April 28, 1901.

As the time for their spring departure approaches they become quite musical, and their cheerful spring song may be often heard in the last days of March and in April until they leave.

That the black snowbirds change color in the spring and become song sparrows, and that song sparrows change back to black snowbirds in the fall, is a widespread belief among the non-ornithological in northern and central Indiana.

121. SONG SPARROW

MELOSPIZA MELODIA (Wilson)

Abundant, especially in the jungly thickets and bushy places along the shore where it finds protection. It probably stays in the region the year round (it certainly did in 1900-1901, and in the winter of 1904-05 so long as observed, to January 3), and it sings all winter through. One can probably hear it every month in the year and on every bright day of winter. During the winter it finds a good deal of food scratching in the washed up piles of Chara and other weeds along the water's edge. At the end of September, 1913, one was observed eating Chironomus insects.

Noted almost daily during our stay at the lake in 1906, singing almost constantly every bright day. It is susceptible to weather;

on cloudy cool days they hide, or scold, while the winter wren, hidden in a safe covert, warbles. They occasionally sing the night through in fine weather; August 4 they were heard singing at all hours of the night. They seem to have a variety of songs. July 20, one was noted singing a peculiarly sweet warble, and also on September 15. In October an albino was seen at Lost Lake.

Green's marsh is a place where they can always be found and there their cheerful song many be heard on any day except the stormiest. This flat is also a favorite nesting ground for the Song Sparrow and many nests may be found any spring in the buttonwood bushes and other shrubs. In June, 1902, several nests were found within an area of a few square rods. Other favorite places for this species that may be mentioned are the borders of Lost Lake, the bushes fringing the lake near the icehouses, and the lake shore from above Murray's to Farrar's; and isolated pairs can usually be found in any and all suitable places.

122. SWAMP SPARROW

MELOSPIZA GEORGIANA (Latham)

Probably rare summer resident; a few records for July and September, 1899, the latter part of September, 1900, and March 24, 1901; often found in the low ground about Lost Lake; seen September 15, 1913.

123. FOX SPARROW

PASSERELLA ILIACA (Merrem)

Probably a common spring and fall migrant but not often observed by us. Noted October 1 and 15, 1899; October 2, 1904; and October 13 and 28, 1906. Most often seen in the edges of the woods.

In Carroll County, some 50 miles south, this sparrow is a common spring and fall migrant.

124. TOWHEE; CHEWINK

PIPILO ERYTHROPHTHALMUS (Linnæus)

Rather common from early spring to late autumn, usually in brushy places and along old fences. Noted from July 17 to October 14, 1900; first noted March 3, 1901, and last on October 21, 1902. Seen rather frequently during summer of 1906, the last one noted October 25, south of the lake in a sheltered copse, and as late as October 24, 1907, and October 21, 1913.

125. CARDINAL; REDBIRD

CARDINALIS CARDINALIS (Linnæus)

One of the most interesting permanent residents, though not very common. One or more pairs, however, can usually be seen in Farrar's woods, another down by Walley's, and others in suitable situations on the east side.

Our definite records are as follows:

December 3 and 18, 1900, one among grape vines near Murray's.

February 26, 1901, one heard, and on February 27, one seen at Shady Point; March 3, 4, 7, 17, and 24, seen or heard; April 19, a pair seen northeast of lake, and one heard near Farrar's pond April 30.

January 15, 1902, two seen northwest of lake. November 15, 1904, one seen near mouth of Aubeenaubee Creek. December 10, a pair on Tippecanoe River; 13th, a pair near Farrar's; 14th, a male at swamp south of lake; 20th, seen; and 30th, seen near Tippecanoe River. July 29, 1906, one near Farrar's, and three seen near the lake on November 14.

September 11, 1907, a male at small kettlehole in Walley's woods, two at south end of lake on 13th, three at pond near Farrar's on 22d, and one south of lake October 5. October 6, 1913, two or three seen at fence south of Farrar's, and two seen October 12.

126. ROSE-BREASTED GROSBEAK

ZAMELODIA LUDOVICIANA (Linnæus)

One of the rarest and most beautiful of our birds. Noted September 20, 1899; and in spring of 1900 and September 18, at Lapaz Junction. In all probability a summer resident, though we have not found its nest or even noted it in the summer. In Carroll County, some 50 miles south, we have found it nesting.

127. INDIGO BUNTING

PASSERINA CYANEA (Linnæus)

Summer resident, not rare. One or more pairs seen each summer at the edge of Overmyer's field south of Farrar's and another in Van Schoick's orchard. Probably more common now than formerly. One seen at Lapaz Junction July 19, 1906, singing from a telegraph wire. Heard singing all summer about the lake, from tops of low trees or telegraph wires. In 1900, four or five were seen July 26 south of Farrar's. On September 18 several young able to fly were seen at Lapaz Junction. On September 20 sev-

eral were noted in woods at edge of field south of lake. In 1901 the species was seen May 22 and often thereafter. In 1906 it was noted frequently. It is often seen perched on the telegraph or telephone wires and is one of the sweetest songsters.

It is one of the earliest birds to leave in the fall.

128. DICKCISSEL

SPIZA AMERICANA (Gmelin)

Not very common summer resident; one is likely to find them in tolerable abundance in meadows, but they rarely or never stray from the boundaries of the fields they inhabit into other kinds of country, so that one may live at the lake the year round and be unaware of their presence unless he goes meadowward. In 1899 a few were noted in July; and in 1901 from May 22 on, they were seen and heard whenever favorable localities were visited.

129. SCARLET TANAGER

PIRANGA ERYTHROMELAS Vieillot

Summer resident, but rare; noted in July and on September 20, 1899; July 18, 20, and 22, 1900; and May 30, 1901. Most frequent in open woodlands, such as Green's woods.

130. PURPLE MARTIN

PROGNE SUBIS (Linnæus)

Summer resident; rare in 1899, but it has become more common recently. In 1899 it was noted only at the south end of the lake when a pair apparently were nesting in a hole in an old elm that stood on the lake shore just west of Norris Inlet. They were observed again the next year (July 17 and 18) at the same place, the old birds feeding the young. On June 20, 1902, it was seen on Long Point. In 1906 it was often noted between July 20 and August 8. In 1907 two were recorded August 4. In 1910 several were seen May 30 and again on July 4 about the town of Culver. On September 3, 1913, two or three were noted at Long Point, and four or five seen September 23.

131. CLIFF SWALLOW

PETROCHELIDON LUNIFRONS (Say)

A rather common summer resident. Noted July to October 4, 1899, July 19 to October 21, 1900, and September 9 to 24, 1913.

132. BARN SWALLOW

HIRUNDO ERYTHROGASTRA Boddaert

An abundant summer resident, arriving as early as April 6 and remaining at least until the middle of October. On October 12, 1900, a large flock observed flying southeast across the lake, skimming, dipping, turning and twittering. In 1913, noted almost daily from September 2 to 24.

133. TREE SWALLOW

IRIDOPROCNE BICOLOR (Vieillot)

The Tree Swallow or White-bellied Swallow is a common spring and fall migrant and a few may possibly remain to breed. On April 6 and 7, 1885, they were abundant, flying about over the west edge of the lake, alighting occasionally on the limbs of a dead tree on shore. It was noted almost daily from April 4 to 29, 1901, and June 20, 1902. In the fall, September 30 to October 15, 1899; October 12 to 18, 1900; October 9 to 24, 1906; October 15 and 16, 1907; and September 23 to October 13, 1913. On September 23, 30 to 40 were seen flying over Green's marsh.

Usually in large flocks in the fall. On October 12, 1906, an immense flock observed on southeast side of lake circling about high in air. The next day many were seen perched on dead trees at south end of the lake.

134. BANK SWALLOW

RIPARIA RIPARIA (Linnæus)

An abundant summer resident, nesting in holes in banks and cliffs, especially at the Gravelpit.

July and August, 1899, abundant; many often seen sitting on telegraph wires, as does also the cliff swallow. Noted July 8, and October 1, 2, 4, 7, 10, 11, 12 and 16.

Noted September 30, and October 11, 1900; May 9, 10, and 14, 1901. June 19 and 20, 1902; July 7, 12, and 20, 1910; and September 7 and 8, 1913.

135. ROUGH-WINGED SWALLOW

STELGIDOPTERYX SERRIPENNIS (Audubon)

Probably a common summer resident, but not always distinguished from the bank swallow. Our notes contain references to it only in July and August, 1899, and September 3, 1913.

136. CEDAR WAXWING; CHERRY BIRD; CEDARBIRD

BOMBYCILLA CEDRORUM Vieillot

Not usually much in evidence during the summer; occasionally seen during the winter; usually pretty abundant at times in autumn; and often very abundant during the spring, at that season moving in large flocks among the treetops apparently feeding largely upon buds and perhaps to some extent on early insects. In 1901, on May 22, 23, 24, 25, 27, 29, and 31, they were present in large numbers among the trees west of the lake, the flocks apparently consisting of between 200 and 300 birds, the treetops being full of them and the notes—weak and lisping from individual birds—were so continuous from the great number of birds present that the united effect was conspicuous enough to attract even the most inattentive, and was by no means unmusical. It is, indeed, this lisping whisper that usually attracts attention to the birds when they travel about even in small flocks. The greater abundance of these birds in spring and autumn seems to indicate that, though a fair number are to be found the year round at the lake, the greater number are migrants, moving through to the northward in the spring and back to the south again in autumn.

On their southward journey in autumn they are accompanied by their young, which they are frequently observed feeding on various wild fruits. In spite of their continuous large numbers, they do not appear to be the birds which make the greatest raids on the stores of wild autumn fruits such as grapes, Cornus berries, etc., which are to be found on the bushes, vines, and trees about the lake; their movements are rather too rapid. The gleaning is mostly done by the delaying robins and bluebirds, by the passing thrushes and white-throated sparrows, and still more by the remaining tree sparrows.

The following are our autumn records:

1899.—October 18, several seen near Culver cemetery.

1904.—October 23, one noted on the east side; October 30, a flock seen near the village of Maxinkuckee; December 24, a good flock on a tree on Long Point, some seemed to be feeding on wild grapes. On December 31, two flocks were seen down by the Tippecanoe River.

1906.—September 8, one heard and seen at Culver; September 9, seen. September 14, an old one noted by Farrar's feeding her clamoring young on wild grapes; on the same date a dead one was picked up on shore, which was sent to the U. S. National Museum (No. 08746).

On one occasion in early autumn in a woods in Wisconsin the old waxwings were observed feeding the berries of the "pigeon oak" or white berried dogwood, *Cornus femina*, to their well-grown and feathered young which were perched on a bough in a row.

137. WHITE-RUMPED SHRIKE

LANIUS LUDOVICIANUS EXCUBITORIDES Swainson

Summer resident, possibly a permanent resident, though we have never observed it in this vicinity in winter. It frequents old hedges and fencerows along public highways. We have noted it October 3 and November 11, 1900; March 24, 1901; and August 9, 1906. It was most often observed along the roads northwest of the lake toward Yellow River.

138. RED-EYED VIREO

VIREOSYLVA OLIVACEA (Linnæus)

A not very common summer resident. Noted as common July to September, and on October 4, 1899; July 17 and 19, and September 18, 1900; July 3, 1901; August 29 and Sept. 6, 1906; August 4 and September 12 and 22, 1907; and September 14, 1913. Probably more common than these few records would indicate.

139. WARBLING VIREO

VIREOSYLVA GILVA (Vieillot)

Common summer resident; its sweet liquid warble heard nearly every day of summer from the leafy tree-tops. Noted on August 4, 1899. In 1900 it was common on various dates in July. In 1901 it was first heard April 27 on Long Point and on almost every day thereafter.

June 19 and 20, 1902, two or three pairs seen on Long Point warbling merrily. On July 1 a pair was seen attacking a robin that was sitting on her nest in a tree just in front of the Chadwick hotel. The robin flew from the nest and out after them, with feathers ruffled and evidently very angry. She drove them into another tree some 20 feet away, then returned to her tree, when one of the vireos followed and renewed the attack only to be driven away again. The vireos would always retreat when the robin got after them. They would attack the robin only when she was quiet or when flying away from the vireos. Why they attacked the robin was not evident; perhaps their own nest was near by.

In 1906 this species was noted at various times between July

21 and September 9; in 1907 it was seen September 13 and 22, and in 1913, one or more were noted almost daily September 3 to 14, in the oaks and hickories about the Chadwick hotel warbling sweetly, often quite early in the morning before people were astir.

140. YELLOW-THROATED VIREO

LANIVIREO FLAVIFRONS (Vieillot)

A rare spring and fall migrant. Several seen in Farrar's woods September 13, 1907.

141. BLACK AND WHITE WARBLER

MNIOTILTA VARIA (Linnæus)

Spring and fall migrant, or probably a rare summer resident; apparently not common. Noted in July, 1899, in Overmyer's woods at south end of lake, where it was again observed September 17, 1906. One seen September 11, 1907, at a small kettle-hole in Walley's woods. One seen September 15, and another October 1, 1913, on Long Point.

142. NASHVILLE WARBLER

VERMIVORA RUBRICAPILLA (Wilson)

Probably a common spring and fall migrant. Noted October 10, 1900, when one was found dead at water's edge on east side of lake; September 29, 1907, one or more near the birch swamp; and October 1, 3, and 7, 1913, several busily feeding in the cotton-woods on Long Point.

143. TENNESSEE WARBLER

VERMIVORA PEREGRINA (Wilson)

Spring and fall migrant, probably not rare. Several noted September 11, 1907, at a small kettlehole in Walley's woods, and others two days later at south end of lake; noted also September 29, 1907, opposite the birch swamp.

144. YELLOW WARBLER

DENDROICA ÆSTIVA (Gmelin)

Our most abundant summer resident warbler. Daily observable throughout the summer, singing in numbers especially in the mornings before sunrise and nesting quite commonly in the low bushes which fringe the lake and the borders of marshes and kettleholes. Definite records are as follows: August 1, 1900;

April 26 to 30, May 1 and 15, and June 2 and 20, 1901; June 19, 20, and 24, 1902; July 3, 1904; July 28 and August 1 and 8, 1906. Nests with eggs found May 15 and June 24; with young June 2 and 20. One nest with three eggs June 24, 1902, 2½ feet from ground in a buttonbush in Green's marsh.

145. BLACK-THROATED BLUE WARBLER

DENDROICA CÆRULESCENS (Gmelin)

Spring and fall migrant, but apparently rare. One seen September 16, several October 9, 1906, in Overmyer's woods; a fine male September 11, 1907, at a small kettlehole in Walley's woods, and another October 4, 1907, on Long Point.

146. MYRTLE WARBLER

DENDROICA CORONATA (Linnæus)

The Myrtle or Yellow-rumped Warbler is the most abundant warbler found in this region. It is quite common during the migrations, arriving early in the spring but soon passing on north. Returning early in the fall it remains quite late, even into winter. Our fall records are as follows: September 28 and October 4 and 16, 1899; September 18, 28, 29, and 30, and October 17, 18 and 24, 1900; October 21 and 23, 1902; October 18, 23 and 25, 1904; October 7, 9, 10, 11, 13, 17, 23, 25, and 30, 1906; October 4, 5, 7, 10, 11, 12, 13, 14, 15, and 16, 1907; and September 14 to October 21, 1913. On most of these dates it was abundant. On October 10, 1906, just after a severe snowstorm, many of these warblers came about the cottages eating flies from the windows and porches, and were quite tame.

They may usually be seen in the fall in considerable numbers, trooping through the bushes and low trees, especially those that skirt the lake.

On October 5, 1913, these warblers were seen feeding greedily upon Chironomus insects that had just completed their metamorphosis and emerged from the water. The warblers would pick them from the limbs and trunks of the trees.

147. MAGNOLIA WARBLER

DENDROICA MAGNOLIA (Wilson)

Spring and fall migrant, not often seen. Noted by us only on September 17 and October 3, 5 and 9, 1906, and September 28, 29 and 30 and October 1 and 20, 1913. On these last dates they were frequent in the cottonwoods on Long Point.

148. BAY-BREASTED WARBLER

DENDROICA CASTANEA (Wilson)

Probably not rare during the migrations. Our only records are September 30, 1900, when several were seen near Delong, and September 29, 1907, when one or more were noted near the birch grove in Walley's woods.

149. BLACK-POLL WARBLER

DENDROICA STRIATA (J. R. Forster)

Probably a common spring and fall migrant. Our only records, however, are September 25 and October 1, 1913, on each of which dates several were seen feeding among the poplars on Long Point.

150. BLACKBURNIAN WARBLER

DENDROICA FUSCA (Müller)

The only example seen by us at the lake was a fine male in perfect plumage on Long Point, October 1, 1913. As it is a rather common spring and fall migrant in Indiana it is probably not uncommon about the lake during the migrations.

151. BLACK-THROATED GREEN WARBLER

DENDROICA VIRENS (Gmelin)

Probably a common migrant, most abundant in October. In 1900 it was noted October 2, 3, 5, 6, and 12; in 1906, on October 4, 5, 6, and 7; and in 1913, on September 14, 15, 17 to 20, and October 1; usually quite abundant.

152. PALM WARBLER

DENDROICA PALMARUM (Gmelin)

Apparently rare; our only records are October 7, 1899, and September 13, 1913, when several were seen along the fence rows at the northwest edge of Lost Lake.

153. OVEN-BIRD

SEIURUS AUROCAPILLUS (Linnæus)

Not common; one seen in Farrar's woods Septembeer 13, 1907.

154. MARYLAND YELLOW-THROAT

GEOTHLYPIS TRICHAS (Linnæus)

One of the most common summer residents, breeding in the grass at the edges of the marshes. Noted July 8 to October 4,

1899; July 17 to September 18, 1900; April 29 to July, 1901 (entire period of observation); June 19 and 20, 1902; September 17, 1906; September 22 to October 3, 1907; and September 9 to October 7, 1913. Several pairs nesting each year in Green's marsh and in other suitable places about the lake.

155. HOODED WARBLER

WILSONIA CITRINA (Boddaert)

A rare spring and fall migrant. One seen October 12, 1900.

156. REDSTART

SETOPHAGA RUTICILLA (Linnæus)

Summer resident, apparently rare. Our only records are August 28, 1906, when one was observed in Overmyer's woods; and in 1907, September 11, 2 females or young at the small kettlehole in Walley's woods; September 13, a female at south end of lake; and September 29, a female near Walley's birch swamp.

157. PIPIT

ANTHUS RUBESCENS (Tunstall)

The Pipit or Titlark is a somewhat erratic spring and fall migrant. November 2, 1902, several were seen near the tamarack swamp; about a dozen seen October 24, between the lakes and about a hundred on Long Point, October 31, 1907.

158. CATBIRD

DUMATELLA CAROLINENSIS (Linnæus)

This well-known bird is a common summer resident, found in all suitable places about the lake. Nest with eggs seen May 15, and young June 2; young able to fly June 16. The Catbirds arrive at least by April 29 and remain as late as October 11. On June 17, one was observed to stop in midsong and snap a medium-sized dragonfly.

159. BROWN THRASHER

TOXOSTOMA RUFUM (Linnæus)

Summer resident, but not common; a few seen nearly every day in summer when looked for. Noted as rare in July and August, 1899. On July 26, 1900, 8 to 10 were seen south of Farrar's; others seen up to September 20. In 1901 they were quite frequently heard and seen after April 5, the date of arrival, and one nest was found on the east side by Van Schoiack's. Noted June

20, 1902, September 11 and 22, 1907; and September 14 and 20, 1913. Most frequent along old hedgerows and edges of woods.

160. HOUSE WREN

TROGLODYTES AËDON Vieillot

Not very common summer resident; usually seen near buildings or orchards. Noted September 29, 1899; April 9 and 13, and June 7, and often thereafter in 1901; also on September 20, 1913.

161. WINTER WREN

NANNUS HIEMALIS (Vieillot)

Probably a rare resident from October to April. Seen occasionally in gulleys and brushpiles in 1901, from April 5 to 11; also on October 30, 1906, and October 13, 1907.

162. PRAIRIE MARSH WREN

TELMATODYTES PALUSTRIS ILIACUS Ridgway

This shy little wren is one of the most interesting and, in a sense, cheery members of the Maxinkuckee avifauna. It arrives from the south late in May or early in June and remains until the end of October or even for a few days in November if the season be unusually fine. Though never abundant it is not a rare bird and one to several individuals may be heard any day in summer or fall in the marshes about the lake, along the Outlet, and at the Inlet. It was most often noted in the rank growth of Typha, Scirpus, and Calamagrostis along the railroad just west of Green's marsh and along the Outlet and about the head of Lost Lake. We have noted it occasionally in the large marsh at Norris Inlet and at various places along the outlet below Lost Lake. At least one pair was found each season in a small pond just north of the Assembly grounds, another near the Winfield cottage, another in a marsh on Aubeenaubee Creek on the east side, and still another in a marsh on the south shore just east of Farrar's cottage; and on one occasion a single bird was heard in the Scirpus patch in front of the Gravelpit. It may occur in other Scirpus patches about the lake but our notes make no mention of it elsewhere than in the places already enumerated.

One does not easily see this bird, so shy is it and so easily can it conceal itself in the dense growths of tall Typha, Scirpus and Calamagrostis. One is generally first made aware of its presence by a rather harsh, screeping, scolding note from near the tops

of the rushes, perhaps only a few feet away, and then lower and lower among the reeds as the irritable little body seeks deeper cover. But if you remain quiet, inquisitiveness very soon gets the better of the bird's timidity, and you note that it is approaching you, evidenced by the less scolding note which comes nearer and nearer every moment until you soon get a glimpse of the curious little brown object as it flits through some open space. After having come close enough to see what you are, the bird seems fairly reassured, and by short easy stages, goes again deeply into the tules, the while continuing, though with less evidence of concern, its curious screeping note. A little later, from farther away in the marsh, comes a merry little song perhaps from the self-same bird which was scolding you but a minute before, or, possibly, from one which your presence has not yet disturbed. On choice days, you may, by stopping your boat in the Outlet just before reaching Lost Lake, be favored with cheery songs from half a dozen of these attractive little songsters in different parts of the tule-lands about you. The first songs heard will come from the remoter places and will divide your attention with the scolding notes from nearby birds. A little later the scolding ceases and the tinkling songs break out here and there in many places, some quite near, others far away.

Their song may be heard on any suitable day during their stay with us, but we have heard it most often during the latter part of the season. Contrary to the habit of most song birds, but in common with many other wrens, this species does not cease singing with the nest building or the rearing of the brood, but continues it long after the young have left the nest; indeed, more singing may be heard in the fall than at any other time. The wrens are most vocal, if we mistake not, on those calm, still days in August and early September, when the sky is overcast, and not a breath of air is stirring; or else later in September or during October when there is a chill in the morning and evening air, but the middle of the day calm, sunshiny and pleasant. Bright warm days of summer do not greatly inspire the bird to song as do similar days later when the air is cooler. On the other hand, calm overcast days with lowering clouds in late autumn do not provoke the wrens to song as do such days in summer. Our most distinct, and perhaps happiest, memories of the day song of the marsh wrens are of those delicious days in September just after the first frosts have given a shade of brown to the marsh plants, and the wrens have completed their preparations if any be necessary, for their fall migration to the southland. They then seem to be simply waiting

for just the right amount of cold, or whatever it may be that starts them south and, while waiting, make the marsh joyous with their song.

That the marsh wren sings at night is a habit to which we do not remember to have seen any reference. It does so habitually, and at all hours of the night, the song being the same as that sung in the daytime, except that it seems to contain a strain of sadness which renders it even more sweet. So far as we were able to determine, these birds sing at night only when the air is still and the moon or the stars shine brightly. We have heard the night song also at the little pond north of the Assembly grounds, and it can doubtless be heard in any of the marshes which these birds frequent. Our notes make mention of the singing as early as May 6 and as late as October 8.

The nesting habits of this wren are of unusual interest. The nest is a large globular affair with a small opening in one side supported by a number of reeds at a height of one to three feet above the surface of the water. Sometimes the nest is simply lashed to two or more reeds by blades of grass passing around them, the ends being woven into the nest; at other times the reeds pass through the walls of the nest, which usually holds it more securely. The nest is made of long leaves of various species of grasses and of cattails and rushes, the lining being of feathers and other soft material.

The great number of these nests which one may find is always a matter of wonder; there always seem to be many more nests than there are birds. This is due to the curious fact, it is said, that these little birds have the house-building habit so strongly developed that after the one necessary nest has been completed and the female has entered upon her family duties, the male continues to build supernumerary nests. Occasionally some of these may be practically completed, but most of them are left in a more or less unfinished state.

Usually at least two broods are reared in one season, and as a new nest is probably made for each brood, the number of observable nests would usually be greater than the actual pairs of adult birds. Few, if any, of these nests remain intact from one season to the next.

Definite dates of observations of this species at Lake Maxinkuckee are as follows:

In 1899 they were noted quite frequently through July and September and were still present October 4. In 1900 they were heard singing July 17, and thereafter until October 8.

In 1901, they were first heard singing May 6, and after that very often. On June 8, many large globular nests were noted in cattails along the Outlet near Lost Lake.

In 1906, between July 21 and September 16, they were on many occasions heard warbling low along the Outlet on cloudy days and at all hours of quiet, moonlit nights. In 1907 they were heard September 9, 22, 27, and 30, and October 1, 5, and 15. In 1913, they were seen or heard almost daily from September 5 to October 7.

163. BROWN CREEPER

CERTHIA FAMILIARIS AMERICANA Bonaparte

Fall and spring visitant, probably sometimes remaining all winter. Noted November 22, 25, 29 and 30 and December 2, 3 and 28, 1900; January 22 and 26, April 18 and 25, 1901; October 18 and 29, 1904; October 9 and 30 and November 1, 1906; and October 23 and 28, 1907; and October 14, 19, 25, and 27, 1913.

These little birds arrive from the north usually in October and may be seen, most often singly, running up the trunk of some tree searching closely in the cracks of the bark for insect eggs or larvæ on which they feed. After ascending one tree to the branches or sometimes higher, the bird will fly to another, alighting on the trunk near the ground, where it enters upon an inspection of that tree. In this manner it examines many trees in one spot before flying to any distant tree.

164. WHITE-BREASTED NUTHATCH

SITTA CAROLINENSIS Latham

This little bird, often locally known as Pumpkin-seed, is one of the most interesting permanent residents of the Maxinkuckee region. It is never present in great numbers, but several could be seen on any day that we cared to look for them. They prefer trees out in the open but may be found also in the denser woods. Our notes indicate their presence every month in the year.

165. RED-BREASTED NUTHATCH

SITTA CANADENSIS Linnæus

This bird appears to be rare in the region of the lake, it having been noted only on two occasions, one south of the lake in Farrar's woods about October 16, and two near the Assembly grounds November 1, 1906, only a little distance from the lake. Their shrill hanking is quite characteristic. It appears to be present only as

a fall and spring migrant, or possibly as a winter visitor. Those seen were very actively searching for insects.

166. TUFTED TITMOUSE

BÆOLOPHUS BICOLOR (Linnæus)

A permanent resident, seen occasionally and heard frequently. The bird itself is both inconspicuous in color and shy in behavior, but its clear whistle "Peeter, peeter", or "Cheevy, cheevy", is a familiar sound of the woodlands. It sometimes makes a call like that of the chickadee.

In some parts of the State this is called the Sugar-bird, as it comes about maple camps when the sap is running, and is supposed to say "sweeter, sweeter, sweeter."

Noted in 1899, from July to September; in 1901, from the first of January to July when observations ceased; in 1904, on October 18 and 20, November 1 and December 9; in 1907, from September 13 to October 21; and in 1913, from September 14 to October 26. Not often seen in the immediate vicinity of the lake, but more common in the open woods near Walley's and east of the lake.

167. CHICKADEE

PENTHESTES ATRICAPILLUS (Linnæus)

Much more common, and also much more fearless than the last, and seen the year round, but more abundantly in winter. It is usually busy hunting for insects in crevices, and it also eats hempseed in the woods. Besides its call it has a loud clear whistle which can be heard for a long distance, and which is most frequently uttered in spring or late winter, but is uttered occasionally almost any time of year. One heard whistling January 24, 1901, and frequently thereafter. It was still heard whistling March 25.

In 1906 it was seen June 23, Sept. 6, and Nov. 13. On the last date a good-sized flock seen eating larvæ from ragweeds near Lost Lake. In 1907 noted daily from September 11 to October 14; in 1913, from September 14 to October 26.

168. GOLDEN-CROWNED KINGLET

REGULUS SATRAPA Lichtenstein

Fairly common spring and fall migrant, most abundant in October. Noted April 18 and 22, 1901; October 25, 1904; October 3, 4, 5, 9, 11, 13, 28 and 30, 1906; October 5 and 11, 1907; and September 15 and October 11, 18, 19, and 26, 1913.

169. RUBY-CROWNED KINGLET

REGULUS CALENDULA (Linnæus)

A rare spring and fall migrant with the preceding. Noted April 18 and 22, 1901, October 23, 1904, and September 20, 1907.

170. BLUE-GRAY GNATCATCHER

POLIOPTILA CÆRULEA (Linnæus)

Apparently a rare summer resident. Our only record is of one seen in Green's woods September 20, 1907.

171. WOOD THRUSH

HYLOCICHLA MUSTELINUS (Gmelin)

A rare summer resident. Occasionally heard in deep woodlands about the lake. Heard north of the lake April 30, and east of the lake June 5, 1901.

172. OLIVE-BACKED THRUSH

HYLOCICHLA USTULATA SWAINSONI (Tschudi)

A rare spring and fall migrant, doubtless more common than would be indicated by the number seen, so shy and retiring is this bird. Noted October 9 and 24, 1906, and September 13 and 20, in Walley's and Farrar's woods; July 20 and September 13, 1907; and September 25, 1913, when one was found dead under a telephone wire.

173. HERMIT THRUSH

HYLOCICHLA GUTTATA PALLASI (Cabanis)

In the swamp in secluded recesses,
A shy and hidden bird is warbling a song,
Solitary the thrush,
The hermit withdrawn to himself, avoiding the settlements,
Sings by himself a song.

—*Whitman.*

This spring and fall migrant and delightful song-bird of the deeper woods is probably common, but not often seen. Its beautiful liquid notes, however, are often heard. We have noted it October 15, 1899; September 12, 13 and 20, 1907; and September 14 and October 6 and 12, 1913.

174. ROBIN

PLANESTICUS MIGRATORIUS (Linnæus)

The Robin is one of the most common and cheery residents about the lake. It arrives early in the spring and remains late in

the fall; indeed, it is probable that a few individuals remain all winter in favored places, particularly in the bottoms along Tippecanoe River.

A good many breed about the lake, and several nests were noted. The oak trees are favorite nesting sites. In 1902, a nest was seen in an oak at the Chadwick hotel, 25 feet up. By June 19 the brood reared in this nest had gone and the old birds had begun a second nest 25 feet up on the limb of another oak near by. The building of this nest was watched for some time. The robins got most of the building material at the side of the road just west of the hotel, or in the edge of a pool near by. Both birds worked very industriously; the intervals between trips for building material were very short, usually not exceeding one minute. The nest was apparently nearly completed by June 20.

Other nests were observed as follows: One in a willow on south shore of Outlet Bay; one 22 feet up in a red oak near the Miller cottage; one in a maple at roadside near the Moninger cottage; and one in a white oak just south of the Bardsley cottage.

In 1904, and again in 1906, the robins seemed to be more common than in former years. On December 8, many were seen in deep woodland and on January 3, 1905, one was seen in a woodland swamp east of the lake eating berries of the winter holly, *Ilex verticillata*.

In 1907, robins were noted almost daily from September 23 to October 23. In 1909, they returned from the south March 1. One was observed November 18, 1911; and in 1913, one or more were noted almost daily from September 5 to October 28.

175. BLUEBIRD

SIALIA SIALIS (Linnæus)

Perhaps the best known and best loved of all our native birds. A common summer resident about the lake, arriving early in the spring, even before all the snow has disappeared, and remaining late in the fall and early winter; breeding in numbers in all suitable places, but most abundant during the spring and fall migrations. Our definite records are as follows:

In 1899, returned from the south March 4, and seen at various times during the period of observation, July to October. On October 5, several were seen and heard flying over Shady Point early in the morning and again later in the forenoon; they were evidently migrating. Others were heard the next day.

In 1900, a few were noted July 17; several were heard flying south early on the morning of August 16, and several were seen

on the 18th; in September, they were noted on the 18th, 22d, 28th, and 30th; in October, on practically every day, particularly large flocks on the 14th, 25th, and 29th; in November, they were noted on the 2d, 3d, 9th, 11th, and 20th.

In 1901, the first was seen March 3, and they were observed almost daily thereafter up to July 7 when our observations ceased.

In 1902, the first one was seen March 6, and they were noted again on June 19 and 20, October 19, November 1 and 2, and December 31.

In 1903, they were common as early as March 5.

In 1904, they were noted almost daily from October 18 to December 11.

In 1906, they were observed throughout the summer and up to November 12.

In 1907, our note books contain entries from September 7 to October 29.

Our only record for 1909, is February 26, when Mr. Chadwick noted their arrival.

Our only record for 1911, is November 17, when Mr. Chadwick saw four.

In 1913, it was noted almost daily during the period of our stay at the lake, September 3 to October 26.

A pair were seen copulating April 7, 1901. They were observed May 29, building a nest in a hole in a fence post on Long Point. On June 2, one egg had been laid, and on June 6, there were five. The old bird was observed on the nest June 14; on the 18th one egg had hatched; on the 24th, four lusty young were observed and on the 26th they were well developed.

In this region their favorite nesting places are abandoned woodpecker holes in old fence posts and old dead snags, particularly in old orchards.

During the period of clearing the timbered land in Indiana, say from 1850 to 1870, and before the farmers had done much in the way of removing the stumps, every field contained hundreds of stumps one to three feet high, of oak, maple, elm, sycamore, hickory, ash, walnut, tulip, and other hardwood trees. Many of these were hollow, the hole being often only three to six inches in diameter, and these holes were favorite nesting places for bluebirds. The senior author remembers distinctly one large 18-acre field in which stumps were particularly abundant and in which there were many bluebirds' nests every spring. An estimate of five bluebird nests per acre, or 90 for the field, would be a very conservative one.

THE REPTILES AND AMPHIBIANS

The number of species of snakes (10) is not large, but the number of turtles is unusually large. Although the total number of reptiles is only 19, nine of these are turtles, several of the species of which are found in large numbers.

While the snakes are of little importance in the biology of the lake, the same is not true of the turtles. All of the nine species but one inhabit the lake and constitute an important factor in their relations to the fishes and other animals dwelling in it. Their function is largely that of scavengers and the amount of dead animal and vegetable matter which they consume is considerable. Dwelling as they do chiefly in the shallow parts of the lake near the shores, they readily find and quickly devour most of the dead fishes and crustaceans that drift in near the shore. The number of amphibians is large, there being 18 species.

In nomenclature, but not in sequence, we have followed Stejneger and Barbour's Check List of North American Amphibians and Reptiles, 1917. As our list was in type before the "Check List" was available, it was not practicable to change the sequence.

THE SNAKES

Introduction

The total number of species of snakes known from the vicinity of Lake Maxinkuckee is 10. This number is not large; doubtless more thorough field work would increase the number slightly. While the species are not numerous, several of them are fairly abundant in individuals. This is particularly true of the common Garter Snake and the Water Snake. The former of these may be seen in suitable situations on almost any warm day from early spring until late in the fall, while the latter is almost equally frequent from the middle of summer to early fall about the borders of Lost Lake and along the Outlet.

Nearly all, perhaps all, of the species bear some relation to the life of the lake, some of them feeding on fishes when opportunity offers, and all feeding upon frogs. Only one of the species of snakes known from the Lake Maxinkuckee region is poisonous; that is the little Prairie Rattlesnake which, fortunately, is quite rare.

LIST OF SPECIES

1. DEKAY'S SNAKE

STORERIA DEKAYI (Holbrook)

This little snake occurs sparingly throughout the eastern United States and westward to Colorado and Wyoming. At Lake Maxinkuckee it is one of the rarest species, only five examples having been seen by us during the entire period of our observations about the lake. One was obtained October 8, 1900, two were taken in 1906, and two October 17, 1907.

This is a small species, reaching a length of only a foot or less. Color, grayish brown, with a clay-colored dorsal band bordered by dotted lines; a dark patch on each side of the occiput; under parts grayish. Scales in 17 rows; ventral plates 120-138.

2. RIBAND SNAKE

THAMNOPHIS PROXIMUS (Say)

This species is found from Wisconsin to Mexico. At Maxinkuckee it is one of the rarer snakes. The only example in our collection was secured September 21, 1900, near Lost Lake, southwest of Mr. Green's house.

It is a very slender, graceful snake. It is probably not rare in the weedy patches west of Culver, particularly about old drained lake beds where the ground is still wet and where there are occasional pools. In the spring of 1901 four were seen by Mr. Clark, two on April 9 west of Culver, one April 30 at Culver Inlet, and one May 20 in Hawk's marsh.

In habits this species does not differ greatly from other garter snakes. It delights in marshy situations and is not averse to an occasional short stay in the water. Its food consists chiefly of small frogs, toads, and insects, with an occasional small fish.

This snake may be known by the following characters:

Lateral stripe on third and fourth rows of scales; scales in 19 rows, little or not at all spotted; color chocolate brown, with three yellow stripes; light brown below lateral stripes; ventral plates 150 to 160; tail about one-third the total length, which rarely exceeds 36 inches.

3. COMMON GARTER SNAKE

THAMNOPHIS SIRTALIS (Linnæus)

This is the most variable as well as the most widely distributed of all the garter snakes. It and its subspecies are found in nearly

all parts of the United States, and it is by far the most abundant snake about Lake Maxinkuckee; it is probably more numerous than all other species combined.

It may be found in all sorts of situations; in cultivated fields and gardens, about yards and barn lots, in grassy meadows and in open woodland, in marshy ground along streams and about lakes, and particularly along paths and public highways. It perhaps most delights in reedy, boggy places and lake margins. It is the first snake to be abroad in the spring and one of the last to go into hibernation in the fall. The first warm days of spring will rouse them from their winter's sleep and bring them forth to bask in the sun. Then they may be found usually lying at full length on a mass of dead grass along a fence row or in some such situation well exposed so as to get the full effect of the sun's warmest rays. Here they will lie quietly through the middle of the day soaking out the accumulated chill of the long winter. Thus they will pass several days before they begin to move about or to seek food.

In the fall they appear to be active to the last, continuing to eat until they go into their winter quarters. At this season they seem to move about more than usual, perhaps because searching for suitable hibernacula. It is in this season that one so frequently observes their tracks across the dusty highway and when so many are run over and crushed by wagons.

Numerous examples were noted about the lake and many specimens obtained. Our earliest record is April 9 and the latest November 22. The species was noted in all the situations mentioned above.

This and all other species of the garter snakes are viviparous, bringing forth their young alive. A female 3 feet long was killed July 26 and 40 young each 6 to 7 inches long were taken from her body. Dr. J. Schenck, of Mt. Carmel, Ill., reports that 78 young 3 to 7 inches long were taken from a female 35 inches long.

The Garter Snake has quite a varied menu; they are known to feed upon insects, insect larvæ, small rodents, young birds and birds' eggs, toads, frogs, angleworms, small mollusks, tadpoles, salamanders, and small fish. Frogs, toads, fish, shrews and field mice doubtless constitute the major portion of their diet. One found dead on the railroad tracks near the elevator in the late autumn of 1906 was quite fat, as snakes are likely to be at that time of year. The stomach was empty of food, but contained a few ascarid-like parasites.

On the whole, however, this snake is beneficial to the farm and should be protected. The disposition which most people have to

kill every snake on sight is entirely irrational and wholly unjustifiable.

This creature, like many other snakes, is protected by an abominably sickening odor, not noticeable at a distance but as disagreeable a smell as one is apt to encounter. This odor, however, is noticeable only when the snake has been annoyed and has become angered. When angry it sometimes flattens out after the fashion of the blowing adder. There is great variation among the individuals of this species found about the lake, and two or more subspecies should probably be recognized. We, however, have grouped them all under the species.

From all other snakes found about the lake, particularly the riband snake which it most resembles, this species may be readily known by its having the lateral stripe on the second and third instead of on the third and fourth rows of scales. This species is also stouter, the tail being one-fourth the entire length. Color olivaceous, dorsal stripe narrow, obscure; 3 series of small dark spots on each side, about 70 between head and vent; side and belly greenish; lateral stripe rather broad, but not conspicuous; colors generally duller than in other species; ventral plates 130 to 160. Length 2 to 4 feet.

4. BUTLER'S GARTER SNAKE

THAMNOPHIS BUTLERI (Cope)

This is the rarest of the species of garter snakes which occur at the lake. The only example we have seen was found freshly killed just south of the Indiana boathouse July 23, 1900.

5. WATER SNAKE

NATRIX SIPEDON (Linnæus)

The Water Snake is a common and well-known snake throughout the whole eastern United States as far westward as Kansas, and is tolerably abundant throughout its range in wet places, such as streams, ponds and lakes. About Lake Maxinkuckee it is to be found along low bits of shore such as that about Norris Inlet and the various other inlets of the lake, and near the Outlet. One of its favorite haunts is that portion of the Outlet between the two lakes. Next to the common garter snake this Water Snake or "moccasin" is the snake most frequently seen about the lake. We have records of numerous examples seen, the earliest date being May 3 and the latest August 29. It is probably most abundant in June. Definite dates are as follows: In 1899, one seen July 11

and another August 29. In 1900, one seen July 13, 17 and 20, all on the west side; one seen on east side of Lost Lake August 1, one at Fish Commission Station August 7, and one near the Inlet August 16. In 1901, one in Culver Bay May 3; a large one on west side May 6; one near Farrar's May 23; a large one on Long Point June 2; another on Long Point June 16; one at Outlet June 19; one 3 feet 9 inches long on west side June 22; and a small one on Long Point June 24. In 1906 a large one found dead on Long Point August 15, a small one in Green's marsh, one at Outlet and one on Yellow River August 16. During the summer of 1906, after the dam was thrown across the Outlet at the railroad bridge the water in the Outlet below the dam became very low, and water snakes could be found along the edge of the water almost any time a visit was made to that place. Attempts were made to get some of them but they escaped, as they usually do, by diving.

This is the species more often seen in the water than any other. It delights to lie coiled on some old log or root in or at the edge of the stream or on the timbers at the dam or the logs of the "drift." It inhabits rather open woodland ponds in great abundance, and in such places they often collect several together on projecting logs. In such situations it lies in wait, basking in the sun, making short excursions now and then into the water after fish or frog, or dropping quietly into the stream when disturbed by the near approach of anyone. Then it hides under the bank, only its head being out of the water, or else swims swiftly away and out of reach. While swimming it usually keeps its head above water, but when closely pressed or annoyed it will go entirely under and swim along on or near the bottom.

The Water Snake is frequently called "moccasin", or "red-belly" and is by many believed to be deadly poisonous. Its bite is, however, entirely harmless, and it is very different from the venomous "water-moccasin" or cotton-mouth of the south.

Although the Water Snake is non-venomous, it has very little to commend it. It is repulsive in appearance and spiteful in temper. It is more destructive to fishes than any other of our snakes; indeed, it seems to subsist chiefly on fish. It will eat any kind of fish it can catch, though it doubtless prefers the soft-rayed species, such as the minnows, suckers and trout; it surely finds them easier to handle than the spiny-rayed species such as the bass and perch. We have found many different fishes in the stomach of the water snake; among them we may mention suckers of various species, various minnows, bass, rock-bass, sunfish, eel, carp and catfish. One large Water Snake was found that had attempted to swallow

a large catfish but the catfish straightened out and set its pectoral spines, and the snake, being unable to get the fish either up or down, perished, a victim of his own greed.

Besides fish the Water Snake feeds also on frogs, crawfish and young birds.

The water snakes mate early in spring, soon after coming out of their winter quarters, and then sometimes congregate in numbers of four or five together. The species is viviparous. In August, 1899, an old snake was found on the railroad track near the ice-houses. It had been run over by a train and 10 young which it contained were prematurely liberated.

The Water Snake probably comes out and basks on bright days in autumn after it has ceased taking food. One found dead near Farrar's in the autumn of 1906, October 20, was cut open and the stomach found to be empty, except for some ascarid-like parasites. The mesenteries were well loaded with a supply of fat probably for the subsistence of the snake during its hibernation. It contained 30 ova, 15 on each side.

Color, brownish; back and sides each with a series of large square, dark blotches alternating with each other, about 80 in each series; belly with brown blotches; rows of scales 23; ventral plates 130 to 150. Length 2 to 4 feet.

6. FOX SNAKE

ELAPHE VULPINA (Baird & Girard)

This large and beautiful snake ranges from New England westward to Kansas and northward. It does not appear to be common about Lake Maxinkuckee, as our notes record but eight examples, as follows: A fine example on west shore of Lost Lake early in July, 1900, and another large one near same place July 8; one seen near Lost Lake September 3, and a large one gotten on Long Point September 25; one in Walley's woods August 25; another on Long Point September 25; one about 6 feet long August 14, 1906, west of Culver near the beaver dam prairie on the road to Bass Lake; and a large one near the Gravelpit early in June, 1907. Individuals seem most frequent in late summer or early fall.

The Fox Snake, often called the Pine Snake, frequents the dry, open woods and the neighborhood of briar patches and copses. We have never observed it in the water or on the immediate lake shore. It is often called the Pilot Snake and is supposed to have some mysterious connection with the rattlesnake. Though entirely harmless, it is one of the most viciously disposed snakes. When

provoked, as Dr. Hay observes, it shows its irritation by vibrating the tip of its slender tail, which, when striking a crumpled leaf or any other small object, may produce a rattling noise very like that made by a rattlesnake under similar circumstances. The large example caught near Bass Lake August 14, bit Professor Wilson on the hand, causing blood to flow freely but producing no serious effect.

While entirely harmless, its habits are not unlike those of the blacksnake and it doubtless destroys many eggs and young of ground-nesting birds. Besides these, its food consists of mice and other small rodents, the larger insects and their larvæ. It probably feeds to some extent on frogs and toads, but we have no evidence that it ever catches fish.

This is a large, light brown snake, with squarish, chocolate-colored blotches about 60 in number; scales in 25 rows; ventral plates 200 to 210; vertical plate broader than long.

7. BLUE RACER

COLUBER CONSTRICTOR FLAVIVENTRIS (Say)

This common and familiar reptile, also known as the Blacksnake or Black Racer, is found pretty generally distributed throughout the eastern United States and southward. It frequents open woodlands, old fence rows and all places where dead leaves are common. It is the largest of the snakes of this region. It is an active, vigorous snake, moving over the ground with great rapidity. It is not a coward, as are most snakes, but will, on occasion, attack a person when disturbed, coming toward one rapidly and with head raised one or two feet. Cope says "the constricting power of the black snake is not sufficient to cause inconvenience to a man, but might seriously oppress a child. The pressure exercised by a strong individual wound round the arm is sufficient to compress and close the superficial veins, and cause the muscles to ache, but it is easy to unwind the snake with the free hand and arm." The Blacksnake is harmless, and its bite, which it rarely inflicts, only amounts to a serious scratch.

The Blacksnake's food consists chiefly of field mice, white-footed mice, and other noxious varmints. It also feeds upon frogs, toads, birds' eggs and young birds, and probably does more harm than good. The greatest objection to it is its disposition to rob birds' nests of their eggs and young. Ground-nesting birds are particularly apt to suffer from the depredations of the Blacksnake; and those species such as song sparrows, catbird, thrasher,

robin, dove and redwing, which place their nests not far above the ground, and the bluebird, chickadee, and downy woodpecker, which deposit their eggs in holes in trees or snags not many feet up, are often despoiled of their eggs or young by this snake.

We have often seen blacksnakes coiled up on limbs of trees or crawling about among limbs several feet above the ground evidently searching for birds' nests. One of us remembers seeing a bluebird greatly disturbed by a large Blacksnake which was apparently about to climb to the bluebird's nest which was in a hole only 3 or 4 feet up in an old elm snag. The snake was coiled up at the foot of the snag, its head elevated perhaps a foot or 18 inches, and it watched the bird intently, its head moving this way and that, following closely the movements of the bird, which fluttered incessantly about the snake and was probably as completely "charmed" or under the power of the snake as birds ever get. When approached the snake became frightened and crawled away among the bushes; and then the bird flew to a limb near by.

A friend who is a close observer of animals tells us that he once saw a ruffed grouse fighting a Blacksnake which was endeavoring to rob the grouse's nest. He shot the snake, and the grouse, after showing some astonishment, feigned lameness to lead him away from the nest.

Another friend says that he once saw a chipmunk "charmed" by a large Blacksnake. The chipmunk was on a log about 12 feet long and the snake at one side near the middle of the log and with head elevated somewhat more than the height of the top of the log. The chipmunk when first seen was uttering the well-known chirping note so expressive of solicitude and running back and forth on the log, at first the full length of the log, then less and less until it ran but a few inches each way from the snake whose head all the time moved to the right and to the left, following closely the movements of the little rodent. At the same time the snake's tail, elevated and rigid was rapidly vibrating and making a noise not unlike that made by a rattlesnake. Unfortunately the observer shot the snake without waiting to learn if the chipmunk were really in any manner under the control of the reptile.

The Blacksnake is not rare about Lake Maxinkuckee. Our notes record seven or eight individuals seen at different times. The earliest record is the last week in May and the latest October 14. A large example seen east of Lost Lake on the latter date was quite stupid and declined to move. A 4-foot individual seen in Walley's woods was evidently blind, due to shedding its skin which was so loose that it slipped off when the snake was handled. The

eyes were white, and the snake instead of seeing, apparently listened. Another was seen in Walley's woods September 21, 1900. On August 13, 1906, a very large one was seen half-concealed in the briars near the ice-houses. When approached it made its tail rattle among the dry leaves precisely like a rattlesnake. On August 14, 1906, a large one was caught near Bass Lake. Another, 5 to 6 feet long was seen in Walley's cornfield September 20, 1907. It was coiled loosely at the base of a cornstalk and seemed disinclined to move, though it stuck out its tongue repeatedly.

This snake is usually lustrous blue-black or pitch-black above and greenish below; chin and throat white. Young olive, with rhomboid black blotches. Body very slender; eye large, scales in 17 or 19 rows; ventral plates 170 to 190. Length 4 to 5 feet.

8. HOUSE SNAKE

LAMPROPELTIS TRIANGULUM (Lacépède)

This is the Common House Snake or Milk Snake so abundant in most of the upper Mississippi Valley States. It does not appear to be very common, however, about Maxinkuckee. The only example seen by us was obtained July 28, 1899, at our station near the Arlington Hotel. It is one of the mildest and most useful of snakes and feeds largely upon the various species of small noxious mammals. Its habits, however, are not entirely beneficial, as it will, on occasion, not refuse to eat such hens' eggs and birds' eggs as it may find.

We have never seen it swimming in the water and do not know whether it ever feeds on fishes or other aquatic animals.

Color, grayish, with three series of brown, rounded blotches bordered with black, about 50 in the dorsal row; an arrow-shaped occipital spot; belly yellowish-white, with square black blotches; dorsal scales in 21 rows. In the young the dorsal blotches are bright chestnut red inside of the black margins, and the spaces between are sometimes white or clear ash.

9. HOG-NOSED SNAKE

HETERODON CONTORTRIX (Linnæus)

This interesting reptile, also known as Spreading Adder and Blowing Viper, is found throughout the eastern United States. It is a common and well known species in most parts of Indiana.

It frequents dry situations such as cultivated fields, old fence-rows, open pastures and roadsides; also dry hillsides and the banks of streams. At times it may be seen along water-courses and the

shores of ponds and lakes. We have rarely observed it in meadows or on wet or marshy ground; nor have we noted it often about human habitations.

Although not often seen in the immediate vicinity of this lake, it is probably not uncommon in suitable situations, especially in dry sandy regions. It appears to be very well known among the inhabitants of the region, and though entirely harmless, is held in great dread by most of them—even its breath is supposed to be fatal. From its method of defending itself by appearing very terrible, a habit which has perhaps given its evil repute, it is one of the most interesting snakes in the region.

One was taken in Walley's woods on a bright day in the spring of 1901. When first approached it assumed a threatening attitude and gave vent to loud hisses; it then broadly flattened out the neck, and the bright colors and color pattern, which had been more or less concealed by the scales, now stood out vividly, the color markings on the back of the neck standing out with especial clearness. When the snake found that none of these tactics availed, it stiffened out and appeared to be dead, and was easily picked up and placed in the collecting can.

During the summer of 1906 a large example of this species was seen on the shore of Lost Lake, but it escaped into a hole in the bank. In the autumn of the same year a young example about 5 inches long was captured near the ice office, and frequent reports of the species having been seen, were heard.

The bite of this snake is entirely harmless—even if it could be induced to bite. From the nature of its food, it is one of our beneficial snakes; it eats very few fish, but subsists on frogs, mice, insects, their larvæ, and grubs. Instead, therefore, of meriting the persecution which it seems almost everywhere, it is well worthy of protection.

From all other snakes of this part of the State, this species may be known by its habit of flattening out both its head and body marvelously. In color, it is brownish or reddish, with about 28 dark dorsal blotches, besides lateral ones and half-rings on the tail; sometimes the color is nearly uniform black. Vertical plate longer than broad, about equal to the occipitals; ventral plates 120 to 150; scales in 23 or 25 rows. Maximum length about 2 feet.

10. PRAIRIE RATTLESNAKE

SISTRURUS CATENATUS (Rafinesque)

This species, known also as the Massasauga, is likely to occur in all prairie regions from Ohio to Minnesota and southward. In

Indiana it is known only from the northern portions of the State. It is the only poisonous snake occurring about Lake Maxinkuckee, all the other species found in that region or elsewhere in northern Indiana being entirely harmless. Formerly the Massasauga was abundant throughout this part of the State, but, with the settling up of the country and the draining of the prairie grass land and the marshes, it has become wholly exterminated in many places and practically so in many others. About Maxinkuckee, however, and elsewhere in Marshall County, it is far from extinct. It is apt to be found in any and all suitable places such as prairie meadows, about the borders of vanishing lakes and in prairie marsh ground anywhere.

In May, 1891, when the spring meeting of the Indiana Academy of Science was being held at Lake Maxinkuckee, several specimens were caught by members in attendance, chiefly in marshy ground about the lake. About 1896 a young man on the eastern side of the lake was bitten on the leg by one. The leg remained swollen for some time and complete recovery was very slow. On August 6, 1899, one was caught on Long Point between the Scovell and Walter Knapp cottages. It was 23 inches long and had five rattles. On August 3, 1900, one was killed 2¼ miles south of Arlington station. It was 18 inches long and had two rattles and a button. Several weeks earlier near the same place a dog was bitten by one without fatal results. On August 26 a small one was killed on the east side of the lake near the T. W. Wilson cottage. On the same day one was killed in a field on the Hawk farm south of Culver. It was about 2 feet long and had nine rattles. Another young individual was killed September 3 on the east side 2½ miles southeast of the Maxwell cottage, and one with nine rattles was killed September 26, 1907, in a meadow on the Newman farm four miles southeast of Culver.

These are all the records we have of the occurrence of the Prairie Rattlesnake in the immediate vicinity of Lake Maxinkuckee. We have heard, however, of numerous examples being killed in marshy meadows northwest, west and south of the lake. In those regions there are numerous and considerable meadows of the wild grass or sedge, *Carex stricta*, which are cut in the early fall by farmers and others for hay or for use in the ice-houses, and other purposes. It is then that this venomous snake is met with most frequently.

Though habitually dwelling in marshy situations it is sometimes seen on higher, open ground. It is rarely seen in open woods or dry thickets.

We know but little about the habits or food of this snake. It apparently does not wander far but remains close about the particular marsh in which it makes its home. They are quiet and not easily disturbed or angered. When observed they will be still or quietly glide away unless interfered with. Then they will usually coil, assume a threatening attitude and rattle more or less. The rattling, however, soon ceases, to be renewed only when again provoked.

The Massasauga is known to feed on frogs, crawfish, meadow mice and shrews. We do not know that it ever feeds on fish, but it is more than probable that it would not disdain to eat mud minnows or any other small fishes it might find in its swampy habitation.

The one fact that this is a venomous snake is sufficient reason for its extermination.

The species is viviparous, the young being brought forth alive. There are usually about six in a brood each 4 to 6 inches in length when born. The birth of the young generally takes place about the first of September.

The Prairie Rattlesnake may be known from others of this region by the large, flat, triangular head on a slender neck, the presence of a deep pit between the eye and the nostril, the long, erectile, perforated poison-fang on each side of the upper jaw, and, usually, the presence of a rattle on the tail.

Color, brown or blackish, with about seven series each of about 34 deep chestnut blotches, blackish exteriorly and edged with yellowish; a yellowish streak from pit to neck; body sometimes all black; scales in 23 or 25 rows; ventral plates 135 to 150. Length $2\frac{1}{2}$ to 3 feet.

THE TURTLES

Introduction

Nine species of turtles are known from Lake Maxinkuckee and vicinity, a number probably greater than has been recorded from any other locality in the State. Five of the nine species are abundant, while each of the remaining four is rare.

The turtles constitute an interesting and important branch of the local fauna. Several of the species are so abundant and easily observed as to attract the attention even of people who are little interested in nature. The great numbers that may be seen on any bright or quiet summer day, basking on timbers or boards in shal-

low water, or on sandy reaches of shore, can not fail of observation even by the least observing.

The turtles are also among the most useful animals of the lake. All the species are scavengers and do much to keep the lake free of the dead fishes and other animals which at times are so numerous that they would prove a menace to the comfort, if not to the health, of the people about the lake, were it not for aid rendered by the turtles in removing them. Several of the species are valuable as food for man, and considerable numbers are utilized at the lake for that purpose.

All these turtles are entirely harmless except, possibly, the snapping turtle. We know of no harm that any of them does. They should all be protected.

LIST OF SPECIES

1. SOFT-SHELLED TURTLE

AMYDA SPINIFERA (LeSueur)

Compared with the other turtles of the lake, the Softshell has a rather northern distribution. It ranges from Canada southward to Kentucky and westward to Minnesota. It is very abundant in the upper Mississippi and its tributaries, great numbers being frequently seen on or about the sandbars which furnish them basking and nesting places. It is rather a river than a pond turtle, and rarely or never ventures into small isolated ponds.

At Lake Maxinkuckee it is very abundant, much more so than would appear to the casual observer, as it is one of the shyest and most wary of turtles, quickly taking alarm and disappearing whenever it is approached. It is found everywhere in the lake. Its pointed, shapely head is often seen sticking up above the surface even over the deeper waters of the lake. Examples of all sizes have been taken from almost every part of the lake shore. It seems to be more common in the region of Norris Inlet, probably because this is the most sequestered part of the lake, where it is less likely to be disturbed than elsewhere.

The Soft-shelled Turtle is the last turtle to make its appearance in the spring, and the first to disappear in the fall. Very small ones, benumbed or dead, may often be seen along shore late in the autumn and early in the spring before the older ones appear. These have probably been unable to take care of themselves. Very small ones have been found in the spring as early as March 18, but no large ones were seen until April 29, and then they were very scarce. It is not until May or June that they appear in abundance.

None has been seen in the winter, and we were uncertain where they spend that part of the year, until in the autumn of 1906 (Sept. 6) an example 5 inches long was found buried up to the eyes in mud at the edge of Lost Lake. It is probable that all of them bury themselves in the mud in the bottom of the lake. As none was seen moving under the ice, it is thought that they spend the winter in a quiescent state. The last one seen swimming about was noted in Lost Lake Sept. 7, 1906.

This turtle is fond of basking during the hotter portions of the year. At this lake it generally prefers sandy or grassy bits of shore and is not often seen on stakes or boards. One of its favorite haunts was the sandy stretch of shore near Farrar's. They also basked in numbers at the edges of small pools in the Inlet marsh. Before the shore was cleared off, they used to bask in great numbers along the south shore of Outlet Bay. On June 11 many of these, with other species, were seen basking at this place and when a rush was made at them from a boat, they scattered in every direction, many of them hiding under a large, dense, floating mass of algæ which was along the shore at that place. The Soft-shells that took refuge under the algæ thrust up their heads now and then to see what was going on. Several were caught. Even when stationary they are hard to catch and hold by hand; the tail is too short and slippery to hold, and it is necessary to grasp them by the sides, but this permits them to claw one's hand severely. They are very pugnacious, and though the gape is not sufficiently large to allow them to get a very deep hold, even a small example is able to give a very severe pinch.

In some places this species basks not only on the sandy shore, but also on any log, board or other object upon which they can crawl. In Wild Cat Creek just below the bridge near Stonebraker's mill east of Burlington, Carroll Co., Indiana, hundreds have been seen on the large boulders with which the bed of the creek was strewn. There they would remain for hours basking in the sunshine, sliding quietly into the water if a passer-by came too near, but soon returning to bask again until evening or until again disturbed.

At Maxinkuckee they begin laying about the middle of June and continue until perhaps near the end of July. A large female killed June 14 contained 33 eggs of various sizes, but none fully developed; another killed on the same date contained several eggs in the large distended oviduct, but none was ready for laying. Still another examined June 17 had eggs ready to deposit. The next day a nest with about 30 eggs in it was found near the ice-houses.

On June 25 one was seen digging a hole in the sandy shore at the southwest side of the lake and the next day another was seen doing the same thing. Each of two examples caught June 27 contained mature eggs. On July 16, 1899, two eggs were found on the bottom in 2 feet of water. On July 18, 1900, at the south end of the lake just east of Murray's, two large soft-shells were seen hurrying into the water from the sandridge pushed up by the ice. Upon examination several nests were found. The sand showed evidence of recent disturbance, and there was no difficulty in finding where the eggs were buried. There were probably 10 or 12 nests in a distance of a few yards along the ridge, though we did not dig into all of them. Some fresh holes into which we dug contained nothing; possibly the turtles had been trying different places and found some unsuitable. Each hole was usually at the edge of an abrupt ascent and was 2 to 4 inches in diameter at the mouth and generally sloped back somewhat. In one or two cases the eggs were uncovered but more often there was some sand over them. The eggs were generally at a depth of 4 to 10 inches and placed either on the bottom or on the sides of the hole which usually widened out somewhat toward the bottom. Five nests examined contained 4, 25, 3, 3, and 1 egg, respectively. The 25 eggs in the second nest evidently belonged to two different sets. In the bottom were 10 eggs that looked old. The yolk in each had settled into the lower half, giving it a pink tinge, while the upper half was opaque white. Above these, and partially separated from them by sand, were 15 other eggs that were uniform pink throughout and had evidently been deposited later. In and about this and other nests were a good many broken eggs, evidently destroyed by some animal, perhaps by the turtles themselves. The three eggs in the third nest were fresh, but those in the fourth and fifth were old and stale. Thirteen of these eggs and two others found elsewhere were taken to the station and placed in sand-boxes exposed to the sun, but none of them hatched. The eggs were quite uniform in size, most of them measuring 1.09 x 1 inch.

On July 21, a large female was caught on her nest by the side of the railroad north of the ice-houses. Nineteen eggs were found in the nest, and two fully developed eggs were taken from the oviduct. These 21 eggs represented two different sizes, those taken from the turtle and a portion of the others measuring .93 x .93 inch, the others 1.07 x 1.07 inches and all were decidedly more nearly spherical than any of those obtained July 18.

The female Soft-shell Turtle caught July 21 weighed just 7 pounds and gave the following measurements:

Length of carapace, 13 inches.
Width of carapace, 10.5 inches.
Length of head and neck, 9 inches.
Length of fore leg and foot, 4.5 inches.
Length of hind leg and foot, 5.5 inches.
Length of tail, 3.5 inches.

Another example measured 11.75 inches long and weighed 5.5 pounds; another 11 inches, 4 pounds; another female measured, length of carapace 12.5 inches, width 11 inches; and still another was 12.5 by 10.25 inches.

The eggs of the Soft-shell probably hatch in the autumn, and there is probably some range in the time of their hatching just as there is in the time of laying. The period of incubation doubtless varies somewhat with the season, whether such as to warm up the soil considerably or not, and also a good deal with the nature of the soil in which the eggs are laid, a warm sandy soil hatching them out sooner than a colder soil. In the late autumn of 1906, on November 16, a nest of eggs was found in the black mucky soil near the south shore of Outlet Bay, which contained well-formed young Soft-shells, the color-markings (spots on back) being distinct. The egg-yolk was not yet absorbed, but occupied one-half the shell while the turtle occupied the other. It seems probable that the turtles would not have left the nest that year, but would have wintered there. It is possible that this was a belated nest.

As an article of food the Soft-shelled Turtle is the most highly esteemed of any of the species found in Indiana, the soup made from it being delicious. Not many of the cottagers at the lake, however, seem to have acquired a taste for this or any species of turtle, and they are not much sought after.

This turtle is the species most often caught in traps, on set-lines, and by anglers. On August 8, several were caught in water 14 feet deep east of Long Point on a hook baited with grasshoppers. On June 27, six were caught on set-lines baited with meat, two others were obtained the same way August 1, and one on August 17. Set-lines placed in Lost Lake were always quite sure to take several any time from June to September. In 1906, a citizen of Culver who set out turtle traps caught numbers of these.

This species probably devours dead fish or other animals found in the water. Its principal diet, however, as evidenced by a number of stomachs examined, appears to consist of crawfishes.

This turtle has few enemies and would be able to escape almost anything that attempted to capture it. A good many young appear to perish during their first winter. The stomachs of some

examples studied were infested by a few parasitic round worms, but we have no evidence that these cause much injury. Unlike the scute-bearing turtles, this species is never covered with algæ or other organisms, although one example was found in 1906 which had the plastron covered with a growth of Opercularia.

This turtle may be readily distinguished from all other turtles of the lake by the flat body, covered with a smooth leathery skin flexible at the margins. Color, olive-green, with dark spots; head and neck olive-green with light and dark stripes; legs and feet mottled with dark. The male has the tubercles on the front of the carapace smaller than in the female, the body longer, and the tail extending considerably beyond the carapace.

2. SNAPPING TURTLE

CHELYDRA SERPENTINA (Linnæus)

The Snapping Turtle is of very wide distribution, its habitat extending from Nova Scotia to the equator and west to the Rocky Mountains. It is doubtless found in every stream and pond in Indiana.

At Lake Maxinkuckee it is quite common, but not nearly so abundant as the Map, Painted, Musk, or Soft-shelled turtles. Although they may be seen almost anywhere in the lake, they do not often occur in the deeper, clear portions; they prefer shallow water with soft muddy bottom, especially water that is well warmed up by the sun. They are more common, therefore, in Lost Lake than in Lake Maxinkuckee, and in the latter body of water prefer shallow bays with marshy shore, such as the region about Norris Inlet and Outlet Bay. They are fond of streams and occur in numbers in Norris Inlet, also in Aubeenaubee Creek, Culver Inlet and the Outlet. In the Norris Inlet region, Outlet Bay, or Lost Lake, they can frequently be caught on set-lines or in turtle-nets baited with meat. They are not often seen basking about the shores, but usually spend their time floating or swimming with only the head projecting above the surface of the water. Numerous examples of various sizes were captured in many places about the lake. They were captured in various ways, some in hauls of the seine, some on set-lines, and many by hand. A few were seen that had been taken in traps.

The Snapping Turtle, Snapper, Mossback, or Mud Turtle, as it is variously called, is most frequent in and about muddy ponds, streams or bogs. It may often be seen long distances from water, however, when it is traveling from one pond to another, or in search of a suitable place for depositing its eggs. It walks along

with a slow, awkward, halting gait, often stopping, holding its head well up as if listening or looking about. When traveling about on the land, a great amount of mud may sometimes be seen on the back. The back or carapace is always rough and more or less covered with mud, and there is often a heavy growth of filamentous algæ on the back, the alga being generally some species of Chætomorpha.

The Snapper is a vicious brute. When attacked it neither retreats nor withdraws into his shell as most species do, but shows fight at once, snapping viciously at any object held near it. It will even leap forward toward its tormentor. When its jaws have once closed on the enemy it holds on with dog-like persistence. Dr. Hay mentions a curious belief with which the writers have been familiar since boyhood days, viz., that a snapper, when a hold has once been secured, will not let go until it thunders. Another version of this superstition with which we are also familiar is that the turtle will hold on until the sun goes down. They may frequently be carried around for some time by the stick which they have seized.

These turtles are carnivorous and very voracious. Their food consists of frogs, fishes, crawfishes, young waterbirds, and such other small animals as they can capture. Several stomachs examined at the lake all contained opercula and fragments of *Viripara contectoides*, indicating that this mollusk is the principal food of this species of turtle at the lake during certain parts of the year. That they sometimes capture young ducks and goslings, catching them by the feet and pulling them under the water, seems well authenticated.

They evidently bury themselves in mud in swamps, frequently some distance from the lake, and hibernate in winter. A single, rather large individual was seen under the ice (Lost Lake, Dec. 18, 1900). It was close up against the ice, which was chopped away, and the turtle, which was apparently too benumbed to pay any attention to what was going on, was taken out. It was kept alive over night in a coop and the temperature, which was somewhat higher than freezing (35°), kept the turtle in such a benumbed condition that it could hardly move by morning.

These turtles begin coming out of the mud about the middle of March, the first one having been seen March 19. From then they came out one by one, and from that time on they continued to be seen on land until through the nesting season. In the fall they were to be seen about the lake as late as the end of September. It is possible that the young turtles spend their first winter in the

water or near it; they are usually seen about the water's edge and in pools early in the spring. On April 3, one about the size of a dollar was caught in a pool east of the railroad. The first winter appears to be a critical period in their lives; quite a number of small ones were found dead at the water's edge in early spring, between April 3 and April 26.

They begin laying about the middle of June. Several were seen on or about nests between June 14 and 20. The nests consist simply of holes made in the sand, usually not very far from water. One of the favorite nesting places was the railroad embankment between the lakes. The eggs are quite spherical in shape and about an inch in diameter. The shell is calcareous, and, although not brittle, somewhat less flexible than in other species. The number of eggs may vary from 20 to 60, and they hatch in August or September. According to Agassiz, the young will snap before they have left the shell. We have never seen one so small that it would not snap viciously.

This turtle is often used for soups, though only the younger examples are suitable for that purpose. The older individuals have a strong disagreeable odor, and the flesh is tough. According to Dr. Hay, Storer wrote that in Massachusetts many persons saved the oil of this turtle and used it for healing bruises and sprains. "As a therapeutical agent it is worthy to stand alongside of goose, rattlesnake and skunk oil."

This turtle reaches a large size. Examples weighing 40 pounds each have been reported, although one of 12 or 16 pounds is generally regarded as a large Snapper.

The measurements of 3 of the larger examples taken at Maxinkuckee are given in the following table:

	1	2	3
Length of carapace (inches)	13.25	11	7
Width of carapace	14.25	10	6.25
Length of plastron	9.12	8.5	5.25
Width of plastron	5	....	3.06
Length of head and neck	11	....	....
Length of hind leg and foot	9.5	....	....
Length of fore leg and foot	9	....	....
Length of tail	12	....	....
Weight	16 lbs.	13 lbs.	10 lbs.

The Snapper has very few enemies. Very young examples may occasionally fall a prey to voracious fishes, but the larger examples are exempt from the attacks of anything except leeches, which are usually present on them in small numbers. A Snapper kept in captivity in a live box in the lake was badly infested with them.

During its confinement in the box it became much emaciated, and the alga on its back grew to extraordinary thickness and length. An immense bunch of leeches had collected in the hollow between the neck and front legs and would probably soon have caused the death of the turtle.

Shell high in front, low behind, the body heaviest forward; head and neck very large, jaws strongly hooked and very powerful; tail long, strong, and with a crest of horny, compressed tubercles; plastron small, cross-shaped, with 9 plates besides the very narrow bridge; claws 5-4, strong, the web small; color, dusky brown, head with dark spots. Size large.

3. MUSK TURTLE

KINOSTERNON ODORATUM (Latreille)

The Musk Turtle, also called the Stink-pot, ranges from the eastern United States westward to northern Illinois. It is abundant in most parts of its habitat, particularly in the small lakes in the upper Mississippi Valley. At Lake Maxinkuckee it is one of the most abundant species, it being exceeded in numbers only by the Map and, possibly, by the Painted, Turtle. On account of its not having the basking habit well developed it is, however, far less conspicuous than either of those species.

The Musk Turtles seem to spend most of their time walking about on the bottom of the lake, and are particularly fond of muddy places, the Outlet region, Green's marsh, Lost Lake and the Inlet being their favorite haunts. They are also found up Aubeenaubee Creek, a region well suited to them. This turtle is not built well for swimming, as it is quite deep in proportion to its diameters. There is, however, an immense amount of individual variation in this respect. It is a strictly aquatic species, and comes out on dry land, or even in the marshes, quite infrequently. It is not so much in evidence early in the spring as the Map and Painted turtles, and is rarely seen basking. The great majority of the numerous examples we have seen were observed in shallow water in such places as Outlet Bay, either walking slowly about on the bottom or partially concealed in the Chara; very rarely have they been observed swimming freely.

We have observed them during every month in the year except January and February. Our earliest record is March 18 (1901), when one was obtained near the railroad and another was seen on the bottom in Culver Inlet. From that date onward they could be seen any day when the water was smooth and the conditions favorable for observation. Even after the lake freezes over they may

be seen. Our latest record is for December 31 (1904), when one was observed through the ice in Outlet Bay. It is, therefore, active practically throughout the year. On December 20, five were found alive in a mink burrow.

Although this species does not usually bask, it does so occasionally. Among a hundred turtles seen basking, probably there would be one or two Musk Turtles. They are quite disposed, however, to rest quietly in the water with the head just above the surface.

In disposition, this is the most vicious of any of our species except the Soft-shell and the Snapper. It is very sly and apt to take hold of one's finger when least expected. It holds on tenaciously and would be capable of inflicting a painful wound were its size not so diminutive.

As to food, one was seen June 6, 1901, in company with a Painted Turtle, swimming along behind a floating dead fish, and nibbling bits out of it. Also, in the late autumn (Oct. 30, 1904), one was seen nibbling at the body of a grass pike 13 inches long that lay in the bottom at the head of the Outlet. This turtle or others stayed near the fish several days, but did not seem to make much progress in disposing of it, perhaps because the cold season was coming on, when they probably eat little or nothing. On September 2, 3 or 4 were seen feeding on fresh cowdung in the edge of Lost Lake. Professor Newman says they often contain *Viripara contectoides*.

We have not been able to determine definitely the breeding season of this species. Among many examples collected November 1 (1904), several pairs were copulating. On September 13 (1906), a pair were observed copulating, the female lying prone, as if dead. September 20 (1907) a female found crushed in the road contained eggs quite well developed. One was dissected November 27 (1904), which contained eggs the size of marbles. October 4, very small ones were abundant in shallow water near shore, some of them showing the placental attachment. These had probably hatched but recently. Early in June, a good many may be seen walking about on the land, and we supposed they were hunting nesting sites. Some very small ones were caught May 6 and 7, 1901, so they probably either hatch quite late in the year, or grow very slowly. This evidence is so conflicting as to render any positive statements regarding the breeding season hazardous.

The enemies of the Musk Turtle do not appear to be many. On December 20 (1904), one was found at the Inlet turned up on its back and the soft parts almost wholly gone, probably devoured

by a muskrat, the tracks of which were in evidence. Another was found November 27, partly devoured. Apparently the muskrat occasionally catches one of these turtles or finds it torpid during the winter season, and feed on it. At any rate, we found them now and then (though not so frequently as we did the Painted Turtle) lying on the ice, usually belly up, with the flesh chewed out from the sides. The muskrats were not actually caught doing the work, but, as it took us some time to catch them actually catching mussels and cleaning out their shells, and as, on several occasions, muskrat tracks, and no other, were seen coming to the turtles, we are convinced we would have caught them at it if our observations could have been longer continued. Probably the muskrats pick up the turtles and lay them aside much as they do shells they are unable to open, and after the turtles are frozen, devour them.

These turtles are often infested by leeches, which doubtless cause annoyance at least.

Like the Snapper, the Musk Turtle is frequently covered with algæ on the back, the algæ often being quite long and thick. The proportion of turtles covered with algæ varies with the season and conditions; in early summer, before the scutes are shed, all or nearly all the turtles would probably be covered; with the shedding of the epidermal scutes the turtle comes forth clean of algæ, and bright in color.

During the late summer and early autumn of 1906, many small musk turtles were seen surrounded by a white halo which was conspicuous at a distance, very much resembling the general appearance of Saprolegnia on fishes. It was found upon examination that the white growth consisted of a dense growth of a stalked branched protozoan, Opercularia. Later it was found that larger musk turtles harbored considerable masses of the protozoan on the plastron, this being frequently entirely covered, so that the turtles were practically botanical gardens above and zoological gardens below. Neither the alga nor the protozoan appears to do the turtles any injury. The alga above may assist the turtle in concealment; the protozoan below is self-supporting, feeding on minute organisms. The turtles in the muddy waters of Lost Lake are much more heavily overgrown than those of the clearer waters of Lake Maxinkuckee.

The Musk Turtle is a harmless creature and certainly does some good as a scavenger. It should, therefore, be protected.

So far as we are informed, it is never utilized as food by man; its small size and disagreeable odor preclude such a possibility. It

is the smallest species in the lake. In the following table are given the weights and measurements of examples of the species, the first 53 of which were caught by us in the Outlet Bay, November 1, 1904, by means of a small dipnet, and afterward sent to the American Museum of Natural History:

No.	Weight in ounces	Carapace		Plastron		Date
		Length in inches	Width in inches	Length in inches	Width in inches	
1	4.75	4.375	3.625	2.375	1.25	Nov. 1, 1904
2	7.25	4.75	4.50	3.00	1.50	
3	3.50	3.875	3.75	2.375	1.25	
4	5.50	4.625	4.00	2.50	1.375	
5	3.50	4.00	3.625	2.25	1.25	
6	5.00	4.375	4.00	2.625	1.375	
7	5.75	5.00	4.00	2.94	1.50	
8	7.00	4.75	3.375	2.875	1.625	
9	7.00	4.75	4.25	2.875	1.50	
10	7.75	5.375	4.625	3.00	1.50	
11	4.25	4.25	3.75	2.25	1.19	
12	7.00	5.00	4.50	3.00	1.50	
13	4.50	4.312	3.625	2.625	1.44	
14	6.00	4.75	3.875	2.625	1.44	
15	7.00	4.75	4.50	3.25	1.625	
16	5.50	4.625	4.00	2.69	1.44	
17	6.00	4.56	4.25	2.625	1.375	
18	5.50	4.25	4.00	2.69	1.375	
19	4.50	4.25	3.625	2.50	1.312	
20	7.00	4.56	4.375	3.125	1.375	
21	3.75	4	3	2.375	1.125	
22	7.00	4.50	4.625	3.25	1.75	
23	8	5	4.563	2.875	1.563	
24	4.50	4.06	3.802	2.25	1.125	
25	3.75	3.802	3.375	2.50	1.375	
26	2.75	3.6875	3.25	2.125	0.94	
27	7	4.802	4.50	3.312	1.75	
28	3.25	3.75	3.312	2.312	1	
29	4	4	3.063	2.625	1.375	
30	3	3.75	3.25	2.25	1.312	
31	3	3.625	3.44	2.063	1.25	
32	5	4.625	3.94	2.625	1.50	
33	6	4.563	4.25	2.75	1.375	
34	5.75	4.50	4.063	2.802	1.375	
35	7	4.802	4.44	2.802	1.50	
36	5.75	4.69	4.25	2.563	1.312	
37	6	4.875	4.25	2.802	1.50	
38	2.75	3.75	3.312	2.19	1.063	
39	5	4.563	3.802	2.625	1.625	
40	5.75	4.625	4.125	2.75	1.50	
41	3.25	4.375	4.125	2.875	1.625	Nov. 3, 1904
42	6.50	4.875	4.312	2.75	1.50	
43	6.50	4.75	4.25	2.625	1.563	
44	6	4.75	4.50	2.50	1.375	
45	4.25	4.125	3.75	2.50	1.375	
46	3.75	4.063	2.563	2.50	1.125	
47	4.25	4.25	3.802	2.50	1.44	
48	3.25	3.875	3.50	2.25	1.187	
49	2	3.25	3	1.75	1	
50	3	3.50	2.187	2.187	1.187	
51	4	3.94	3.687	2.50	1.44	
52	3.75	3.312	2.50	2.50	1.687	April 29, 1901

No.	Weight in ounces	Carapace		Plastron		Date
		Length in inches	Width in inches	Length in inches	Width in inches	
53	6.375	4 25	2.75	3 375	1 875	
54	5	3.687	2.563	2 94	1.687	
55	7.25	5	4.75	3	1 375	Oct 21, 1907
56	6	4 625	4 25	2 563	1 44	
57	6.50	4.25	4 50	2 94	1.50	
58	3.25	3.75	3.50	2 25	1.187	
59	7	5.125	4 44	2 75	1 625	
60	6 25	4.563	4 375	2 875	1 50	
61	4 25	4.187	3 625	2.375	1 312	
62	2.25	3.625	3.44	2.19	1 19	
63	4	3.94	3 75	2.375	1 25	
64	6.25	4 625	4.125	2.875	1 50	
65	4.25	4 125	3 75	2 375	1 25	
66	2.75	3.75	3.25	2 19	1.063	
67	3.75	3.94	3.625	2 41	1 25	
68	4.50	4	3.25	2 375	1.311	
69	5.25	4.44	4.00	2.615	1.312	
70	3.25	3.625	3.44	2.19	1 19	
71	3	3.625	3.375	2 25	1.125	
72	7	4 94	4 25	3 00	1.563	
73	4.50	3.94	3 44	2.41	1.25	
74	4.75	4.375	4 063	2.625	1.44	
75	7	4.875	4.50	2 875	1 50	
76	4.50	4 063	3 625	2.50	1.25	
77	5 25	4.19	4 00	2 875	1.312	
78	7	4 75	4 44	2 625	1.375	
79	5.75	4.125	3.19	2.50	1 44	
80	5.75	4.75	4 125	2.563	1 44	
81	2.25	3.19	3	1.94	1	
82	4.25	4.125	3.19	2.375	1 19	
83	3	3.625	3.375	2 25	1.125	
84	3	3.50	3.25	2.25	1 125	
85	7.25	5.25	4 312	2 94	1 625	
86	4	4	3 625	2 25	1.19	
87	6	4.50	4.25	2 69	1 375	
88	6.25	4 75	4.25	2 75	1.563	
89	6	4.75	4 25	2.75	1 375	
90	4.25	4	3 625	2.50	1.25	
91	3.25	3.50	3 25	2 125	1 125	
92	6	4 69	4 312	2 625	1 375	
93	6.75	5.063	4 312	3	1 563	
94	3.00	3.563	3.375	2.25	1.125	
95	5.75	4.50	4 00	2.802	1 312	
96	3.00	3.625	3 25	2.25	1.125	
97	4.25	4.44	3 875	2 625	1 50	
98	4.75	4 25	4 19	2 50	1 375	
99	3 00	3 625	3 25	2 125	1 125	
100	4.50	4 19	3.75	2 625	1 312	
101	5	4 375	3 94	2 50	1 25	
102	4 50	4 375	3 875	2 41	1 375	
103	3.75	3 94	3 50	2 375	1 25	
104	7	4 75	4 69	2 875	1 50	
105	6	4 50	4 25	2 75	1 625	
106	7.50	5.25	4 50	2 875	1 50	Oct 22, 1907
107	5.25	4 125	4	2 75	1 375	
108	6 50	4 94	4 125	2 802	1 50	
109	6.25	4 563	4 25	3 063	1 563	
110	4	4 125	3 94	2 50	1 312	
111	2.50	3 563	3 19	2 125	1 063	
112	6.25	4 875	4 69	2 69	1 375	

No.	Weight in ounces	Carapace		Plastron		Date
		Length in inches	Width in inches	Length in inches	Width in inches	
113	5.25	4.375	4.125	2.802	1.312	
114	4.50	4.25	3.94	2.75	1.25	
115	4.50	4.25	3.94	2.50	1.375	
116	6.25	4.75	4.125	2.755	1.50	
117	6.25	4.75	4.375	2.875	1.44	
118	5.25	4.312	4.505	2.69	1.50	
119	3.75	4.063	3.625	2.44	1.312	
120	5.50	4.625	4.125	2.625	1.375	
121	7	5	4.625	2.94	1.563	
122	2.75	3.563	3.312	2.19	1.125	
123	4.25	4.375	3.802	2.50	1.375	
124	2.25	3.25	3.063	1.875	0.94	
125	4.50	4.063	3.875	2.312	1.25	
126	2.75	3.312	3.25	2.19	1.063	
127	3.75	4.063	3.75	2.50	1.19	
128	6.25	4.802	4.25	2.69	1.50	
129	5	4.50	4.125	2.69	1.44	
130	6.25	4.69	4.312	2.94	1.44	
131	3.50	3.94	3.69	2.375	1.312	
132	3.25	3.875	3.375	2.44	1.19	
133	3.50	3.75	3.563	2.25	1.19	
134	8.50	5.125	5.00	3.00	1.625	
135	4.25	4.312	3.875	2.563	1.375	
136	3.25	3.875	3.25	2.312	1.25	
137	5.75	4.563	4.125	2.94	1.563	
138	2.75	3.75	3.312	2.25	1.19	
139	5.25	4.563	4.125	2.563	1.375	
140	5.25	4.44	4	2.625	1.44	
141	4.00	4.063	3.75	2.625	1.25	
142	4	4.25	4.00	2.50	1.312	
143	3.50	3.75	3.625	2.125	1.19	
144	5.25	4.69	4.312	2.69	1.375	
145	3.25	3.69	3.625	2.25	1.19	
146	6.50	4.802	4.625	2.802	1.50	
147	3.50	4.00	3.44	2.375	1.19	
148	4.75	4.125	4.00	2.50	1.312	
149	4.00	4.00	3.94	2.50	1.312	
150	5.25	4.44	4.25	2.75	1.50	
151	3	3.75	3.50	2.375	1.25	
152	6.25	4.94	4.625	2.75	1.44	
153	4	4.063	3.802	2.375	1.312	
154	2.50	3.625	3.25	2.25	1.125	
155	2.75	3.563	3.19	2.19	1.125	
156	2	3.19	3.125	1.94	1.00	
157	3.25	3.802	3.563	2.375	1.25	Oct. 21, 1907
158	3.50	3.94	3.563	2.44	1.375	
159	4.75	4.312	4.063	2.50	1.50	
160	3.00	3.802	3.375	2.25	1.375	
161	5.00	4.312	4.063	2.625	1.44	
162	3.50	3.875	3.375	2.312	1.125	
163	2.75	3.75	3.25	2.25	1.19	
164	3.25	3.802	3.563	2.25	1.19	
165	3.50	3.563	3.375	2.19	1.125	
166	3.75	4	3.563	2.25	1.19	
167	1.75	3.063	2.875	1.94	0.875	
168	.50	2.19	2.25	1.25	0.69	
169	.50	1.94	2.063	1.19	0.563	
170	.50	1.94	2.00	1.063	0.625	
171	.25	1.44	1.50	.802	.50	
Average	4.66	4.19	3.78	2.51	1.32	

The Musk Turtle may be known from the following description:

Carapace rather long and narrow, the outline rising gradually from the front to a point beyond the center, then abruptly descending, the bulk of the body, therefore, thrown backwards; margin of carapace turning downward and inward rather than outward; shell dusky, clouded, sometimes spotted; neck with two yellow stripes, one from above the eye, the other from below it; head very large, with strong jaws; carapace with traces of a keel. Length 6 inches or less.

4. MAP TURTLE

GRAPTEMYS GEOGRAPHICA (LeSueur)

The Map Turtle is found from the Mississippi Valley eastward to New York, but is more common in the western part of the range. It is common everywhere in the lakes and larger streams of Indiana.

At Lake Maxinkuckee it is by far the most abundant turtle and is found in all parts of the lake; the heads may often be seen sticking up above the surface even in the deeper portions of the lake. Like most of the other turtles of the lake, however, they prefer shallow bays. Examples have been taken almost everywhere about the shores of the lake. It occurs in both lakes, in the lagoons between them, in the Inlet and Outlet, and perhaps also in the smaller streams about the lake. It does not travel far from shore, and is not found in the pools and woodland ponds of the region.

The Map Turtle makes its appearance swimming at the surface or basking, early in the spring; the first seen in 1901 was on April 27, and they were seen in gradually increasing numbers from that time on. They are very abundant from May to August or September. They are essentially aquatic in their habits and are never seen away from the water except when laying their eggs. Though most numerous near the shore and in protected bays, they may often be seen far from shore out in the lake, slowly swimming about or quietly resting at the surface. When approached, they sink silently beneath the surface, swim slowly a short distance, again come up and rest with head above the water as before. In our seining operations about the lake small map turtles were taken at nearly every haul. They were particularly abundant in the patches of Scirpus and on sandy bottom covered with a growth of Chara. They were less common among the Potamogetons, Myriophyllum and Ceratophyllum. A few can usually be seen on any log, board or other floating object of sufficient size and stability,

but they most delight in low, sandy, somewhat grassy beaches. A favorite basking place of this kind is on the south side of Outlet Bay near the wagon bridge. Here a score or more could often be seen. They would crawl out upon the shore about 8 or 9 o'clock in the morning, or earlier if the day were bright and warm, and there they would remain for many hours. They usually rest quietly basking in the sun, occasionally moving about a little. From the amount of time they spend basking during the day, it is supposed that they feed principally at night.

The basking ground along the south shore of Outlet Bay was so much used that the grass and weeds were much worn off by the turtles, and a great many shed scutes were to be found there. A dense growth of algæ occurred near shore in which the turtles would hide when frightened. On April 23 a Map Turtle of medium size was seen basking, sitting crosswise on the back of a somewhat larger Painted Turtle.

The time of mating was not positively observed. On October 4, and later in the fall, they appeared frequently in pairs walking about on the bottom of the lake, or a small one following a large one about. On April 27 small ones were also noted following large ones about as if about to mate. As a pair of musk turtles were observed actually mating in the autumn, it is probable that the other turtles, including this species, occasionally do so at that time. They begin laying their eggs at least as early as June 12. They do not go far from the water, but dig their nests in the sandy shores or banks near the lake. They even sometimes attempt to make nests in rather stiff clay, or in rather hard ground. On June 18 one was seen in the road back of the Miller cottage, digging a hole for a nest. The hind feet were used in digging. On June 23 one was seen on her nest between the ties of the railroad south of the ice-houses. After the turtle had left, the place was examined and 11 eggs were found. Occasionally an egg may be dropped in the water or on the shore where there is no nest. The eggs are elliptical-cylindrical, about $1\frac{1}{2} \times \frac{3}{4}$ inch, the shell being quite soft and flexible.

This turtle continues basking later in the fall than any other species. On November 2 and 3 quite a number were seen on the stones along the east side of the lake, and one was seen basking as late as November 22. Late in autumn when the air gets chilly these turtles, when basking on stones or boards, assume a peculiar position. The legs, instead of being drawn up toward the body, are stretched out straight and stiff and the turtle on being approached tumbles rather than scrambles into the water. The

cold of autumn benumbs them quite considerably. On November 30, while walking along the south shore of the lake, several turtles of this species were observed to leave shore and take to the water. They attempted to dive, but were unable to do so; they plunged their heads below the surface, tilting up the posterior part of the body, and finally succeeded in getting all under water except the hind legs, which, projecting above the surface, fanned the air frantically in the most ludicrous fashion. Seven of these turtles were caught; four of them were quite large. They were placed in an open-bottomed live-box near the station where it was thought they would bury themselves in the soft sand for the winter. All, however, were soon frozen.

In the autumn these turtles, along with the Painted, show a tendency to migrate from the larger lake into Lost Lake. They usually go down the Outlet, but in the autumn of 1906 a dam was built across the Outlet at the railroad bridge, and the turtles were seen in considerable numbers climbing over the dam or making the journey over the road by land.

The Map Turtle does not hibernate, but many, if not all of them keep walking about on the bottom of the lake, where they can be seen through the ice whenever it is clear. Throughout the winter of 1900-1901 they could be seen any day when the ice was not covered with snow. In the early winter of that year these turtles appeared to congregate in considerable numbers in the northwest corner of Lost Lake, in shallow water near shore. On Dec. 15, 25 were counted in this place, and only one or two were seen elsewhere. Later on in the season they were found in various other places; a good many were found in the bottom of Outlet Bay. On Christmas day, 1900, in walking out 119 steps from Chadwick's pier, 69 map turtles and one musk turtle were counted. They were also found in some numbers in the Norris Inlet region. These turtles keep moving about more or less all winter, although they are not nearly so active as in the summer; and they probably eat little or nothing. They do not appear to swim any or leave the bottom. They do not appear to take fright easily and would probably be unable to make good time in attempting to escape even if they tried; one can walk above them and study their actions in detail through the clear ice. While walking about the motion of the limbs is quite jerky and irregular. Where they walked over soft bare muddy bottom the tracks left by them could be plainly seen, two parallel rows of dots, the distance between the rows indicating the size of the turtle; by following these, the animal could frequently be tracked down.

The Map Turtle is unable to withstand a freezing temperature, at least in air. During the winter several were caught where the ice men had taken out ice, and were set out on the ice. They began to stiffen almost immediately, and froze solid in a very short time. They were very gradually thawed out by being placed in cold water, but did not revive.

The Map Turtle is probably a scavenger and does much to rid the lake of dead animal matter. It also feeds largely on the smaller mollusks, particularly *Viripara contectoides*. It is never used for food, perhaps on account of its small size as compared with the two species here used for food, the Snapper and Soft-shell. So far as our observations go it has no enemies except, possibly, leeches.

The Map Turtles reach only a moderate size. The largest examples seen by us weighed 4 to 4½ pounds.

The following table gives weights and measurements of 24 individuals examined:

MEASUREMENTS OF MAP TURTLES

No.	Weight	Carapace				Plastron	
		Length (Straight)	Length (Curve)	Width (Straight)	Width (Curve)	Length	Width
1	4 lbs.	10 25	10 75	7 50	9 75	9 12	5.00
2	4 25	10 75	11 00	7 50	9 00	9 25	5.00
3	4	10 40	10 60	7.12	9 33	9.00	4.88
4	3	8.75	9 20	6.37	8.37	8 00	4.50
5	2 oz.	4 20	4 27	3 25	3 80	3 63	2.00
6	2 oz.	4 07	2 25	3 20	3 88	3 50	1 88
7	6 14 oz.	4 75		3 63		3 88	2 88
8	4 2½ oz.	3 94		1 13		3 43	2 43
9	3 32 oz.	3 63		2 94		3.13	2.31
10	2 65 oz.	3 43		2 81		2 43	2.13
11	2 43 oz.	3 25		3.06		3.00	2.25
12	85 oz.	2 19		2.00		1 94	1 43
13	81 oz.	2 13		1.94		1.81	1 38
14	2 lbs.	8 00					
15	3 oz.	3 38		2 87		2 87	1.63
16	2 5 oz.	3 43		2 75		3 00	1.56
17	3 5 oz.	3 81		2 87		3 25	1 67
18	3 25 oz.	3 67		2 75		3 13	1 50
19		2 13		1 87		1 87	1 37
20	.75 oz.	2 125		2 25		1 682	.93
21	.75 oz.	2 125		2 25		1 682	.93
22	1 50 oz.	3		2 93		2 434	1 31
23	4 50 oz.	4 434		3 868		3 50	1 744
24	6 00 oz.	4 744		4 434		3 93	2

The Map Turtle is usually free from growths of algæ or other organisms. The young differ from the older in being decidedly more strongly keeled, the portions of the carapace each side of the

keel being rather straight, so that the shell of the young turtle looks somewhat like a roof. The young are covered with delicate reticulations which give pleasing color patterns, but which disappear more or less completely in the adult. This is one of the most inoffensive of the turtles and can hardly be induced to bite.

Carapace ovate, broadest behind, the margins flaring outward, highest near the middle and not strongly convex; carapace strongly notched behind and usually decidedly keeled. Color dark olive brown, with greenish and yellowish streaks and reticulations, especially distinct on neck, legs and edge of carapace; plastron yellowish.

5. ELEGANT TURTLE

PSEUDEMYS ELEGANS (Wied)

This is the rarest as well as the most beautiful turtle occurring about Lake Maxinkuckee. Its habitat extends from the Carolinas to Mexico and in the Mississippi Valley northward to Indiana and northwestward to the Yellowstone. It was described originally from specimens taken near New Harmony, Indiana. According to Dr. Hay it has been found at Mt. Carmel, Ill., and in the Tippecanoe at Winamac. At the latter place Dr. Hay obtained a specimen about July 1, 1892. There seem to be no other Indiana records until now.

During our several seasons at Lake Maxinkuckee we obtained but one specimen of this turtle. This was secured by Mr. Clark June 13, 1901, at the south end of the lake near the small spring, where, about 200 feet from shore, the water was about 3 feet deep and the bottom covered with Chara. The specimen was a very fine one. The length was about 6 inches. We saw the shell of a second example in a shop in Culver. It had been caught in a trap in Lost Lake, and the carapace was 9.5 inches long and 7 inches across.

We know but little of the habits of this fine turtle. It is probably entirely aquatic.

It may be known from the following description:

Shell broad and depressed; carapace serrated behind, a slight emargination in each scute and deeper ones between them.

Color of carapace olive, with lines and spots of yellow and black, the lines running mostly lengthwise on the vertebral scutes, and transversely on the costals; a yellow band of varying width down the middle of each costal scute, parallel with other lines and bands of black and yellow, some narrow, some wide; on the upper and lower surfaces of marginal scutes are spots consisting of con-

centric circles of yellow and black; between them a yellow band crossing each marginal; plastron yellow, with a black blotch on each scute, these often ocellated with yellow; spots on bridge usually confluent; head with numerous narrow stripes of greenish or yellow; a broad stripe from under eye extending backward on neck, being met at angle of mouth by a stripe from middle of lower jaw; another stripe, often blood red, from posterior corner of eye running back on neck; legs and tail striped with yellow.

Length 10 inches or less.

6. WESTERN PAINTED TURTLE

CHRYSEMYS MARGINATA (Agassiz)

The Western Painted Turtle is found from central New York westward through the Great Lakes and the Mississippi Valley and southward to the Gulf. It is generally common and is abundant throughout Indiana. It is found in practically every stream, pond and lake in the state. While it is not rare in running streams, it is in the small lakes and ponds that it most delights to dwell. Choice situations are small muddy ponds in which are many old logs or chunks on which they may bask.

Next to the Map Turtle this is the most abundant species in Lake Maxinkuckee; and, excepting the Spotted Turtle and the Elegant Turtle, it is the most beautiful.

In the spring they are first noticed about the middle of March in the small pools along the railroad between Green's flat and the Outlet. Here they become very abundant in April, sitting on logs, chunks, or other objects, sunning themselves. They do not appear in numbers in the lake proper until later. By the first of June they can be found anywhere in shallow water about the lake.

During the summer and until December they may be seen basking in the sun. Wherever a log, post, board or other object affords support above the water there they will sit quietly all day long, sliding off into the water only when disturbed. A favorite place was on the boards and timbers in the lake off the ice-houses. From July to October hundreds could be seen at this place. The earliest and latest dates upon which we saw this species basking were March 17 and December 3. They were observed moving about under the ice as late as December 16.

Near the end of Long Point on the north side was a portion of an old pier which had drifted ashore and grounded in shallow water. This was a favorite basking place for turtles throughout the summer and fall, and 40 to 50 could be seen there any time.

When disturbed they would scurry into the water where they could be seen scattered about near the pier, their heads sticking out of the water, ready to crawl out again when the cause of their alarm had disappeared. The majority were painted turtles, though there were usually among them several maps and a few soft-shells, an occasional musk turtle, and now and then a snapper.

On July 25, 1899, 286 painted turtles were caught at one haul with a 35-foot seine off the Assembly grounds.

This turtle is a shallow water species and is not often observed out in the lake at any great distance from the shore; in this respect it differs markedly from the Map Turtle, the Soft-shell and the Snapper. We have no record of any Painted Turtle having been seen in the lake more than a few rods from shore.

On the other hand it is seen oftener than any other species on dry land about the lake.

Early in June they begin wandering about, apparently hunting for suitable nesting places. They probably wander farther from the lake than any other species (excepting the Snapper), and may be seen in the fields, pastures, along the railroad, and in the open woods. They lay their eggs about the middle of June in shallow holes which they dig in the sand with their hind feet. The eggs appear to hatch out late in the fall. On September 28 a nest of 10 young, each about an inch long, was dug up in a potato field on Long Point. Favorite nesting sites are the sandy slopes of the railroad grade and the Assembly grounds, the field south of Green's flat, and the north shore of Long Point. Soon after hatching the young seek the nearest water, crawl into the mud, and remain until spring.

In the fall they seem restless and wander about a great deal. They are often seen crossing the railroad between the main lake and Lost Lake. The number killed by passing trains is astonishingly great. It is probably within safe limits to say that not fewer than a hundred are killed at Maxinkuckee every year by passing trains. Many are also killed by wagons on the public highway.

Along with the painted turtles killed in these ways there are killed a good many map turtles and a few each of the snappers and musk turtles, as well as a great many frogs, toads, and snakes.

The Painted Turtle muds up and hibernates during the winter. We never observed many under the ice. Early in the fall those about Outlet Bay and along the west side of the lake tend to migrate to Lost Lake, or more definitely to Green's flat and the shallow ponds along the railroad below the Outlet.

Here they "mud up" for a brief period. The first warm days of March call them forth, however, and they may again be seen on the logs and chunks basking in the sun.

The food of this turtle consists chiefly of small mollusks, crustaceans, insect larvæ, and dead fish. On June 6 a Painted Turtle and a Stink-pot were observed both feeding on a floating dead fish, and at other times we have seen the former species feeding upon dead fish. In every case the turtles began eating at the caudal end of the fish.

We have no evidence that this species ever catches live fish. The stomach of one examined October 8 contained a quantity of Spirogyra. Others examined contained Spirogyra and quantities of another alga, Lyngbya; another contained some Naias. This turtle is therefore largely a vegetable feeder. It is probably chiefly a scavenger and in this capacity serves a useful purpose in freeing the lake beaches of dead fishes, waterdogs, and the like, which wash up on the shore in considerable numbers.

This turtle is not often used as food, although there is no reason why it should not be so utilized. It has no disagreeable odor and the flesh is doubtless tender, palatable and nutritious.

The enemies of the Painted Turtle are not many. Among animals doubtless the worst is the muskrat. On December 18 a large example of this turtle was found at Norris Inlet, turned on its back and partly devoured. Muskrat tracks were the only ones about, and it is evident that that animal had been feeding on it. It is this turtle more than any other that is found, back down, on tussocks in the winter along the Inlet and Outlet, and with the body more or less gnawed away, probably the work of muskrats.

On another occasion (November 19), we found a small live Painted Turtle lying upside down on a log. It may have been left there by a muskrat or a raccoon.

Leeches are often found on this turtle and doubtless cause it considerable annoyance. All the turtles of the lake, but this one especially, usually harbor the flat leech (*Clepsine*) in considerable numbers. These are usually found on the bare skin along the sides and in the axils of the arms, at which time they are probably sucking blood. The leeches are also frequently found on the shell of the turtle, either on the carapace or plastron, but when in this situation, it is doubtful if they are obtaining any food. Winter seems to be the period of greatest mortality with them; in spring, one occasionally finds them lying about dead in such places as they make their winter quarters, such as the pools in Green's flat. Mention has already been made of the great number that are destroyed

by being run over by trains on the railroad and by wagons on the public highway. Many are destroyed and many more intolerably annoyed by thoughtless men and boys who shoot them or stone them whenever they see them basking near shore.

The claws of some of the painted turtles caught early in the spring of 1901 (Apr. 4) just after they came out of winter quarters, seemed to be remarkably long and sharp. Four examples were caught, and the length of the middle claw of the front feet was taken. The claw of the first was $\frac{1}{4}$ inch long, that of the second $\frac{3}{8}$ inch long, that of the third $\frac{1}{2}$ inch and that of the fourth $\frac{3}{8}$ inch. The turtles were only of moderate size, the carapace being about $4\frac{1}{2}$ to 5 inches long.

The Painted Turtle is easily distinguished from all other species of this region by its shiny black, blue-black or brownish-black color, and bright red on the neck. It may be described as follows:

Shell broad and depressed, broadest behind the middle; shell flaring posteriorly, its surface very smooth, no trace of keel even in the young.

Color of carapace dark green or greenish black, the hinder border of the costal and vertebral scutes narrowly bordered with black, the anterior border with slightly wider bright red lines lying immediately against the black margin; the red or yellow lines not joining to form straight lines across the back; a very narrow red line along middle of back; upper surfaces of marginal plates with many crescent-shaped bright red marks; lower surfaces of the marginals black, with large splotches of blood-red and bright yellow; plastron bright yellow or brownish red, with a large dusky blotch on central portion; soft skin of head, legs and tail dark olive, with red stripes; two large waxy yellow spots on back of head, nearly as large as eye, these prolonged backward as two narrow pale yellow stripes; another short yellow stripe from upper corner of eye and another from lower side of eye back on neck; two red stripes on front of each fore leg, and similar ones on posterior surfaces of thighs; besides these, numerous small red spots all over soft parts. Sometimes, in the brownish-black individuals, the sutures of the back are red. The red markings fade to yellow in alcohol.

The Painted Turtle varies somewhat in color, the ground-color in most of the examples being a brownish-black. In some cases there is a considerable mixture of green in the ground-color, giving the whole shell a somewhat livelier hue. In some examples seen the lines between the scutes of the carapace were red, and there were other markings of red on the back—sometimes a red dorsal

median line and a small red spot in the middle of each of some of the scutes. These color-markings were observable at some distance while the turtles were in the water and made the turtles possessing them objects of peculiar beauty. As the epidermal scutes of these turtles grow old they occasionally become covered with various growths. An alga which appears to belong to the genus Chætomorpha grows on the dorsal scutes, and, less frequently, a branched stalked protozoan, Opercularia, grows on the ventral scutes. Sometime during the year, usually in the late summer, the turtles shed these epidermal scutes, and can frequently be seen with some clean new scutes and old overgrown ones. At the end of the shedding period they come forth bright and new, their colors apparently much clearer. In the autumn of 1906 one of these turtles was caught with the alga on it in fruit, the base of the alga being green, while the fruiting tips had a reddish cast.

There is considerable variation in the epidermal scutes of this turtle, one frequently being added irregularly. An example caught in 1906 had 2 additional triangular scutes, symmetrically placed at the anterior corners of the anterior dorsal scute. In some cases the anterior marginal scute, and those on each side of it are ornamented with peculiar serrations.

Excepting the musk and spotted turtles this is the smallest species found in this region. Its maximum length is about 6 inches and the maximum weight three-quarters of a pound. The following table gives the weights and measurements of a number examined:

MEASUREMENTS OF PAINTED TURTLES

No.	Weight	Carapace		Plastron	
		Length in inches	Width in inches	Length in inches	Width in inches
1	.....	4 87	3 5	4 37	3
2	.....	4 37	3 13	4 00	2 5
3	.....	4 25	3 13	3 87	2 5
4	.....	4 5	3 25	4 00	2 5
5	6 75 oz.	4 67	3 25	4 19	2 13
6	12 00 oz.	5 37	2 93	4 87	3 31
7	12 81 oz.	5 63	3 87	5 13	3 25
8	2 65 oz.	3 13	2 57	2 79	2 06
9	6 25 oz.	4 87	3 87	4 00	2 00
10	11 00 oz.	.....	.....	.....	.....
11	10 75 oz.	5 94	5 19	4 87	2 37
Average	8 82 oz.	4 76	3 47	4 21	2 56

Several young seen May 22 were each about the size of a silver quarter.

7. SPECKLED TURTLE

CLEMMYS GUTTATA (Schneider)

The Speckled Turtle is found from New England to North Carolina and west to Indiana. In this State it has been found only in the northern part. It has been recorded only from Kendallville, Rochester, English Lake and Lake Maxinkuckee. It is not a very common turtle at Lake Maxinkuckee. Two specimens were obtained at the lake in May, 1891, by members of the Indiana Academy of Science.

The first example seen by us was got at the south end of the lake October 1, 1900. It was next seen April 1, 1901, when two were found on a tussock in Green's flat. The following is the record of all the remaining individuals seen by us: April 3, 1901, one found dead on Green's flat and another found dead in the elevator pond; April 4, four caught and several others seen basking in Green's flat; April 9, several seen in a ditch in Green's flat and one in a tamarack swamp west of lake; April 15, one caught in Green's flat; April 24, several seen in Hawk's marsh chasing each other in a lively manner; they were evidently mating; three pairs and one odd one were caught; April 25, caught one male in Green's flat; April 26, several seen in Green's flat; April 30, one seen in Green's flat; May 14, one found dead on the west edge of Long Point; May 22, several seen in a ditch near the tamarack swamp, four of which were collected.

The only one seen in the fall was found in Hawk's marsh September 3, 1906. One was obtained in a ditch near Fort Wayne, September 28.

This interesting and beautiful little turtle is by preference an inhabitant of the small ponds, marshes and open ditches, and is less aquatic than any of the preceding species. We never saw it in Lake Maxinkuckee proper. The one found at the south end of the lake was south of the Farrar cottage at a small pond. As may be seen from the above, its favorite haunts are Green's flat, Hawk's marsh and the vicinity of the tamarack swamp. None was seen on the east side of the lake, but careful search in April and May would doubtless reveal its presence along Aubeenaubee Creek and Norris Inlet, and possibly at Culver Inlet. Late in May, when the ponds have become pretty dry, these turtles disappeared.

They began mating about the middle of April. Several were seen paired April 19 to 24. When mating, they are more active than we have observed any other species to be. The males chase the females rapidly and persistently until the female is captured.

Then the male would immediately climb upon the female's back. Several pairs that were placed in a tub were continually assuming this position, although actual copulation was not observed.

We have never found the eggs of this species and know very little about its nesting season or habits. Its eggs are said to be only three or four in number, about 1.25 by .75 inch in size, and to be laid in June.

This turtle is apparently silent, as we have never heard any note which we could positively associate with it.

A good many dead ones are found in the spring; the winter is probably a critical period with them.

These turtles are entirely harmless and should be protected. Their food consists chiefly of crawfish, tadpoles, angleworms, and other weak animals found about the water and in the marshes.

The Speckled Turtle may be readily distinguished from all others by the following description:

Shell moderately to strongly depressed, oval, widest behind, no trace of keel in adult and scarcely evident in the young; nuchal scutes very narrow; plastron large, the hinder lobe about three-fourths width of carapace, with a shallow notch in posterior border; anterior lobe truncated, not movable on a transverse hinge; plastron of male concave; snout not at all projecting; upper jaw notched, the edge nearly straight; legs and feet covered with scales, those on front limbs large and overlapping; feet not large, claws rather short, the web not extensive; tail long, that of the male bringing the vent beyond the carapace.

General color of carapace black, patches of reddish brown showing through the darker; on each scute from one to 12 round bright orange spots, each larger than the pupil; plastron red, orange and black, the black predominating, the orange usually occupying the center and the margin; head black above, with orange dots; usually a large orange spot just above the ear; neck black, with more or less red; shoulders with much red or orange; upper surface of limbs black, with yellow and red, lower surfaces red and orange; tail black, red at base. Length of carapace 4 to 5 inches.

Weights and measurements of 14 examples are given in the following table:

No.	Weight in ounces	Carapace		Plastron		Sex
		Length in inches	Width in inches	Length in inches	Width in inches	
1	3.87	3.56	2.69	3.00	1.87	
2	4.13	3.50	2.13	3.19	1.94	
3	3.87	3.75	2.50	3.00	1.75	
4	4.13	3.81	2.69	3.13	1.94	
5	3.75	3.50	2.69	2.94	1.87	
6	4.50	3.56	2.75	3.25	1.94	
7	3.50	3.44	2.56	3.00	1.81	
8	4.37	3.63	2.75	3.37	1.94	
9	. . . . .	4.00	3.00	3.50	2.63	male
10	. . . . .	3.75	2.87	3.25	2.50	male
11	. . . . .	4.00	3.00	3.63	2.50	female
12	. . . . .	3.87	2.87	3.25	2.37	
13	4.30	3.63	2.75	3.31	2.25	
14*	3.39	3.56	2.68	3.00	2.19	male
Average		3.68	2.71	3.2	2.1	

*In the last specimen the carapace had strong concentric striæ and the plastron parallel radiating striæ. The tail was much larger than in the next preceding specimen.

8. BLANDING TURTLE

EMYS BLANDINGII (Holbrook)

This species occurs from New England westward to Illinois. It is found in southern Canada, but is not known from the southern states.

It is nowhere abundant; indeed, in most parts of its range, it must be regarded as a rare species. In Indiana it is known only from the lakes in the northern part of the State. It has been recorded from Lagrange and Steuben counties (Levette), Lake Maxinkuckee (Hay), Rochester (Gould) and English Lake. Only one specimen has previously been recorded from Lake Maxinkuckee; this was obtained by Dr. O. P. Hay in May, 1891.

It is apparently as common about Lake Maxinkuckee as anywhere in the State. Our notes record more than eleven examples as having been collected or observed by us in the neighborhood. The definite dates are as follows:

March 29, 1901, one caught on west side of lake near the small pond at the elevator; April 4, one taken in Green's flat; April 9, one taken in a ditch east of Tamarack swamp; May 17, one caught climbing the bank in front of Assembly grounds, and another near same place next day; May 20, a large one found in Hawk's marsh; May 22, two taken near Tamarack swamp; July 29, 1906, a large one caught in a kettle hole swamp in Walley's woods; September 11, one seen in a ditch between Arlington and Delong; September

14, a large example in Hawk's marsh; November 4, several large examples, some about 9 or 10 inches long, found dead on Yellow River west of Knox. They had been killed by pearl hunters.

Those taken May 17 and 18 were walking about on dry land as if hunting for a nesting site. We have never seen this species in the lake; it is, rather, an inhabitant of small shallow ponds, marshes and muddy ditches.

Very little was learned regarding the habits of this turtle. As only one of our specimens was found in the water, all the others being out on the land, it appears that it is somewhat less aquatic than the Speckled Turtle. On May 17 and 18 those observed walking about on the land had apparently come up out of the lake. They acted as if hunting nesting sites, though we found none.

The species is described as follows:

Shell elongate oval, widest just behind the middle, without keel; carapace not serrated behind; plastron large, entirely closing the shell; head long and wide; limbs and feet scaly; tail scaly, that of male about one-fifth length of shell, that of female shorter. Color dark green to black, each scute with several round, triangular or oblong spots of yellow or orange, the marginal ones largest, all sometimes wanting; plastron yellow, with the outer posterior portion with a brown blotch which sometimes covers the whole scute; head and neck above and along sides dusky, with numerous yellow dots; chin, throat and under side of neck yellow; legs yellow, with brown mottlings; tail striped longitudinally with yellow and brown. Length 9 inches or less.

Dr. Hay states that the young of this species can be distinguished by the absence of yellow or orange spots on the shell, in marked contrast with the young of the speckled turtle on which the spots appear even before the young are hatched.

9. BOX TURTLE

TERRAPENE CAROLINA (Linnæus)

The Box Turtle is found from New England to Texas and westward to Iowa and Kansas. Although occurring throughout Indiana, it is rare about Lake Maxinkuckee. The only record given by Dr. Hay for northern Indiana is Marshall County. During our observations there we saw only three specimens, as follows:

April 13, 1901, a dead shell found near a small pond back of the Farrar cottage at the south end of the lake.

May 22, 1901, one caught in a ditch near the Tamarack swamp west of the lake.

July 10, 1902, one found in Walley's woods near the railroad south of the lake.

We have heard of perhaps half a dozen others taken or seen within a few miles of the lake.

The second and third examples listed above give the following measurements:

No.	Carapace		Plastron		Circumference in inches
	Length in inches	Width in inches	Length in inches	Width in inches	
2	5	3.87	4.75	3	
3	6.75	7.25	5.5	3.5	15.5

This species is entirely terrestial in its habits and is the only strictly land tortoise found in the vicinity of Lake Maxinkuckee. It is never seen in the water and only rarely in or about marshy situations. It most delights in dry, sandy open woodlands where there is some underbrush and where the ground has a thick covering of dry decaying leaves. Favorite places are old overgrown fencerows along the borders of woodland, in blackberry and raspberry patches and in beech and oak forests where there are old decaying logs and chunks.

The Box Turtle is a silent, solitary, and solemn creature; one rarely sees more than one at a time. During the mating season, however, two are sometimes found together. Very rarely is one seen moving about, and a person is not apt to find any of these turtles unless he direct his observations to the ground. And when one is found it will be seen resting perfectly still, with its head projecting from the shell and staring at you stupidly. When you pick it up it will draw in its head and feet and close its shell tightly. Occasionally it will make a slight hissing noise, the only noise we have ever heard it make. It is a wholly harmless, inoffensive creature. It is easily domesticated and, as a garden pet, possesses many interesting and attractive characteristics, albeit not very exciting.

Their mating season in this region is in late April and May, and the eggs are laid in shallow burrows in sandy soil. We know nothing about the number of eggs laid nor the period of incubation.

The food of this species consists chiefly of grubs, angleworms and succulent plants and fruits. When kept as pets they will eat cabbage, lettuce, musk melon, tomatoes, mushrooms, angleworms and meat. They soon learn to take food from one's hand.

Shell broadly oval, sometimes four-fifths as broad as long, high, very convex, and extremely solid; plastron large, tightly closing the opening of the carapace, consisting of two lobes movable on each other and the carapace, the bridge entirely obliterated; plastron rounded in front and behind; head of moderate size, the snout not projecting; upper jaw with the cutting edge drawn down in front into a hooked beak, the hook not notched, the alveolar surface narrow; lower jaw turned upward at the tip; legs and feet scaly; claws stout, the web between the toes narrow; tail short.

Color of carapace yellow, brown and black, sometimes the darker color predominating, sometimes the yellow, ground color usually brown or reddish brown, the yellow appearing as spots of various shapes, often radiating from the point of growth of the scute; the ground color may appear to be yellow relieved with black spots; plastron variously ornamented with black and yellow. Young with a single yellow spot on each scute of the carapace. Length of carapace 4 to 6 inches in full grown examples.

THE AMPHIBIANS

Eighteen species of amphibians are now known from the vicinity of Lake Maxinkuckee. These include one waterdog, seven salamanders, one toad, two tree-toads, and seven frogs.

All of these are of some importance in their relations to the life of the lake, and several of them, such as the water-dog and the various species of frogs, of very considerable importance. Of all the animals inhabiting the lake perhaps the worst enemy of the fishes is the water-dog. And of the vertebrate animals about the lake, exclusive of the fishes themselves, frogs doubtless enter most largely into the menu of the large-mouth black bass. All of the species are more or less aquatic, all being found in or about the water.

LIST OF SPECIES

1. WATERDOG

NECTURUS MACULOSUS (Rafinesque)

The Waterdog or Mudpuppy is one of the most common, and certainly the most interesting, of the several species of amphibians occurring in or about Lake Maxinkuckee.

It is strictly aquatic in its habits and is found only in the water. It is found in both Lake Maxinkuckee and in Lost Lake and apparently approximately abundant in each. That it was seen more

frequently in the former is probably due to the fact that our observations were more often directed to that lake.

While pretty generally distributed throughout the lake, it is naturally most often met with in relatively shallow water near shore. It appears to prefer those locations where the bottom is of muck, marl or other soft material covered with a growth of short Chara. In such situations it makes considerable burrows in the bed of the lake or sometimes merely under the Chara or other covering. Here it rests when not moving about in search of food or for other reasons. The burrow usually has two openings, a few inches apart, one evidently for entrance the other for exit; and the animal, when in the burrow, is often seen with its head projecting from one of the openings as if watching for small fishes or other food that may approach. Thrusting an oar or pole into the burrow would frequently reveal the presence of the animal. They seem to occupy these burrows singly, as in no instance were two individuals found in the same hole. Whether they are more prone to remain in their burrows during the day-time or night our observations did not clearly disclose. Certain evidences, however, which will be presented later in this account, indicate that this curious batrachian is largely nocturnal in habit, and the burrows, if they could be examined with equal facility at night, would probably be found more frequently empty.

While nearly all examples seen in the lake were in water one to ten feet deep, they doubtless on occasion go out to greater depths, evidenced by the frequency with which they are taken on hooks of set-lines placed at a depth of 10 to 35 feet. They are doubtless most abundant in water less than 15 feet deep, but extend out to more than twice that depth in some numbers. It is probable that their bathymetric distribution is practically coincident with that of the plant covering of the lake bottom.

That the species is largely nocturnal is indicated by a number of habits which were observed. Frequently individuals were seen, or were caught with seines, at night when they had come near shore in shallow water evidently for the purpose of feeding on the small fishes which also come into shallow water at night to feed. Although large schools of the same species of fish were often seen in the same places in the daytime water-dogs were rarely noted and then usually in the winter and under the ice. Set-lines were much more apt to have water-dogs on the hooks when examined in the morning than when inspected in the evening.

That the species is, however, not wholly nocturnal is shown by the fact that individuals are often seen in daytime moving about

on the bottom, especially in winter under the ice, and the further fact that they are sometimes taken in the daytime by anglers or on set-lines.

They also appear to be active throughout the year; there is no evidence that they hibernate. We have observed them moving about and have caught them at all seasons, practically in every month in the year.

Actually, we saw them most frequently in winter, probably not because they were more abundant then or moving about more constantly, but because they were less active in their movements and therefore more easily observed, and especially because the presence of a sufficiently strong sheet of transparent ice on the lake gives an ideal condition for observation and study of the lake bed even in considerable depths.

As already stated, the water-dogs make shallow burrows in the soft bottom or under the Chara mat, in which they make their homes. They are also found under water-logged chunks or boards where they may be sometimes seen with their heads slightly exposed. Then again they may be observed now and then among the roots of the pond-lilies or the denser patches of Potamogeton, Myriophyllum and similar aquatics.

In late autumn and early winter, when the water has cooled, and the straw-colored minnows, grayback minnows and skipjacks crowd to the shore, water-dogs may be sometimes seen coming in among them, evidently for the purpose of preying upon the fishes. Later, during the winter, on bright sunny days, these animals were frequently seen in some numbers crowded close to shore and lying motionless under the clear ice. Several were caught by cutting holes through the ice above them. Occasionally one would take alarm while the ice was being chopped away, and swim off, rather slowly at first and then quite rapidly, with lateral flexions of the tail. Though not so rapid in their movements in winter as in summer, they can swim quite swiftly when occasion arises. When not frightened, if moving at all, they walk along the bottom with great deliberation, moving their heads from side to side as if smelling their way along. In walking, diagonal limbs are moved in unison, that is, the right front with the left hind leg and the other two the same way, with a good deal of circular or rotary motion at the hips and shoulders like one turning a crank. When one is caught in the hand or when a feint is made to take hold of one, it will make quick, vicious snaps at the hand. The jaws are strong enough to make the bite painful. This quick snappy motion offers a suggestion as to the manner in which the animal catches fishes.

The Water-dog seems to feed chiefly on small fishes and crawfishes. The stomachs of several examined December 10, 1900, and later the same winter, were literally packed with fishes. At various times in December one or more were seen among schools of skipjacks near shore, apparently feeding on them. Examples examined December 18 contained, in one instance, two small fishes each about 3 inches long, another the bones of the hind legs of a frog, and still another a fish hook baited with a piece of liver,—evidently from some fisherman's line. Of several stomachs examined December 28, some were filled with full grown skipjacks, while others contained several small fishes each. Four examined February 27 contained several minnows evidently taken from fishermens' hooks. On March 2 several others examined contained a number of bait minnows and one a large crawfish. Three examined March 8 contained 6 shiners, 3 crawfish, 2 Aselli, 2 leeches, and several long flat worms; and a fourth contained 3 crawfish and 3 snails (probably Physa. One examined March 18 contained one small minnow and a large worm. The stomachs of four examined April 27 were all empty, as was another (a male) inspected May 9. On November 16, 1904, one was found with stomach empty and another with one long red leech. One examined January 1, 1905, contained 2 straw-colored minnows, 3 crawfish, 2 large insect larvæ, and 1 large brown flat leech.

The species of fishes which we have found in the water-dog stomachs are the skipjack (*Labidesthes sicculus*), the straw-colored minnow (*Notropis blennius*), the grayback (*Fundulus diaphanus*), and two or three species of bait minnows not indigenous to the lake and evidently stolen from fishermen's hooks. One fisherman reported that he had seen a water-dog trying to catch a sunfish, but we were not able to verify this observation. We have frequently observed these animals in shallow water near shore among schools of the small fishes named above and evidently intent on preying upon them; never, however, did we see one capture a fish. As already stated, they were most disposed to feed near shore at night during the summer; but in winter when ice covered the lake they seemed habitually to come into shallow water under the ice in the daytime, particularly on bright sunny days. Sometimes they seem to congregate in considerable numbers under the ice. In the winter of 1899-1900 some boys found several bunched under the ice in a little cove of Lost Lake just north of the Bardsley cottage, and succeeded in killing 15 by hitting on the ice above them with a stout club.

Crawfish also form an important and considerable element in

the menu of the water-dog, while the smaller, softer-shelled mollusks, insect and other larvæ, and perhaps other small aquatic animals, are utilized to some extent.

According to Mr. J. J. Stranahan, for many years Superintendent of the Fish Cultural Station at Put-in-Bay, the water-dog is very destructive to the eggs of the whitefish. He states that in January, 1897, many of these animals were pumped up with the water supply of the Put-in-Bay station and that the stomachs of a considerable number of them contained whitefish and cisco eggs, the contents of one stomach consisting of 288 whitefish eggs and four cisco eggs. From June to August, 1894, while Dr. H. F. Moore of the Bureau of Fisheries was engaged on investigations in Lake Erie he examined the stomach contents of a number of water-dogs at Sandusky and elsewhere and found fish eggs present in many cases.

While writing this account (August, 1907), a specimen of water-dog was received by the Bureau from a lake near Irwin, Colorado. Its stomach contained six or eight examples of Gammarus (a small crustacean) and several small bits of rotten wood, the latter taken incidentally along with other food.

Garman* states that the water-dog subsists on crustaceans, insects and mollusks.

It is undoubtedly a bottom feeder, and its habit of walking or crawling about over the bottom makes the finding of fish nests and the destruction of the eggs a particularly easy matter. The evidence, therefor, would seem to be conclusive that the water-dog is wholly carnivorous in its habits; that its food consists chiefly of small fish, and in season, of fish eggs, along with a smaller proportion of crustaceans, mollusks, insect larvæ, etc.

Water-dogs may be caught quite readily in any season on hooks baited with minnows, crawfish, liver, bits of meat, or almost any animal matter. Setlines placed by us for experimental purposes at various depths and places in the lake usually yielded at least one water-dog every time examined. When the hooks were set at a greater depth than 35 or 40 feet, however, they rarely caught any. On hooks set in Lost Lake for catfish and dogfish, water-dogs were often taken.

Anglers often catch them while still-fishing in the spring, summer and fall, but it is during ice-fishing in the winter that they are most troublesome and most frequently taken. All fishing through

*A Synopsis of Reptiles and Amphibians of Illinois. Bull. Ill. State Lab. Nat. Hist., Vol. III, Art. XIII, p. 383, 1891

the ice is necessarily still-fishing and the fishermen are much annoyed by the water-dogs stealing the bait from their hooks as well as being caught thereon. Their abundance in the vicinity of ice-fishing is doubtless increased to some extent by the practice of the fishermen of throwing dead minnows from their minnow buckets through the ice holes into the lake. While this attracts predaceous fish it serves also to attract the troublesome Necturus.

Although the water-dog is entirely harmless, fishermen scarcely without exception firmly believe it to be poisonous and are in mortal fear of its bite. So strong is this fear that when a fisherman finds a water-dog on his hook he never tries to dislodge the hook while the animal is alive but either cuts the line and lets it escape or mashes its head and then removes it from the hook with many misgivings as to whether it is safe to remove even a *dead* water-dog from the hook.

When caught on the hook this animal squirms and thrashes about a good deal at first but soon becomes quiet and remains so until lifted out of the water when it again becomes very active, its squirming contortions, slimy touch and repulsive appearance all contributing to the fisherman's dread.

The breeding habits of the water-dog have not been fully studied by us, though a number of interesting observations were made. Several nests were found and the eggs and young seen at different times. The breeding season is in the spring. A nest was found June 12, 1901. It was under a submerged board in shallow water at Long Point. The eggs, which were not numerous, were about the size and color of yellow peas, and each was fastened to the board above by a small gelatinous cord. One of the parents remained near the nest, apparently watching it. The eggs, however, disappeared one by one, probably taken by crawfishes. Apparently none of these eggs remained to hatch and we were unable to determine the period of incubation.

In our observations of these animals we were struck by the frequency with which they were found dead in pairs. We are unable to say what significance, if any, lies in the observation that these animals are often found dead in pairs; it is probably a mere coincidence. The condition of the examples found dead was such as to make it difficult if not impossible to determine the sex and the cause of their dying; nor could their stomach contents be satisfactorily examined. There seems to be a brief period of unusual mortality among them early in the spring when considerable numbers may be found dead along the shore; a phenomenon analogous

to that observed in the bluegill. During the summer and fall occasionally dead individuals are found.

The food value of the water-dog has never been fully tested. Some years ago some experiments were made at Put-in-Bay by Mr. J. J. Stranahan which indicated that this batrachian might, through proper treatment, be made a very palatable and nutritious article of food. Its repulsive appearance, however, will to some extent militate against any extensive or general use of the animal for this purpose.

Summing up, then, the water-dog does not appear to have anything to commend it or in favor of its preservation; it seems to serve no useful purpose except that it is an interesting member of the local fauna.

It is an animal feeder and is destructive to several species of fishes, in that it preys not only on the adults but upon their eggs as well.

Following are dates on which water-dogs were observed at the lake: April 6 and 7, 1885, the senior author was at Lake Maxinkuckee, and saw a large number of dead water-dogs frozen in ice in what is now known as Green's marsh south of Outlet Bay. There was more water in that place then than we have ever observed there since. The water-dogs had apparently come out into the marsh and, the temperature suddenly dropping, were caught in the freezing ice; or possibly they had died from another cause and their bodies had been carried by the current on to the marsh.

In October, 1898, Mr. Chadwick reported them as abundant and stated that they are often caught while fishing through the ice in winter; also that they are often seen in shallow water on muck bottom in winter.

In 1899, one seen September 10.

In 1900, one found under a board in shallow water on Long Point August 8; one found dead near Maxinkuckee pier August 11; one seen dead floating near Long Point August 15; one got in Culver Inlet August 21; one found dead near shore near Arlington Hotel August 22, and another at Outlet August 31; one seined in Lost Lake September 1; one very large example found dead in lake near Lakeview Hotel September 29; two found dead in Culver Bay October 11; two dead on south shore November 9, and two more November 17, also two on east side November 22; a small one dead in a pool near Farrar's December 3; one got with rake and another seen at Long Point among a school of skipjacks December 10; one seen near shore on Long Point among skipjacks, and

another seen through the ice farther out, December 12; December 28 many of various sizes observed under the ice, crawled up as near shore as possible. In 1901, one killed and several others seen January 7; several seen under ice January 9; several seen near shore January 10; one seen in its burrow in front of station January 16, 18 and 19; a dead one seen January 19; one seen under the ice swimming straight for shore and later three others seen January 21; one caught by a fisherman January 23; one speared February 7; four caught February 27; six caught on hooks of set-line March 2, and about six others seen while looking down a hole in the ice where a fisherman was bobbing; a dead one found March 7, and three others March 8; one caught on a hook March 10; two found dead March 13, evidently killed by fishermen; a large one under a board lying on lake bottom and another caught March 18; one seen in Outlet, apparently going down toward Lost Lake March 20; one found dead April 1; a great many seen in Outlet Bay April 27; four seen April 27 and five dead at mouth of Aubeenaubee Creek, April 30; one seen under stones in Outlet April 29; a fisherman got two on a hook May 1; a dead one seen in Outlet May 4; one caught on outline May 7, and one May 9, the latter a male; three dead ones seen in Outlet May 13; five dead found along shore in various places May 20; also on May 23 and 31; a nest found June 1; several dead on shore June 4; one caught on hook from Chadwick pier June 20.

In 1904, one found near shore, and a small one under a board, November 16; one seen on bottom in about 4 feet of water off Long Point, December 15; one seen under ice near Inlet December 21; two seen near shore in south part of lake December 27.

In 1905, a large example caught from under ice at Long Point, January 1; one seen under ice near shore January 3.

In studying the feeding habits and food of the water-dog many stomachs were examined. Several dissected December 10, 1900, were literally packed with fishes. Two others were seen on the same day among a large school of skipjacks on which they were evidently feeding. Three were examined December 18; one contained two small fish each about 3 inches long, another the bones of the hind legs of a frog, while the third contained a fishhook baited with a piece of liver—evidently from some fisherman's line. One examined December 20 contained two strawcolored minnows, 2 and 3 inches long respectively. Seven water-dogs were caught and their stomachs examined December 28. The data obtained are given in the following tabulated statement:

FOOD OF WATER-DOGS

No.	Length in inches	Sex	Stomach Contents
1	12	F. ?	5 skipjacks packed tight.
2	12½	F.	7 large skipjacks, 1 small skipjack partly digested, 2 bluegills, 1 and 2 inches long, respectively, one small fish, not identifiable, one worm and a small quantity of vegetation. The water-dog's eggs were large.
3	9½	M.	2 dragonfly larvæ, 4 other small larvæ, one fish much digested.
4	9½	M. ?	1 large skipjack, one small bluegill, one crustacean and 2 larvæ.
5	10	F. ?	Homogeneous muddy mixture, some bits of plants, remains of 3 fishes and 2 dragonfly larvæ.
6	6½	F. ?	3 small fishes (probably bluegills), 2 other fishes much digested, one isopod and 2 larvæ.
7	7½	F.	6 small flat fine scaled fishes, probably bluegills.

On November 2, 1904, one caught under an old board in Outlet Bay contained only a small bit of weed. One was caught on same date in a minnow-trap which it had doubtless entered for the purpose of feeding on the minnows confined therein. One caught at Chadwick's pier November 6 contained 2 crawfish. Another taken at same place contained one crawfish and 2 Physa shells. Another taken under a board south of Green's pier November 12 had the remains of one minnow. One examined 3 days later was entirely empty. In 1905, one examined January 1 contained 2 strawcolored minnows, 3 crawfish, 2 insect larvæ and one flat leech.

Two examined January 7 contained several small fishes each, and four dissected February 27 contained several small minnows evidently taken from fishermen's hooks. On March 2 several examined contained a number of bait minnows and one large crawfish. At various times in December one or more were seen among schools of skipjacks near shore, on which they were feeding. Three examined March 8 contained 6 shiners, 3 crawfish, 2 Aselli, 2 leeches and several flat worms. Another had 3 crawfishes and 3 snails, probably Physa.

2. SPOTTED SALAMANDER

AMBYSTOMA MACULATUM (Shaw)

The Spotted Salamander has a rather wide range, extending from Nova Scotia to Nebraska and southward. It is not very common about Lake Maxinkuckee, probably the soil is too sandy. One specimen was obtained at Culver in 1906, and one captured under a chunk in Farrar's woods on October 5, 1907. This one had a row of yellow spots along the middle of the back.

In spite of its rather handsome coloration, the Spotted Salamander, with its blunt stubby head and slimy body, is a rather unattractive creature. They spend the day hiding under logs, chunks or stones, in moist cool ground. They probably seek their prey at night. Although generally viewed with distrust, they are perfectly harmless, and probably do good by devouring noxious insects.

Costal grooves 10 or 11, usually 11; sole with one indistinct tubercle, or none; black above with a series of round yellow spots on each side of the back; body broad, depressed and swollen; skin punctate with small pores from which exudes a milky fluid; 2 or 3 clusters of enlarged pores on head; a strong dorsal groove; tail $2\frac{1}{3}$ in length; length 6 inches.

3. TIGER SALAMANDER

AMBYSTOMA TIGRINUM (Green)

The Tiger Salamander does not appear to be common in this region. Our collections contain only two specimens, one obtained in 1906, and one in Farrar's woods October 5, 1907.

4. COMMON SALAMANDER

AMBYSTOMA JEFFERSONIANUM (Green)

The Common Salamander is frequent from Virginia to Indiana and northward. At Lake Maxinkuckee it does not appear to be common, only five examples having been taken. These were obtained under logs in damp ground on the east side of the lake in the autumn of 1906 (August 3 and October 14); all had small pale blue spots along the lower portion of the sides. None has been seen spawning here.

In some parts of the country, one of the first signs of spring, soon after the ice has disappeared and the water is still frigid, and before the frogs have yet begun to sing, is the sight of a number of these creatures in the bottom of shallow pools, too stiff almost to move, preparing to lay their eggs. The eggs are small, shot-like, black objects, surrounded by a thick sphere of clear jelly, a number cohering to form an irregular mass. As the water warms up, the eggs develop rapidly, first lengthening somewhat, then bending to a comma-like form, and finally the little fish-like larva, with gill-tufts on each side of the neck, wiggles through the jelly. On April 23, 1901, some larval salamanders were found swimming in Farrar's pond, which may have belonged to this species. The creatures develop rapidly into the mature form and leave the pool; in a few weeks none can be found there. The mature form spends

its days under chunks and logs in moist places, and probably spends its nights in search of prey.

This species can be distinguished by its 12 costal grooves, single indistinct tubercle on the sole of the foot, and the color, which is usually black or blackish, with pale bluish spots on the body.

5. FOUR-TOED SALAMANDER

HEMIDACTYLIUM SCUTATUM (Schlegel)

This curious little salamander appears to be quite rare. Our collections contain but 4 specimens. These were obtained October 7, 1906, under logs in a dry woodland near the tamarack swamp west of the lake. The young, 44 mm. long, has the tail compressed laterally as if to fit it for aquatic life; the larger examples have the tail more nearly cylindrical.

This species brown in color, the snout yellowish, whitish below and with small inky spots.

6. RED-BACKED SALAMANDER

PLETHODON CINEREUS (Green)

The Red-backed Salamander is common throughout the eastern part of the United States. It is not often seen, however, except by those who especially search for it. This graceful, slender salamander does not appear to be particularly rare about the lake, although it is not often seen. October 7, 1906, four were obtained a few miles west of the lake. On October 16, 1906, while turning over logs in Farrar's pond, 11 examples were obtained in a short while. On October 15, 1907, a search was made again for them in Farrar's pond, but none was found. It was much wetter this year than the previous year, and it was thought that the wetness of the pond may have driven them out. On looking under chunks on higher ground bordering the pond, about a dozen were secured in a little while. Some were still quite small; a few had a well-marked broad red stripe down the back, but in most this was wanting.

Little is known by us of the habits of this salamander. It is said to be nocturnal in habit, and to lay its eggs beneath logs and moist leaves instead of in the water. The eggs are laid in the latter part of April.

Costal grooves 16 to 18; palatine teeth not extending outward beyond inner nares; plumbeous above, often with a broad brownish red dorsal band; belly marbled; body very slender; tail cylindric; inner toes rudimentary; length 3½ inches.

7. TWO-LINED SALAMANDER

EURYCEA BISLINEATUS (Green)

Apparently rare. Our notes make mention of this species but there are no specimens in the collection.

8. COMMON NEWT

NOTOPHTHALMUS VIRIDESCENS (Rafinesque)

The Newt is found throughout the eastern part of the United States and is particularly abundant in the north and northeastern part of its range. At Lake Maxinkuckee only one example was captured; this was obtained in Farrar's pond June 11, 1901, while collecting crawfishes. In addition to the example captured another very small one seen in the swamp adjoining the lake below Farrar's, but it quickly hid among leaves in the bottom.

This graceful and bright-colored little batrachian is probably common in the region of the lake in woodland ponds. It is so elusive, however, that it is difficult to capture. It is a graceful, rapid swimmer, quickly dodging under leaves when pursued.

This salamander lays its eggs, single, round, clear objects, among the leaves in the bottom of brooks and ponds. They can frequently be found in late spring by lifting up the leaves, the minute yellow larvæ wiggling inside the clear envelope.

Above olive green or reddish of varying shades; lemon yellow below; each side usually with a row of several rather large scarlet spots, each surrounded by a black ring; back with a pale streak; belly with small black dots; head with 3 longitudinal grooves; three large pores behind eye. Length 3.5 inches.

9. COMMON TOAD

BUFO AMERICANUS Holbrook

The Toad, familiar everywhere over the eastern United States, is not particularly common about the lake during summer and autumn. One occasionally sees them hopping about in the grass or along the road, usually one at a time. In the breeding season, however, they congregate in large numbers in pools and along the lake shore. Only a few examples were taken, but they could be captured almost anywhere about the lake.

The last seen in 1900 was on October 6, at which time they were observed working their way backward into the ground, as if to hibernate. From March 31 to April 11, it was noticed that chickens were scratching them out of their winter-quarters and

eating them. They came out of winter-quarters about April 23, when they repaired to the water at once and began singing. By April 27 they were in full chorus in a pool by the railroad, and were busy mating and spawning. The height of the mating season extended from about the last of April until well into May, although they continue mating until the fourth of July and perhaps even later. They have been heard singing as late as August 26.

A great number were observed mating in Culver Inlet April 30. The males cling very tightly to the females; some captured and kept all afternoon in a botany can filled with plants did not relax their hold. The singing toads are usually unmated males. They sit at the water's edge and call with a tremulous, hardly muscial, note, beginning with explosive emphasis and dying down at the end, the loose skin under the throat being blown up into a hemispherical bubble while they call. A good many dead toads were found in the pool at the same time, indicating that the mating season is one of especial mortality among them. The female toads were noted spawning while clasped by the male. The eggs are laid in gelatinous strings, two strings laid at a time, each string of clear jelly, about 3 16 inch in diameter and containing 2 rows of eggs, black objects about the size of pinheads with a whitish point on each. While carried in a closed vessel the toads uttered a low, purring, humming noise, quite pleasing to the ear. Two were placed in a bucket over night and a number of eggs were found there in the morning.

The toads of this region represent two distinct color phases, one type being more or less slaty blue and the other brick red. This difference in color is not usually noted when one sees single toads hopping about, but where numbers are congregated during the breeding season the contrast is quite noticeable. It appears to have nothing to do with age or sex, and toads of different colors are often found mating together.

The toads spawn in the lake as well as in the shallow pools. The eggs soon hatch into small black tadpoles which, in warm water, rapidly develop into minute toads, which can be seen hopping along shore. Young toads were seen hopping about on July 27; they are almost black, much darker than their parents. After mating and spawning, the toads scatter again, and in the autumn one comes across them of various sizes, the variation in size being probably the result of the long breeding season.

The toad is a decidedly beneficial creature, as it captures great numbers of insects. They frequently fall a prey to snakes, and

these, with the exception of thoughtless boys, appear to be their chief enemy.

In addition to its mating song the toad appears to have a song it sings on land, a low, pleasing, tremulous strain.

The singing is often prolonged late into the summer, and "its music in retired ponds and swamps, as darkness creeps over the face of nature, is both weird and somnific."

10. CRICKET FROG

ACRIS GRYLLUS (LeConte)

The Cricket Frog is common in swamps throughout the eastern United States. It is common along the shore of Lake Maxinkuckee, but more particularly abundant along such parts of the lake edge as are low and swampy. It is abundant along the shores of the various inlets of the lake, and quite common about the Outlet and the shores of Lost Lake. Numerous examples were taken, representing all parts of the shore, and the various inlets of the lake.

Although the cricket frogs are related to the tree-frogs, they never stray far from the water's edge, but remain along the shore ready to jump into the water at the slightest alarm. They are very alert and strong jumpers, and are therefore difficult to catch. When they jump into the water they do not dive to the bottom, as many of the water frogs do, but swim back to shore. They are very variable in appearance; some have a bright green y-shaped mark, but in others this is brown or obscure. The cricket frogs come out of their winter-quarters and remain out until late in the fall; they have been seen on shore as early as March 7 and as late as November 30.

Although the Cricket Frog comes out early in the spring it does not begin to sing until the water is well warmed up, which is some time after the Pickering Frog and the Swamp Tree-frog have begun their singing. They began singing as early as April 28 and continued until as late as August 5. After a short season of rest they sing again more or less in late autumn. One was heard singing September 12, and they were heard singing again October 22.

During the height of the singing season the rattle of these frogs is almost continuous, and at times nearly deafening. The note resembles the rattling of pebbles. Toward the end of the singing season, the music was rather peculiar. After an interval of silence, one would start the song, then all the others would begin spasmodically and sing awhile. During the summer it is easy to

start one of these frogs singing by concealing one's self and striking two pebbles together, thus imitating the note of the frogs. The first one seen singing was started this way. It had been difficult actually to see any of these frogs singing as they usually became silent when approached. By the means described above, one that was in sight was started, and the whole process observed. They sit fully out of the water, hidden in grass or rushes, inflate a large bubble under the chin, and work their flanks considerably while rattling.

In raking out leaves and water weeds near shore in the late autumn these frogs are frequently brought out, torpid and stiff. In such places they doubtless spend the winter.

On December 3, several dead Cricket Frogs were found in a cut-off east of Farrar's, and several were found hiding and in a semitorpid condition under leaves at the water's edge.

The Cricket Frog probably subsists on insects, especially the small midges so abundant at the water's edge. They are sometimes used for bait.

The following brief description will assist in identifying the species:

Toes broadly webbed, tipped with small disks, tympanum indistinct; hind legs very long; brownish above; middle of back and head bright green or reddish brown; a dark triangle between the eyes; sides with three oblique blotches; a white line from eye to arm. Length 1½ inches.

11. SWAMP TREE-FROG

PSEUDACRIS FERIARUM (Baird)

The Swamp Tree-frog is common throughout all parts of the eastern United States where there are ponds, swamps or creeks. Its presence is usually made known by sound rather than by sight, as the frog, though quite noisy, is both shy and inconspicuous and easily overlooked.

At Lake Maxinkuckee this frog is probably common, scattered about in the marshy regions surrounding the lake. It is not often seen, however, and only a few examples were secured. One was obtained on Aubeenaubee Creek July 8, 1899, three about the shore of Lake Maxinkuckee July 28, 1900, one in Norris Inlet August 8, 1900, and one in Farrar's pond at the edge of the lake below Farrar's October 8, 1907.

A few days after the first high-pitched "peep, peep" of Pickering's Tree-frog has sounded from the marshes, the announcement

of the arrival of spring, the Swamp Tree-frog begins its chorus, and although it is not the first frog to be heard, it is its chorus coming from the woodland ponds and from the creeks and marshes, that announces to the world in general that "the frost is out of the ground." These frogs all seem to wake up at about the same time, so that the very first song is a pretty full chorus. They begin singing first in the pools and ponds surrounding the lake, and only later stray down to the lake shore. In 1901 they were first heard about March 23; at the beginning of their song season they sang only during the warmer parts of bright days. Intermixed with the chorus came at intervals the high piping of *H. crucifer*.

From March 23 to about the middle of April they sang chiefly during the warmer part of the day, the chill of the night quickly silencing them. About April 24 till May 9, they sang chiefly during the evenings and mornings; later on they sang in diminishing numbers and chiefly on moist muggy nights. They were heard singing as late as June 22. The song is a rattle with a rising inflection at the end, or like the scraping of a coarse-toothed comb.

It was quite difficult at first to catch this frog in the act of singing, as they become immediately silent on one's near approach. On April 5 some were seen singing near Hawk's pond. The frogs stuck their heads above the water, expanded the skin under their throat until it looked like a large yellow bubble; this vibrated somewhat, but did not collapse while the frogs were singing. All the frog out of the water was pretty well hidden behind the bubble, so that the animal itself easily escaped detection. Later on they were occasionally seen singing in a row at the edge of the pools. A pair were seen mating April 9 over by Hawk's pond. In a pond where many were heard singing a number of small bunches of eggs were found which probably belonged to this species. They were placed in an artificial pool and kept under observation, but did not hatch.

The small tadpoles soon develop, and about June minute frogs of this species can be seen hopping about, leaving the water.

The Swamp Tree-frog has a second season of song in autumn. This is usually sung by individuals rather than in chorus, and the singers are frequently found some distance from the water, anywhere in damp situations. They are quite frequently heard in low copses or in cornfields on damp days in autumn, and one was known to have its abode in a damp cellar a good distance from any pond. One example found in autumn in a cornfield was quite plump, and was found to be full of well developed eggs. As these frogs are dormant during the winter it is probable that the ova reach their

full development in autumn, and that the brooding instinct developed by this time, is held in abeyance until spring, when the frog wakes and recommences the song begun the autumn before.

During the autumn of 1900 this frog was heard singing at the edge of the lake from October 28 to November 20.

These frogs can usually be seen better during the autumn than any other time. They are then to be found on the ground in damp situations and are somewhat sluggish and inactive. They are quite handsome and elegant in appearance.

These little frogs often fall a prey to the large-mouth black bass and pickerel and are sometimes used for bait by anglers.

Fingers and toes ending in small disks; fingers not webbed, toes scarcely so. Tympanum distinct. Bluish ash, a dark dorsal stripe from snout backward, bifurcating above middle of body; a stripe on each side of this and one on side of head and body, the latter pale-edged below. Length 1 inch.

12. COMMON TREE-TOAD

HYLA VERSICOLOR Le Conte

The Tree-toad is generally common throughout the United States east of Kansas. At Lake Maxinkuckee it is frequently heard in the evenings or in damp weather preceding a rain. Very few examples were seen, however, and it does not appear to be abundant. One was taken August 6; on September 13 one was found on the rushes near Lakeview Hotel. It was dark blue-green in color to simulate the rushes on which it was found. Three examples were obtained near the lake July 8. The first one heard in 1901 was on April 29 and the species continued trilling through the summer. In 1906, two examples were seen, both of the usual gray color it assumes when resting on bark.

One of the favorite haunts of the Tree-toad in spring is in clumps of low willows growing in wet situations. Here they nestle in a crotch and trill almost continuously. Even when they can be heard everywhere they are difficult to find, as the sound is hard to follow, and they become silent at one's near approach. Their resemblance in color to the object upon which they rest protects them, and by the time one gets close enough to distinguish them clearly they give a prodigious leap to safety, the bright colors of their under parts showing like a streak of yellow through the air.

Green, gray or brown with irregular dark blotches; below yellow, behind white; tympanum $\frac{2}{3}$ diameter of eye; fingers $\frac{1}{3}$ webbed; skin with small warts. Length 2 inches.

13. PICKERING'S TREE-TOAD

HYLA CRUCIFER Wied

Although its range extends over all the eastern United States, there are comparatively few people who know Pickering's Tree-toad at sight. Its presence is manifest to the ear rather than to the eye. At Lake Maxinkuckee it is seldom seen, only two examples having been obtained by us. These were captured in Aubeenaubee Creek, September 3. It appears, however, not to be uncommon. Its shrill peep is the first sound to waken the marshes in spring. It begins singing a few days before Pseudacris, and after that species has begun, the high-pitched "peep, peep" of the little Hyla can be heard above the rattling chorus of the swamp tree-toad. Pickering's Tree-toad does not sing in concert, but different individuals appear to pipe to each other. It sings about the edges of flat shallow marshes, such as those by the Inlet, and by the tamarack swamps. It continued to sing from early April until about May 9.

In autumn a sound much resembling the springtime note is frequently heard from forest trees or low shrubs on damp days. All attempts to find the author of the note were unavailing, but it is supposed that it is made by this toad. It is one of the characteristic sounds of autumn.

The following description will assist in recognizing the Pickering Tree-toad: Yellowish or fawn-color, with dusky rhomboidal spots and lines, the latter usually arranged in the form of an oblique cross; head with lines; limbs barred; tympanum very obscure. Length one inch.

14. LEOPARD FROG

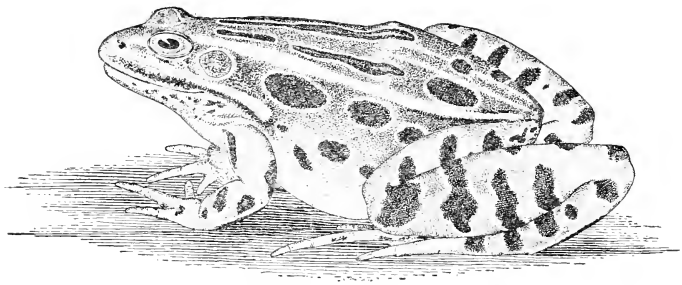
RANA PIPIENS Schreber

The Leopard Frog is the most widely distributed of the frogs found about the lake, its range extending over North America westward to the Sierra Nevada and southward into Mexico.

At Lake Maxinkuckee it is to be found almost anywhere along the shore and in low grassy meadows and in the shallow ponds of the region. Examples were taken in Lost Lake, in Culver Inlet, in various places about Lake Maxinkuckee, in the shallow pond by Hawk's marsh, and in the woods northeast of the lake.

The Leopard Frog is the least aquatic of the frogs. It does not spend much of its time in the water, but prefers to dwell in meadows and moist grassy places, and can even be found in quite dry

situations; for this reason it is often called the Meadow Frog or Grass Frog. After the tadpoles have transformed they quit the water and scatter everywhere through pastures and meadows, in this respect rather resembling toads than frogs. One of their favorite haunts in late summer is some meadow, where they sit at the edge of a burrow snapping up insects that come along, and quietly backing into the hole at the approach of danger. One such, that had become too plump with food to squeeze into the burrow, was caught and kept a captive. When undisturbed, it frequently uttered low tremulous notes, quite pleasing to the ear. Another favorite habitat is the prairie-like flats at the edge of ponds. It is only occasionally that they are found at the water's edge, ready to jump in at the sign of danger.



Spring Frog or Leopard Frog (*Rana pipiens*)

There are occasions, however, when this frog seeks the water. They retire to the bottom of ponds or to the edge of the lake to hibernate, and frequently on lifting a stick or board from the bottom near shore in late autumn, one or more of these frogs can be found under it, straight and stiff, unable to move. In the spring a good many are often found dead under the ice of the thawing ponds, and it appears that the wintering-over process results in considerable mortality among them.

Early in the spring as soon as the ice has left, they begin to be commonly seen about. One of the earliest records is March 18. As soon as the sun has slightly warmed up the pools in the neighborhood of the lake they appear in numbers. A dismal croaking can be heard in marshy places, but no singer can be seen, and although all heads in sight seem to go down under water, the croaking continues. For a long time this croaking was a mystery, and was attributed to some other creature, but on a trip along a

ditch west of the lake in the spring (April 9), two of these frogs were observed engaged in a lively tussle, like a boxing-match. They then sank to the bottom of the ditch and began croaking. Conspicuous gular pouches projected from each side of the head, giving it a lance-like appearance, much more like that of a serpent than a frog. As the frogs croaked the pouches worked in and out like parts of a bellows. Although the frogs were entirely under water no bubbles escaped.

In the spring when these frogs first come out of winter quarters, they are semitorpid and easily captured, but with the advent of warm weather they become active and are difficult to capture without a landing net.

In some places these frogs are esteemed as an article of diet. In Chicago they are hunted almost to extermination. The frog hunters go with sacks to the ponds where they breed, and catch them in great numbers. When placed in the sack they croak constantly, the sound being much like that which they make during the mating season. The saddles are seen in great numbers on the fish markets where they retail at 15 cents per dozen.

The Leopard Frog mates and spawns throughout April and probably into the month of May. One of the favorite spawning places was a shallow temporary pool near Hawk's marsh. Here on April 8 (1901) a great many were seen mating. The male which usually appears to be the smaller, clasps the female closely around the waist and simply hangs on and squeezes. He probably assists by this pressure in forcing out the spawn which he is at hand to fertilize. The eggs on being extruded rapidly absorb water in the gelatinous envelop and swell up to irregular masses as large as, or larger than, the parent frog. The eggs, which are black and resemble small shot, rapidly hatch out into rather dark tadpoles which are not so black nor so small as those of the toad. The tadpoles leave the water in the early summer of the same year, and can be seen about the beginning of July, crawling up into the grass, the shrivelled tail in some cases still persisting.

The Leopard Frog has quite a number of enemies. In the water they are eagerly seized by fish, and are frequently used for bait. The larva of the water bettle, Dytiscus, attacks the tadpoles and devours them. Snakes catch a good many. At the edge of Bass Lake (Aug. 14, 1906), a pitiful crying, much like that made by a young chicken when caught, was heard in the grass, and it was found that a garter snake had one of these frogs half-way into its mouth, while the frog was vainly trying to escape.

The Leopard Frog is an entirely harmless creature, and is of great service in helping keep down hordes of insects.

This frog can be easily distinguished from any other of the frogs about the lake except the Pickerel Frog, which it resembles considerably, but from which it can be told by the absence of yellow on the under part of the hind legs, the absence of any marked color, the blotches being rather rounded than square, and black in color instead of dark brown. The following description will assist in identifying it:

Brownish or green, with irregular black blotches edged with whitish, these mostly in two irregular rows on back, usually 2 spots between eyes; legs barred above, belly pale, glandular folds large; head rather elongate. Length 2.75 inches.

There are two distinct shades of ground color among these frogs; some are rather dark brown, while others are bright green.

15. PICKEREL FROG

RANA PALUSTRIS Le Conte

The Pickerel or Swamp Frog has a rather narrow distribution compared with its near relative, the Leopard Frog, it being confined to the eastern part of the United States. It is not common about Lake Maxinkuckee; only 15 examples were collected. These were found in various situations, four of them being obtained at Lost Lake, one by Farrar's, three or four in Lake Maxinkuckee and four or five in Aubeenaubee Creek. One was found along the railroad between the lakes. Dr. Hay, in his report on the reptiles and batrachians of Indiana, reports two specimens in the State Normal School collection from Lake Maxinkuckee.

Very little was learned about its habits. It probably has nearly the same habits as the Leopard Frog. Its rank odor probably protects it from some enemies that prey on the Leopard Frog, and would prevent it being used for food, even if it were common enough to be caught for that purpose.

During the spring of 1901, a woodsman living near the lake gave information that he often heard proceeding from the forest ponds a tremendous quacking like that of many ducks. A visit was made to ponds east of the lake with the result that the same sound was heard, but the perpetrators of the noise were too shy to allow themselves to be seen. It was thought that the noise was made by the Pickerel Frog, which may sing under the water like the leopard frog, and thus escape detection.

The Pickerel Frog may usually be readily distinguished from

the Leopard Frog, which it much resembles, by the decidedly yellowish cast of the under part of the hind legs, and by its strong minky odor.

The following brief description may assist further in its identification:

Light brown, with two rows of large oblong rectangular blotches of dark brown on back; one or two on sides; a brown spot above eye; a dark line from nostril to eye; upper jaw white, spotted with black; head short, obtuse; toes well webbed; glandular folds low.

16. WOOD FROG

RANA SYLVATICA LeConte

The Wood Frog is somewhat common in damp woods through the eastern part of the United States. At Lake Maxinkuckee it is not particularly common, only about 20 examples having been seen. Of these, four were taken on the shore of Lost Lake, and three on the shore of Lake Maxinkuckee, the others were obtained in the various inlets of the lake, a few in Culver Inlet, a few in Norris Inlet, but the greater number in or along Aubeenaubee Creek.

The earliest date on which it was seen was May 24, the latest August 23. In general it prefers the neighborhood of creeks in low damp woods, and in such situations it is the most common frog in some parts of the State. It is too small to be used for food.

This frog, with its slender, elegant form and rich coppery color, is one of the most handsome of our frogs.

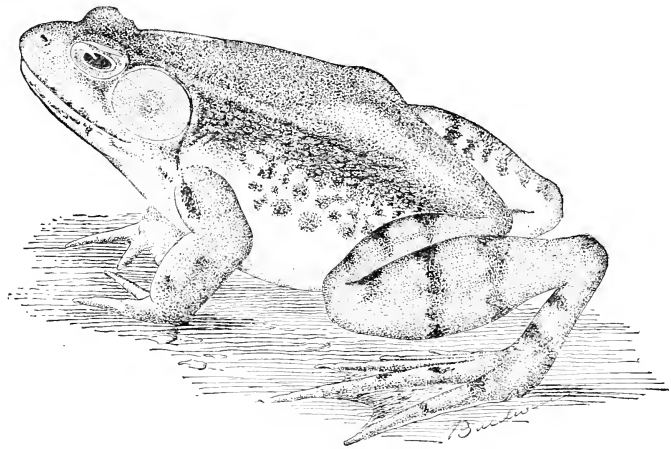
Side of head with a dark brown band, wider behind, from snout to shoulder, bordered below by a yellowish white line; usually a black spot at base of arm. General color pale reddish brown; arms and legs barred above. Head small, pointed; femur and tibia about equal, the latter considerably more than half body; a rounded outer metatarsal tubercle present. Length about 2 inches. This species can be easily distinguished from any other about the lake; farther north it has a relative much resembling it.

17. GREEN FROG

RANA CLAMITANS Latreille

The Green Frog is well known throughout the eastern part of the United States. At Lake Maxinkuckee it is common. Examples are occasionally seen along the lake shore. It is much more common, however, about springs, pools and creeks. Of about 25 examples obtained four were caught at the edge of Lost Lake, five in Aubeenaubee Creek, three in Norris Inlet and four in Lake Maxinkuckee.

This frog is more aquatic than the Leopard, Marsh or Wood Frog, and does not often stray far from water. Its favorite haunt is the edge of some creek, spring or pool, where it plunges with a surprised "chung," at the first alarm. It makes straight for the bottom and usually a bit of stirred up mud shows where it has landed; or, where leaves are present in the bottom, it works its way under them. It can remain under water some little time without discomfort. As its tadpole does not develop during the first year, this frog does not spawn in shallow pools, but usually chooses some place where the water is permanent. The tadpoles—rather large grayish creatures—can be found in muddy pools and creeks.



Green Frog or Spring Frog (*Rana clamitans*)

The Green Frog makes its appearance early in the spring and can be seen until late in the autumn. A few dead ones were seen during the winter and early spring; the first live one was seen April 15, and they were seen as late as October 9. Many tadpoles were seen in Hawk's marsh which seems to be one of their favorite breeding places. The call of the Green Frog is a repeated "thrum, thrum, thrum," usually heard late in the evening or at night. They began thrumming about May 5, and continued until as late as August 26.

The Green Frog is excellent as an article of food and grows larger than the Leopard Frog. It is occasionally seen on the markets, not so frequently, however, as the Leopard Frog, because

it is much more difficult to capture. In the autumn of 1906 large numbers of these frogs were seen to jump into pools in Overmyer's and Culver's woods, but though these pools were thoroughly dredged with a dip-net none of the frogs came to bag. This frog exhibits a marked variation in the color of the underside,—some of them being plain white, others a rich yellow color; this difference seems to be merely an individual variation. They also vary greatly in the size of the tympanum. It is sometimes very difficult to distinguish this species from the young of the Bullfrog, as they greatly resemble each other in general appearance. The Green Frog has the glandular folds on the back more or less distinct and the web of the foot not reaching the tip of the fourth toe, and can be always distinguished by these characteristics. The following brief description gives the details more fully:

Green or brownish, brighter in front; generally with irregular small black spots; arms and legs blotched, yellowish or white below; tympanum large; glandular folds large; toes well webbed; first finger not extending beyond second; tibia and femur equal 1½ body. Length 3 inches.

18. BULLFROG

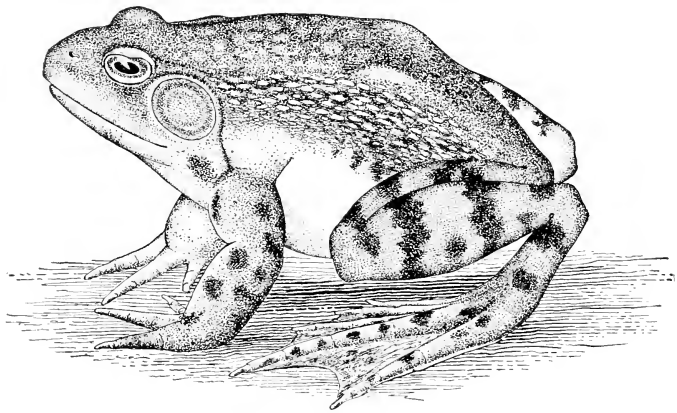
RANA CATESBEIANA Shaw

The Bullfrog was formerly rather common in sluggish streams and ponds throughout the United States east of Kansas. At Lake Maxinkuckee it is said to have been formerly abundant, but it has been hunted until it is now rare. The method of hunting them was by means of a bicycle lamp at night which so blinded them that they could easily be picked up.

This is the rarest frog about the lake, only six examples having been seen, and of these only three were captured. One was obtained near the Fish Commission station while seining for minnows at night. A lantern was in use which probably blinded the frog. A large one was seen November 20 down by Norris Inlet, at the edge of the water. It was somewhat torpid, but managed to escape. On January 7, 1901, one of the ice-fishers saw a large Bullfrog on the bottom in several feet of water off the Gravelpit. He cut a hole in the ice, let down a hook and pulled out the frog. It was too torpid to move. One was obtained April 15, 1901 (No. 35445, U. S. Nat. Mus.). On May 1, a large one was seen in the pond back of the Winfield cottage, and on September 30, 1907, one was seen basking on the shore of the Outlet about two miles below Lost Lake.

The deep, sonorous, bull-like bellow of this frog can be heard about some portion of the lake shore throughout the summer. They usually are heard toward the southeast shore of Lost Lake where the miry shore and fringe of rushes give them good protection. During the summer of 1906 one kept bawling almost every day from the neighborhood of the ice-houses. They keep up their bawling from May 1 to as late as August 26.

Like the Green Frog, the Bullfrog rarely strays far from the water, but stays by the shore, ready to jump in at the slightest alarm. There are few animals hunted more persistently than these. They are captured by several methods—by shooting, by



Bullfrog (*Rana catesbeiana*)

use of acetyline light, and by the use of red flannel on fishhooks at which they readily jump, so that in spite of the almost inaccessible bits of shore they frequent, they are unable to hold their own.

The Bullfrog is said to be very voracious, and is reported to capture and swallow young ducklings. On account of its rarity at the lake, little was learned of its habits.

The Bullfrog can usually be identified by its size and voice. The following short description will assist in identifying specimens:

Greenish, of varying shades, with small faint dark spots above; head usually bright pale green; legs blotched; tympanum large; toes broadly webbed; femur equal to tibia, not half body. Length 5 to 8 inches.

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