The Crustaceans of Lake Maxinkuckee.[1]

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During the physical and biological survey of Lake Maxinkuckee, Indiana, carried on more or less intermittently from July, 1899, to October, 1913, for the United States Bureau of Fisheries, considerable attention was given to the Crustaceans inhabiting the lake and its connecting waters. The full detailed report on those investigations will, it is hoped, be published elsewhere. In the present paper it is our purpose to present only the more important considerations and conclusions, largely omitting the vast body of details and observed facts upon which the present contribution is based.

A very comprehensive study of the Plankton was made by Professor Chancey Judah, now of the University of Wisconsin. It is hoped the results of Professor Juday's studies may be published soon. A similar thorough study of the Parasitic Copepods was made by Dr. Charles B. Wilson, a brief summary of whose report is made part of this paper.

Except during the summer of 1899 and 1900, the field work on Lake Maxinkuckee was nearly all done by one or two investigators only. This made it impossible to pay equal attention to all the groups of animals and plants; indeed, many groups could receive scarcely more than passing notice, while others had to be wholly neglected. Among those groups which received but slight attention are the worms, polyzoans, protozoans, smaller crustaceans, insects, and the like. Although considerable collections were made in some of these groups, insurmountable difficulty was experienced in finding specialists to work them up. Our reports on several of those groups are therefore necessarily brief and general in character.

Occasional notes and memoranda were made regarding various species which we did not have opportunity to observe regularly or methodically. Such of these as seem to possess some value or interest are given in the following pages.

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Collecting Stations.

Lake Maxinkuckee is in Marshall County, Indiana, 34 miles south of South Bend, 94 miles southeast of Chicago, and 32 miles north of Logansport. Its elevation above sea-level is 735 feet. It is about 2.6 miles long from north to south, about 1.6 miles wide, and its surface area is 1,854 acres. Its greatest depth is about 90 feet.

Observations were made and collections obtained in all sorts of places and situations in and about the lake. Certain localities mentioned specifically in this series of papers may be more definitely described as follows:

Arlington.—A flag station on the west side of the lake, at the base of Long Point.

Aubeenaubee Creek.—A small stream entering the lake near the middle of the east side.

Birch Swamp.—About two miles west of the lake.

Bruce Lake.—A small lake a few miles southwest of Lake Maxinkuckee.

Culver Inlet.—A small stream entering the lake at the northeast corner.

Drained Lake.—An old lake bed a mile northwest of the lake.

Farrar's Creek.—A small creek entering the lake at the southwest end.

Green's Marsh.—A few acres of wet ground between Long Point and the railroad on the west side of the lake.

Long Point.—A small peninsula projecting into the lake on the west side.

Lost Lake.—A small, shallow, muck-bottomed lake lying west a few rods from Lake Maxinkuckee.

Norris Boathouse.—On the southeast shore of the lake.

Norris Inlet.—The principal inlet of the lake, entering the lake at the southeast corner.

Outlet Bay.—A small bay on the north side of Long Point.

Outlet.—The small stream through which the water flows from Lake Maxinkuckee into Lost Lake.

Spangler Creek.—A small brook entering the lake from the east.

Walley's.—A farm on the outlet creek just below Lost Lake.

Weedpatch.—An east-and-west bar about 1,200 feet long and 500 feet wide, in Lake Maxinkuckee, in 10-foot water southeast of Arlington.

Winfield's.—On west side north of Outlet Bay.

For convenience of treatment, the Crustaceans of Lake Maxinkuckee may be divided into five groups, as follows: (1) the Plankton species;

(2) the Parasitic Copepods; (3) the Amphipods or Beach Fleas; (4) the Isopods or Sowbugs; and (5) the Crawfishes.

The Plankton Species.

The list of species contained in the Plankton collections of 1899 and 1900, and a discussion of their abundance, distribution and habits, will be found in Professor Juday's report. A few additional species were later obtained in the small ponds about the lake.

Of the individual species not much can be said; our studies were too general for that purpose. It may be stated, however, that plankton species of crustaceans constitute a large part, probably nearly all, of the first food of the young of many fishes, and much of the food of some species of fishes throughout their entire lives. The little Stickleback (*Eucalia inconstans*), for example, may be mentioned as one of such species. Examples of this species kept in an aquarium fed eagerly on any and all plankton crustaceans which we placed in the aquarium with them. We observed also that these small crustaceans are captured and eaten freely by those curious carnivorous plants, the bladderworts.

Of the whole group it can be said that they are present throughout the year in greater or less abundance. The abundance varies greatly, however, from time to time, as shown by Juday. On September 6, 1906, peculiar ripples were observed on the surface of the otherwise smooth lake. Upon cautiously approaching the spot it was found that the disturbance was caused by large schools of young black bass, circling about and feeding voraciously. Upon drawing a towing-net through the place great quantities of several species of plankton crustaceans were obtained.

On many occasions the lake surface in large areas was seen to be covered with a thin scum which, on examination, was found to consist chiefly of the cast-off skins of minute crustaceans.

On November 5, 1906, Entomostraca were present in such remarkable abundance at and near the surface of the lake that the water had the appearance and consistency of thick soup, the little animals actually crowding each other in the water. The next day great windrows of these crustaceans were found washed up on the shore at Long Point. Two days later they were again observed forming dense clouds at and near the surface of the lake off the Norris boathouse. A 4-drachm vial was simply dipped into the water and about 100 of the creatures were secured.

A quantity of plankton collected July 7, 1909, and examined qualitatively by Professor A. A. Doolittle of the department of biology, Washington, D. C., high schools, gave the following results:

Species.	Per cent.
Diaptomus oregonensis Lilljeborg	0.38
Cyclops leuckarti; (*edax* Forbes)	4.11
Diaphanosoma leuchtenbergianum Fischer	0.40
Daphnia retrocurva Forbes, var	1.06
Daphnia hyalina Leydig	84.02
Total	99.97

The Copepods (free-swimming species) frequently bear attached Protozoa, sometimes in such numbers as to make them appear bristly. They seem to be more abundant in winter when the lake is covered with ice. Whenever holes are cut through the ice these crustaceans often come crowding to the light and air.

The Cladocera are, generally speaking, the larger and more showy element of the crustacean plankton. Their stomach contents, which at times forms conspicuous masses, was found to be composed largely of phyto-plankton elements, especially *Botryococcus brauni*, which, because of its color, was easily recognizable. One of the smaller Cladocera, *Chydorus*, was found to constitute an important part of the food of the Unionidæ or mussels of the lake, as it also does of the small fishes.

One of the most notable species of the Zoo-plankton was *Leptadora hyalina*. This is usually a deep-water species, but on September 2, 1906, it was taken in quantities in a surface tow-net in Outlet Bay. Though one of the largest of the plankton crustaceans, this species was so transparent as to be quite invisible except by its movements among the associated individuals of *Lyngbya*.

Two other species of Entomostraca not usually classed as plankton were noted, namely, the fairy shrimps. One, *Branchippus serratus*, was found dead in large numbers floating on the surface in deep water July 11, 1899. Later in the same day considerable numbers were seined in shallow water off Norris Inlet. Again, on August 21 and 31, a few were seen floating.

Another species, *Branchippus vernalis*, was found abundantly in small temporary ponds west and south of the lake in the spring of 1901. A school of these curious crustaceans of delicate structure and pearly appearance. apparently usually swimming on their backs, their numerous gill-feet moving rapidly in the water, makes a very pretty sight.

The Parasitic Copepods are reported on by Dr. Wilson. It may be here remarked that, as compared with other bodies of water, these forms are comparatively rare in Lake Maxinkuckee. In certain rivers which we have examined, particularly the Kankakee, Maumee, and sloughs along the Mississippi, certain large species of *Lernaeocera*

are so abundant during the summer and fall that they infest most of the rock bass, crappies, and bluegills. They seemed to be worst on the rock bass, nearly every one of which was bleeding in one or more places where these parasites had fastened in their skin. At this season these fishes are said to be "wormy" and are rejected by anglers and others who chance to catch them.

The Isopods or *Sowbugs* are represented at the lake by two aquatic species, one in the lake proper, the other (*Porcellio scaber*) in the woodland ponds and in damp places. The lake species is abundant all the year round among the Chara, especially in Outlet Bay. It is one of the most important fish foods, particularly of rock bass and bluegills. It sometimes forms the greater part of the food of those species. Little or nothing was learned of the habits of the pond species. There are, of course, several land species of these curious crustaceans.

The Amphipods are represented by several species in the lake and the neighboring ponds. A large species (probably *Gammarus pulex*) was found near the shore, and a smaller form (probably *Hyalella knickerbockeri*) farther out in the lake among the aquatic plants. The Horsetail (*Ceratophyllum demersum*) was one of its favorite haunts. Some of our herbarium specimens of this plant were found full of these beach fleas. Many specimens were obtained from the plants raked up from various depths. The Amphipods could be obtained by washing the plants in a tub or bucket of water. A few were taken at night in the towing-net. Some were found in stomachs of fishes seined August 3, 1906, south of Arlington station.

The freshwater shrimp (*Palæmonetes exilipes*) was not common in or about the lake. Only a few were obtained, one on August 2, 1899, one on September 6, 1899, and one on October 23, 1900, all in the Outlet. Two were secured in Lost Lake, one on August 1, the other September 1, 1900. Another was taken November 27, 1900, upon a mass of aquatic plants dredged some distance from shore in the lake. This species therefore appears to be rather rare at this lake. In Little River near Aboite, Allen County, Indiana, immense numbers of this shrimp were found in masses of *Ceratophyllum*, from which the transparent creatures jumped with great alacrity when hauled up out of the water. They were found in great abundance also in Chester River near Chester, Md.