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Three Southeastern Minnesota Lakes as Possible Habitat For *Hexagenia* Mayflies¹

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Three small lakes near Winona, Minnesota, were sampled to determine if they supported populations of *Hexagenia* mayfly nymphs. *Hexagenia* nymphs were rare in Lake Winona and the Gravel Pit, and none was found in Crooked Slough. A low dissolved oxygen content at the mud-water interface is probably the limiting factor in Lake Winona and Crooked Slough. The limiting factor in the Gravel Pit is probably the bottom type.

In June, 1961, work was begun at Winona State College to determine the environmental factors that influence the emergence time of *Hexagenia* mayflies from the Upper Mississippi River. One phase of this project was to determine if *Hexagenia* mayflies occurred in any of the small lakes near Winona, Minnesota. It was hoped that comparisons could be made between mayfly emergence time in the lakes and in the Mississippi River.

Methods and Materials

Samples of mud from the bottoms of three lakes were obtained with an Ekman dredge that had a sampling area of 36 square inches. The collected organisms were separated from the mud by means of a pail-type sifter similar to that described by Fremling (1961). Small amounts of debris were placed in clear water in a large, white enameled pan. Most macroscopic animals were conspicuous by contrast and by their swimming movements. A binocular dissecting microscope was used to examine the invertebrate animals, all of which were identified according to Pennak (1953). Sampling stations in the lakes were established to include various water depths, types of vegetation and bottom types. Five dredge samples were usually taken at each station. Water samples were taken during the winter and early spring to determine the level of dissolved oxygen in the lakes under study.

Lake Winona

The body of water that was investigated most thoroughly in this study was Lake Winona. The lake, an abandoned river channel, is about 600 feet above sea level (Schwartz and Thiele, 1954). A large sand bar separates it from the Mississippi River; the city of Winona is located on this bar. The lake was dredged in 1916 to obtain fill for building and to construct a dike road that would divide the lake into two parts connected by a narrow opening under a bridge. The lake was dredged again during 1951 and 1952 to increase the depth to 8 feet. A third dredging in 1957 and 1958, was done along the Winona shore to develop beach facilities.³

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³ Personal interview with Mr. Michael Bambenek, Director the Park Board, Winona, Minnesota.

The Minnesota Conservation Department (1960) has described Lake Winona as a medium sized, hard water lake of moderate fertility. The maximum depth is 45 feet. Eighty-seven per cent of the lake is shallower than 15 feet and the median depth is 9 feet. The upper lake is the smaller, with an area of about 85 acres, while the lower lake is much larger with an area of 235 acres.

According to tests made by the Minnesota Conservation Department in 1953, the thermocline occurred at a depth of from 15 to 20 feet in July and August. Tests in September, 1960, showed the thermocline to be between 10 and 25 feet. The dissolved oxygen concentration in parts per million at depths of 15 to 20 feet were 0.9 and 0.4 in July and August, 1953. In September, 1960, at the same depths, the counts were 7.6 and 5.2 ppm.⁴

During the summer months, a heavy algae bloom that generally begins in the upper lake gradually spreads over the entire lake. The algae and heavy growth of rooted plants often necessitate copper sulfate applications to render the lake more desirable for swimming and fishing. The City of Winona treated the lake with copper sulfate three times in 1960. The first treatment consisted of 1,800 pounds, the second, of 1,000 pounds and the third, of an unknown quantity.

The lake bottom is composed of layers of decaying plant material and silt that is brought into the upper lake by a creek. This type of bottom is considered to be good habitat for burrowing mayflies and the food supply should also be adequate since the mayfly diet is composed mainly of mud and the contained algae and plant debris (Hunt, 1953; Fremling, 1960). The lake is in most places less than ten feet deep and many investigators have found *Hexagenia* mayflies at these depths in other waters. Although most habitat requirements seemed to be met in Lake Winona, extensive sampling located very few *Hexagenia* nymphs. Among the most numerous macroscopic arthropods were midge larvae of the family Tendipedidae. On May 27, 1961, one *Hexagenia bilineata* nymph was recovered at the lower end of the lower lake. Intensive sampling in the same area on September 9, 1961, and January 6, 1962, produced no *Hexagenia* nymphs. On January 6, 1962, samples were

⁴ Personal communique from the Minnesota Conservation Department, St. Paul, Minn.

taken through the ice at three locations in the lower lake. Again, no *Hexagenia* nymphs were found. A list of other organisms found during the sampling is presented in Table I.

TABLE I. Macroscopic organisms collected during the sampling of three small lakes near Winona, Minnesota:

Organisms	Gravel Pit	Lake Winona	Crooked Slough
<i>Hexagenia</i> sp. (Ephemeroptera)	1	1	0
<i>Baetis</i> sp. (Ephemeroptera)	0	2	0
<i>Caenis</i> sp. (Ephemeroptera)	1	0	2
<i>Chaoborus</i> sp. (Diptera)	7	1	147
<i>Culicoides</i> sp. (Diptera)	0	0	6
<i>Chironomus</i> sp. (Diptera)	4	294	32
Order Trichoptera	1	0	22
Sub-Order Zygoptera (Odonata)	0	0	14
Order Amphipoda	0	0	10
Class Nematoda	1	0	6
Class Oligochaeta	13	4	7
Class Hirudinea	0	5	4

Gravel Pit

The Gravel Pit is a man-made lake located approximately three miles northwest of the Winona city limits. Digging of the Gravel Pit began in 1908. The material excavated was almost entirely gravel with only a thin layer of soil on the surface. As soon as digging reached the level of the river, water began to seep into the pit. The Gravel Pit was abandoned in 1958 when it had a maximum depth of 30 feet and an area of 120 acres.⁵ The water in the Gravel Pit remains very clear all year. There is no inlet or outlet and the water level is controlled by the river through subterranean seepage. Sampling in June, 1961, revealed that very little silt had accumulated on the gravel bottom of the pit.

Water depth in the Gravel Pit was quite similar at each dredging station, ranging from 17 to 20 feet. Among the most numerous organisms found were members of the Class Oligochaeta. One mayfly of the genus *Hexagenia* was recovered and, also, one of the genus *Caenis*. Other organisms included midges of the families Tendipedidae, and Culicidae.

⁵ Personal interview with Mr. Sill Kohner, Winona Aggregate Company.

Crooked Slough

Crooked Slough, an isolated channel of the Mississippi River, is located about three miles north of the Winona city limits. A dike constructed between Crooked Slough and the river has cut off the inlet stream and left only a narrow creek as an outlet stream. Water enters Crooked Slough by runoff and by subterranean seepage from the nearby river. Its proximity to the river insures ample exposure of Crooked Slough to *Hexagenia* mayflies.

All samples from Crooked Slough were collected on May 31, 1961. The water depth ranged from 5 to 33 feet and the substrate consisted of soft muck, sand, gravel and combinations of each. No *Hexagenia* nymphs were recovered. A list of macroscopic organisms recovered from Crooked Slough are presented in Table I. Oxygen samples were not taken but the depth, lack of circulation, types of organisms found and composition of the bottom indicated that an oxygen deficiency probably existed at the bottom during much of the summer.

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