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LIMNOLOGY OF THE MIDDLE MISSISSIPPI RIVER AND ADJACENT WATERS. II. OBSERVATIONS ON THE LIFE HISTORIES OF SOME AQUATIC DIPTERA

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In the course of a study of the limnology of five lakes on the leveed floodplain of the Mississippi River near Quincy, Illinois, observations were made on the life histories of a number of aquatic dipterans. The lakes occupied depressions formed by stream action on the floodplain and were very shallow, ranging in depth seasonally from one to four feet. The bottoms were muddy, and there were no submerged or floating aquatic plants. Morphometric data are summarized in Table 1. Further information on morphometry and physical and chemical characteristics is included in a report on the general limnology of the lakes (Dorris, *in press*) which, with the present study, is taken from a thesis submitted in partial fulfillment of the requirements of the Doctor of Philosophy degree in Zoology at the University of Illinois under the direction of Dr. Max R. Matteson. I am indebted to Dr. Selwyn S. Roback for his kind assistance in checking the identity of the larvae.

Data are available for the three-year period from August, 1949, to July, 1951. Dredge hauls were made at approximately monthly intervals from stations located near the middle of each lake. The length of insect larvae taken in these collections was measured, and the following analyses are based largely on the length-frequency data.

Coelotanypus concinnus (Cocquillett).—The larvae of this species occurred occasionally in small numbers in all of the lakes. A series obtained from Goose Lake indicates that this species has a two-year life cycle. Figure 1 shows the length-frequencies calculated as percentages of the sample number. The size range of the larvae was 3 to 11 millimeters. Apparently, larvae under three millimeters in length passed through the screen (40 meshes per inch). The larvae pupated after reaching a length of 10 to 11 millimeters.

At any time, the population of *Coelotanypus concinnus* consisted of individuals of two size groups (Fig. 1). The larger individuals present in August, 1949, were designated as Class I. By September, 1950, these larvae had all emerged. The smaller individuals of this population were designated as Class II, and by October, 1950, they had grown to a length of six to nine millimeters. At that time, Class II was associated with larvae three to four millimeters long which presumably were hatched during the summer of 1950 and were designated as Class III. By October, 1951, all of Class II had emerged and Class III had grown to a length

of six to nine millimeters. With Class III at that time was a group of smaller larvae, designated as Class IV. Class III attained a size of six to ten millimeters by July, 1952, and Class IV was composed of individuals four to five millimeters long. At that time, a number of larvae three millimeters long probably constituted a new class, Class V. The growth of the members of a class or brood was slow after the attainment of a length of three millimeters. The mode of a class usually did not move into the next size-range until May or June of the summer following hatching. In the second summer the larvae grew to maturity and pupated.

The presence at all times of two modes in the population and the progressive movement into larger size-intervals over a two-year period indicate that this species has a two-year life cycle in these lakes.

Pelopia (= *Tanypus*) sp.—The

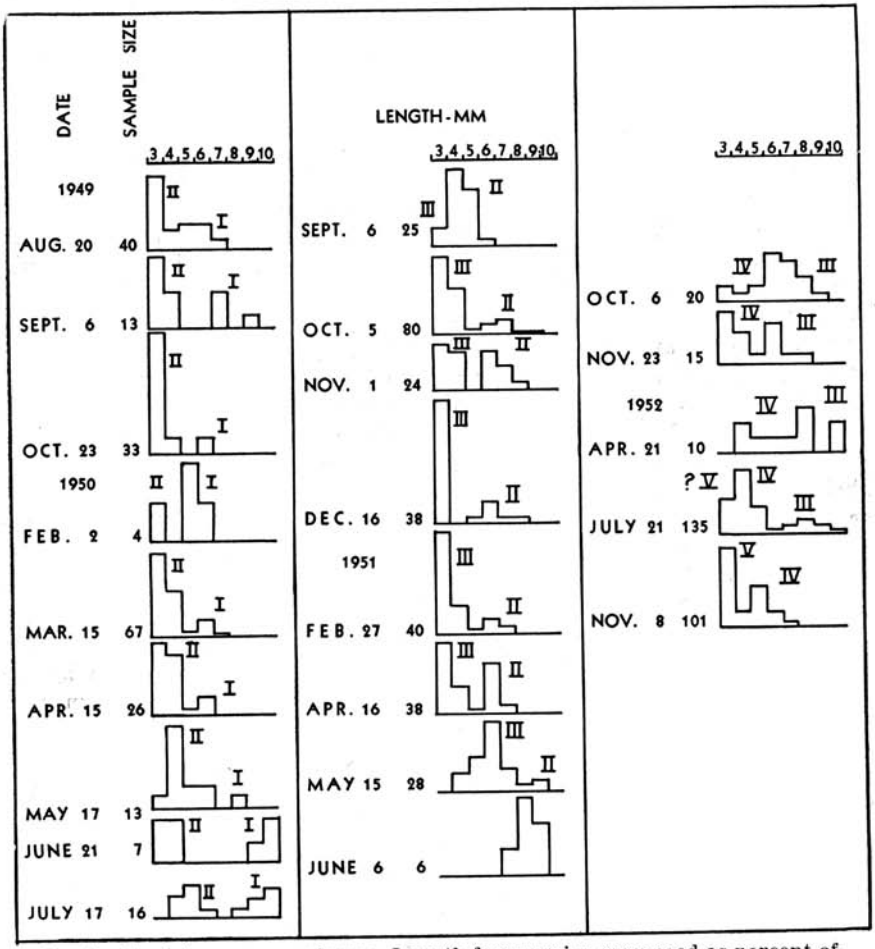

FIG 1.—*Coelotanypus concinnus*. Length-frequencies expressed as percent of sample; age classes indicated by roman numerals.

larva of this species has not been associated with the adult stage and has no specific name as yet. It was called *Tanypus* species B by Malloch (1915). The larvae appeared as serotinal components of the open-water bottom-fauna from late May until September. During the remainder of the year they were completely absent from the bottom of the open water. Collections made near shore during the winter indicated that the larvae were in this area during that season, but they were never found in as large numbers as in the open lake in summer. The graphs (Fig. 2) indicate that this species may have a two-year life cycle in these lakes. There was a bimodal distribution of the larvae at the time of their first appearance in the open water in June, indicating the presence of both young and old larvae. Pupal respiratory horns were not developed until late summer, indicating pupation and emergence at that time. The rather large number of small larvae still in the population at the end of the summer appeared to carry over until the next summer.

Procladius spp. — Lindeman (1942) quoted from the manuscript of Wood (1938) and constructed a graph from Wood's data which showed a reduction in the population of *Procladius* larvae in April and again in late July at Lake Minnetonka, Minnesota. These data were interpreted as indicating the presence of two broods of *Procladius* in Lake Minnetonka. Moffett (1943) reported two generations of *Procladius* each year in the littoral of Douglas Lake, Michigan. Malloch (1915) found adults of *Procladius*

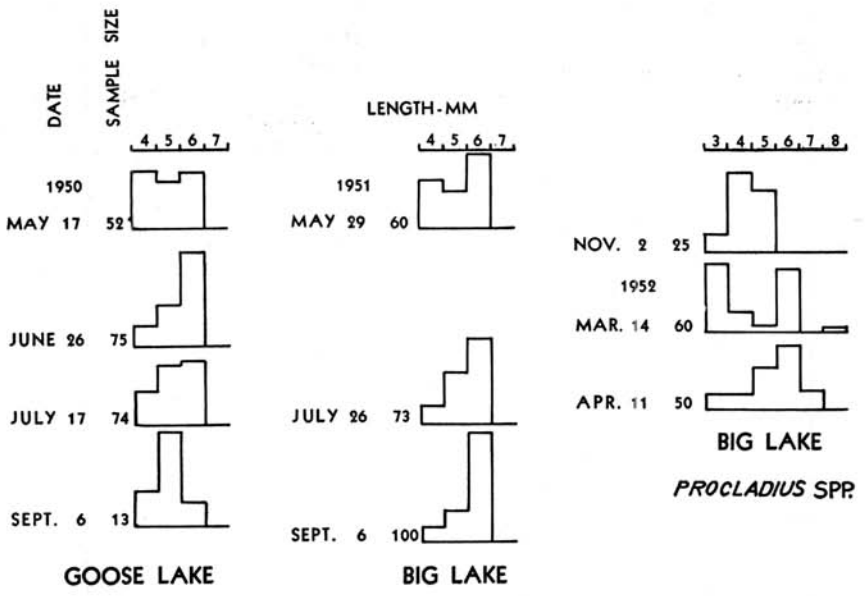

FIG. 2.—Length-frequencies of midge larvae from various localities.

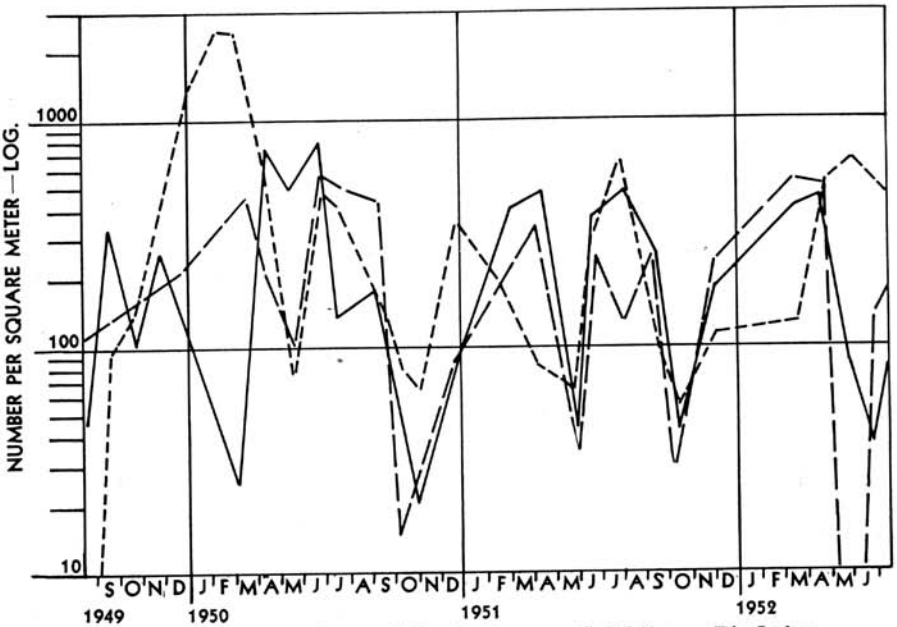

FIG. 3.—Seasonal abundance of *Procladius* spp. Solid line = Big Lake; broken line = Sand Lake; dotted line = Hagerbamer Lake.

culiciformis from April to October in Illinois.

In the lakes of the present study, the numbers of *Procladius* larvae frequently reached a peak in March or April and declined to a low point in early summer (Fig. 3). Emergence of adults may have begun in March, since advanced larvae with well-developed pupal eyes were found as early as March 6. All of the larvae present at the low point in early summer were small.

A second peak in numbers of *Procladius* larvae occurred in the summer, and the emergence of adults of this population resulted in a decrease in October. The larvae which hatched from eggs laid by adults of this second population apparently did not develop rapidly. There was often a continuous increase in numbers throughout the winter, perhaps because the larvae were attaining sufficient size to be retained by the collecting screen.

The large number of small larvae present in the March collection from Big Lake (Fig. 2) may have been larvae newly hatched from eggs laid the preceding summer or they may have hatched before the winter began and did not grow large enough to be collected until March.

These data indicate the presence of two broods or two populations of *Procladius*. Larvae of the species of this genus cannot be separated satisfactorily (Johannsen, 1937). *Procladius culiciformis* (L.) and *Procladius* nr. *adumbratus* Johannsen have been provisionally identified from a few pupae collected from these lakes. *Procladius culiciformis* was probably the more common of the two species. Pupae of *Procladius*

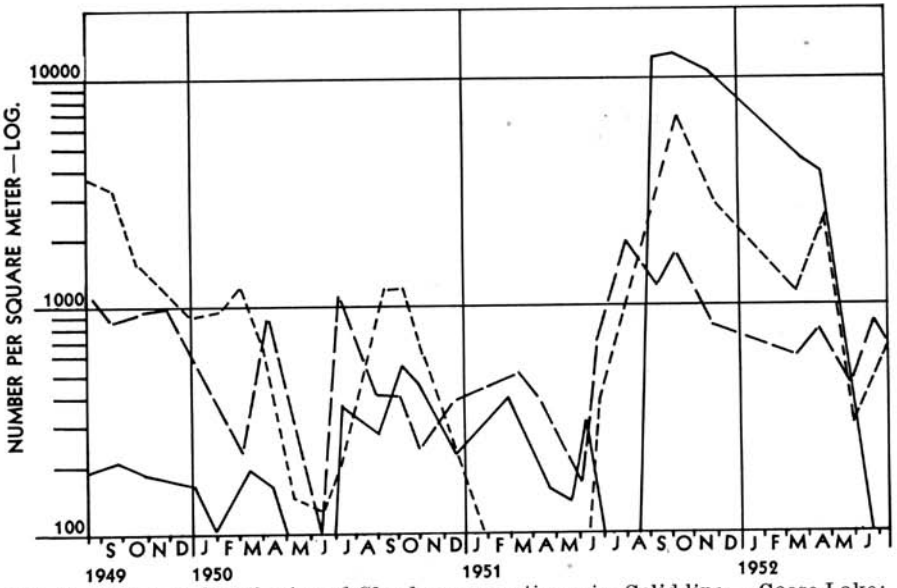

FIG. 4.—Seasonal distribution of *Chaoborus punctipennis*. Solid line = Goose Lake; broken line = Big Lake; dotted line = Hagerbamer Lake.

nr. *adumbratus* were found in the late summer and early fall, and this species may have made up part or all of the second population. The interrelations of the species of *Procladius* will require further study.

Chaoborus (= *Corethra*) *punctipennis* Say.—Larvae of this species formed an important part of the bottom fauna in the lakes of this study (Fig. 4). They exhibited pronounced seasonal fluctuations in abundance. A midwinter decline in numbers frequently was followed by a sharp increase in the early spring population in February, March, or April. Such increases were observed as follows: at Big Lake in April, 1950, and in April, 1952; at Mud Lake in February, 1951; at Hagerbamer Lake in March, 1950, and in April, 1952; and at Goose Lake late in January, 1950, and in February, 1951. A midwinter decline followed by an increase in the spring has been reported by a number of other investigators. Moore (1950) found that the decrease occurred in January and the increase in March in Lake Providence, Louisiana, and suggested that a sampling error might account for the decrease. He discounted this possibility, however, since it did not apply to other organisms. Deevey (1941) reported a very irregular winter population of *Chaoborus* in Linsley Pond, Connecticut. The mean population increased from a low point in early September to a high point in late October. Then there was a sharp decrease early in December, and an increase to a second winter peak in January. Another sharp decrease in February was followed by a new high point in April. Deevey explained these variations as being caused by migration into deeper water. Migration may have accounted for the low

TABLE 1.—Summary of Morphometric Data from Lakes on the Leveed Floodplain of the Mississippi River near Quincy, Illinois.

	Big Lake	Goose Lake	Hagerbamer Lake	Mud Lake	Sand Lake
Location	T1S, R9W S22, 26, 27	T1S, R9W S10	T2S, R9W S22	T2S, R9W S35, 36	T2S, R9W S35
Main axis	NNW-SSE	NNW-SSE	WNW-ESE	NW-SE	NW-SE
Area (acres)	56	63	24	39	42
Maximum length (feet)	6770	5030	1770	4660	4400
Maximum width (feet)	950	1120	740	540	580
Length of shoreline (feet)	17,400	12,620	5360	11,640	11,840
Depth (inches)	14-48	24-78	11-36	12-65	16-60

point in December, but even the deeper parts of Linsley Pond showed a decrease in February. Juday (1921) found a low point in the *Chaoborus* population in Lake Mendota, Wisconsin, in February, followed by an increase at the end of March. Berg (1937) found a low point in March in Esrom Lake, Denmark, followed by a high point in April.

Midwinter or late winter declines in the numbers of *Chaoborus* larvae may be accounted for by mortality of the larvae. The phenomenon is of too wide occurrence to be caused by a sampling error. The increase in numbers which follows shortly afterwards is remarkable, since it may occur even under the ice, as in Lake Mendota and Linsley Pond. Deevey's hypothesis of migration does not account for this increase, since the same thing appears to happen in all of Linsley Pond. The increase might be only in the numbers of younger larvae, which would involve a new hatch from eggs. Deevey (1941) gave length-frequencies for *Chaoborus*, but there were no small larvae in his collections in the midwinter or early spring. Lindeman (1942) found young larvae in April and suggested an early spring emergence of adults to account for their presence. However he could not find adults at that time of the year, and there were no pupae in the bottom population. As an alternative hypothesis, he suggested that these young larvae may have been hatched late and from eggs deposited during the preceding summer. Collections from the present study were examined for evidences of late hatching. At Hagerbamer Lake, April 20, 1952, 4.8% of the larvae were about 4 millimeters long, while all of the rest were 6 or 7 millimeters long. These small larvae were not newly hatched, however, since on March 14 small larvae

were present (2.2%), and also on November 24, 1951 (7%). These small larvae probably hatched late in the preceding summer and had not reached a very great size before winter stopped their development. A few four-millimeter larvae were found at Mud Lake, February 22, 1951, and at Big Lake, April 11, 1952. Even if any of these larvae had been newly hatched, their numbers were not sufficient to have accounted for the spring increase.

The hypothesis of late winter hatching in this species is disputed by other information. The latest date on which pupae were found was September 26, 1949, at Goose Lake. Collections made as late as September 18 on other occasions have failed to produce pupae. Almost all emergence usually occurred by the middle of September. Water temperature at this time was still well above 15°C and was probably nearer 20°C. Juday (1921) reported that eggs from captive females hatched within 48 hours at temperatures of 21 to 24°C. It is very probable that all eggs were laid while the water temperature was still high enough to permit development to begin immediately; thus there is little reason to expect a late winter hatch. There is some evidence that emergence may occur before pupae are found in the collections. At Big Lake, June 23, 1950, 10% of the larvae were small forms of the four-millimeter size. There is a possibility that these young forms were hatched from eggs laid by adults which had their origin elsewhere.

The larvae of *Chaoborus punctipennis* are occasionally limnetic in distribution, and it well may be that the peculiar winter distribution of these larvae is in some way connected with this habit. However, no *Chaoborus* larvae were ever found in plankton collections made in the course of this study.

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