A SURVEY OF THE INSECT BOTTOM FAUNA OF A LIMITED AREA OF WINTERGREEN LAKE, KALAMAZOO COUNTY, MICHIGAN

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AN ABSTRACT

Submitted to the College of Science and Arts Michigan State University of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Department of Entomology

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ABSTRACT

A survey of a limited area of Wintergreen Lake, Kalamazoo County, Michigan was conducted to determine the nature and quantity of the bottom insect fauna, the communities of insects that may exist there and certain aspects of the biology of insects that were present in sufficient quantity to be studied.

From January 12, 1957 to December 28, 1957, Ekman dredge samples were taken monthly from six stations along a longitudinal transect of the lake. A total of 13,394 specimens were collected in 144 samples for a yearly average of 3,348 specimens per square yard. Sixteen families from seven orders were represented. *Chaoborus*, *Leptocerus*, *Tendipes* "A", *Glyptotendipes* and *Tanytarsus* were the five most important groups collected.

The genus *Chaoborus* and *Leptocerus americanus* (Banks) were the two most prevalent taxa. The genus *Chaoborus* was associated with the deeper water and *Leptocerus* was most common in *Ceratophyllum* beds in the shallower parts of the lake.

Tendipes "A", a complex of several species of the subgenus *Tendipes*, was the third most prevalent group and the most generally distributed in the lake. The greatest concentration of *Tendipes* "A" was in the shallower areas of the lake.

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INTRODUCTION

The magnitude of pollution, erosion, algal blooms, fertilization, and insecticide contamination in lakes and streams are often measured by their effects on biological conditions. Insect populations, because of their importance in aquatic ecology and their relative ease of being sampled, are a convenient index of general biological conditions.

The effects of a large population of waterfowl on Wintergreen Lake has led some observers to believe that the insect production in the lake may be high. This hypothesis had not been supported by facts from any previous survey. To conduct a complete survey on Wintergreen Lake without disturbing the birds in sanctuary there was not possible, so the present study was restricted to a limited area of the lake. The value of a restricted survey was considered, and, in view of valuable data obtained with limited sampling by other investigators of other lakes, it was concluded that the present study could be worthwhile.

Therefore, the purpose of this study was to determine with a limited amount of sampling, (1) the nature of the bottom insect fauna of Wintergreen Lake, (2) the habitat of certain insect communities that existed there and (3) the life cycles of those insects that were present in sufficient quantity to be studied.

LITERATURE REVIEW

Attempts to assess aquatic bottom faunas have resulted in a variety of techniques, but procedures have not been standardized.

The following examples are cited to illustrate the variety of techniques and extent of sampling used by reputable investigators. There is no intent to make critical comparisons, since each survey was associated with a different problem, and the interpretation of results were also different.

Adamstone (1924) formed conclusions about the productivity of Lake Nipigon (Area, 1,750 square miles) on the basis of data from 16 series of samples taken over a three year period. Eight to ten hauls with an 81 square inch Ekman dredge on a single date comprised a series. Eggleton (1931), in his study of the profundal bottom of three lakes, used a 36 square inch Ekman dredge to take 1,331 samples from Douglas Lake, Michigan; 403 from Third Sister Lake, Michigan; and 145 from Kirkville Green Lake, New York. Not all of the samples from Douglas Lake and Third Sister Lake were from the profundal zone. The field work extended over a period of 5½ years with intermittent curtailments. In making a survey of a moorland pond, Macan (1949), at various times, used a special grab-type sampler, a Petersen grab, a pond net and a floating cage to trap emerging adults. The study was for a duration of 5 months. To determine the seasonal food-cycle dynamics in a 14,480 square meter lake, Lindeman (1941) took a total of 338 samples in 30 series. The samples were taken at three different zones with a 36 square inch Ekman dredge.

Lack of sufficient prior knowledge of sampling conditions, or heterogeneity of sampling sites, sometimes makes the design of sampling procedures difficult. Eggleton (1931) encountered bottom types that varied from thick ooze to hard sand, and the number of dredge hauls to complete a sample were therefore varied from 5 to 50. Macan (1949) designed a grab-type sampler to cope with areas that were especially weedy, but he was uncertain of the effectiveness of the sampler in capturing certain insect forms, so a pond net was used to supplement his grab-type samples. However, to correlate results of samples that are not uniformly collected is not statistically correct, unless the intention is to compare methods.

Tent trapping of emerging adults and bottom sampling of immature forms have been used together in attempts to obtain more valid assessments of production in lakes and streams by Macan (1949)and Ide (1940). Scott and Opdyke (1941) found little or no correlation between number of emerging insects and the numbers of larvae and pupae sampled from the bottom. Guyer and Hutson (1954) correlated tent trapping results with those of Ekman dredge samples to determine the efficiency of sampling techniques and obtained significant results with a moderate amount of sampling.

Needham and Usinger (1956), in a study to determine the extent of sampling necessary to obtain significant results in

a single riffle, found, that to estimate the total wet weight of organisms in the 30 by 100 foot area, 194 square foot Surber samples would be needed to give significant figures with 95 percent confidence, and 73 samples would be sufficient to insure the inclusion of the most common genera.

Harris (1957) presented a short statistical method for determining the efficiency of past sampling methods in a stream. The efficiency rating (based on the number of species found in a number of independent sets of samples) may be used to determine the number of samples to take in subsequent series to include a reliable representation of the insect fauna present. This method has application in routine pollutional surveys, but the extent of sampling necessary in preliminary surveys is still governed by the intuition of the investigator.

Due to the num erous variables in survey methods, such as those mentioned, it is difficult to compare the findings of different investigators, except in very general terms.

The following discussion presents representative bottom faunal studies. For convenience the generic names with priority, Tendipes and Chaoborus, are used instead of Chironomus and Corethra when the latter names were used by authors being cited.

In his study of the relationship between fish-food and feeding habits of fish in Third Sister Lake, Ball (1948) presented the quantitative fish-food data in terms of volume and numbers. From April 1939 to May 1941 invertebrates were collected from submerged plants and from the bottom with an

Ekman dredge. Sampling was confined to the shallow areas which were the most productive of fish food organisms. The results of the plant samples taken from May to October 1939 are best given in Ball's own words. "The most abundant organism, both by number and by volume, was the caddis. This insect outnumbered even the ever-present midge larvae on the plants of the lake, and comprised nearly twice the volume of the nearest other group, the libelluline dragonflies. The caddis larvae constituted 51 percent of the total volume and 42 percent of the total number of organisms. Next in importance in number and volume were the dragonflies, followed by damselflies, snails, midges and leeches in the order named. None of the other invertebrates made up more than 1 percent of the total."

For the same period, the volumetric abundance of organisms in bottom samples was dragonfly nymphs, Trichoptera larvae, leeches and midge larvae, named in order of decreasing volume. The first two groups constituted 70 percent of the total production. The descending order of numbers was, caddis larvae, midge larvae, scuds, damselfly naiads and mayfly naiads, all of which constituted about 90 percent of the total number organisms collected. In the 1940 bottom sample series, Odonata naiads, Trichoptera larvae and midge larvae constituted 60 percent of the number and 70 percent of the volume of the macroscopic invertebrates The scud, Hyalella, was most numerous, but volumetrically represented less than 1 percent of the total. Midge larvae also were much more numerous than the trichopteran larvae, but only had a third as much bulk.

The bottom sampling data in 1941 extended only from April 1 to May 16, and during this interval of time a difference in composition of the organisms was evident. Midges alone accounted for 55 percent of the total numbers, and Hyelalla and mayfly naiads ranked next, constituting 12 percent and 10 percent of the total organisms respectively. The descending order by volume was Odonata naiads, midge larvae, snails and trichopteran larvae. Hyalella and mayflies, that were numerically important, comprised only 3.62 percent of the total volume.

Whereas Ball considered the littoral and sublittoral zones of Third Sister Lake, Michigan, as the most productive of fish-food organisms, Borutsky (1939) considered the profundal zone to be important also in Lake Beloie, U.S.S.R., and limited his paper to the study of the profundal zone. The important organisms of the area studied were Tendipes plumosus (Linnaeus), Chaoborus spp. and Oligochaeta, and of less importance Tanypus spp. Other organisms found in small numbers in the profundal zone, but highly important in the littoral zone were not considered.

Johnson (1933), in reporting on the productiveness of nine Minnesota lakes, found that most of the lakes had a predominant Tendipedid population. Chaoborus spp., annelids or amphipods were sometimes the most abundant or were a major constituent in some of the lakes. In one lake, Lake Pepin, bivalve mollusks were numerous and ranked second to tendipedids. In each of the lakes, two Ekman dredge samples were taken from each of four types of habitat, the deepest part of the lake, the shallower vegetationless zone, the submerged vegetation zone and the emerging vegetation zone. Classification of lakes according to the kind and abundance of bottom fauna was mentioned by Johnson, but no attempt was made to fit the Minnesota lakes into such a classification. Brundin (1949) and other European workers have also used invertebrates in classifying lakes.

Pearcy (1953) presented bottom fauna data from Clear Lake, Iowa, that indicated the biomass to be greater in deep water than in shallow water except in October. Hyalella and tendipedids together comprised 85.8 percent of the total volume of organisms in shallow water and 89.1 percent of the total number. In deep water the tendipedids, predominantly Tendipes tentans (Fabricius), constituted 94.5 percent of the fauna by volume and 55.5 percent by numbers. The free-living flatworm, Planaria, comprised 20.6 percent of the number of organisms in deep water.

Macan (1949) found the shallow vegetated area of Three Dubs Tarn to harbor a greater number of species than the area near the middle of the tarn. The number of specimens collected in the shallows were predominantly Hemiptera, Trichoptera and Hydracarina in that order. About half of the total number of organisms collected in the mid-pond region were tendipedids. Mussels of the genus Pisiduim ranked second in numbers and in the spring ephemeropterans of the genus _Caenis_ ranked third. In the summer only one specimen of _Caenis_ was recorded in comparison to 386 during the spring.

Scott, Hile and Spieth (1938), in their investigation of Tippecanoe Lake, Indiana, considered the littoral zone and the three basins in the lake as separate entities. In the littoral zone(.5-1.25 meters) the important groups in order of descending numbers were Amphipoda, Tendipedidae, snails of the genus _Physa_, Hydracarina, Oligochaeta and Ephemeridae. Specimens of the family Tendipedidae alone increased in numbers with increase in depth.

In the depths beyond 3 meters, the important taxonomic groups were _Tendipes_ spp. _Chaoborus_ spp and Oligochaeta. In two of the basins _Chaoborus_ increased in numbers to the maximum depths of 11 and 17 meters. In the deepest basin the number of _Chaoborus_ specimens increased up to the 17 meter depth, and then gradually decreased to 0 at 37 meters at the basin's maximum depth.

The _Tendipes_ distribution varied in each basin. In the deepest basin the population density was 700-1100 per square meter at depths between 11 and 31 meters. The population density decreased to 100-200 per square meter at the 3 meter limit of the basin and to 0 per square meter at the 37 meter depth limit of the basin. In the basin with a maximum depth of 17 meters, _Tendipes_ increased from 400 per square meter at the 3 meter depth to 750-850 per square meter in the 13-17 meter depth range. The shallowest basin showed a steady decrease from 990 per square meter at 11 meter depth to about 25 per square meter at the 3 meter depth.

Many papers have been written on the effect of artificial fertilization on fish-food organisms in impounded waters or small lakes. In a preliminary study of fertilization effects on the bottom fauna in Michigan experimental ponds, Tack and Morofsky (1946) found a tendency toward a general increase in quantity of invertebrates following fertilization. There was a substantial increase in Tendipedidae in treated ponds compared to control ponds. Odonata nymphs and Culicidae larvae also may have been increased in some of the ponds due to fertilization.

Ball and Tanner (1951)made observations of the fertilization effects produced in a lake of low productivity, North Twin Lake, Michigan. Lack of pre-fertilization data of the bottom fauna precluded comparisons of the fauna before and after fertilation. During the time of fertilization the order of importance volumetrically was dragonflies, caddisflies, mayflies and midges. The order of prevalence was midges, mayflies, mollusks, caddisflies, dragonflies and scuds.

Of the many kinds of organism taken during surveys, tendipedids have received much attention, and for this reason are reviewed separately. Tendipedids' frequency, diversity of habitat, importance in aquatic ecology or value as biological indicators of "pollution" has been noted in many papers.

Gaufin and Tarzwell (1952),(1956), and Richardson (1925) reported certain species of tendipedids among the last surviving forms in "polluted" water. Gaufin and Tarzwell (1956) attributed the remarkable ability of Tendipes riparius (Meigen) to thrive in septic and recovery zones of polluted streams to the midge's possession of hemoglobin, which apparently acts in the transportation and storage of oxygen. Walshe (1949) experimentally demonstrated that T. plumosus, T. riparius and related species exhibited complete anaerobiosis for sustained periods of time, and recovered from ill effects in an hour when returned to aerobic conditions. Gaufin and Tarzwell (1956) found species of Tendipes, supposedly pollution tolerant, in clean water, and for this reason cautioned against using tendipedids alone as pollution indicators. The preponderance of tolerant species of tendipedids in septic zones was perhaps due to the quantity of available food, and not due to a septic condition demand. Tack and Morofsky (1946) found a tendency toward increased numbers of tendipedids in fertilized ponds that were able to support fish life.

Though tendipedids are distributed widely in a variety of habitats, and can be found in water that is lethal to many other aquatic insects, they are generally associated with and most abundant in shallow water of lakes, ponds and streams favored by abundant growth of aquatic plants (Usinger, 1956; Miller, 1941).

Tendipedids are found at various depths. Adamstone and

Harkness (1925) found tendipedids in Lake Nipigon at depths of 147 feet, although the greatest populations were at 30 feet or less. Eggleton (1931), Johnson and Munger (1930) and Scott and Opdyke (1941) found tendipedids common in deep water. Johnson and Munger (1930), in their study of Lake Pepin, found tendipedids, Tendipes plumosus (Linnaeus) in this case, to be scarce or absent in shallow water and in the clean bottom of the river. They recorded concentrations elsewhere in the lake as high as 7,000 per square yard with a probable average of 3,000 per square yard during the month of July. Scott and Opdyke found tendipedids common in deep water, but more of these insects emerged from over shallow water, suggesting that tendipedids, like Chaoborus larvae, may migrate horizontally when emerging.

Sprules (1947) stated that factors, such as bottom type, temperature, currents, and other chemical and physical factors, may have more influence than depth in determining the distribution of tendipedids. Curry (1956), in his study of T. staegeri (Lundbeck), found this species in water from 1 inch to 57 feet deep, indicating that depth requirements for this species was not critical.

Temperature and dissolved oxygen are not as critical with tendipedids as with many other insects, but these do exhibit some distributional and biological effects. Time of emergence and generations per year have been markedly affected by temperature. In controlled experiments on Tendipes tentans, (Fabricius) Sadler (1935) found that hatching time varied from

17.5 days at 8.8 degrees Centigrade to 3 days at 22.1 degrees Centigrade. When temperature was not a factor, the duration of the fourth and final instar was unaccountably variable, being from 4-5 days to 2-3 weeks resulting in an overlap of generations. In nature this may be observed as a relatively constant population of larvae with emergences of adults throughout the warmer months. The observed number of generations per year was four plus.

Judd (1953) found that emergences as a whole in Dundas Marsh were at their peaks on the day following a peak in temperature. Since 80 percent of the total trapped insects that emerged were tendipedids, these overall results undoubtedly reflect tendipedid behaviour. Judd recorded the emergence period for *T. tentans* as May 13 to October 15 with a peak on June 2 much in excess of other times. The high emergence of *T. tentans* on one day could be interpreted as indicative of a single generation, but in view of Sadler's (1935) results this could be the result of overlapping generations coupled with the influence of warm weather.

HISTORY AND DESCRIPTION OF LAKE

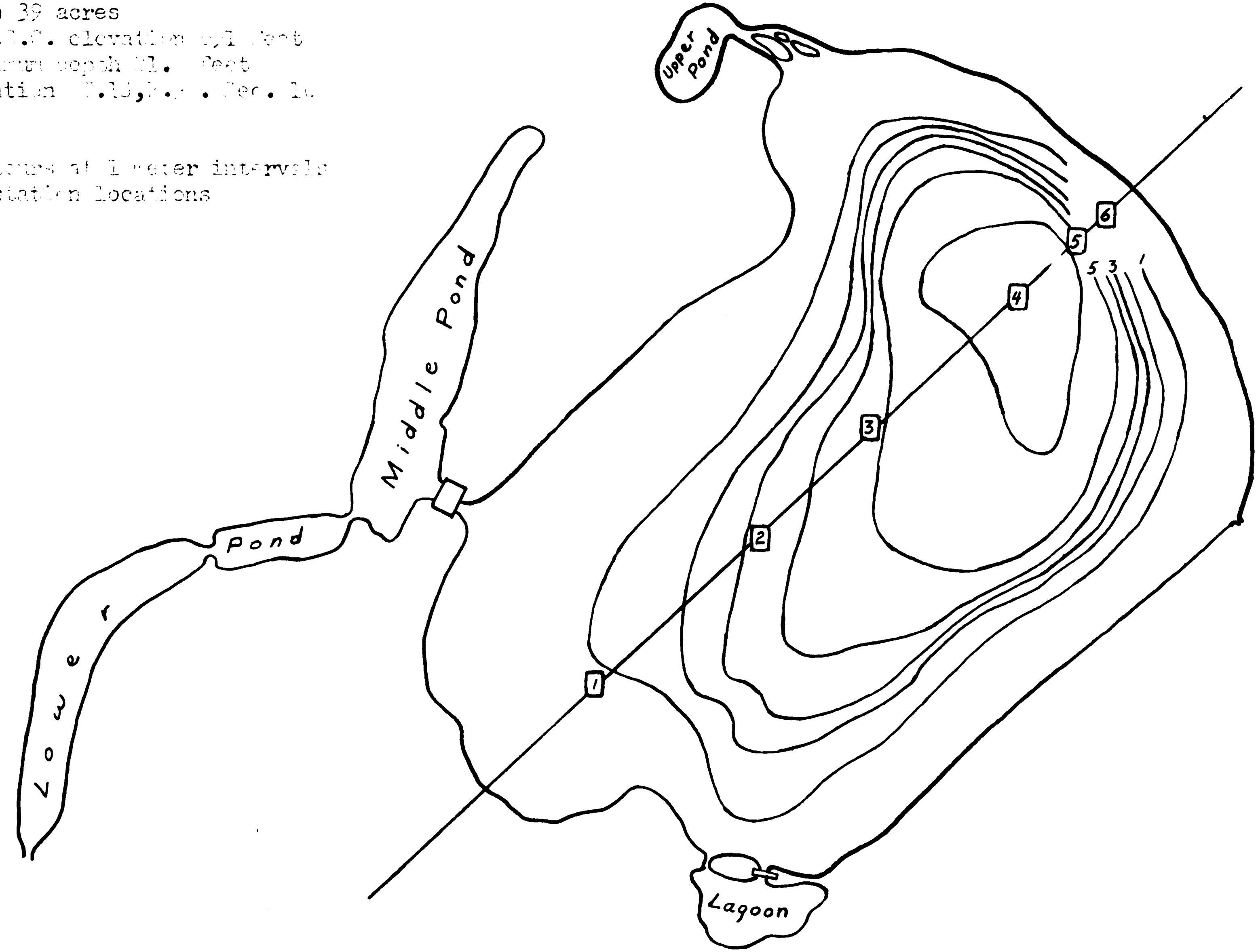
Wintergreen Lake (figure 1), of the Kellogg Bird Sanctuary is located at T1S, R9W; section 8 of Kalamazoo County, and is one of the many lakes of this area classed as a hard water drainage lake. It covers approximately 39 acres and is oval shaped with the greater axis being 1750 feet long and in a northeast to southwest direction. Near the western corner the lake connects with a long oval intermittent pond designated as Middle Pond which covers 2.7 acres. Middle Pond's long axis runs in a north by northeast to south by southwest direction, and its southern end connects with Lower Pond which covers 2.4 acres and is crescent shaped. A line through the cusps of Lower Pond would run in a northeast to southwest direction. The westerly end of Lower Pond connects with Gull Lake by way of a short stream. At its north corner, Wintergreen Lake drains Upper Pond which is also oval-shaped, with its long axis running northeast by north and southwest by south, and is 0.5 acres in area. A water weed filled lagoon is at the southern corner of the lake.

As are most of the lakes of Kalamazoo County, Wintergreen Lake is of glacial origin; its basin probably having been formed by the depression of the earth under the pressure of a huge chunk of ice left by the retreat of the Wisconsin glacier. Such pit lakes are typified by their circumjacent hills and their relatively short life. Aging of Wintergreen Lake is evidenced by the extent of encroaching shoreline.

Figure 1. General features and station locations in Wintergreen Lake, Kalamazoo County, Michigan.

Area 39 acres
U.S.G.S. elevation [illegible] feet
Maximum depth [illegible] feet
Location T.[illegible], R.[illegible], Sec. [illegible]

Contours at 1 meter intervals
▢ station locations



The predominant encroaching vegetation consists of water willow, Decodon verticillatus (L) Ell. and buttonbush, Cephalanthus occidentalis L. Nearly all of the littoral zone of the western half of the lake is occupied by yellow water lily, Nuphar advena Ait, whereas the eastern half of the lake has a sandy shoreline except for a 400-foot Nuphar advena bed at the eastern corner. The submersed plant, coontail, Ceratophyllum demersum L. is confined to a band around the lake between the depths of 4 and 18 feet. Around the 12 foot depth at the southwest end of the lake, there is a scattered amount of the pondweeds Potamogeton pectinatus L., Potamogeton foliosus Raf. and Najas flexilis (Wild) Rostk. et Schmidt. Beyond the 18 foot depth there appears to be no rooted vegetation.

Temperature stratification data taken by Gull Lake Biological Station students in 1956 and 1957 showed that no hypolimnion existed in the lake during the summer stagnation, but a thermocline was present at the deepest part of the lake.

According to a conversation with Mr. VanDeusen, who has occasion to discuss the lake with natives of the area, Wintergreen Lake, prior to 1926, had long been known as an excellent fishing hole. Fetterolf (1952) in his fish population study of the lake reported that the poundage per acre of game and pan fish was higher than in any other lake for which he had records.

In 1926, W. K. Kellogg had acquired all the property

surrounding the lake, and inaugurated operations to maintain the area as a bird sanctuary. Later, in 1929, the property was deeded to Michigan State University to continue the sanctuary's operation. Besides providing a haven for birds, the main objective at the sanctuary has been to study the various aspects of migratory waterfowl. To obtain more complete information to this end, other investigations not in themselves ornithological, have been encouraged. It is for this reason, in part, that this study of the lake was encouraged.

PROCEDURE

A preliminary examination of Wintergreen Lake was made to select sampling sites which would give a satisfactory index of the bottom insects and yet not interfere with the birds in sanctuary. With primary concern for the birds, a random grid selection of sites or numerous cross transects had to be discounted. A median longitudinal transect seemed most satisfactory under these conditions, since it was usually unobtrusive to the birds, it crossed the lake's greatest depth and terminated on shores with littoral zones that were representative of the rest of the lake. The stations along the transect also were not selected at random, but were selected on the basis of depth, bottom type and rooted vegetation. Station 1 was at the southwest end of the transect in 3 feet of water proximal to the greatest concentration of _Nuphar_. The bottom was sand and silt but covered by detritus to the extent that dredge samples seldom contained anything but detritus. Station 2 was in 10 feet of water, and had a bottom that was composed primarily of silt and detritus, the proportion varying with the seasons. A sparse growth of _Potamogeton_ was present but it was rarely taken in any of the samples. The conditions at station 3 were similar to those at station 2 except that there was less rooted vegetation, the proportion of silt to detritus was higher and the depth was 15 feet. Station 4 was at the lake's greatest depth of 21 feet, and was the most constant station as far as consistency of the bottom was concerned. The depth of the ooze was not determined. It was dark black in color and had a consistency that was almost gelatinous. Station 5 was located at 18 feet where the bottom contour declined sharply. This was normally the outer border of the Ceratophyllum bed at this part of the lake, but wind and wave action sometimes caused this vegetation to be scarce or lacking at this spot. Station 5 was by far the most variable in bottom type. It varied from primarily detritus to marl to ooze with a varying amount of rooted vegetation. Station 6 was at the northeast end of the transect in 6 feet of water and Ceratophyllum was always present. The bottom was a composite of marl and detritus.

No definite time limit was set for sampling, but it was agreed with Mr. Van Duesen, who manages the sanctuary, that an attempt would be made to be on the lake for only a short time. Preliminary sampling in October and November of 1956 indicated that even with the assistance of a second man, three or more hours might be required during inclement weather to take two samples at each of seven stations. This amount of time was in excess of what was hoped would be the maximum, but by reducing the stations to six and relying on good weather for sampling, it was thought that this time could be reduced. In view of the variation in intensity of sampling used in the past by other writers, it seemed feasible to obtain valid information even with the restrictions imposed.

The sampling was begun in January 1957 when the lake was frozen and could be walked on. At each of the stations a hole was cut through the ice about 3 feet long and wide enough to accomodate the 6"x6" Ekman dredge and a foot square screen which was placed under the dredge before lifting it from the water. The use of the screen was to recapture any insects that might escape in the overflow from the dredge. A sample was taken from each end of a hole in an attempt to avoid sampling an identical spot. Each sample was emptied into a separate galvanized pail that was labelled with the station number and the letter "A" or "B" designating it as the first or second sample from that station. The samples were then taken ashore where they were preliminarily washed with a 20 mesh screen to remove enough silt so the sample could be stored in a gallon jar. This screen was the same one used during the sampling process. Clear water was added to cover the remaining mud. The reduction of the sample volumes facilitated their transportation to East Lansing when time was insufficient to sort the samples immediately. Usually much of the sorting could be done at the Gull Lake Biological Station laboratories near by. The sampling method was the same when the ice was out except that the sampling was done from a boat. Buoys were used to mark the stations at first, but prevalent high winds caused them to break loose or drift, so beginning with the May collections their use was discontinued altogether, and the landmarks originally used to lay out the stations were relied upon for orientation.

At East Lansing, unsorted samples were kept alive in a constant temperature room held at 15 degrees Centigrade. It was felt that live insects could be more easily detected and sorted, although there was some danger in holding the samples too long because of emergences and predation.

Sorting was a tedious task averaging four hours per sample. Even after thorough rinsing some samples still had a volume of two quarts which was then examined a tablespoonful at a time. These small subsamples were diluted in a half pint of clear water in a white pan and picked over by hand.

Specimens of Chaoborus were difficult to detect even under this condition so the subsamples were poured through a screen after having picked out the other insects. On the screen the Chaoborus were easily seen and handled. After the first four subsamples when no Chaoborus were found and it seemed likely that none would be found, the use of the screen was discontinued for sorting the remainder of that sample.

The insects collected in January and February were kept in Dietrich's fixative for 24 hours before transferring them to permanent storage solution (70% alcohol, 26% water and 4% glycerine). However no particular advantage seemed to be gained with this treatment so all subsequent collections were put directly into vials of permanent storage solution with their collection data labels until they could be identified and tabulated.

PRESENTATION AND DISCUSSION OF RESULTS

The number of samples is admittedly small, a fact of which the writer was aware at the outset, however this was necessitated by the limit of time desired to be spent on the lake during the birds' nesting and migratory periods.

With the number of samples reduced, the probability of getting reliable results was also reduced. Relying on chance that the variation between the "A" and "B" samples would be small, the data were tabulated meticulously as for a more extensive quantitative study.

Great variations between the "A" and "B" samples often did exist, but despite this fact the data on the whole do indicate that a substantial bottom insect population did exist in Wintergreen Lake. The total of 144 samples taken throughout the year with a 36-square inch Ekman dredge yielded a total of 13,394 specimens, or an average of 3,348 per square yard for the year. Sixteen families from seven orders were represented. Dipterous and Trichoptera larvae and pupae constituted 68.8 percent and 26.4 percent of the total collected numbers respectively.

Only five taxa, Chaoborus, Leptocerus, Tendipes "A", Glyptotendipes and Tanytarsus appeared in sufficient numbers to indicate definite facts about their biology. Tendipes "A" is a complex of several species which is elaborated on later in this paper. The data recorded in tables 1-7 show the seasonal variation of the various taxonomic groups. In table 1 the data from a series composed of 12 samples per collection

TABLE I

TOTAL NUMBERS OF INSECTS COLLECTED IN TWO THIRTY SIX SQUARE INCH EKMAN DREDGE SAMPLES PER EACH OF SIX STATIONS PER COLLECTION DATE FROM WINTERGREEN LAKE, KALAMAZOO COUNTY, MICHIGAN

	Jan 12	Feb 9	Mar 16	Apr 5	Apr 26	May 18	Jul 8	Aug 11	Sep 14	Oct 5	Nov 10	Dec 28	Tot.	% of Total
DIPTERA														
Culicidae														
Chaoborus spp.	1439	1685	139	809	829	608	59	36	197	465	166	447	6879	52.74
Heleidae														
Palpomyia spp.	5	8	5	12	23	16	6	9	18	19	15	17	153	1.14
Tendipedidae														
Tendipes "A"	20	5	152	82	122	58	11	0	0	10	78	120	658	4.91
Tendipes "B"	3	1	15	20	19	14	5	0	23	0	34	7	141	1.05
T. nervosus (Staeger)	1	1	0	0	0	17	0	0	0	5	5	24	53	.40
Glyptotendipes spp.	52	16	27		2	7	7		5	335	86	9	546	4.08
Tanytarsus spp.	51	13	160	17		22	4	7	14	220	66	29	603	4.50
Polypedilum spp.		1	3			15	2		1	1	5	1	29	.22
Cryptochironomus spp.			1		2	1	4	3		1		1	13	.10
Pseudochironomus spp.		1	1	5									7	.05
Microtendipes spp.												3	3	.02
Calopsectra spp.			1		1	3	4						9	.67
Pentaneura spp.						1							1	.01
Tanypus spp.				3		2	14						19	.14
Procladius spp.		1	35	21	27	25	4				2	9	124	.93
Anatopynia spp.				2		2						1	5	.04
TRICHOPTERA														
Leptoceridae														
Leptocerus americana (Banks)	244	131	683	428	61	1095	640	10	37	100	57	18	3504	26.36
Triaenodes spp.	2		4	4		4				2		2	18	.13
Oecetis spp.						11	3			2			16	.12
Leptocella spp.												1	1	.01
Psychomyiidae														
Polycentropus spp.			1	2		5				1			9	.07
Phryganaeidae														
Phryganea spp.	1												1	.01
EPHEMEROPTERA														
Baetidae														
Caenis spp.	6	3	5	37	6	68	29	10	28	17	15	45	269	2.01
Ameletus spp.	1	1	1								4	2	9	.07

TABLE 1 (CONT.)

	Jan 12	Feb 9	Mar 16	Apr 5	Apr 26	May 18	Jul 8	Aug 11	Sep 14	Oct 5	Nov 10	Dec 28	Tot.	% of Total
ODONATA														
Coenagrionidae														
Ischnura spp.	4		24	3		39	3		11	10	15	13	122	.91
Enallagma spp.	2	4	7	35		10	1			1	4	4	69	.52
Libellulidae														
Libellula spp.				3		8	1			1			13	.10
Basiaeschna janata (Say)											1		1	.01
Perithemis spp.												1	1	.01
Tetraganeuria spp.				1										
COLEOPTERA														
Hydrophilidae														
Troposternus spp. (adult)							2						2	.01
Dytiscidae														
Bidessus spp.	4				1							1	6	.04
Chrysomelidae														
Donacia spp.	1												1	.01
LEPIDOPTERA				3									3	.02
Pyralidae														
HEMIPTERA														
Notonectidae							2						2	.01
Notonecta spp.										2			2	.01
Corixidae														
Pleidae														
Plea striola Fieber (adult)										1			1	.01
Totals	1836	1871	1264	1487	1093	2031	801	76	334	1193	553	755	13,294	

TABLE 2

TOTAL NUMBERS OF INSECTS COLLECTED IN TWO THIRTY-SIX SQUARE INCH EKMAN DREDGE SAMPLES PER COLLECTION DATE AT STATION 1, IN WINTERGREEN LAKE, MICHIGAN

	Jan 12	Feb 9	Mar 16	Apr 5	Apr 26	May 18	Jul 8	Aug 11	Sep 14	Oct 5	Nov 10	Dec 28	Tot.	% of Total
DIPTERA														
Chaoborus spp.	3												3	
Palpomyia spp.	2	3	1	1	5	4	4		7	7	11		45	7.
Tendipes "A"	2	1	5	25	15	5	2			2	7	8	72	11.4
Tendipes "B"		1	5	11	5	9	1		23		21	2	78	12.
T. nervosus (Staeger)											3	16	19	3.
Glyptotendipes spp.					2	1	5			5	62	2	77	12.7
Calopsectra spp.			1		1	3	3						8	1.3
Tanypus spp.							13						13	2.1
Procladius spp.		1	17	11	8	4	3				1		45	7.
TRICHOPTERA														
Leptocerus spp.	15	61	4	2		10			17	17	38	3	164	27.9
EPHEMEROPTERA														
Caenis spp.		1		1	5	2	28		17	3	10		67	10.9
Ameletus spp.											4		4	*
ODONATA														
Ischnura spp.						2			11		15		28	4.
Enallagma spp.	1	1									3		5	*
COLEOPTERA														
Bidessus spp.	4												4	*
Donacia spp.	1												1	*

*Less than 1 per cent of the total.

TABLE 5

TOTAL NUMBERS OF INSECTS COLLECTED IN TWO THIRTY-SIX SQUARE INCH EKMAN DREDGE SAMPLES PER COLLECTION DATE AT STATION 2, IN WINTERGREEN LAKE, MICHIGAN

	Jan 12	Feb 9	Mar 16	Apr 5	Apr 26	May 18	Jul 8	Aug 11	Sep 14	Oct 5	Nov 10	Dec 28	Tot.	% of Total
DIPTERA														
Chaoborus spp.	1		3			1	1		1	10		3	20	2.1
Palpomyia spp.	3	3	2	5	14	1	2	4	7	11	1	6	59	6.2
Tendipes "A"	8					1					2	6	17	1.8
Tendipes "B"						2						3	5	*
T. nervosus (Staeger)	1	1				15						5	22	2.3
Glyptotendipes spp.		12					2			3		6	23	2.4
Tanytarsus spp.	20	1	124			20		2		4		26	197	20.8
Cryptochironomus spp.										1			1	*
Pseudochironomus spp.		1											1	*
Calopsectra spp.							1						1	*
Tanypus spp.				1		2	1						1	*
Procladius spp.			15	2	6	11	1				1	2	38	4.0
TRICHIPTERA														
Leptocerus spp.	106	5	154	1	27	176	6	1	3	5		3	487	51.5
Triaenodes spp.	2												2	*
EPHEMEROPTERA														
Caenis spp.	6	1	1	1	1	11		7		9		13	49	5.2
Ameletus spp.			1										1	*
ODONATA														
Ischnura spp.	4		5									1	10	1.1
Enallagma spp.		2	4					1					7	*
Libellula spp.						1							1	*
COLEOPTERA												1	1	*
Bidessus spp.														
Total	151	26	309	9	48	241	14	15	11	43	4	75	946	

*Less than 1 per cent of the total

TABLE 4

TOTAL NUMBERS OF INSECTS COLLECTED IN TWO THIRTY-SIX SQUARE INCH EKMAN DREDGE SAMPLES PER COLLECTION DATE AT STATION 3, IN WINTERGREEN LAKE, MICHIGAN

	Jan 12	Feb 9	Mar 16	Apr 5	Apr 26	May 18	Jul 8	Aug 11	Sep 14	Oct 5	Nov 10	Dec 28	Tot.	% of Total
DIPTERA														
Chaoborus spp.	57	92	34	20	25	18	7	11		50	19	61	394	64.6
Palpomyia spp.				4	2	7					1	4	18	2.9
Tendipes "A"		3	3	3	5	1				4	34	70	123	20.7
Tendipes "B"											1		1	*
Glyptotendipes spp.			6										6	*
Tanytarsus spp.			3										3	*
Tanypus spp.				2									2	*
Procladius spp.				1		2							3	*
TRICHOPTERA														
Leptocerus spp.	2	32	3		8	2	3			4			54	8.8
EPHEMEROPTERA														
Caenis spp.		1	1										2	*
Ameletus spp.		1											1	*
ODONATA														
Ischnura spp.		1											1	*
Enallagma spp.						1							1	*
COLEOPTERA														
Tropisternus spp.							1						1	*
Total	59	139	41	30	40	31	11			58	55	135	610	

*Less than 1 per cent of the total.

TABLE 5

TOTAL NUMBERS OF INSECTS COLLECTED IN TWO THIRTY-SIX SQUARE INCH EKMAN DREDGE SAMPLES PER COLLECTION DATE AT STATION 4, IN WINTERGREEN LAKE, MICHIGAN

	Jan 12	Feb 9	Mar 16	Apr 5	Apr 26	May 18	Jul 8	Aug 11	Sep 14	Oct 5	Nov 10	Dec 28	Tot.	% of Total
DIPTERA														
Chaoborus spp.	1346	1592	101	679	394	408	38	17	183	282	75	381	5496	99.3
Palpomyia spp.												1	1	*
Tendipes "A"					8	4						20	32	*
Tendipes "B"												1	1	*
Tanytarsus spp.						1							1	*
TRICHOPTERA														
Leptocerus spp.				1								2	3	*

*Less than 1 per cent of the total

TABLE 6

TOTAL NUMBERS OF INSECTS COLLECTED IN TWO THIRTY SIX SQUARE INCH EKMAN DREDGE SAMPLES PER COLLECTION DATE AT STATION 5, IN WINTERGREEN LAKE, MICHIGAN

	Jan 12	Feb 9	Mar 16	Apr 5	Apr 26	May 18	Jul 8	Aug 11	Sep 14	Oct 5	Nov 10	Dec 28	Tot.	% of Total
DIPTERA														
Chaoborus spp.	27	1		110	410	52	11	8	12	119	72		822	54.4
Palpomyia spp.							1				1	1	3	*
Tendipes "A"			3	3		3				4	1	15	29	1.9
Tendipes "B"			1			1						1	3	*
T. nervosus (Staeger)						2				1			3	*
Glyptotendipes spp.			1			3					12		16	1.1
Tanytarsus spp.			5			1					1		7	*
Pseudochironomus spp.			1										1	*
Pentaneura spp.						1							1	*
Procladius spp.				2		4						5	11	.7
TRICHOPTERA														
Leptocerus spp.	2		32	1		415	4	2	2		3	1	462	30.6
Triaenodes spp.			3			3						1	7	*
Oecetis spp.						9							9	*
Polycentropus spp.			1			3							4	*
EPHEMEROPTERA														
Caenis spp.			12			40	1		6		5		64	4.2
ODONATA														
Ischnura spp.			19			37	1						57	3.8
Enallagma spp.		1	3	1									5	*
Libellula spp.						5							5	*
COLEOPTERA														
Tropisternus spp.							1						1	*
HEMIPTERA														
Notonecta spp.							2						2	*
Total	29	2	81	117	410	579	21	10	20	124	95	24	1512	

*Less than 1 percent of the total

TABLE 7

TOTAL NUMBERS OF INSECTS COLLECTED IN TWO THIRTY-SIX SQUARE INCH EKMAN DREDGE SAMPLES PER COLLECTION DATE AT STATION 6, IN WINTERGREEN LAKE, MICHIGAN

	Jan 12	Feb 9	Mar 16	Apr 5	Apr 26	May 18	Jul 8	Aug 11	Sep 14	Oct 5	Nov 10	Dec 28	Tot.	% of Total
DIPTERA														
Chaoborus spp.	5		1			129	2		1	4		1	143	3.7
Palpomyia spp.	1	2	2	1	2	1		5	4		1	1	20	*
Tendipes "A"	10	1	144	46	94	44	9				34		383	9.8
Tendipes "B"	3		9	9	14	2	4				12		53	1.4
T. nervosus (Staeger)										4	2	3	9	*
Glypto-tendipes spp.	52	10	14						5	327	12	1	421	10.8
Tanytarsus spp.	31	9	30	15			4	5	11	187	32		324	8.3
Polypedilum spp.		1				1	1				5		8	*
Cryptochironomus spp.								3	1				4	*
Pseudochironomus spp.				6									6	*
Procladius spp.			2	5	10	3							22	2
TRICHOPTERA														
Leptocerus spp.	119	31	485	423	22	493	619	6	15	74	16	9	2312	59.6
Triaenodes spp.				4		1				2			7	*
Oecetis spp.				4		2	1			2			9	*
Polycentropus spp.				2		2				1			5	*
EPHEMEROPTERA														
Caenis spp.				36		15		3	11	5		32	102	2.6
ODONATA														
Ischnura spp.				3			2			10			15	*
Enallagma spp.	1			34		9	1			1	1		47	1.2
Libellula spp.				3		2	1			1			7	*
Basiaeschna spp.												1	1	*
Perithemis spp.												1	1	*
Tetragoneuria spp.				2									2	*
COLEOPTERA														
Bidessus spp.				1	1								2	*
HEMIPTERA														
Hesperocorixa spp.										2			2	*
Plea striola Fieber										1			1	*
LEPIDOPTERA				3										
Pyralidae														
Total	222	54	687	597	143	704	644	22	48	621	115	52	3909	

*Less than 1 per cent of the total

date were combined to better demonstrate seasonal fluctuations.

An incident I think worthy of note here was that, one night in late August while general collecting at an ultra-violet light trap on the shore of Wintergreen Lake more than a gallon of adult Caenis specimens came to the trap in an 8 hour period. It was assumed that these tiny ephemeropterans came from the immediate vicinity, yet the bottom samples indicated they were present in the lake in immature form in relatively constant but small numbers throughout the year.

The collecting stations in Wintergreen Lake may be classified into three general types, one with dense higher aquatic plant growth, represented by station 6; one with sparse or intermittent vegetation, represented by stations 1, 2, 3 and 5; and one with no vegetation, represented by station 4.

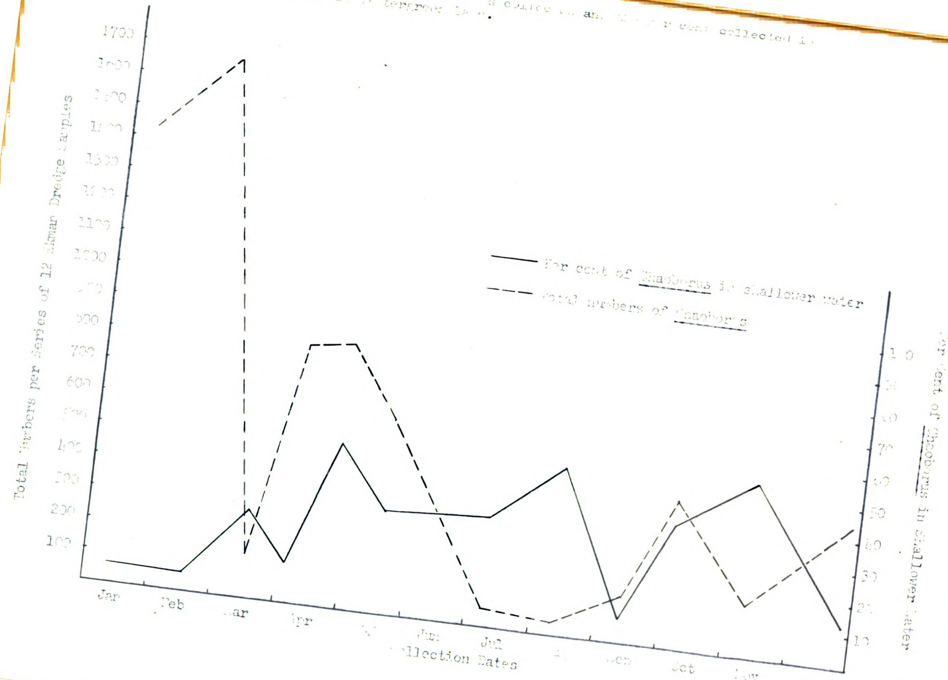
At station 4, the number of specimens was much higher than elsewhere in the lake, but few of the taxa were represented. Only 6 genera were taken at station 4, and 99.4 percent of these specimens belonged to the genus Chaoborus. The number of Chaoborus from this station alone constituted 41.5 percent of the total number of insects collected from the lake.

Table 7 shows station 6 was also relatively high in numbers of specimens, and the taxonomic groups were well represented. Only 10 of the total of 38 taxa collected were not represented at station 6. Four of the 10 taxa not represented at station 6 were single specimens and 2 taxa appeared only 2 or 3 times at other stations. The stations with few plants yielded fewer specimens than either station 4 or 6, but the number of taxonomic groups was ordinarily well represented.

The general population of insects in the lake bottom was relatively high between January and May with a decline beginning after May. In August the lake seemed practically devoid of insects. After August the number of specimens increased, but did not attain the general high level recorded for the first part of the year. The smaller number of specimens collected in the fall was perhaps greatly influenced by the small size of the specimens at that time and the coarseness of the screen used in sorting. It is assumed that had the collecting duration been extended an increase in numbers of specimens detected in the subsequent samples would have occurred.

As previously stated, Chaoborus was the predominant genus represented in the lake, and was associated primarily with station 4 in the open-watered and deepest part of the lake. Fifty-three per cent of the total number of collected insects were specimans of Chaoborus. Tables 4 and 6 show Chaoborus to be most abundant at stations 3 and 5 although Leptocerus is a contending genus for predominance at station 5. The fact that Chaoborus and Leptocerus were apparently sharing the same niche may seem peculiar at first since the writer associated Chaoborus with open deep water and later associates Leptocerus with higher aquatic plants in shallower water. However the numbers of both Leptocerus and Chaoborus were never large in the same sample. Apparently the habitat of these two organisms is actually distinct, being governed by the sharp division between the Ceratophyllum bed and the openwater at station 5. Since samples "A" and "B" were taken from opposite sides of the boat or hole in the ice in winter, occassionally these samples would be from opposite sides of this division line causing a difference in the two samples.

A representative sample of Chaoborus was selected from each sample and determined to species. Two species, C. flavicans (Meigen) and C. punctipennis (Say), were the only two found, and the former was the more abundant being twice as prevalent as the latter. C. flavicans was somewhat larger on the average, and the only one that appeared in the pupal stage. The entire collection was re-examined to try to find C. punctipennis in pupal form or about to pupate, but none were noticed. The pupae of C. flavicans were taken in the May and July collections from the deepest part of the lake. At the same time larvae that were about to pupate were taken at station 6. This fact does little to substantiate the idea suggested by Scott and Opdyke (1941), Borutsky (1939) and others that Chaoborus migrate to shallower water prior to emergence. However the data plotted in figure 2 do indicate such a tendency. During the periods of sharp decrease of total collected Chaoborus, indicating emergence, there was a corresponding percentage increase of Chaoborus in shallow water. The increase in the percentage of Chaoborus in



Total Numbers per Series of 12 Ekman Dredge Samples
1700
100
200
300
400
500
600
700
800
900
1000
1100
1300
Per cent of Chaoborus in shallower water
Total numbers of Chaoborus
Per Cent of Chaoborus in Shallower Water
10
20
30
40
50
60
70
80
90
100
Jan
Feb
Mar
Apr
Jun
Jul
Sep
Oct
Nov
Collection Dates

shallower water was attributed to the migration of Chaoborus from the deep water to the shallower water.

The above information coinciding with the appearance of pupae or mature larvae in the March, April-July and October-November collections further substantiated the three periods of emergence.

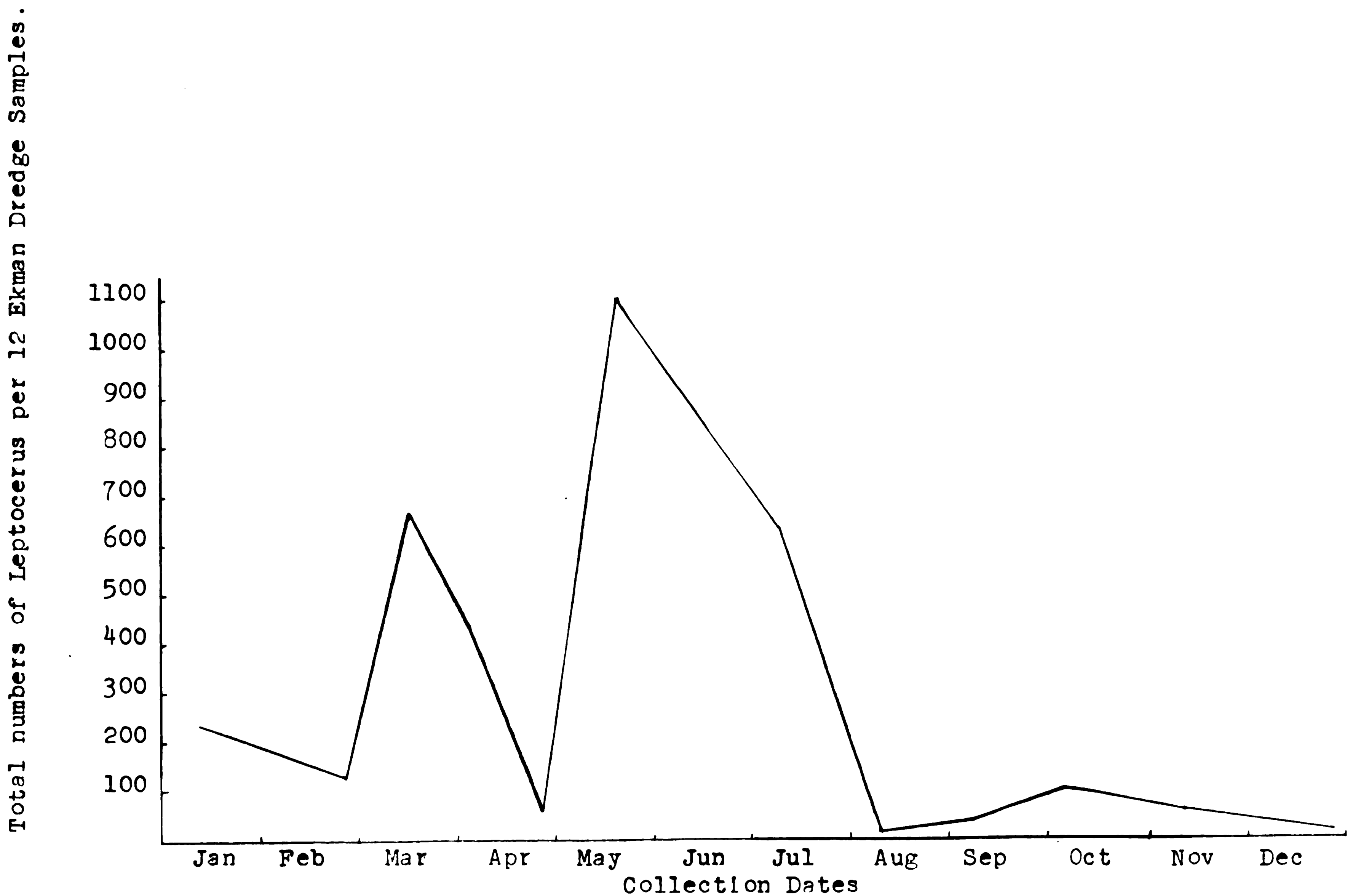
Mature larvae were recognized by their swollen thoraces, opaque appearance and by the presence of the pupal air tube which was visible through the integument of the thorax.

Therefore there was evidence of three periods of emergence of Chaoborus occurring in Wintergreen Lake, one in latter March, one from the latter part of April to July and one in November; and there was a migration to shallower water during these periods.

Leptocerus constituted 26.4 percent of the total number of insects collected, and 98.8 percent of the number of Trichoptera. They were of the single species, L. americana (Banks), and were usually found most abundant in association with Ceratophyllum in shallow water. Although an active swimmer when detached, most of the collected specimens were sessile on Ceratophyllum, being arranged in a manner similar to the leaves of the plant. The camouflaging effect may have been sufficient to defy detection by casual observation or an inexperienced person.

The seasonal variation in numbers is shown in tables 1-7. The data is plotted in figure 3, and sharp decreases in

FIGURE 3. Total Numbers of Leptocerus americana (Banks) per 12 Ekman Dredge samples per collection date.



numbers on April 26 and August 11 is interpreted as periods of emergence. That emergences were occurring during August is corroborated by notes taken while sorting that state that many pupae of Leptocerus appeared in the August collections. Pupae could be recognized through their translucent cases by their long antennae which were coiled several times around the posterior end of the body. Pupae were not noticed in the April 26 collections, although they may have occurred. To save time, space and material the specimens of Leptocerus were not saved, so it was not possible to recheck for pupal occurence in the April collections.

High winds (30-35 mph according to radio weather report for March 16, 1957) sometimes hampered collecting and changed the nature of some of the stations in regards to the amount of vegetation, and hence, the number of Leptocerus larvae that may have been collected. The weather on April 26 was moderately windy with slight rain in the Wintergreen Lake area, which made collecting difficult, but vegetation was not appreciably disturbed at the stations. Wind disturbances were not noticed at any time at station 6. If disturbances had occurred, it would have meant an increase in vegetation and Leptocerus specimens since the prevailing winds blew across the lake in the direction of this station. Yet the data presented in table 7 show that the numbers at station 6, where Leptocerus was most common, followed the general trend in the lake and decreased in number in the April 26 collections. The decrease was interpreted as due primarily to an emergence.

Considering the time of the year, the low values recorded for February were regarded as aberrant.

The group, designated *Tendipes* "A", is a composite of several species of the subgenus *Tendipes* that have tripartite median labial teeth, 2 pairs of ventral abdominal gills, lateral lobes on the tenth body segment and in most cases 4 black mandiblar teeth, although occasionally with 3 black and 1 yellow mandibular tooth. According to Curry (1955) this would include the species *plumosus* (Linnaeus), *tentans* (Fabricns), *tuxis* (Curran) and *staegeri* (Lundbeck) and according to other writers T. *decorus* (Johannsen) as well. Slide preparations of a representative selection of various sizes of *Tendipes* "A" from all stations for various dates were examined and were determined as 90 percent T. *plumosus*. The mounts were taken to Central Michigan University at Mt. Pleasant where Dr. LaVerne Curry kindly verified the determinations and corrected some of the determinations that had been misdetermined as T. *staegeri* by the writer. These specimens had atypical characteristics of the epipharyngeal teeth that were similar to those of T. *staegeri*. Dr. Curry pointed out some characteristics that were helpful, and mentioned that the number of black mandibular teeth had not been a reliable taxonomic character among specimens of T. *plumosus* in his collection, although four black mandibular teeth seemed a reliable character as used by other taxonomists.

The complex, *Tendipes* "A", was the most versatile of the taxa in that it appeared at all the stations at least during some part of the year. From the data presented in tables 2 through 7, a preference for the vegetated and shallow areas was exhibited. If it were assumed that the complex was predominantly T. plumosus, this would contradict the findings of Adamstone (1923), Johnson and Munger (1930), Scott, Hile and Spieth (1938) and others who found this species confined or most abundant at depths greater than 18 feet. The tables show the yearly total of Tendipes "A" at station 4 to exceed only one other station, station 2, at a depth of 10 feet. Station 6, which was 6 feet deep, contributed 58.4% of the total numbers collected.

The paucity or absence of insects during the summer was interpreted as primarily due to emergence of adults, although predation undoubtedly accounted for some of the decrease from previous months. The erratic appearance of the figures from January 12 to July 18 may have been influenced by the extent of sampling. Guyer (1952) reported that he found Tendipes in colonies, thus variations in numbers could be recorded from samples taken close to each other. If this is so, it is likely that, with the limited samples taken here, fluctuations in numbers might be recorded that have no significance in indicating emergence of adults.

Because the study was being conducted from headquarters 70 miles from the lake, it was not feasible to use tent trap methods to establish emergence periods. As an alternative, the larvae were measured and recorded to ascertain if growth rates would indicate emergences other than the general emergence for the summer. The results are given in figure 4. Since pupae are shorter than their respective mature larvae, they were considered as 28/mm long in the calculations to give a better indication of maturity. In figure 4 the mean lengths of the collections are connected by a longitudinal line which indicates the change in mean lengths. The vertical lines terminated by X's give the upper and lower limits of two (standard deviations) from the mean. The inconsistency of the dispersion indicated in figure 4 was perhaps due to differences between the species within the species complex besides irregular growth patterns within the predominant species, T. plumosus. No other emergences were indicated by this method.

Curry (1954) had noted that T. tentans larvae may pupate when they were 9-21 mm. long. That such variations may have occurred, in a complex like Tendipes "A" is very likely, but the total effect was not considered important in interpreting the results here.

The sampling results of Glyptotendipes and Tanytarsus (Figure 5) showed similar trends, thus the two genera were considered together. The parallelism of the time and location of the appearance of these two genera was interpreted as their being identical in habit. Only in March and May at station 2, were Tanytarsus specimens taken in significant numbers without a corresponding appearance of Glyptotendipes specimens.

The large numbers of Tanytarsus and Glyptotendipes larvae

FIGURE 4. Seasonal changes in mean lengths of Tendipes "L" larvae in [illegible] Lake showing the standard deviation from the mean.

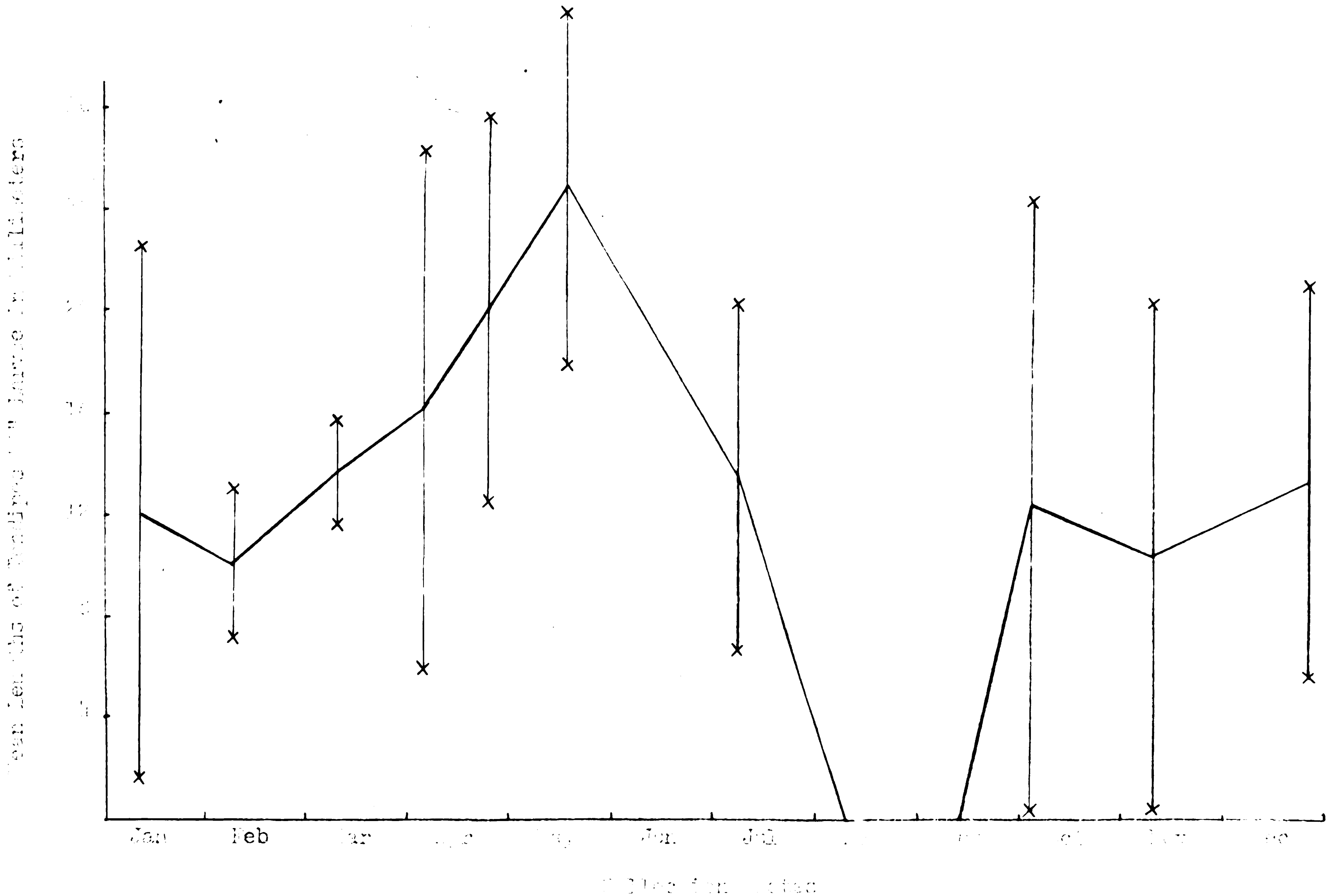
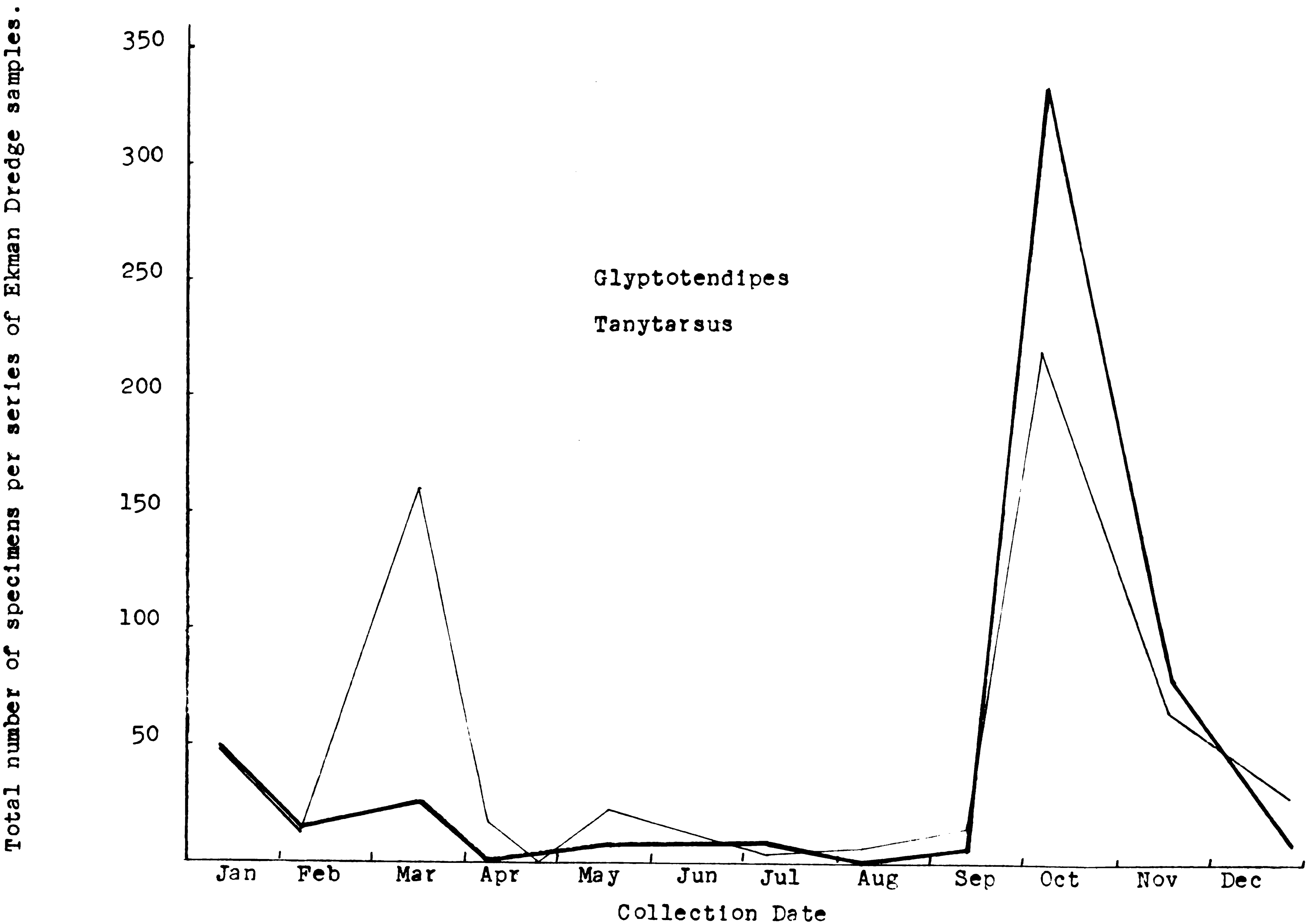


FIGURE 5. Total numbers of Glyptotendipes spp. and Tanytarsus spp. per series of 12 Ekman Dredge samples per collection date.



that were collected in October, and persisted above the yearly average into November, is interpreted as the progeny of a hatch that probably occurred in midsummer. Lack of data, other than what appears in tables 2-7 and figures 5 and 6, precludes drawing further and more definite conclusions since the two genera may have been composed of several species.

An attempt was made to compare the insect populations of Wintergreen Lake with other lentic waters. Much of the published data available were not obtained from general surveys, were procured by a different method or were presented in a form that could not be compared. Therefore the following comparisons are not exact, and some of the inferences may be biased.

The figures given by Scott and Opdyke (1941) average 2,177 dipterous larvae per square meter in Winona Lake in June and August of 1934 and 1938. When the data in table 1 is extrapolated for comparison, it shows an average of 2,732 dipterans per square meter for the year. The June collection was not taken in Wintergreen Lake, but the August collections yielded only 55 dipterous larvae of the total 76 insects collected. The extrapolated equivalent of the August data is 792 dipterans per square meter, a figure much lower than what was recorded for Winona Lake for the same period. No other information is given about other bottom insects or conditions at other times of the year in Winona Lake.

The data given by Macan (1949) was difficult to compare, since a variety of sampling equipment was used. However a comparison of weed faunas in Three Dubs Tarn and in Wintergreen Lake showed differences in faunal composition. Caddis, corixids and ephemeropterans were the predominant insects in the shallow weedy area of Three Dubs Tarn, whereas the predominant insects in the shallow weedy area of Wintergreen lake were tendipedids and caddis. Virtually no corixids and few ephemeropterans were taken from Wintergreen Lake. Tendipedids were predominant in the deeper parts of Three Dubs Tarn, and tendipedids, though an important group in Wintergreen Lake, were rarely collected in the deepest part of the lake. In general, the populations of tendipedids and corixids in Three Dubs Tarn were greater than in Wintergreen Lake, but all other insects common to both lakes were more numerous in Wintergreen Lake.

The unusual population of _Tendipes plumosus_ in Lake Pepin reported by Johnson and Munger (1930) was much larger than the average for a comparable group, _Tendipes_ "A", reported here. _Tendipes_ "A", which was estimated as 90 percent _T. plumosus_, averaged 165 per square yard for the year and 456 per square yard at their maximum in March. The July average in Lake Pepin was 3,000 per square yard. The largest single sample of _Tendipes_ "A" in Wintergreen Lake compares favorably only with the July average of _T. plumosus_ in Lake Pepin.

Borutsky (1939), in reporting on the biomass of the profundal of Lake Beloie, U.S.S.R., gives density figures for _Chaoborus_ which average larger than the figures that are given here. Most of the Lake Beloie data were from depths greater than occurred in Wintergreen Lake, and Chaoborus populations tended to increase with depth up to a limit in deep lakes. The population densities increased to a maximum at 11 meters and then declined beyond this depth. The population densities of Chaoborus in Wintergreen Lake were from 4-9 times greater than population densities at similar depths in Lake Beloie.

Scott, Hile and Spieth (1938) when observing the trend of Chaoborus in three separate basins in Tippecanoe Lake noted that population densities increased up to the maximum depths, 11 and 17 meters, in the two shallower basins. In the basin that was 37 meters deep, the population densities reached their maximum at 17 meters, and then decreased gradually to 0 at 37 meters. At corresponding depths in each basin (the range from 3-11 meters) the population densities were greater the shallower the basin. The maximum density, 990 per square meter, was recorded at the maximum depth in the 11 meter basin. The yearly average for Chaoborus at the deepest part of Wintergreen Lake was 9893 specimens per square meter, during the period of maximum recorded abundance in February the population at station 4 was 34,387 per square meter.

Brydon (1956) when reporting on the control of the Clear Lake gnat, Chaoborus astictopus D. and S., found the larvae most abundant in Clear Lake, California in March. The average concentration in the lake bottom during this time was

39.96 per square foot. Emergences of adult Chaoborus from Clear Lake, augmented perhaps by emergences from lesser bodies of water near by, during June and late September, were considered an extra nuisance in the area. Although the concentrations of Chaoborus larvae in Clear Lake are much lower than those recorded for Lake Beloie, Tippecanoe Lake and Wintergreen Lake, the population in Clear Lake is evenly distributed throughout the lake and the average productivity per unit area of the entire lake may be greater than any of the other lakes mentioned.

SUMMARY

Ekman dredge samples were taken from the bottom of Wintergreen Lake from January 1957 through December 1957 from six stations located on a longitudinal transect. A total of 13,394 specimens were collected, or an average of 3,348 per square yard for the year. Sixteen families from seven orders were represented. Five taxa that appeared most often were Chaoborus, Leptocerus, Tendipes "A", Glyptotendipes and Tanytarsus.

Chaoborus was the predominant genus collected during the study, and was composed of two species, C. flavicans (Meigen) and C. punctipennis (Say). The genus Chaoborus was associated with the deeper part of the lake, but migration to shallower water during emergence was noted. Three major emergence periods were determined, one in latter March, one between April and July and one in November.

Leptocerus was represented by a single species, Leptocerus americana (Banks), and constituted 26.4 per cent of the total number of insects collected and 98.8 per cent of the Trichoptera specimens. Leptocerus larvae were associated with Ceratophyllum in the shallpwer areas of the lake. Two major emergence periods were determined, one in latter April and another in August.

The larvae of the Tendipes "A" group were the most widely distributed appearing at all stations during some period of the year. They were most prevalent in the shallower water of the lake. Tendipes "A" was composed of approximately

90 per cent T. plumosus larvae. The group was too complex to determine whether important emergences occurred other than during the summer months.

The genera Glyptotendipes and Tanytarsus were similar to each other in distribution and frequency. Both genera were associated with vegetation in the shallow parts of the lake. The preponderance of Tanytarsus and Glyptotendipes specimens in the October collections was interpreted as the progeny of adults that emerged during the summer. No other emergences were clearly indicated.

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