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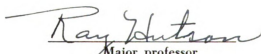
A QUANTITATIVE AND QUALITATIVE
INVESTIGATION OF THE ADULT MIDGES
OF THE FAMILY TENDIPEDIDAE
IN FERTILIZED AND UNFERTILIZED PONDS

presented by

Gordon Earl Guyer

has been accepted towards fulfillment
of the requirements for

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Major professor

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THESIS

A QUANTITATIVE AND QUALITATIVE INVESTIGATION OF THE
ADULT MIDGES OF THE FAMILY TENDIPEDIDAE
IN FERTILIZED AND UNFERTILIZED PONDS

By

GORDON EARL GUYER

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TABLE OF CONTENTS

	Page
I. INTRODUCTION	1
II. LITERATURE REVIEW	2
III. OBJECTIVES	3
IV. EXPERIMENTAL STUDIES	4
A. Description of ponds	4
B. Description of trap	10
C. Sampling of adult insects	12
D. Light trap	13
E. Laboratory procedure	14
V. NOMENCLATURE	16
VI. A LIST OF INSECTS RECOVERED FROM THE	
FUNNEL TRAP SAMPLES . . .	18
VII. DISCUSSION	20
A. Relative abundance of various subfamilies	20
Table 1 (The Subfamilies of	
Tendipedidae)	21
Figure 1 (Percentage Composition	
of Subfamilies	22
B. Tribe Calopsectrini	23
C. Subfamily Pelopiinae	25
D. Subfamily Hydrobaeninae	26
E. Family Heleidae	27
F. Family Culicidae	27

Table of Contents (Con't.)

G. Other insects sampled	29
H. Tribe Tendipedini	29
1. Seasonal variation	29
Figure 2 (Seasonal Variation of Temperature and Tendi- pedini Population	30
2. Variation of pond populations . .	32
Figure 3 (Percentage Distribu- tion of Insects by Ponds). .	34
3. Species of the tribe Tendipedini .	36
Figure 4 (The species of Tendipedini)	38
Table 2 (The species of Tendipedini)	39
Tables 3 through 8 (Seasonal Distribution of Species of Tendipedini found in Pond A, B, C, D, E, and F) . . .	40-45
VIII. SUMMARY	53
IX. LITERATURE CITED	54
X. KEY TO PLATES	58

I INTRODUCTION

The popularity of the farm pond program throughout the United States has increased rapidly in the past several years. There has developed simultaneously a sharp interest in biological production of small ponds with special emphasis on fertilization to increase production.

Members of the family Tendipedidae have been observed to respond exceedingly well to the application of fertilizer and it is with this thought in mind that this study was undertaken. Since the larvae of members of the Tendipedidae are, at present, very difficult to determine to species, a method of collecting adult insects was used. An inverted funnel trap was employed to collect the adult insects. During the summer of 1951 at the Lake City Experiment Station insects were trapped from each of the six experimental ponds. The insects collected were classified to species and verified by members of the United States National Museum.

The following discussion compares the fertilized and unfertilized ponds as to quantitative and qualitative production of members of the family Tendipedidae.



II LITERATURE REVIEW

The family Tendipedidae has been studied extensively in Europe for many years by such prominent workers as Brundin (1949), Goetghebuer, and Thienemann, to mention only a few. These workers have focused their research on the correlation of midges with lake type classification and have also reported extensively on midge biology. In the United States the work with the family Tendipedidae centers around Johansen (1934), (1937a), (1937b); Malloch (1915), (1917) and Townes (1945), who were primarily interested in classification but have added pertinent information on biology and ecology of the midges.

The use of fertilizer in pond management was extensively investigated by Smith and Swingle (1939), (1947), (1950),; Howell (1942) and others in the southern states with phenomenal success. Tack and Morofsky (1946) began an investigation of the effects of fertilizer in a northern climate. Ball (1948), (1949) and Ball and Tanner (1951) have recently concentrated their studies on pond fertilization with special emphasis on fish production. From the conclusions of many of these investigations it is obvious that one of the organisms significantly increased by fertilization is the midge. The midge has been equally important as a fish food organism as it has been reported consistently in the stomach of many fish (Clemans, Dymond, and Bigelow, 1924).

The purpose of this study was to discover which species

of midges were increased by fertilization and to investigate the life history of these species.

III OBJECTIVES

The overall objective was to study one step (midges) in the complex food chain which exists in the biological production of ponds.

The immediate objectives were as follows:

1. Compose a check list of the species of Tendipedidae and Heleidae present in the experimental ponds.
2. Test the workability of a specially designed adult insect trap as a quantitative and qualitative insect sampler.
3. Compare Tendipedidae populations of ponds fertilized at different rates as to number of species of insects present and make a quantitative comparison of these insects.
4. Compare shallow ponds with deeper ponds as to number of insects and species present.

IV EXPERIMENTAL STUDIES

A. Description of the Ponds

The ponds at which this investigation was undertaken are located at the Michigan State College Lake City Experiment Station. This is located in the north central section of the lower peninsula of Michigan in an area where the winters are very severe, having continuous periods of exceedingly low temperatures and considerable snow deposits. The construction of the ponds was begun in the fall of 1943 and was completed in June 1945.

Ponds "A" and "B" have a surface area of approximately one-half acre, while ponds "E" and "F" are somewhat smaller with a two-tenths acre surface area. The maximum depth of ponds "A", "B", "E", and "F" is about six feet. The other two ponds used in this experiment, "C" and "D", have a surface area of about 1,500 square feet. The maximum depth of pond "C" is one and one-half feet and of pond "D" is two and one-half feet.

Ponds "A", "B", "E", and "F" were constructed by removing a surface deposit of muck exposing a sandy soil bottom. The dykes were built by bringing in clay and other fill. Ponds "C" and "D" were pits which remained after fill had been removed.

Ponds "A", "B", "E", and "F" are equipped with inlet and outlet structures which make it possible to drain and refill the ponds. The water supply for these ponds consists of a reservoir which was built by constructing a dam across a small

stream known as Mosquito Creek. It is possible to eliminate all flow of water through the ponds during periods of investigations. The water supply for ponds "C" and "D" is taken entirely from the seepage of subsurface water with a small amount of run-off water entering the ponds. Ponds "C" and "D" have no inlet or outlet. The only way the water may be removed is by pump.

Pond "A" has been used exclusively as a check for the fertilization experiments carried on by Tack and Morofsky (1946). It has never received any fertilizer. The water in pond "A" remained very clear until the second week in August when some turbidity was observed. However, it was consistently clearer than pond "B" which will be discussed later. There was no rooted vegetation in pond "A" and all algae present was of a planktonic nature. The dykes of pond "A", like those of all the ponds, have been planted with Reed Canary Grass which is the principal plant found within several feet of the water. Doctor Peter I. Tack found that by planting Reed Canary Grass, the washing away of dykes by wave action was almost completely eliminated.

Pond "B" is a pond very similar to pond "A" in many respects. However, pond "B" has been fertilized very heavily and extensive blooms of planktonic algae were present at all periods during the investigation. There was no rooted or floating vegetation in pond "B". Plankton samples were taken at ten-day intervals throughout the summer and the plankton increased in pond "B" until August 1 when it reached its peak;

at this time it was eight times as prevalent as the bloom in pond "A". At the peak of the plankton bloom in pond "B" it was impossible to see a white object at a depth of two and one-half inches. The application of fertilizer in pond "B" was at the rate of 100 pounds of 10-6-4 N-P-K to the acre on August 9. All fertilizer was broadcast by hand over the pond surface. Both ponds "A" and "B" contained 289 Northern black bullheads Ameiurus melas melas (Rafinesque) which had an average weight of six ounces. These were the only fish stocked in the ponds. However, there were fathead minnows Pimephales promelas promelas (Rafinesque) and Northern red-belly dace Chrosomus eos (Cope) present. It is most probable that these minnows entered the ponds through the inlets. During the summer of 1951 in both ponds "A" and "B", the production of young fish was very great. At the end of the growing season schools of young bullheads were abundant and many young minnow fry were observed.

The bottom of both ponds "A" and "B" was covered with a soft organic ooze to a depth of two to six inches. This material was distributed evenly over the bottom to within three feet of the shore where it gave way to a sandy, wind swept shoal area.

Pond "C", as previously stated, is one of the shallow ponds and has been set aside as check similar to pond "A". Pond "C" had no higher aquatic vegetation except around the margin where several small willows were intermingled with grass, clover and sedge. The bottom of pond "C" was very

firm and of a clay nature without any organic deposit. Pond "C" has remained unfertilized and it has been consistently low in productivity (Bray, 1949). The water in pond "C" was turbid but this turbidity was due to inorganic colloids present in the water.

Pond "D", the fertilized shallow pond, had a dense phytoplankton bloom throughout the summer season. The water was a deep green color and was exceedingly rich in small invertebrate organisms such as the immature stages of insects, scuds and zooplankters. Pond "D", like pond "C", was entirely free of rooted vegetation. Duckweed, Lemna sp., was present near the shore.

The bottom of pond "D" was covered with an organic ooze similar to ponds "A" and "B" and this ooze was of a pulpy peat nature (Roelofs, 1944). Several places in the pond this ooze reached a depth of eight inches. Five pounds of 10-6-4 N-P-K fertilizer was applied to pond "D" on June 22, July 12 and August 9. There were no fish in either pond "C" or pond "D" during the summer of 1951 while the experiment was being conducted.

Pond "E" is a pond which has been very inconsistent in its reaction to the application of fertilizer. It has never passed through the biological chain of events which eventually leads to the formation of dense plankton blooms. Pond "E" had a dense growth of Chara sp. which was intermingled with Spirogyra sp. Often during extended periods of warm, bright weather the growth of Chara sp. and Spirogyra sp.

would rise to the surface, due to the formation of excess oxygen, and remain there until cool, cloudy weather when it would settle to the bottom. This cycle was repeated several times during the summer of 1951. Several investigators (Patriarche and Ball, 1949; Swingle and Smith, 1950) have observed that in some ponds it is very difficult to get a plankton bloom and that in these cases the fertilizer increased the production of filamentous algae rather than the planktonic type.

The water in pond "E" was extremely clear at all times and it was possible to see the movement of organisms on the bottom at a depth of five and one half feet. The fish population of pond "E" consisted of 33 large black bullheads Ameiurus melas melas (Rafinesque) with an average weight of 20 ounces and a few Northern redbelly dace Chrosomus eos (Cope). When the pond was drained in August only three of the large bullheads remained. The most significant explanation for the mortality of the bullheads was the fighting which occurs during the breeding season (Adams and Hankinson 1928). Twenty pounds of 10-6-4 N-P-K fertilizer was added to pond "E" on June 22, July 12 and August 9.

The biological community which existed within pond "F" was very unusual and did not follow the typical fertilized pond biota. The plankton was abundant all summer in pond "F" but it never reached the density of the bloom of pond "B". The first time a significant bloom occurred was in the summer of 1950 and perhaps in succeeding years it will continue

to multiply. On the bottom of pond "F" were numerous colonies of Nostoc sp. balls. This is the only pond where this alga was present and there appeared to be no satisfactory explanation as to why this phenomenon occurred.

The bottom of pond "F" was not as homogeneous as the other ponds for the deepest deposit of organic material was in the narrow east end and the remainder of the pond had the organic ooze mixed with gravel. During the fall of 1950 gravel was spread over the west half of this pond to fill several low spots which interfered with draining operations.

There was a very large population of minnows in pond "F" in May and they reproduced very successfully during the summer so a large number of fish were present all during the experiment in this pond. The following species of minnows were present in pond "F": northern redbelly dace Chrosomus eos (Cope), western golden shiner Notemigonus crysoleucas auratus (Rafinesque), common shiner Notropis cornutus (Agassiz), northern fathead minnow Pimephales promelas promelas (Rafinesque) and there were a few black bullheads. Pond "F" received 20 pounds of 10-6-4 N-P-K fertilizer on June 22, and July 12 and on August 9 ten pounds were broadcast over the pond.

A number of comments may be given in regard to general operation of the ponds during the experiment. Doctor Peter I. Tack was carrying on simultaneously an experimental operation with fish production and this made it necessary to drain the ponds in May and again in September to remove the fish.

The ponds were never completely exhausted of water and they were refilled the same day drained, thus it was unlikely the draining had a serious affect on the insect production. The only water which left the ponds during the experiment was through seepage and evaporation and to compensate for this a small amount of water was allowed to enter the inlets.

B. Description of the Trap

The trap used to sample the adult insects was a modification of one used by Brundin (1949) in southern Sweden. The trap consisted of an inverted funnel which sampled a one square yard area (Plate I, Figure 1). The diameter of the larger opening of the funnel was 41 inches and it tapered to a $3\frac{1}{2}$ -inch neck. The distance from the bottom of the funnel to the top of the trap was twenty inches, including the neck which was $2\frac{1}{2}$ inches. At the top of the trap a $3\frac{1}{2}$ inch Kerr type ring was soldered in place; to this was screwed a two quart fruit jar (Plate I, Figure 2). A paper cup, with a hole cut in the bottom, was placed within the neck of the fruit jar and scotch tape was used to keep this in place (Plate I, Figure 2). The trap was built of sheet metal with all joints soldered and around the bottom of the trap a heavy wire was built in to keep the trap rigid. A line was connected to the two quart jar and a buoy was fastened to the other end of the line.

As the insect pupae moved to the surface to emerge as adults they first came in contact with the funnel and worked

their way up the sides of the funnel and eventually emerged in the jar which was partially filled with air. The paper cup which was inverted in the neck of the jar prevented the insects from resting on the surface film and gave them a place to rest as they dried their wings and body. Some workers using this type of trap have not found it necessary to include an extra retaining device in the jar. In this study it was quite apparent that the insects often became trapped in the surface film and the entire sample was in such devastated condition that it could not be classified until the paper cup was included in the operation.

This type of trap appeared to have several very commendable attributes. The trap collected adult insects which at the present time are much easier to identify than the immature forms. The trap gives a quantitative comparison of production when comparing several bodies of water. The pupal exuviae may be collected and associated with the adults. The one disadvantage is the large size and heavy weight. In this investigation weight was not an important factor as the traps were moved only short distances but if the traps were to be transported often they might be constructed of metal net as Brundin (1949) used and sample only one-fourth square yard.

The tent trap used by Miller (1941) is a trap which might be used to collect similar data and perhaps it could be constructed with less expense. It is questionable whether the insects could be removed as quickly and easily from the tent as from the jar. The use of adult insect samplers is

not a new idea for it was used as early as 1905 in the United States by Needham (1908) and several other workers have recognized the advantages of this type of insect sampling device (Adamstone and Harkness, 1923; Ide, 1940).

C. Sampling of Adult Insects

The following equipment was used in sampling the adult insects: inverted funnel trap, waders and cyanide killing jars.

Three samples were taken each week from each pond. To be as impartial as possible the traps were placed at different positions on the bottom of the pond each time a sample was taken. All depths were sampled since the traps were shifted back and forth from shallow water to the deeper water in the center of the pond. The traps were placed in the ponds at one o'clock p. m. and remained in the ponds for the succeeding twenty-four hours.

The following procedure was followed in placing the traps in the pond and removing the insects after twenty-four hours. First the paper was scotch taped in the Mason jar and the jar was screwed on the funnel. By the use of waders the trap was taken out into the pond where the sample was to be taken. The trap was carefully eased into the water and when the air in the big funnel had been displaced by water it was lowered toward the bottom of the pond (Plate II, Figure 2).

Two important precautions should be injected here. First, the trap should be lowered in an upright position to

keep the two-quart jar dry. Second, the trap should rest evenly on the bottom in an upright position. If the trap was operated on a lake it need not rest on the bottom. However, in ponds of five feet it operated most efficiently on the bottom. No matter at what depth the trap is to be placed the jar should be under the water to eliminate the condensation of moisture on the inside of the jar.

At one o'clock the following day the trap was carefully raised from the bottom and moved toward the shore, being extremely careful to keep the funnel submerged to prevent the loss of specimens. The jar was loosened and a lid slid over the opening (Plate 3, Figure 2); this was done without turning the jar over and it proved to be a very effective way of holding the insects.

The jars were taken into the laboratory and a cyanide bottle was placed in the mouth of each jar and allowed to remain there until all specimens were asphyxiated.

D. Light Trap

A New Jersey light trap was operated the same night a funnel trap sample was taken. This was done to compare the effectiveness of the light trap with the funnel trap in midge sampling and to give additional specimens for laboratory study.

The light trap (Plate II, Figure 1) attracts the midges by means of a 100-watt bulb and is provided with a fan which blows them into a killing jar. The light bulb and fan are

fastened to the inside of a large cover, which sheds rain, and a funnel is below the fan, fastened to three legs that support the trap when it is placed on the ground.

The midges taken from the light trap corresponded very closely to those removed by funnel trap sampling. It appeared that for taxonomic work the light trap would be a very effective way of collecting specimens.

E. Laboratory Procedure

The following equipment was used in processing and classifying the insects in the laboratory: dissecting microscope, dissecting tools, slides, cover slips, absolute ethyl alcohol, diaphane solvent, diaphane and minuten nadeln.

After the insects were dead they were removed from the jar and spread on a white sheet of paper. It was found that by classifying and pinning the specimens within 24 hours after they were taken from the ponds they were much easier to work with and the characteristics used in species determination were more pronounced.

The insects were first sorted macroscopically as far as possible toward species determination. The insects were then examined under a dissecting microscope and in most cases it was possible to separate the different species without further operations.

The first time a new species was observed a slide mount was made of the genitalia of the male; this was also done whenever species determination was doubtful. The following

is a summary of the technique used in making the genitalia mounts (Townes 1945). If the specimen is dried out it is placed in a relaxing jar for several hours. The terminal third of the abdomen is then clipped off with a pair of fine scissors. The clipped-off part is then placed in a test tube of 10 percent sodium hydroxide and placed in a boiling water bath for eight to ten minutes. The specimen is then transferred to a watch glass of water and then to a watch glass of 95 percent ethyl alcohol. After several minutes in this solution it is transferred to a microscope slide. On the slide it is turned right side up, the excess alcohol is drained off, and is covered with diaphane solvent. The final process is the covering of the specimen with diaphane and then easing the coverglass into place. It is of upmost importance to give the slide and the pinned specimen a corresponding number so they can always be associated.

After all the specimens from a pond for a particular day were classified and recorded a number of specimens representing each species were pinned and placed in insect trays. The remainder of the insects were preserved by placing them in small vials and a crystal of paradichlorobenzene was added. All insects were preserved in this way and it proved to be a very wise procedure as all of the specimens were available for recounting or comparison at the end of the experiment.

V NOMENCLATURE

The principal references used in classifying the prominent groups are listed below.

TENDIPEDIDAE (Chironomidae)

Subfamily Tendipedinae

- a. Johannsen (1905), (1937)
- b. Malloch (1915), (1915b)
- c. Townes (1945)
- d. Hauber (1944), (1947)

Subfamily Pelopiinae

- a. Hauber (1945)
- b. Hauber and Morrissey (1946)
- c. Morrissey (1950)
- d. Malloch (1915)
- e. Townes (1945)

Subfamily Hydrobaeninae

- a. Townes (1945)

HELEIDAE (Ceratopogonidae)

- a. Malloch (1945)
- b. Thomsen (1937)

CULICIDAE

- a. Matheson (1944)

Townes' (1945) work was used almost exclusively for the preliminary classification of the subfamilies of Tendipedidae and it was the most frequent reference used in specific determination of the tribe Tendipedini. When difficulty arose in the classification of female specimens, Malloch's (1915) work was useful.

For verification of the insects they were shipped to the United States National Museum, Washington D. C. A complete sample of all species were first identified and genitalia mounts made of all specimens; they were then packed and sent to the museum. Doctor Alan Stone verified the species of Tendipedidae and Culicidae and the Heleidae were determined by Doctor W. W. Wirth. The returned specimens provided a very valuable check list for all the insects sampled. Before the final tabulation was compiled all insects were compared with those verified by the experts at the museum. This procedure worked out very satisfactorily in handling large numbers of insects with the greatest accuracy possible.

Until the publication of Townes (1945) appeared, the family Tendipedidae had always gone under the name Chironomidae and the most important genus Tendipes was known as Chironomus in American and British literature. Much of the European literature is based on the genus name Tendipes and it appears that Townes adoption of this name follows the rules of nomenclature and will eventually standardize the nomenclature for this group of insects.

In this paper the nomenclature of Townes and that of the United States National Museum was used exclusively.

VI A LIST OF INSECTS
RECOVERED FROM THE FUNNEL TRAP SAMPLES

TENDIPEDIDAE

Tendipedini

1. Tendipes brunneipennis (Joh.)
2. Tendipes staegeri (Lundb.)
3. Tendipes modestus (Say)
4. Tendipes plumosus (L.)
5. Tendipes nervosus (Staeg.)
6. Tendipes decorus (Joh.)
7. Cryptochironomus digitatus (Mall.)
8. Cryptochironomus fulvus (Joh.)
9. Glyptotendipes paripes (Edw.)
10. Glyptotendipes lobiferus (Say)
11. Pseudochironomus banksi (Townes)
12. Tanytarsus nigricans (Joh.)
13. Lauterborniella varipennis (Coq.)
14. Microtendipes pedellus var. pedellus (Deg.)
15. Paratendipes albimanus (Mg.)
16. Polypedilum nubeculosum (Mg.)
17. Polypedilum simulans (Townes)
18. Harnischia viridulus (L.)
19. Harnischia tenuicaudata (Mall.)
20. Kribioxenus bicornis (Townes)
21. Tanytarsus punctipes (Wied.)

TENDIPEDIDAE (Cont.)

Pelopiinae

1. Procladius bellus (Lw.)
2. Procladius culiciformis (L.)
3. Pelopia punctipennis (Mg.)
4. Pentaneura spp.

Hydrobaeninae

1. Cricotopus trifasciatus (Panz.)
2. Cricotopus brunnicans (Walley)
3. Cricotopus spp.
4. Hydrobaenus spp.

HELEIDAE

1. Atrichopogon levis (Coq.)
2. Jenkinshalea albaria (Coq.)
3. Bezzia glabra (Coq.)
4. Bezzia sp.
5. Dasyhelea sp. near traverae (Thomsen)

CULICIDAE

Chaoborinae

1. Chaoborus punctipennis (Say)

VII DISCUSSION

A total of 174 square-yard samples were taken between June 13 and September 10 from the six experimental ponds. In ponds "C" and "D" one-fifth of the bottom area was sampled and in ponds "A", "B", "E" and "F" a smaller percentage of the bottom area was covered by the traps. The traps were placed in each pond 29 times during the experiment and allowed to remain there for 24 hours. A total of 261 square feet of bottom was sampled in each pond during the summer of 1951. There were 5,832 insects representing 35 species taken from the six ponds or an average of 33.5 insects per sample. It is important to remember that these samples represented the emergence of adult insects over a 24 hour period and had no relationship to the standing crop or to the number of immature organisms in the pond. The term "yield" as outlined by Clarke (1946) would very conveniently cover this group of insects which was taken by the traps.

This report is restricted to the order Diptera of which the following three families were represented: Tendipedidae, Heleidae, and Culicidae.

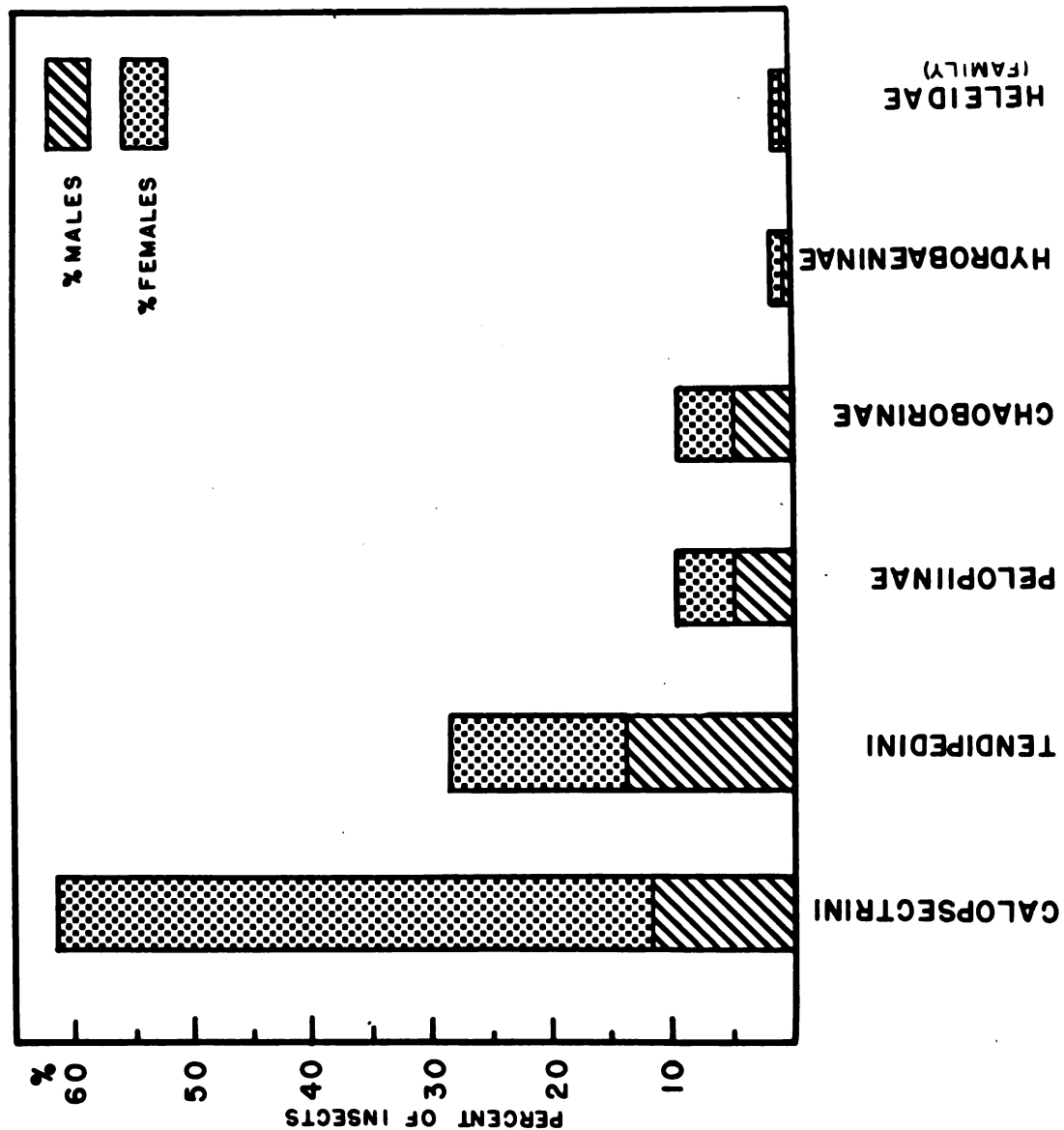
A. Relative abundance of various subfamilies

The family Tendipedidae made up 91.7 percent of the total number of insects sampled. There were 29 species of Tendipedidae sampled belonging to the following subfamilies:

THE SUBFAMILIES OF TENDIPEIDAE

Subfamily	Pond A		Pond B		Pond C		Pond D		Pond E		Pond F	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
Tendipedini	197	142	401	450	12	16	38	40	37	45	121	121
Pelopiinae	117	89	37	41	7	6	10	8	56	71	54	56
Calopsectrini	364	64	192	89	39	27	23	19	494	127	1419	305
Hydrobaeniane	7	2	3	3	6				8	13	5	1
Heleidae (Family)			1		1	1	1		10	5		2
Chaoborinae (Culicidae)	1		5	3	38	44	182	160		1	1	1

FIGURE 1
PERCENTAGE COMPOSITION OF SUBFAMILIES



Tendipedinae, Pelopiinae and Hydrobaeninae. Figure 1 shows the percentage composition of the different groups sampled and from this it is apparent that 60 percent of all insects were members of the tribe Calopsectrini.

B. Tribe Calopsectrini

The tribe Calopsectrini is an exceedingly difficult group of insects to work with due to the following two reasons. First, the tribe Calopsectrini has never been classified to genus or species. Second, there is a noticeable absence of literature pertaining to the Calopsectrini. It was very easy to separate, by the use of color and other characteristics, the members of this group into subgroups. These subgroups were probably different species but since no keys were available to classify them, this practice was discontinued and the group was treated as a tribe only.

There were 3,163 specimens belonging to the tribe Calopsectrini collected and of these 80 percent were females. A constant ratio existed between males and females throughout the season with the females always in a significant majority. These specimens were separated very carefully and there appeared to be no explanation for this unusual occurrence. The distribution of the tribe Calopsectrini as to ponds was equally as unique. Fertilizer did not increase the production of this group, in fact the greatest production was in the ponds fertilized at a low rate. Pond "F" produced 52 percent of the Calopsectrini collected, while

pond "B", which was very productive in Tendipedini, produced only 9 percent.

The part the tribe Calopsectrini played in the biological cycle which was taking place in the aquatic environment of these ponds is scarcely understood. There is no report of the tribe Calopsectrini being represented in bottom samples or adult sampling devices, although, they were the most numerous group of insects emerging in this study. It seems probable that they were present in similar habitats but may have been overlooked or included with other groups. The small size of these insects may account for their absence in many samples. The maximum length of the adult Calopsectrini was four millimeters and it was surprising to observe that all insects belonging to the tribe Calopsectrini were almost the same size. There was no way of investigating how many of the small larvae and pupae of these insects were taken as food by minnows. They would be digested very rapidly by a fish since they were so very delicate. Several attempts were made to sample the bottom of pond "F" with an Ekman dredge to recover some of the larvae but in all instances it was impossible to see the larvae, even by the use of a dissecting microscope.

The emergence of the members of the tribe Calopsectrini was very constant throughout the summer without any cyclic variations. It appeared as if there were several generations emerging during the investigation but until species are better known it will be difficult to determine the num-

ber of generations. There were many questions unanswered in the survey of the tribe Calopsectrini and the opportunities for further research are abundant.

The tribe Tendipedini made up 27 percent of all insects collected and might be elaborated on at this point. However, the principal objective of this project was to study the tribe Tendipedini, so a complete chapter will be devoted to the discussion of this tribe.

C. Subfamily Pelopiinae

There were 552 specimens belonging to the subfamily Pelopiinae sampled, representing 9 percent of the total production. Three genera were represented with at least five species taken. It was impossible to identify several of the species, so the discussion will be limited to the three identified species.

In the subfamily Pelopiinae there was no significant increase in the fertilized ponds. Pond "A", the check pond, produced 39 percent of the Pelopiinae taken. Pelopia punctipennis (Mg.) made up one half of the Pelopiinae specimens taken from the traps. Pelopia punctipennis (Mg.) had two definite periods of emergence, one occurring the last week in July, the other the last week in August. Procladius bellus (Lw.) followed the emergence curve shown in Figure 2 and it is quite possible this species has two generations a year like many of the Tendipedini. The other species of Pelopiinae had an erratic emergence and were so seldom

sampled that little information as to life cycles could be gathered.

Several investigators have published reports on the classification of the subfamily Pelopiinae but the literature has a noticeable absence of ecological notes. Hauber (1945) states that most species are carnivorous and quite commonly cannibalistic. Leathers (1922) reports of one species killing its prey, which very often includes large numbers of diatoms, and sucking the contents. Most workers are unanimous in their reports on types of habitat most often associated with the Pelopiinae. They report the immature stages most frequently occurring in shallow ponds and slow moving streams. The ponds studied appear to be well suited to Pelopiinae production as the food habits and ecological requirements were present.

D. Subfamily Hydrobaeninae

There were 48 specimens collected belonging to the subfamily Hydrobaeninae and these insects were included in two genera. It was possible to identify two species and several other specimens were classified only to genus.

Nearly one-half of the specimens of Hydrobaeninae were taken from pond "E" and of these Cricotopus trifasciatus (Panz.) predominated. Johannsen (1937) reports the larvae of Cricotopus trifasciatus (Panz.) was normally associated with pond lilies and Elodea. Pond lilies and Elodea were not present in pond "E" but there was the extensive growth of Chara sp. and Spirogyra sp. in which this species may have

lived. Not enough specimens were collected to establish what effect fertilizer had on the subfamily Hydrobaeninae. In this study the members of the subfamily Hydrobaeniane were most prevalent in the ponds with a growth of filamentous algae and were very scarce where plankton was abundant.

E. Family Heleidae

Only 21 specimens were collected belonging to the family Heleidae and of these 15 were taken from pond "E". Thomsen (1937) reported that many of the aquatic Heleids which she collected were taken from blanket algae. Pond "E" had an extensive growth of filamentous algae and evidently provided the type of habitat necessary for Heleid production. The emergence of the different species of the family Heleidae was restricted to a very limited period. Each time a species was taken it showed up in only one sample. The family Heleidae and the subfamily Hydrobaeniane were very similar in total production, response to fertilizer and habitat preferred.

F. Family Culicidae

The family Culicidae was restricted to one species, Chaoborus punctipennis (Say) belonging to the subfamily Chaoborinae. Chaoborus punctipennis (Say) was restricted almost entirely to the shallow ponds. Ponds "C" and "D" produced 97 percent of the specimens collected. This is in direct contrast to the reports of Welch (1935) and Herms

• The first step in the process of creating a new product is to identify a market need. This can be done through market research, which involves gathering information about the target market and its needs. Once a market need has been identified, the next step is to develop a product concept. This involves creating a detailed description of the product, including its features, benefits, and target market. The product concept is then used to create a business plan, which outlines the company's strategy for developing and marketing the product.

• The business plan is a critical document that provides a roadmap for the company's growth. It includes information about the company's financial goals, marketing strategy, and operational plan. The business plan is used to attract investors and secure financing for the company. Once the business plan has been developed, the next step is to create a prototype of the product. This involves building a small-scale version of the product that can be used to test the market and gather feedback. The prototype is then used to create a full-scale production plan, which outlines the company's strategy for manufacturing and distributing the product. The production plan is then used to create a marketing plan, which outlines the company's strategy for promoting and selling the product.

• The marketing plan is a critical document that provides a roadmap for the company's marketing efforts. It includes information about the company's target market, marketing strategy, and promotional plan. The marketing plan is used to attract customers and increase sales. Once the marketing plan has been developed, the next step is to launch the product. This involves creating a launch plan, which outlines the company's strategy for introducing the product to the market. The launch plan is then used to create a sales plan, which outlines the company's strategy for selling the product. The sales plan is then used to create a distribution plan, which outlines the company's strategy for distributing the product.

(1937), as they found the abundance of Chaoborus at a depth of 30 to 35 meters. Chaoborus punctipennis (Say) appeared to prefer the environment of the fertilized pond, as 80 percent of the specimens collected were taken from pond "D". This evidence is substantiated by Bray (1949), as he found the larvae of Chaoborus punctipennis (Say) to be restricted to the fertilized pond. The peak emergence of Chaoborus punctipennis (Say) was confined to two periods, one June 13 to June 22 and again between July 26 and August 14. During the remainder of the season only occasionally was a specimen collected.

The reason pond "B" produced so few specimens, even though it was heavily fertilized, is not well understood. One explanation for this low productivity may have been that the fish in pond "B" consumed sizeable numbers of Chaoborus. There is no agreement in the literature as to the importance of Chaoborus as a fish food organism. Herms (1937) reports as many as 100 of these insects were found in the stomach of one "calico bass" a species of fish which feeds near the bottom ooze where the larvae occurs, principally during the winter. In contrast to this, Howell (1941), Ball (1948) and Patriarche and Ball (1949) observed that Chaoborus was not taken by the bluegill. There are no reports of Chaoborus being taken by bullheads but there is also an absence of stomach analysis through the winter months. It is possible that Chaoborus may have been reduced in this way.

• Die Bedeutung der Sprache ist in der Literatur und in der Kunst von zentraler Bedeutung. Die Sprache ist das Medium, durch das wir unsere Gedanken und Gefühle ausdrücken können. Sie ist das Werkzeug, mit dem wir unsere Welt verstehen und gestalten können. In der Literatur wird die Sprache oft auf eine Weise verwendet, die über den reinen Informationsaustausch hinausgeht. Sie wird genutzt, um Emotionen zu wecken, Bilder zu malen und neue Perspektiven auf die Welt zu eröffnen. In der Kunst ist die Sprache ebenfalls ein wichtiges Element. Sie kann in Form von Texten, Bildern oder Tönen verwendet werden, um eine Botschaft zu vermitteln oder eine Geschichte zu erzählen.

• Die Rolle der Literatur in der Gesellschaft ist vielfältig. Sie kann dazu beitragen, das Bewusstsein für soziale Probleme zu schärfen, die Moral zu lehren oder einfach nur zur Unterhaltung dienen. Literatur ist ein Spiegelbild der Gesellschaft, in der sie entsteht. Sie zeigt uns, wie andere Menschen leben, denken und fühlen. Durch das Lesen von Literatur können wir uns mit anderen Kulturen und Epochen verbinden und ein besseres Verständnis der menschlichen Existenz gewinnen.

• Die Kunst ist eine Form der kreativen Expression, die es uns ermöglicht, unsere Welt auf eine neue Weise zu sehen. Sie kann in vielen verschiedenen Formen auftreten, wie zum Beispiel in der Malerei, der Musik oder der Literatur. Kunst ist eine Möglichkeit, unsere Emotionen und Gedanken in eine greifbare Form zu bringen. Sie kann uns inspirieren, neue Ideen zu entwickeln und unsere Vorstellungskraft zu erweitern. Kunst ist auch ein wichtiger Bestandteil der menschlichen Kultur und trägt dazu bei, unsere Identität zu definieren.

• Die Verbindung von Literatur und Kunst ist ein Thema, das seit Jahrhunderten diskutiert wird. Es gibt viele Beispiele dafür, wie Literatur und Kunst ineinander verzahnt sind. Ein bekanntes Beispiel ist die Dichtung, die oft in Form von Bildern oder Skulpturen dargestellt wird. Auch die Musik hat eine lange Tradition, literarische Werke zu vertonen. Die Verbindung von Literatur und Kunst ermöglicht es uns, unsere Erfahrungen auf eine noch tiefgründigeren Weise zu verarbeiten und zu teilen.

• Die Zukunft der Literatur und Kunst ist ungewiss, aber es gibt einige Trends, die wir beobachten können. Die Digitalisierung hat neue Möglichkeiten eröffnet, Kunst und Literatur zu verbreiten und zu konsumieren. Online-Plattformen ermöglichen es uns, Werke aus aller Welt zu entdecken und zu diskutieren. Gleichzeitig gibt es auch Herausforderungen, wie zum Beispiel die Frage nach der Authentizität von Kunst in der digitalen Welt. Es bleibt abzuwarten, wie sich diese Trends weiterentwickeln werden und welche Auswirkungen sie auf die Literatur und Kunst haben werden.

G. Other Insects Sampled

Since the project was established primarily as a study of the midges, other groups were not classified to species. There were eight specimens of Trichoptera and nine of Ephemeroptera taken from the samples. There appeared to be some adjustment needed in the trap to allow the mayflies to emerge successfully, especially those of the genus Caenis. In pond "F" there was a large population of mayflies belonging to the genus Caenis. These insects would come up into the jar but were unable to get out of the water to complete the subimago stage and eventually emerge as adults.

The trap appeared to sample the Trichoptera successfully but this order was poorly represented in the ponds. Two specimens of the family Cecidomyiidae were recovered from a sample taken in pond "C". The trap appeared as if it would be equally as useful in sampling other aquatic orders, if they were present, as it was in collecting midges.

H. The Tribe Tendipedini

1. Seasonal Variation

The seasonal variation of Tendipedini collected from all ponds is shown in Figure 2. The curve of insect emergence is based on the total number of Tendipedini taken during each sample. The circles on the graph represent each time a sample was taken. If more samples could have been taken the curve would have taken on a smoother appear-

• The first part of the document discusses the importance of maintaining accurate records of all transactions and the role of the accounting system in providing reliable financial information.

• The second part of the document describes the various methods used to collect and analyze data, including interviews, surveys, and focus groups.

• The third part of the document presents the results of the study, showing that the accounting system is a critical tool for managing financial resources and that it can be used to identify areas for improvement.

• The fourth part of the document discusses the implications of the findings for the development of accounting systems and the role of accountants in the future.

• The fifth part of the document provides a summary of the key findings and conclusions of the study.

• The sixth part of the document discusses the limitations of the study and the need for further research.

• The seventh part of the document provides a list of references and a bibliography.

• The eighth part of the document provides a list of appendices and a bibliography.

• The ninth part of the document provides a list of figures and a bibliography.

• The tenth part of the document provides a list of tables and a bibliography.

• The eleventh part of the document provides a list of abbreviations and a bibliography.

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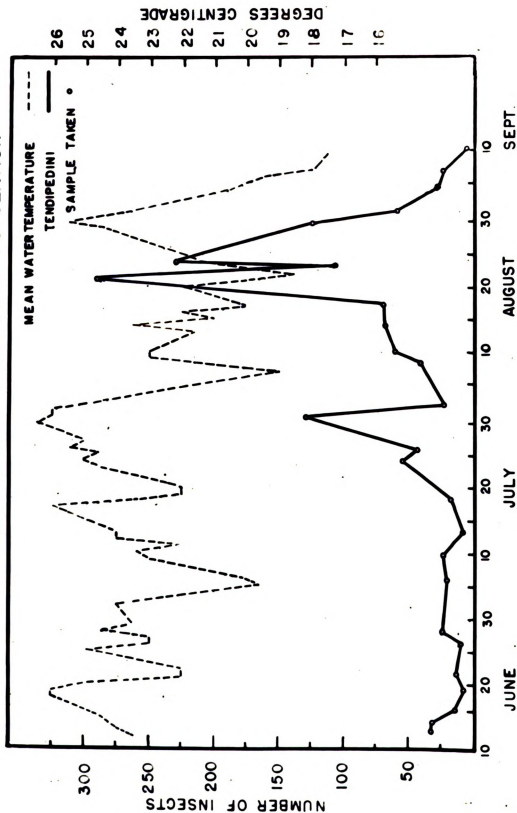
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• The forty-ninth part of the document provides a list of figures and a bibliography.

• The fiftieth part of the document provides a list of tables and a bibliography.

FIGURE 2
SEASONAL VARIATION
OF TEMPERATURE AND TENDIPEDINI
POPULATION



ance, however, the effects of sudden temperature changes on insect emergence shows up very clearly. Surface water temperatures were taken at eight in the morning and at five in the afternoon each day and the temperature curve is plotted from the average of these two temperatures.

There was one period when the emergence of Tendipedini, as a group, was exceedingly great. This emergence began about July 20, reached its peak on August 20 and rapidly declined during the succeeding ten days. The water temperature dropped seven degrees during the first week in August. The Tendipedini emergence fell in direct proportion to the water temperature decline. The water remained cool for two weeks but the emergence of insects rapidly increased until the peak emergence was reached. Each time a sample was taken it was apparent that there was a direct correlation between rise and fall in water temperature and insect emergence. The variation of insect emergence was not as sharp a fluctuation as the temperature change. It appeared that the emergence operated within limits of temperature variance. The rise or fall in temperature would only serve to increase or decrease the emergence for a certain day and would be compensated for in the following samples. A very excellent example of this occurred on August 22 when the temperature dropped sharply and the following sample responded to this decrease. The insects increased sharply in the sample taken the next day, although the temperature was still relatively low.

On weekends during April and May observations were made on the ponds, although no samples were taken. It was very evident that a tremendous emergence of Tendipedini occurred the first week of May. At this time there were large rafts of pupal exuviae on the surface of pond "B" similar to those present in August during the large emergence. It seems safe to conclude that there were two generations a year of the predominate Tendipedini species in the experimental ponds.

Bray (1949), working on the same ponds with the larval forms, reported a conspicuous decline in his midge samples between August 1 and September 1. This decline corresponds favorably with the emergence of adults in this study. Ball (1948) reports the same type of decline in larval abundance in bottom samples but the drop is somewhat earlier in the season. This perhaps can be explained, as his experiments were conducted in the southern section of Michigan where the growing season is considerably longer. This discussion of emergence and number of generations is including all of the species of the tribe Tendipedini. Not all of the species followed this cycle but the species which were present in large numbers and those responding most actively to fertilizer did follow this emergence curve. Those species which were exceptions to the curve will be discussed separately in the succeeding chapter.

2. Variation of Pond Populations

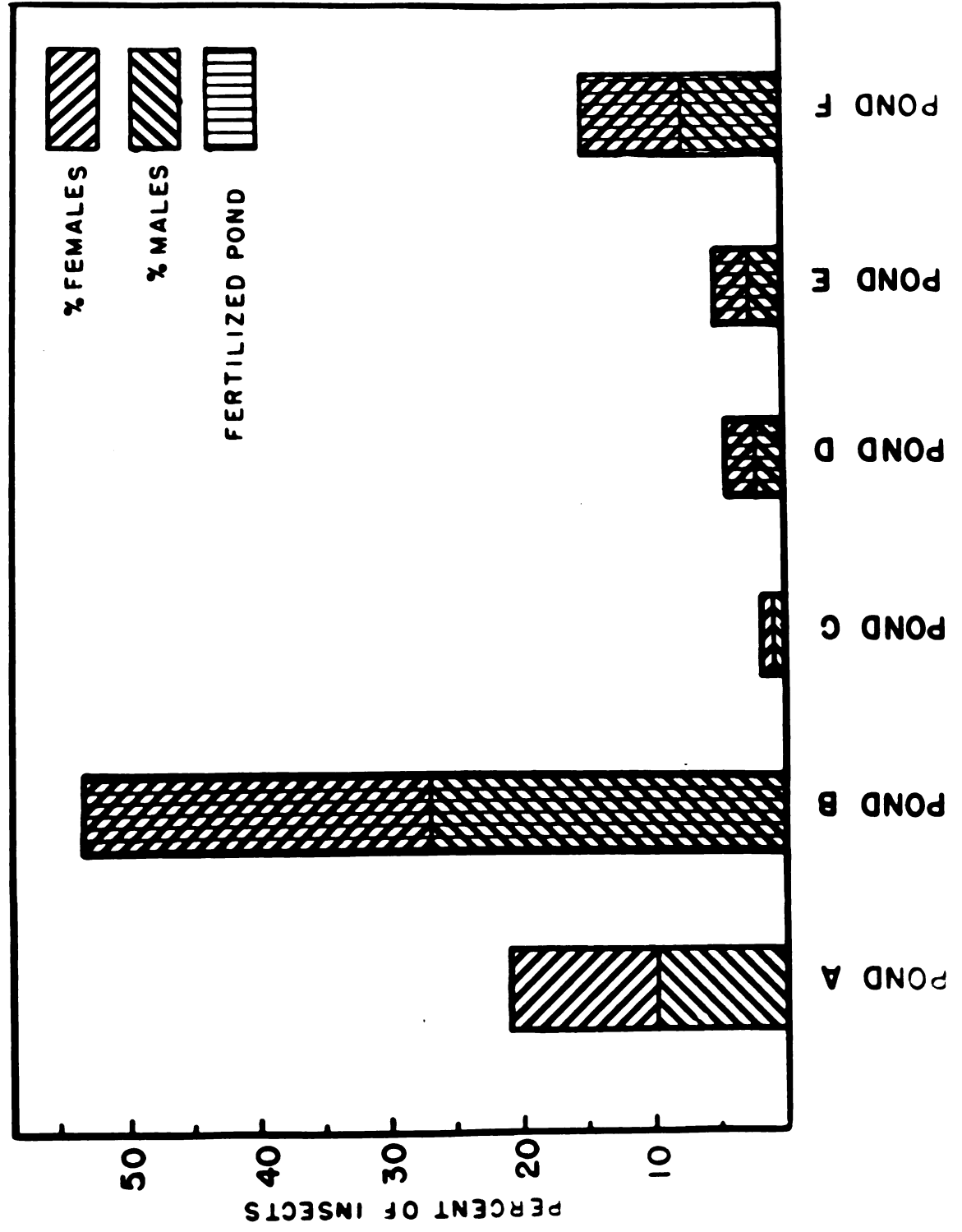
This discussion of variation in production of the dif-

ferent ponds will be restricted to the tribe Tendipedini, since the other groups were discussed in a previous chapter. Figure 3 shows the percentage distribution of Tendipedini in each pond.

In comparing pond "B", the heavily fertilized pond, with pond "A", the check, it was apparent that for every midge produced in pond "A", three were produced in pond "B". Since the two ponds have similar histories and were very much alike except for fertility, it would seem that this increase in midge production was due to the application of fertilizer.

Figure 3 shows that both ponds "E" and "F", the other two fertilized ponds, were lower in Tendipedini production than the check. This data is in complete contradiction with that from pond "B" where fertilizer appeared to increase production. Several substantial explanations were available to clarify this low productivity in ponds "E" and "F". Ponds "E" and "F" have received considerably less fertilizer than "B" and they have been very slow in the biological response to fertilizer. Pond "E" has not produced a plankton bloom and 1950 was the first season that pond "F" produced any significant phytoplankton. The majority of the insects produced belonging to the family Heleidae, subfamily Hydrobaeninae and tribe Calopsectrini were taken from ponds "E" and "F". In this study it appeared that where these three groups were the principal insects emerging, the species of the tribe Tendipedini were exceed-

FIGURE 3
PERCENTAGE DISTRIBUTION OF INSECTS BY PONDS



ingly scarce. It was obvious that there was a large amount of environmental preference among the members of the tribe Tendipedini and without doubt, this same phenomenon will occur when the other groups are studied and identified more specifically.

Several experiments were set up to determine whether the midges preferred the fertilized water for egg deposition or perhaps the larvae were more successful in completing their development in the fertilized water. Lund (1942) performed similar investigations with mosquitoes and his technique of setting up jars with different types of fertilizer was used. The midges would not deposit their eggs in these jars, however, Culex spp. deposited eggs in large numbers in all of the fertilized jars. It was very unusual to find a Culex egg raft in the unfertilized jars.

In ponds "E" and "F" there was considerable production of predacious insects, such as dytiscid larvae, Belostoma sp., Ranatra sp., and Notonecta sp. Pond "B" had very few predacious insects.

It appeared that no single factor limited the greater production of insects in the fertilized ponds; rather, a series of environmental advantages which included greater availability of food, fewer predators and perhaps preference for certain waters for egg deposition were responsible for the increase.

Ponds "C" and "D", the two shallow ponds, must be discussed separately as they were specific in their Tendi-

pedini production. Figure 3 shows that both ponds "C" and "D" were lower in total production than any of the deeper ponds. The average production for ponds "C" and "D" was only 1.8 insects per sample, while the average for "A" and "B" was 20.7 insects per sample. The shallow depth of ponds "C" and "D" seemed to be the only explanation for this marked variation in abundance. It would appear that the tribe Tendipedini preferred a habitat where the depth of the water was four to six feet over a pond with a depth of three inches to two feet.

The emergence was considerably less in the shallow ponds but the ratio of unfertilized to fertilized remained at one to three, the same as ponds "A" and "B". The ratio of males to females of the tribe Tendipedini, in all ponds, was approximately one to one and there was no evidence that either sex emerged first.

3. Species of the Tribe Tendipedini

The tribe Tendipedini includes many of the species of midges most often referred to in fisheries work and limnological investigations. This group includes the larger midges, many of which have large, red larvae often referred to as "bloodworms". The importance of these larvae as fish food organisms has been recognized for many years. Many investigators have reported midges occurring as a primary or secondary source of food for many species of fish (Muttkowski, 1929; Clemens, Dymond and Bigelow, 1924; Ball

1948; Ball and Tanner, 1951).

In this investigation the tribe Tendipedini provided 27 percent, by number, of all insects sampled. If a volumetric comparison had been made the tribe Tendipedini would have produced the greatest percentage of insects, for many of the species were very large. The Tendipedini taken in this experiment responded very well to the application of fertilizer. No other group of insects increased in number as rapidly and adjusted themselves so completely to the added fertility. There was a great difference among the species as to number of individuals emerging and the type of habitat where they were most often taken.

There were 21 species of Tendipedini taken (Table 2) and this represented 62 percent of all species sampled during the experiment. There were 1,620 specimens identified belonging to the tribe Tendipedini and of these 780 were members of one species, Tendipes brunneipennis (Johannsen), (Figure 4). There is very little information in American literature pertaining to the biology and life cycles of the 21 species of Tendipedini taken in this investigation. For this reason all biological observations which will add pertinent information to the biology of any of these insects will be included in the following discussion.

FIGURE 4
DISTRIBUTION OF SPECIES OF TENIPEIDINI

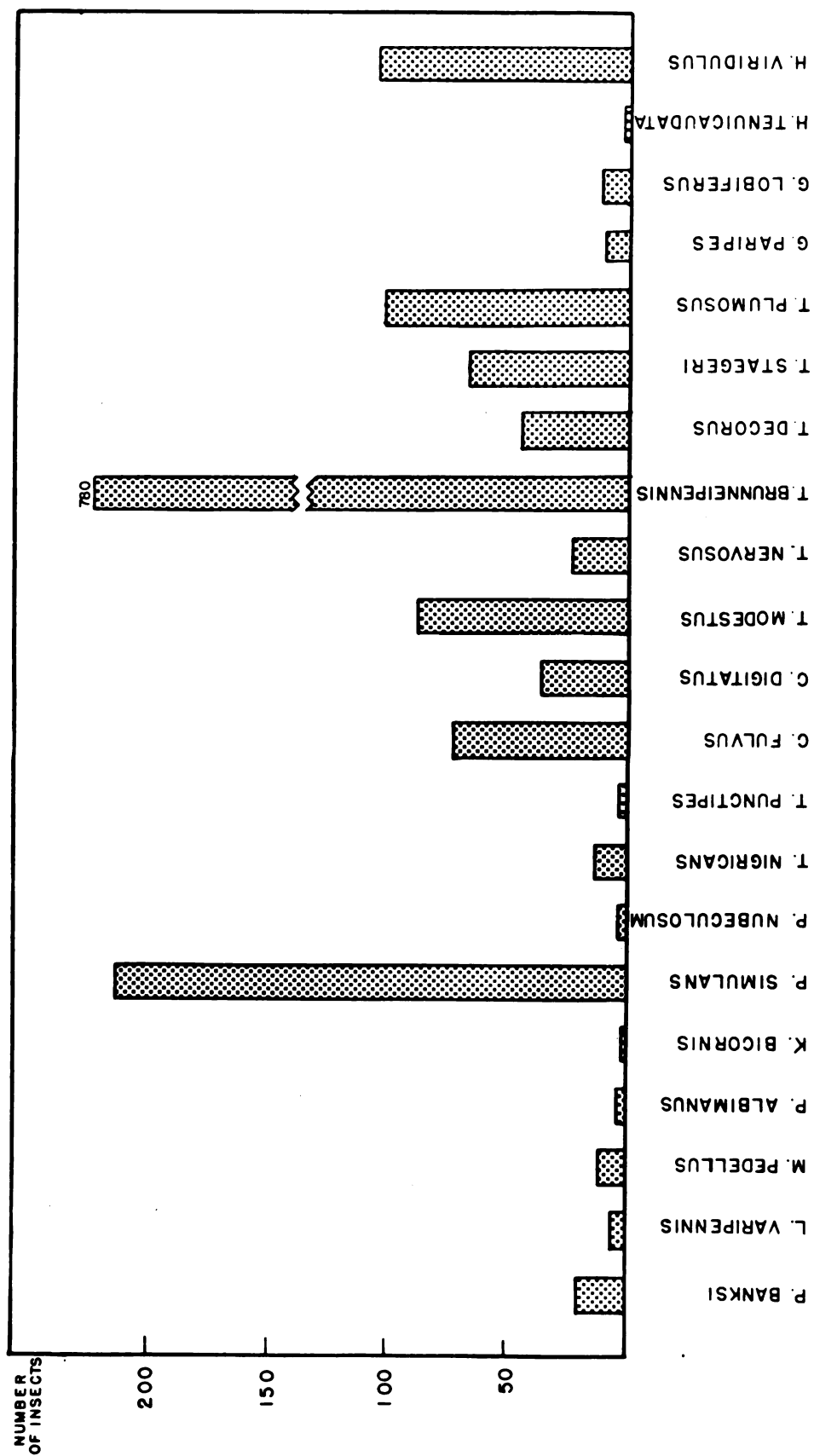


TABLE 2
THE SPECIES OF TENDIPEDINI

Species	Females	Males	Percent	Pond present
<u>Pseudochironomus banki</u>	13	5	1.3%	B, F
<u>Lauterborniella varipennis</u>	3	2	.4	A, B
<u>Microtendipes pedellus</u> var. <u>pedellus</u>	4	7	.7	E, F
<u>Puratendipes albilimanus</u>	1	1	.2	F
<u>Kribioxenus bicornis</u>		1	.05	A
<u>Polypedilum simulans</u>	132	63	14.	A, B, C, E, F, D
<u>Polypedilum nubeculosum</u>		2	.2	A
<u>Tanytarsus nigricans</u>	6	6	.7	E, F
<u>Tanytarsus punctipes</u>		1	.05	F
<u>Cryptochironomus fulvus</u>	32	39	4.4	A, B, E, F
<u>Cryptochironomus digitatus</u>	16	18	2.2	A, B, C, D, F
<u>Tendipes modestus</u>	42	47	5.5	A, B, C, D, E, F.
<u>Tendipes nervosus</u>	6	15	1.4	E, F
<u>Tendipes brunneipennis</u>	373	408	48.0	A, B, C, D, E, F
<u>Tendipes decorus</u>	18	25	2.6	B, D
<u>Tendipes staegeri</u>	32	35	4.2	B, C, D
<u>Tendipes plumosus</u>	54	47	6.2	B
<u>Glyptotendipes paripes</u>	4	5	.6	B, D, F
<u>Glyptotendipes lobiferus</u>	5	5	.6	B, F
<u>Harnischia tenuicaudata</u>		2	.3	B
<u>Harnischia viridulus</u>	55	49	6.4	A, B, C, D, E, F

TABLE 6
SEASONAL DISTRIBUTION OF SPECIES OF TENDIPEDINI FOUND IN POND D

Date		Species present															
		<u><i>Polypedilum simulans</i></u>		<u><i>Cryptochironomus digitatus</i></u>		<u><i>Tendipes modestus</i></u>		<u><i>Tendipes brunneipennis</i></u>		<u><i>Tendipes decorus</i></u>		<u><i>Tendipes stangeri</i></u>		<u><i>Glyptotendipes paripes</i></u>		<u><i>Hamischia viridulus</i></u>	
		♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂
June	13						2										
	14							1									
	16							1									
	19																
	22			4	3					2	4						
	25			7	1												
	28																
July	3							1		3	5						
	6			3	1		1	1							5	3	
	10				2		1							1			
	13																
	16					1				1							
	18									2							
	24																
	26																
	31																
Aug.	2																
	8																
	10							2		1			1				
	14																
	17										4						
	21																
	23										1						
	24										1						
	30							1									
Sept.	1		1					3	4								
	4																
	7									1							
	10										1	1					

TABLE 7
SEASONAL DISTRIBUTION OF SPECIES OF TENDIPEDINI FOUND IN POND E

Date	Microrandallia pedatae	Polydora alaudae	Tanaisius affinis	Cyrtodonta fulva	Rondellus modestus	Tendipes nervosus	Tendipes brunneipennis	Harpacticoides vernalis
June 13								
" 14								
" 16				1				
" 19				1				
" 22								
" 28				1				
July 3				1				
" 6								
" 10								
" 13								
" 16								
" 18								
" 24								
" 28								
" 31	1							
Aug. 2								
" 8	1							
" 10	1							
" 14	2			1				
" 17	1			1				
" 21	4							
" 23	1		1	1				
" 24								
" 30	2							
Sept. 1	1							
" 4								
" 7	1							
" 10	2							

[illegible][illegible]

Tendipes brunneipennis (Johannsen)

Tendipes brunneipennis (Joh.) was the most numerous species of Tendipedini taken and was present in all of the ponds. This species made up 48 percent of all the specimens collected belonging to the tribe Tendipedini. Pond "B" produced 78 percent of the individuals of Tendipes brunneipennis (Joh.) collected. This species was used as a reference species, since it was very numerous, followed the two generation emergence curve, and responded exceedingly well to the application of fertilizer.

In comparing pond "B" with pond "A", this species was seven times as numerous in samples taken from the fertilized pond. In pond "E" eleven specimens were recovered and pond "F" sixteen. It was interesting to note that this species was exceedingly abundant in pond "B" but in ponds "E" and "F" which were very close to pond "B", the species was very seldom taken. This increased the evidence to support the hypothesis that these suborders and species have a restricted environmental preference.

From Tables 3, 5, 7 and 8 it can be seen that this species was declining in numbers in the first three samples. Very few specimens were taken again until July 24 when the emergence built up very rapidly. The evidence indicated that Tendipes brunneipennis (Joh.) had two periods of emergence following the curve of Figure 2.

Polypedilum simulans (Townes)

This species made up 14 percent of the Tendipedini population, which made it second in numerical importance. It was found in all of the six ponds. Pond "A" produced 67 percent of specimens of Polypedilum simulans (Townes) while ponds "C" and "D" produced only one specimen each. This species was more prevalent in the check pond and those fertilized at a low rate.

In pond "A" Polypedilum simulans (Townes) was taken in four samples and did not appear in the sample again until July 24. This, like Tendipes brunneipennis (Joh.), had two generations following the emergence curve of Figure 2.

Harnischia viridulus (Linnaeus)

A total of 104 Harnischia viridulus (Lin.) specimens were sampled from the ponds. The distribution of this species was very similar to that of Polypedilum simulans (Townes). This species was most abundant in pond "F" where 46 specimens were collected by the trap.

Harnischia viridulus (Linnaeus) specimens were present in the samples from June 28 until September 1, thus, the possibility of two generations a year was very unlikely, with such a long period of emergence.

Tendipes plumosus (Linnaeus)

Tendipes plumosus (Linnaeus) was the largest specimen collected and the pupae of this species was over two centi-

meters long. This species was restricted to pond "B" where 101 specimens were taken. There were a few specimens taken intermittently throughout June and July but the maximum emergence occurred between August 17 and September 4. On May 6 there were many very large pupal exuviae on the surface of pond "B" and several adult specimens of Tendipes plumosus (Lin.) were taken with a collecting net. From this it appeared that this species had two generations during 1951. Townes (1945) reports this species nearly always at a depth of over 12 feet and usually at depths of 18 to 60 feet. This may have some bearing on this species not being sampled from the shallow ponds.

Tendipes modestus (Say)

This species was present in all of the six ponds but only three specimens were sampled from the shallow ponds. Pond "F" produced over half of the Tendipes modestus (Say) specimens taken. The emergence of this species was evenly spaced from June 19 until the experiment was concluded on September 10, without any samples having more than five specimens.

Cryptochironomus fulvus (Johannsen)

Four ponds were represented by this species but two-thirds of the specimens were restricted to pond "F". Cryptochironomus fulvus (Joh.) was completely absent in the two shallow ponds. The emergence of this species in pond "F"

7

was limited to the period between August 14 and September 2. In the other ponds the emergence was scattered through July, August and September. Malloch (1915) reports the adults of this species present from April 23 to September 18.

Tendipes staegeri (Lundbeck)

The heavily fertilized ponds produced 85 percent of the insects collected belonging to Tendipes staegeri (Lundbeck). In ponds "B" and "D" the emergence appeared at two periods much the same as Tendipes brunneipennis. In pond "C" only the first emergence was evident and no specimens were taken after June 28.

Tendipes decorus (Johannsen)

All of the specimens of Tendipes decorus (Johannsen) except one were recovered from pond "B". The emergence of Tendipes decorus was restricted to the period between August 21 and September 10. Miller found this species emerging from Costello Lake only once during June and July. In the warmer climate in the vicinity of Urbana, Illinois, Malloch (1915) found this species in May and June and again in September and October. Townes (1945) reports this species having a fluctuating abundance, with adults on the wing from early spring to late fall. From the results of this experiment and those of other workers it appears that Tendipes decorus (Joh.) is a species very dependent on temperature variation.

- The first step in the process is to identify the problem or issue that needs to be addressed.
- This involves gathering information and understanding the context of the problem.
- Once the problem is identified, the next step is to develop a plan of action.
- This plan should outline the steps that need to be taken to solve the problem.

- The plan should also include a timeline and a budget.
- It is important to have a clear understanding of the resources available and the constraints of the project.
- Once the plan is developed, the next step is to implement it.
- This involves putting the plan into action and monitoring progress.
- It is important to have a system in place to track progress and make adjustments as needed.

- The final step in the process is to evaluate the results.
- This involves assessing the effectiveness of the plan and the impact of the actions taken.
- It is important to have a system in place to collect data and analyze it.
- The results of the evaluation can be used to inform future decisions and improve the process.

- The process of problem-solving is a continuous one.
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Cryptochironomus digitatus (Malloch)

Pond "D" the shallow fertilized pond produced two thirds of the individuals of Cryptochironomus digitatus (Malloch). All the specimens taken from pond "D" were found in samples between June 22 and July 10.

The remaining 12 species had fewer than 25 specimens each and made up less than 6.5 percent of the total Tendipediini collected. The different species appeared to arrange themselves into definite groups according to reaction to fertilization, depth of water and plant growth. The following discussion will include a description of the environment and those species which were included under the group.

The first group includes those species which showed a direct response to the application of fertilizer by an increase in numbers in the fertilized ponds. These species had, as far as could be determined, two generations a year. The initial emergence occurred during the first two weeks of May, the second during the middle of August. Species taken from ponds "E" and "F" are not included in this group. Ponds "E" and "F" did not respond as rapidly to fertilization and were not typical of the heavily fertilized ponds. The species included in this group are as follows:

1. Tendipes brunneipennis (Johannsen)
2. Tendipes decorus (Johannsen)
3. Tendipes staegeri (Lundbeck)
4. Tendipes plumosus (Linnaeus)
5. Harnischia tenuicaudata (Malloch)

1

The second group includes the species which were more numerous in the unfertilized ponds. They are as follows:

1. Lauterborniella varipennis (Coquillett)
2. Polypedilum simulans (Townes)
3. Kribioxenus bicornis (Townes)
4. Polypedilum nubeculosum (Meigen)
5. Tendipes modestus (Malloch)

The third group includes those species which were more prevalent in ponds "E" and "F". Several of these species were taken in only one sample but they will be included in the list since they were restricted to ponds "E" and "F".

1. Microtendipes pedellus var. pedellus (DeGeer)
2. Paratendipes albimanus (Meigen)
3. Tanytarsus nigricans (Johannsen)
4. Tanytarsus punctipes (Wiedemann)
5. Cryptochironomus fulvus (Johannsen)
6. Cryptochironomus digitatus (Malloch)
7. Tendipes modestus (Say)
8. Tendipes nervosus (Staeger)
9. Glyptotendipes paripes (Edwards)
10. Glyptotendipes lobiferus (Say)
11. Harnischia viridulus (Linnaeus)

Tanytarsus nigricans (Joh.) and Glyptotendipes lobiferus (Say) are reported by Berg (1950) to be net-spinning plankton-eaters. He reports Glyptotendipes lobiferus (Say) to live in the stems of higher aquatic plants and that

Tanytarsus nigricans (Joh.) was found in silken tubes within rolled leaves. There were no higher aquatic plants in ponds "E" and "F" to enable the larvae of these two species to carry on this type of activity. The only possible plant material from this type of habit would be the Chara or Spirogyra which was abundant in pond "E". This habit of using plant material in their environmental setup may be the reason these two species were more numerous in ponds "E" and "F".

There were three gynandromorphs taken during the summer from the samples. Townes (1945) reports this to be a common occurrence especially among those species of the subgenus Tendipes whose larvae live in the deeper parts of lakes. He reports gynandromorphism is due to parasitism by a mermithid worm which is found in the mature female larvae. When the parasitized female Tendipedid becomes an adult, it has male genitalia.

VIII SUMMARY

1. A comparison was made between adult insects emerging from shallow and deep ponds fertilized at different rates. An inverted funnel trap was used to sample the specimens.
2. The application of fertilizer produced a heavy growth of planktonic algae in ponds fertilized at a rate of 100 pounds of 10-6-4 N-P-K per acre.
3. The application of fertilizer appeared to increase the production of many species of the tribe Tendipedini. Other tribes of the family Tendipedidae did not respond directly to fertilizer application.
4. All insects, with the exception of Chaoborus punctipennis (Say), were more numerous in the deeper ponds.
5. The evidence presented from this investigation showed that the more numerous species of the tribe Tendipedini had two generations a year, the first emerging between May 1 and May 15 and the second from August 18 to August 23.
6. A total of 21 species belonging to the tribe Tendipedini were taken and of these 48 percent were specimens of Tendipes brunneipennis (Joh.).

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7

X KEY TO PLATES I - VI

Plate I

Figure

1. Complete view of the funnel trap with two quart jar in place.
2. Enlarged view of jar with inverted paper cup in position.

Plate II

1. The New Jersey light trap.
2. Lowering the trap into the pond.

Plate III

1. Raising the trap from the bottom of the pond.
2. Removing the jar after the sample had been taken.

Plate IV

1. The south shore of pond "F".
2. Pond "C" in the foreground and pond "D" in the background.

PLATE I



Figure 1



Figure 2

PLATE II



Figure 1



Figure 2

PLATE III



Figure 1



Figure 2

PLATE IV



Figure 1



Figure 2

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