THE SOIL AS AN ECOLOGICAL FACTOR IN THE ABUNDANCE OF AQUATIC CHIRONOMID LARVAE

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INTRODUCTION

In recent years much attention has been given to the restocking of our lakes, rivers and streams with fish. Along with this restocking program there has been an intensive study of the food cycle of the fish. These studies have shown that chironomid larvae are very important in the food cycle of the game fish. Since the larvae of the Chironomidae are so important, a study of the factors influencing their abundance should be considered along with the restocking program.

Most species of aquatic chironomid larvae in pools are found burrowing in the river bottom soil to a depth of 2 inches. They are also found in decaying leaves which are mixed with the soil. Since the chironomid larvae are found in these conditions, the writer believes the following points should be considered in order to determine if the soil is an important factor in the abundance of chironomid larvae.

1. Type of soil
2. Organic matter content.
3. pH of the soil.
4. Nitrate content of the soil.

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LITERATURE REVIEWED

Sullivan (1929) states that abundant chironomid larvae are found in all kinds of habitats. He did not give a description of the various types of habitats found or the number of chironomid found in each. There was no indication as to how many chironomid larvae should be considered as "abundant."

Jewell (1922) states that plenty of chironomid larvae were found but again there is no indication as to how many should be considered as "plenty." She states that no burrowing ephemerids were found in an acid stream but there were any numbers of chironomids. She states that the pH is a limiting factor for the burrowing mayfly nymphs but does not affect the chironomids.

Krecker (1933) gives a definite count of chironomid larvae per square yard and at the same time considers the type of soil as an important factor. In his study he found 60 chironomids per square yard of sand and only 20 in clay. Since this study was carried on in Lake Erie, its results cannot be compared with those in a stream except that it shows the type of bottom soil is important in the abundance of chironomid larvae.

Stehr and Branson (1938) made a number of population studies on sandy riffles and sandy pools. Their average mean count per square yard for February in a sandy riffle was 0 while the average mean count in a sandy pool was so small that it was not recorded. This paper shows that sand is not considered very productive as far as chironomid larvae are concerned.

Gersbacher (1937) in his very excellent paper on the development of stream bottom communities, states that in sand very little life can exist. According to him, the highest count of chironomids that could exist in his studies was 33.8 per square yard.

In this paper he states that as soon as algae and other detritus, which provide food and hiding places for chironomid larvae, starts accumulation, a count of 250 per square yard was considered low in many of these areas. This seems to show that there is a correlation between organic content and abundance of chironomids.

In mud bottom communities he found as high as 120 chironomids per square yard, but, if the pool is stable for the burrowing Mayflies, *Hexagenia*, will start migrating in with a corresponding decrease in the chironomid population. Silt and an accumulation of detritus is necessary for the burrowing mayfly nymphs.

PROCEDURE

The winter quarter was selected as the time in which to carry on the field work for the following reasons: First, the population is more constant throughout the winter than the spring, summer and fall months. This is due to the fact that there is no emergence of chironomid larvae. Secondly, the larvae that hatched late in the fall would be large enough to be easily seen and handled. Finally, the larvae would remain more or less constant in size through the winter months because of the low metabolic rate which exists during low temperatures.

Blacklick Creek in Franklin County, Ohio, was selected as the stream in which to do most of the field work. However, a few samples were taken from Big Walnut Creek, Alum Creek and Olentangy River. Not as many samples were taken as the writer desired because of the flood conditions which sometimes made collecting impossible.

The soil samples were taken by the Peterson trap, which is one of the standard instruments for population studies of aquatic insects. As soon as a sample was obtained, it was placed in a 40 mesh net and as much soil as possible was washed out. The remaining material was then placed in a labeled bucket in which it was taken to a laboratory. There the larvae were picked out and counted. Finally the insects were placed in a 4 per cent solution of formaldehyde.

Observations show that the greatest depth the chironomids burrow is 2 inches. The mayfly nymphs, *Hexagenia*, burrow to a depth of 1¾ to 2 inches. Each sample was composed of a composite of 4 hand trowel samples which were taken around the Peterson samples at a distance of 1 foot. The composite sample was placed in a half pint jar and conveyed to a laboratory where it was put in a cold air cabinet and kept at a temperature of 2° C. in order to prevent bacterial growth until the time of testing. Because the Peterson trap cannot be used in a rubble riffle, all samples were taken in pools. They were obtained at a water depth of 2¼ to 3 feet.

The soil samples at the time of analyzing were dried in an oven at a temperature of 50° C. The following standard methods were used in analyzing the soil:

1. Glass electrode for pH.
2. Phenol disulphonic acid for nitrates.
3. Pipette method for soil types.
4. Chromic acid digestion method for content of organic matter.

The basis used for classification of soils was as follows:

Soil Particles	*Diam. in mm.*
Clay	.002 or less
Silt	.002—.05
Sand	.05—2.0
Gravel	above 2.0

Soil textures were defined as follows:

A. Soils containing up to 20 per cent silt and clay.
   1. Sand..............19 per cent or less silt and clay.

B. Soils containing 20 per cent to 30 per cent silt and clay.
   1. Sandy loam........20 per cent or more fine gravel; coarse and medium sand.
   2. Fine sandy loam...30 per cent or more fine sand; 25 per cent or less gravel; coarse and medium sand.
   3. Sandy clay........20 per cent or more silt.

C. Soils containing 50 per cent or more silt and clay.
   1. Loam.............20 per cent or less clay; 50 per cent or less silt.
   2. Silt soil...........20 per cent or less clay; 50 per cent or more silt.
   3. Clay loam.........20 to 30 per cent clay; 50 per cent or less silt.
   4. Silty clay loam.....20 to 30 per cent clay; 50 per cent or more silt.
   5. Clay..............30 per cent or more clay.

Gersbacher (1937) states that the total population of specific type in river bottom pools remain constant. When mayfly nymphs migrate in a pool there is a corresponding decrease in the number of chironomids. The total population was the number of chironomids plus the chironomids equivalent of the mayfly nymphs. The equivalent was determined by the amount of water displaced by the mayfly nymphs and chironomids. Results show that 20 chironomids displaced the same amount of water as one mayfly.

DISCUSSION OF RESULTS

The analysis of each sample for soil texture, pH, per cent of organic content and the chironomid population is shown in Table I. The tests for available nitrates are not listed because Nos. 6, 18 and 20 showed possible traces. Therefore, available nitrates in the soil is not a factor in fresh water streams, because as shown in Table I they do not influence the chironomid population at all.

It is interesting to note in Table I that the pH of the soil samples varied from 7.3 to 8.5. This shows a very narrow range of 1.2. Since the range is so narrow, no conclusion can be drawn although Jewell (1922) states that the pH has no influence as a factor in the abundance of chironomids.

TABLE I

THE ANALYSIS OF EACH SAMPLE FOR SOIL TEXTURE, pH, PERCENT OF ORGANIC CONTENT AND THE CHIRONOMID POPULATION

Sample	Soil Type	pH	Percent Organic Content	Chironomids per sq. yd.
1	Sand	7.7	0	1,375
2	Silt-loam	8.2	1.40	1,727
3	Sandy-loam	7.6	1.37	256
4	Sand	7.6	0.29	1,738
5	Loam	7.6	1.75	5,379
6	Sandy-clay	7.7	2.74	1,762
7	Sandy-loam	7.9	1.46	2,783
8	Loam	7.6	1.98	517
9	Sandy-clay	7.6	1.62	605
10	Clay-loam	7.5	1.33	3,014
11	Clay-loam	7.3	2.39	9,933
12	Sand	7.6	0.89	132
13	Clay-loam	7.7	2.23	3,140
14	Sand	7.9	0	539
15	Sandy-clay	7.7	1.08	572
16	Sandy-clay	7.7	1.64	4,169
17	Sandy-loam	8.2	0.89	979
18	Clay-loam	7.9	3.49	946
19	Clay-loam	7.8	3.60	6,638
20	Loam	7.7	2.86	2,475
21	Sandy-clay	7.7	1.59	6,116
22	Sandy-loam	8.1	0.40	4,665
23	Sand	8.5	0.23	649

In Table II the samples of each type of soil are averaged for per cent of organic content, pH, and the chironomid population.

The lowest average population of chironomids was 387 in sand. The finer the texture of the soil, the more abundant the chironomids. The finest of these soils, the clay-loam, contained an average count of 4,723. This shows that there were approximately seven times as many chironomids in the clay-loam as in the sand. This agrees with Gersbacher (1937), who also found approximately seven times as many in the mud, which was the finest type of soil, as in the sand.

Sullivan (1929) stated that abundant chironomids were found in all types of habitats. Table II shows that the number of chironomids vary greatly with the different types of soil. This disagrees with Sullivan in that their abundance is determined by the type of soil in the pools which the chironomids habitat.

TABLE II

THE AVERAGE PERCENT OF ORGANIC CONTENT, PH, AND THE CHIRONOMID POPULATION FOR EACH TYPE OF SOIL

Soil Type	pH	Percent Organic Content	Chironomids per sq. yd.
Sand	7.8	0.22	387
Sandy-loam	8.0	1.03	2,176
Sandy-clay	7.7	1.74	2,843
Silt-loam*	8.2	1.40	1,727
Loam	7.8	2.19	2,790
Clay-loam	7.6	2.61	4,723

*Since only one sample was taken, it is disregarded in the general conclusions. However, it is very interesting as a comparison.

As the percentage of organic content increases, the population of chironomids does likewise. In the silt-loam type there is a drop in the organic content and of the population count. However, this can only be considered an interesting observation, since only one sample was obtained in that type of soil. Gersbacher (1937) states that as soon as algae and other detritus accumulate in sand, there is an increase in population. Table II shows that there is a definite correlation between the organic content of the soil and the population of Chironomidae. Therefore it can be stated that the organic content is a factor, which is correlated with the soil type, in the abundance of chironomid population.

The pH in Table II ranges from 7.6 to 8.2. The average range was 0.6. As previously stated, the range is so small that it cannot be considered as a factor.

In Table III the average of the soil types, organic content, and the total population, (which is the chironomid population plus the chironomids equivalent of the *Hexagenia*), are compared.

Gersbacher (1937) states that when conditions are suitable for *Hexagenia* nymphs, we have a migration into the area of *Hexagenia* nymphs with a decrease in the chironomid population. Considering Table III, we see that as the texture of the soil increases in fineness, with a corresponding increase in percentage of organic content, there is also an increase in the total population until the soil texture reaches the finest of the loam type. The loam type of soil has a total population of 5,543 which is 37 more than the clay-loam type. It appears after a certain number of chironomids (approximately 5,000 inhabit an area, the area must be considered a limiting factor if soil type and percentage of organic content are suitable.

TABLE III

THE AVERAGE PERCENT OF ORGANIC CONTENT AND TOTAL POPULATION OF EACH SOIL TYPE

Soil Type	Percent Organic Content	Chironomids
Sand	0.22	867
Sandy-loam	1.03	3,024
Sandy-clay	1.74	3,875
Silt-loam	1.40	1,727
Loam	2.19	5,543
Clay-loam	2.41	5,406

CONCLUSIONS

Soil type is a factor in the abundance of chironomids.

The pH is not a factor in the fresh water streams studied.

There were very few available nitrates in the soil.

The texture of the soil is important as a factor in the abundance of chironomids.

The organic matter content is also an important factor.

Area may be a limiting factor when soil texture and organic matter content are not.

This study shows that soil texture and organic matter content as well as area are important enough to warrant further study.

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