To Dr. Peters, Compliments of the author - Bayliss L. Prater

A Quantitative Analysis of the Mayfly Naiad *Leptophlebia cupida* in a Temporary Woods Pool near Defiance, Ohio

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Introduction. Population density tends to fluctuate above and below a carrying capacity level. The fluctuations may result from changes in the physical environment or interactions within the population. These population changes are two types, (1) seasonal changes in size usually caused by seasonal changes in environmental factors and, (2) annual fluctuations (Odum, 1960).

Temporary ponds, ponds which are dry for part or most of the year, afford an ideal location for a population ecology study. Further, these ponds present in a small space a rather unique environment to perform a study of seasonal changes in environmental factors (or lack of same) upon this "short term" community to determine whether these communities will indeed have a population change or growth of the expected form and rate. It is a well-known fact that, even though a temporary pool or pond has water for only a few weeks, there is a definite succession of organisms (Odum, 1960).

A quantitative study of the mayfly naiad *Leptophlebia cupida*[1] was conducted because: (1) of the large size and abundance of the species, (2) they were bottom dwelling organisms; thus, the sampling and area calculations could be made with greater ease, (3) their unusual metamorphosis and tendency to congregate prior to emergence was of interest, and (4) it is somewhat common knowledge that the mayfly is an important food for fish and other larger organisms. The fact that the woods pools habitat was lacking fish as a predator promised the possibility of fruitful and new data.

In the autumn and winter when the water level is very low, the naiads of *Leptophlebia cupida* are found along the margins of the Maumee River, as well as of the permanent streams such as Mud Creek. In the early spring when these bodies of water expand, there is an annual migration of the naiads to the newly flooded areas, frequently moving up temporary tributaries.

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[1] Currently, in considering the correct use of the names *Blasturus* and *Leptophlebia*, it is felt that the name *Leptophlebia* be applied to the species formerly in the genus *Blasturus* as shown by Edmunds (1948).

Those naiads that do not find their way into the temporary tributaries at high-water time keep close to the water's edge and reach new habitats as the water rises and floods adjoining low areas in the spring. Migration begins from the nearby stream to the temporary woods pool as soon as melting of the ice permits. When the water level subsides, some naiads are left in small isolated woods pools, such as the pool sampled in this study. Emergence occurs 5-10 weeks after flooding. Traver (1925) mentioned the migration of some of the naiads into shallow water just prior to transformation.

Methods. A sampling box, 30.5 x 30.5 x 70 cm, was constructed from 10 gauge plate steel (Prater, 1968). Both ends of the sampling box were open. Seven cm from the bottom, rectangular openings were cut on opposite sides and two sheets of galvanized steel mesh were placed over each opening. A piece of fine nylon plankton mesh was inserted between the steel mesh to preven macro-organisms from entering or leaving via the openings. The purpose of these openings was to equalize the water level and pressure on the inside with that on the outside so that organisms could not enter the sampling box from the underside. Handles aided in handling and transportation of the sampling box.

The woods pool, located in northwestern Ohio, was mapped by the baseline method (Welch, 1948), while the pool was dry noting the border left by the water the year before. It was in the shape of a crude, reversed "C", varied approximately between 18 and 50 ft. in width, and measured about 220 ft. long. A field note system was devised, using the map as a major part of the field note. The field note map was divided into 165 grids, each grid one meter square. By means of a table of random numbers, five sampling stations were selected and marked for further reference by circling the station on the field note. One sample from each of five random sampling stations was taken beginning in March and ending in May. After the position of the stations was determined and recorded, the sampling box was placed as near the center of the first sampling square as possible. The sampling progressed from one end of the woods pool to the other, even if the second randomly chosen station was at the opposite end of the pool. This procedure minimized the disturbance of the naiads by omitting the unnecessary wading through the pool.

The organisms were dipped out of the sampling box by the use of a long-handled, white dipper and transferred into the fine mesh dip net. Dipping was continued until no organisms could be observed in the dipper. From this point dipping continued until 10 consecutive null dippings were made to make certain that all the naiads had been removed from the sampling area. This method resulted in no more than a three percent sampling error. The error was determined by comparing the routine sampling procedure with a procedure in which the sampling box was left undisturbed for two hours. The normal sampling procedure was repeated each hour and an average of three percent additional naiads were collected.

Results and Discussion. Macroscopic organisms collected and classified are shown in Table 1. A total of 2,619 mayfly naiads were collected from 50 sampling stations during the sampling period. The number of naiads ranged from 3-101, averaging 52.4 per 0.1 m^2. The mean, standard deviation, and sampling error of the sampling mean are shown in Table 2.

Table 1. Macroscopic organisms collected in a temporary woods pool near Defiance, Ohio, in 1964.

Arthropods:	Molluscs:
Asellus	*Lymnaea*
Culex (larva)	*Physa*
Chironomid	*Menetus exacuatus*
Dytiscus	**Polygyra*
Cyclops viridis	
Daphnia magna	Amphibians:
Eucypris virens	*Acris gryllus*
Eubranchipus	*Rana clamitans*
Cambarus	***Ambystoma jeffersonianum*

* Collected due to high water level.

** Numerous eggs. Two adults were found 15 m from the pool under a log and eggs were "hatched" in the laboratory to 5 cm in length (taken from the pool).

Table 2. The number of mayfly naiads per 0.1 m^2 collected at five sampling stations in a temporary woods pool near Defiance, Ohio, in 1964.

Date Coll.	Station 1	2	3	4	5	Total	Mean	S*	Sm**
3-26	3	8	6	3	5	25	5.0	2.1	1.0
3-30	10	12	16	10	15	63	12.6	2.8	1.3
4-4	42	34	28	33	30	167	33.4	5.4	2.5
4-8	70	35	30	61	40	236	47.2	17.4	7.9
4-12	49	50	52	61	57	269	53.8	5.2	2.4
4-16	72	65	56	81	52	326	65.2	11.8	5.4
4-20	69	83	101	82	63	398	79.2	14.7	6.7
4-24	81	63	68	92	90	394	78.8	13.0	5.9
4-30	68	100	77	74	86	405	81.0	12.0	5.4
5-4	59	80	64	71	62	336	67.2	8.4	3.8

* S—Standard Deviation

** Sm—Standard Error of the Sampling Mean

A study of the rate of growth of the mayfly population proved useful. This was calculated by dividing the change by the period of time elapsed during the change. If time is plotted on the horizontal axis and the number of organisms on the vertical axis, a population growth curve can be obtained from this plot (Fig. 1). The slope (straight line tangent) at any point is the population growth rate.

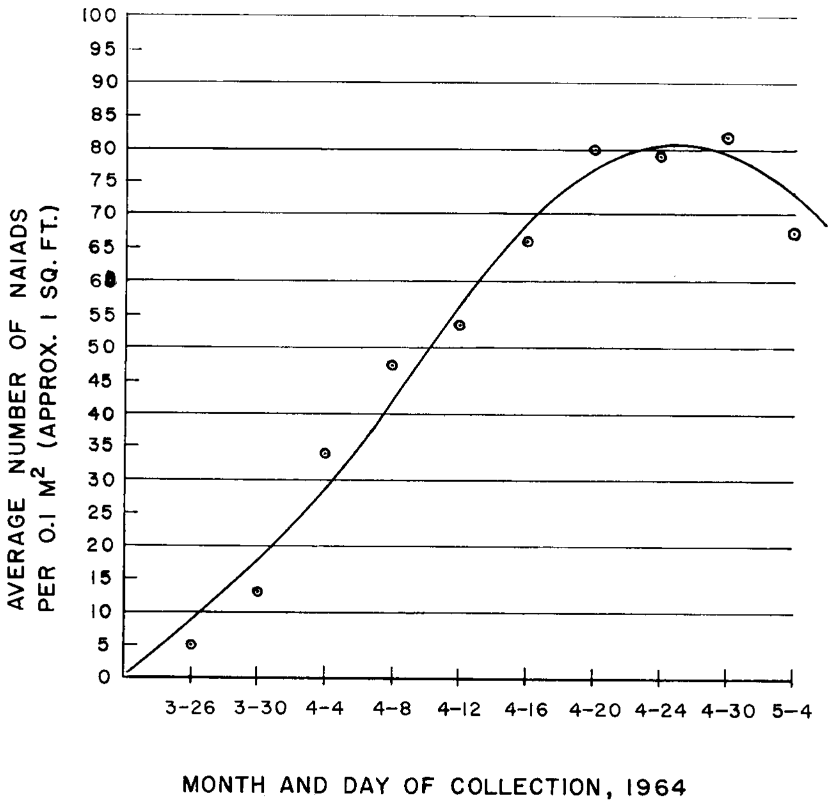

Fig. 1. The population growth curve of *Leptophlebia cupida,* naiad.

It seems quite evident that the naiad *Leptophlebia cupida* was affected by some environmental resistance. It can be seen in Figure 1 that the population reached a stationary position for the sampling days of April 20, 24, and 30. The rate of increase can not continue indefinitely. The role of the environmental resistance in shaping the population growth curve for the naiad is not fully understood. Other factors are undoubtedly responsible for the shape of the population curve; one being the hatching of the nymphs into an adult mayfly.

The upper level or carrying capacity of this particular pool seems to be reached around April 20th. Nicholson (1933) has called the sigmoid type curve "density conditioned," because it is the result of greater and greater action of detrimental factors as the density of the population increases. Possibly there is an "overshoot" in the population growth curve of the mayfly naiad, explaining the drop in number collected on May 4th. This "overshoot" occurs when nutrients or other requisites accumulate prior to population growth. This study is ideal for population growth forms because the best opportunity to observe population growth is when the population enters or is introduced into a new unoccupied environment.

In the analysis of the results presented, if the mayfly naiads tend to form groups of a certain size, the distribution of the groups may more nearly be random (this species of mayfly is not a strongly clumped distribution of individuals). If it were, the sample methods would be somewhat misleading. I feel that the population does not show a pattern of clumped distribution, but one of random groups (Table 2).

The population density of the woods pool is the population biomass per unit area. Even though it was determined that the arithmetic mean was 52.4 naiads per 0.1 m^2, these data have little meaning alone. A crude density could be calculated, if wanted, but the specific density is also of considerable importance. It is important to know whether a population is changing, increasingly, or decreasing in size at any given time. The mayfly increased in population at such a rapid pace that density per unit space seems to lose meaning. Indices of relative abundance (i.e., the percentage of sample plots occupied by a species) may yield more meaningful data. The upper limit of density of the pool appears to be determined by the energy flow (productivity), the trophic level to which the organism belongs, and the size and rate of metabolism of the organism. Within limits, the density possibly varied according to some interaction with other species (competition) and the action of the physical limiting factors mentioned.

The pH value of the water varied from 5 to 8. The change in temperature was somewhat more rapid than in the river and the lake because of the shallow depth. The protection of the woods pool from wind possibly affected a greater temperature fluctuation. Ide (1935) studied the effect of temperature on the distribution of the mayfly fauna in a stream in depth; however, there was no direct correlation of his findings to those of the study made in the woods pool. As the mayfly population increased, oxygen concentrations dropped sharply, accompanied by an increase in temperature. Leonard (unpublished data), in a study of the same pool in 1965, used a comparison of oxygen content to the disappearance of the mayfly naiad. He found that the mayflies could no longer be found in the pool when the oxygen content dropped below 4 ppm and at a temperature above 20°C with a pH of 5. However, in my study of two years prior, temperature played little or no significance in the disappearance of the naiad. Possibly, since the pool dried before

Leonard's maximum temperature was reached, the mayfly naiads would have vanished if the water had not receded. Leonard's sampling began in April and ended the first week of May, with a low temperature of 4°C and a high of 16°C. My study ended two weeks before his. There was a greater abundance of water in 1965 than in 1962, the year I conducted my first sampling.

As the water in the woods pool evaporated, the water became restricted and the volume of water, as well as surface area, decreased rapidly. This resulted in the development of a rich supply of fauna by crowding and reproduction. Organisms in such a pond must be able to survive in a dormant stage during dry periods or be able to move in and out of the pond.

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