Excerpt from Canadian Entomologist December, 1936.

THE LIFE HISTORY OF EPHEMERA SIMULANS WALKER IN LAKE WAWASEE*.

BY HERMAN SPEITH,
New York, N. Y.

INTRODUCTION

Ide (1935) has studied the various instars in the development of the nymph of *Ephemera simulans* Walker, but does not state the length of the life cycle. Neave (1932) decided that in Lake Winnipeg species of *Hexagenia*, a genus very closely related to *Ephemera*, took two years to complete the life history cycle. The length of the life cycle and the rate of development of the species of *Ephemera* have been discussed but never satisfactorily settled. The present paper attempts to answer these questions with respect to *Ephemera simulans* in Lake Wawasee.

METHOD

The data for this paper have been derived from the specimens of *Ephemera simulans* collected during the summers of 1926 and 1927 in connection with a quantitative study of the bottom fauna of Lake Wawasee (see Scott, Hile, and Speith, 1928).

The methods employed in the quantitative study were as follows: From the first of June until August 26, 1926, 113 littoral stations, more or less evenly spaced around the entire periphery of Lake Wawasee, were sampled. These were divided into two series of 58 and 55 each. It is important to note that the stations of the second series were interspersed between those of the first series. At each station samples were taken at depths of 5, .75, 1, and 1.25 meters.

Deep water samples were taken during a corresponding period in 1927. They were made on the odd contours from the 3 meter contour on one side of the lake to the 3 meter contour on the other side of the lake. Twenty such series, totaling 339 individual stations, were taken.

EMERGENCE OF IMAGOES

In Indiana the main emergence of *E. simulans* usually occurs during a relatively short period, during the last of May and the first few days in June. Stragglers, however, precede and follow this by several days. The following dates represent the emergence of huge numbers of individuals, or "swarms" as they are commonly known:

22 May, 1930	Spencer, Indiana
23 May, 1929	Lake Wawasee, Indiana
24 May, 1929	Lake James, Indiana
4 June, 1929	Spencer, Indiana
5 June, 1927	Winona Lake, Indiana

*The author wishes to thank Dr. Will Scott of Indiana University for allowing the removal of the specimens from the general quantitative collection at Indiana University, and also the American Museum of Natural History and especially Dr. F. E. Lutz for having so kindly made available a room in which to conduct research.

7 June, 1927 ..... Lake Wawasee, Indiana

Unfortunately no emergence dates are available for 1926. There is no reason, however, to suppose that they varied from the average.

The imagoes, having shed their subimago cast sometime during the afternoon, engage in the nuptial flight and mate just at dusk. This, in the case of the lake forms, occurs at the edge of the lake. The females then fly out over the lake and deposit their eggs.

DEVELOPMENT AND DISTRIBUTION OF NYMPHS

Eggs of *Ephemera,* stripped from fertilized females, hatched within 14 days after having been kept in an environment much warmer than the normal one. The eggs of *Hexagenia,* which kept under identical conditions, hatched in 15 days but when they were kept in an environment more nearly like the natural one they took 21 days to hatch. It seems likely that *Ephemera simulans* eggs take from 20 to 30 days to develop in their natural habitat.

Upon hatching, the young nymphs are negatively phototropic and positively thigmotropic, and burrow into the substratum at once.

During 1926 no specimens were found in the samples from the first 64 stations. It should be recalled that 58 stations made up the first series. Thus collections had been made in representative habits around the entire lake and the second series well started before any specimens were found. Specimens of other species of Ephemerida were, however, collected during this period. At station 65, 4 specimens ranging from 3.5 to 4.5 mm., were collected. (See Table 1.) Measurements were made from the front of the head to the posterior tip of the abdomen. It is also well to note that the measurements were made from preserved specimens. Since all specimens were preserved under similar conditions, however, the relative lengths should remain the same.

No specimens of less than 3 mm. were collected. Apparently specimens of smaller size were either too small to be seen or else they were lost in the preparation of the quantitative sample. Specimens of *E. simulans* were found at a majority of the littoral stations from No. 65 to 113 (Table 1). The lack of specimens at such stations as 73, 75, 79, and 81 to 88 can be attributed to the type of bottom.

Specimens of *E. simulans* doubtless were present in various stages of development, but too small to be collected, at the time the samples from the stations previous to No. 65 were taken.

The deep water samples taken from the first of June to the last of August in 1927 contained only one specimen of *E. simulans.* Nymphs of *Hexagenia occulta* Walker, the only other burrowing species to be found in the lake, were taken at various times during the summer.

The single deep water specimen of *E. simulans* was collected August 12, 1927, at a depth of 3 meters. It was 6 mm. long. The average length of the specimens collected from littoral stations on August 12, 1926, was 6.63 mm.

A study of the specimens collected from the littoral region show that the growth of *E. simulans* during the summer months is rather rapid. (See Table I.) Thus while the average length was 3.9 mm. on July 19, it was 11.39 mm. on August 26. This represents approximately a three-fold increase in 39 days. The

rate of growth, however, seems to be highly variable. Thus in every sample where 22 or more individuals were collected, the smallest specimen was less than one-half the length of the longest. In many cases the disparity was much greater. All individuals, however, represented early developmental stages.

Table I.
(measurements in millimeters)

Station	Date	Number Spec.	Min. Spec.	Max. Spec.	Average Length
65	7.19.26	4	3.5	4.5	3.9
73	7.21.26	7	3.5	6.	4.3
71	7.22.26	6	3.	5.	3.9
72	7.26.26	1	6.	0	6.
74	7.27.26	64	3.5	8.	5.37
76	7.28.26	1	4.5	0	4.5
78	7.29.26	10	4.	6.	5.2
80	8. 2.26	1	6.	0	6.
88	8.11.26	22	4.	10.5	7.01
89, 90	8.12.26	63	4.	9.	6.63
91	8.13.26	57	5.	10.5	7.5
92, 93	8.14.26	143	5.	11.	7.2
94, 95	8.16.26	69	4.5	12.	8.4
96, 97	8.17.26	199	4.5	11.5	7.9
98, 99	8.18.26	375	5.	15.	8.27
100, 101	8.19.26	111	5.	12.	7.8
103	8.20.26	3	6.	9.5	6.23
104	8.21.26	11	7.	13.	9.0
107, 108	8.23.26	92	5.	13.	9.24
109, 110	8.24.26	444	5.5	15.	9.25
111, 112	8.25.26	313	6.	15.	9.82
113	8.26.26	138	7.	15.	11.39

BIOLOGICAL PRODUCTIVITY

From the standpoint of productivity, *E. simulans* plays an important role in the lake. The nymphs feed upon the organic material that is found in the substratum through which they burrow. How available these nymphs in turn are as food for other animals, particularly fish, is questionable. The nymphs are negatively phototropic and positively thigmotropic, as was noted earlier in this paper. There is no evidence, so far as I know, either from my own experience or that of others, to indicate that they leave their burrow at night. Unless this is so, it seems doubtful if they can be ferreted out by other animals. The one exception is during the emergence period when the nymphs leave the burrows and swim to the surface. At this time fish feed freely on nymphs, subimagoes and imagoes.

SUMMARY

From the data given above a few facts stand out:

1. The emergence of *E. simulans* occurs in Indiana during the last of May and the first few days of June.
2. During the month of June and the first half of July, no specimens of *E. simulans* were collected in either littoral or deep water quantitative samples

taken in Lake Wawasee in 1926 and 1927. It is especially interested to note that no specimens of approximately half grown size were collected.

3. During the last half of July and the greater part of August, 1926, thousands of individuals of *E. simulans* were taken from littoral samples. During a corresponding period a year later, only one specimen, and that at 3 meters, was collected from deep water.
4. The average rate of growth for the littoral specimens was very rapid, being almost three-fold in 39 days. Unquestionably this rate of development does not continue throughout the winter. Murphy (1922) has shown that in *Baetis* the rate of growth and length of the nymphal period depends directly upon the temperature. If this applies also to *E. simulans,* and there seems no reason to doubt it, the rapid growth would continue in Lake Wawasee until the last of September and gradually slow down as the water cools off. Even at that the nymphs probably will have reached almost mature length before the winter arrives.
5. There seems to be some evidence that the burrowing nymphs may not be accessible as food for nekton animals. The greatest exception to this would be at the time of emergence when imagoes and subimagoes, as well as nymphs, are freely eaten.

CONCLUSIONS

From these data concerning the rate of development and the distribution in time and place of the nymphs, it seems obvious that in Lake Wawasee *Ephemera simulans* Walker is a burrowing form that is restricted to the littoral area and takes only one year to complete its life cycle.

BIBLIOGRAPHY

Ide, F. P. 1935 Post embryological development of Ephemeroptera (Mayflies). External characters only. Canad. Jour. Research 12:433-478.
Neave, F. 1932. A study of the mayflies (*Hexagenia*) of Lake Winnipeg. Cont. Can. Biol. Fish. 7 (Ser. A, General No. 12): 177-201.
Scott, Will, R. O. Hile, and H. T. Spieth. 1928 Investigations of Indiana lakes. I. A quantitative study of the bottom fauna of Lake Wawasee (Turkey Lake). Indiana Dept. of Conservation.