Hexagenia (Ephemeroptera) Population Recovery in Western Lake Erie Following the 1953 Catastrophe

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HEXAGENIA (EPHEMEROPTERA) POPULATION RECOVERY IN WESTERN LAKE ERIE FOLLOWING THE 1953 CATASTROPHE

Studies made in autumn 1953 (Britt 1955), following a period of stratification and low oxygen conditions, showed that the number of Hexagenia (Ephemeroptera) nymphs of the deeper water of western Lake Erie was greatly reduced. The nymphs appeared to be entirely eliminated from some areas where the water was deepest and where the bottom mud contained large quantities of organic matter. In channels and in shallow water around the shores and bays, a portion of the population survived.

Further studies have been made to determine whether the mayflies will repopulate the affected areas or will be succeeded by other bottom fauna. Methods and equipment were the same as those used in the 1953 study. Bottom fauna collections were taken from the same areas or stations as those of 1953. The locations where collections were made are shown in Figure 1.

On June 8, 1954, dredgings were made at four stations south and southwest of Rattlesnake Island. These collections yielded 70, 20, 35, and 45 very small nymphs per square meter. This was an average of 42.5 nymphs per square meter per station. This is approximately one tenth the normal population for this area (Britt 1955).

Since the autumn 1953 collections from these stations had yielded no live nymphs, a question arose as to where these small nymphs had come from and how they had managed to get into these areas. There are two possible answers to this question. (1) It is possible that the nymphs may have migrated from the shallow water where a part of the normal population had survived. During autumn, winter, and spring, strong currents are common in this area. Therefore, any nymphs swimming or moving over the surface of the mud could have been swept along and deposited at a new location. (2) All specimens collected at these stations in the spring of 1954 were extremely small, appearing to have passed through no more than four or five instars. This suggests the possibility that some of the eggs may have passed through the period of low oxygen concentration in a dormant state and hatched either very late in the autumn or early in the spring. Britt (paper in preparation) has demonstrated that in some species of mayflies there is a definite diapuase. Whether any of the eggs of Hexagenia go through a dormant state is unknown, but the following experiment indicates that some the eggs remain unhatched for long periods of time even at room temperature.

On June 28, 1954, eggs were removed from an adult *Hexagenia limbata.* These were placed into a petri dish half full of lake water. The dish was then placed on top of a table where air could circulate freely over the water surface. Temperature varied, but for the following three months it was well above normal room temperature. The eggs began to hatch on July 11. The greatest hatching rate occurred about July 20. A few eggs were still hatching by August 29. At this time the petri dish and the remaining eggs were transferred to a refrigerator where the temperature was just above freezing. On October 11 the eggs were moved to a constant temperature of 11°C. Examination on October 28 showed that a few eggs had hatched while at this temperature. The eggs were then placed at constant temperature of 22°C. Two days later, October 30, ninety new hatches had occurred. The remaining eggs were again put into the refrigerator near the freezing unit and unfortunately the water froze. On December 23 the frozen collection was brought back to room temperature. Observations over the period from December 23, 1954 to January 6, 1955 revealed no hatches.

This experiment showed that although the major portion of *Hexagenia limbata* eggs hatched within about a month at room temperature, some of the eggs hatched after a period of several months. Such a wide difference in hatching time indicates a phenomenal difference in metabolic rate. The causes of this difference are unknown at the present time. It appears, however, that the eggs having the lower metabolic rate could survive at a reduced oxygen concentration. The stratified conditions in western Lake Erie were broken up by wind action on September 4, 1953. According to the above experiment, there should have been a few unhatched eggs of Hexagenia remaining on the bottom at this time. Since the water temperature was above 11°C. until November 5, 1953 and after April 26, 1954 until the four collections were made, there was ample time for such hatches to occur. The sizes of the specimens found in the June 8 collections appear to substantiate this theory.

The autumn 1954 collections were made at the same stations as those of 1953. The results from these collections are shown in Figure 1. In order to make comparison of results easy, the results of the 1953 collections are also included.

Although 10 stations had slightly lower numbers of nymphs in 1954 than in 1953, the overall average was much greater in 1954. The average for the 61 stations in 1954 was 827.5 nymphs per square meter as contrasted with the average of 44.3 nymphs per square meter at the same stations in 1953. This was about 18.7 times the autumn 1953 population.

The 23 stations within the acute angle drawn on Figure 1 had an average of 235 nymphs per square meter in 1954 contrasted with 112 in 1953. This was about 2.1 times the 1953 population. The spectacular increase in populations was that of the stations lying outside this acute angle. The 38 stations in this area had an average of 1186.2 nymphs per square meter in 1954, but they had

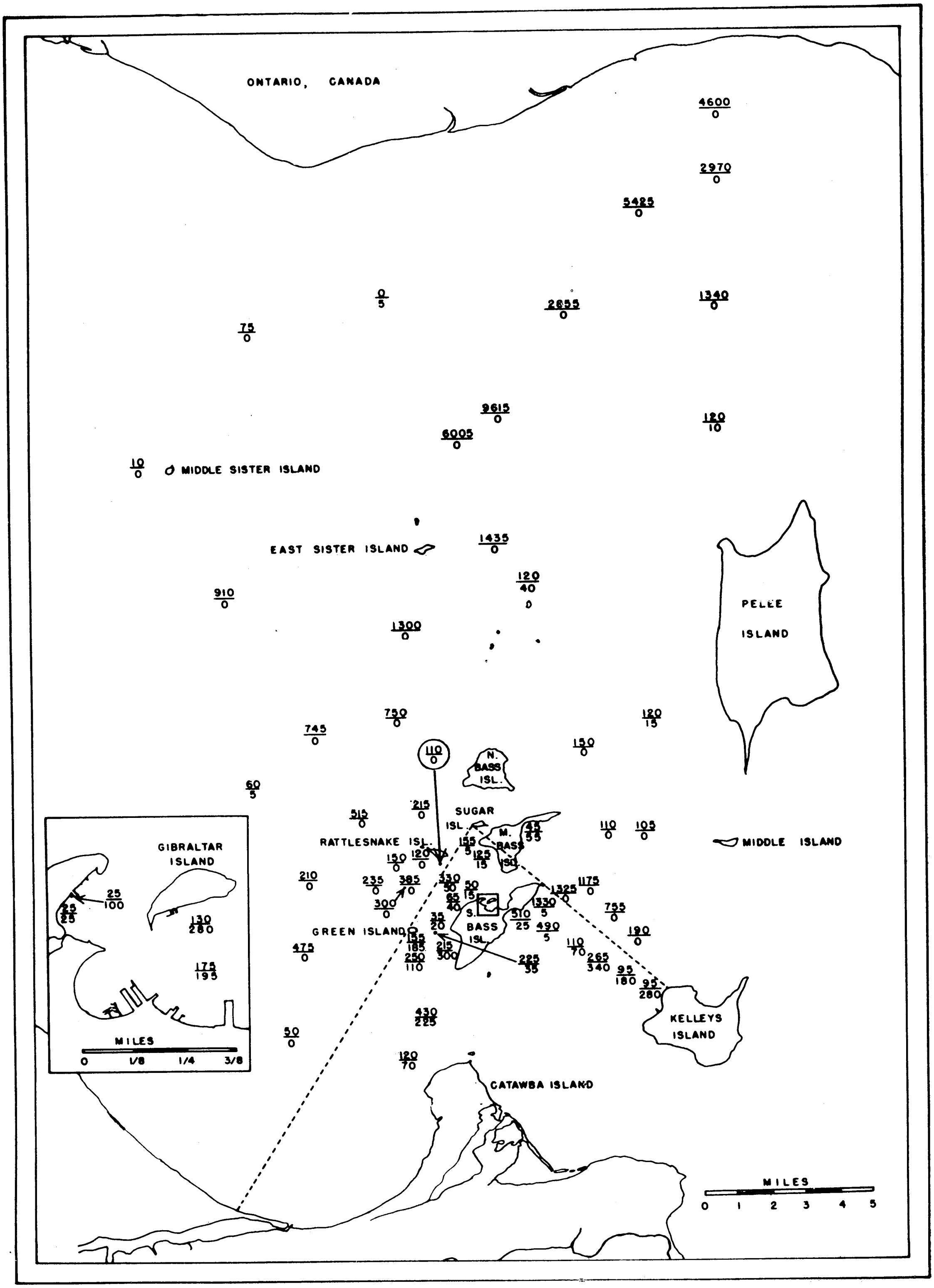

FIG. 1. Map showing the part of western Lake Erie where the collections of Hexagenia nymphs were made. In each group of numbers, the top group represents the number of Hexagenia nymphs per square meter in that area in autumn 1954; the bottom number represents the number of nymphs found at the same place in autumn 1953. EXAMPLE: $\frac{120}{40}$ = 120 nymphs/sq. m. in 1954 and 40 nymphs/sq. m. in 1953. The station within the circle should be located south of Rattlesnake Island near the point of the arrow.

an average of only 3.4 nymphs per square meter in autumn 1953. This indicates that in this area the 1954 population was about 349 times that of 1953.

Discussion

From the foregoing results, it appears that the 1954 population of Hexagenia compares favorably with those of other years. Wright and Tidd (1933: 279), using data from only a few stations, estimated the average populations of Hexagenia in western Lake Erie as 283 and 510 nymphs per square meter in 1929 and 1930, respectively. Calculations (Britt 1955) from data collected by Wood (Wood 1953) from 150 stations in this study area in 1952 and 1953 gave an estimated average of about 320 nymphs per square meter. In a more restricted area south of Rattlesnake Island (indicated by circle and arrow in Fig. 1), Chandler (personal communication) found averages of 493 and 351 nymphs per square meter in 1942 and 1943, respectively. In this same area I collected 388 and 300 nymphs per square meter in June of 1952 and June of 1953, respectively.

Although the distribution of Hexagenia in 1954 appeared to be uneven, the average number of nymphs per square meter appeared to be equal to or slightly above normal. This rather high average may be due to the fact that almost all the population was composed of the small first-year nymphs whose numbers had not yet been reduced by such environmental factors as predators, low temperatures, currents, etc.

One of the interesting problems arising from this study is why the stations in the channels and near the shores (within the acute angle of Fig. 1) did not show a greater increase in numbers of nymphs in 1954. About one third of these stations had even smaller numbers than in 1953. Some of the factors which may have been responsible for this are: (1) Wind direction and velocity at the time of mating flight may have caused most of the eggs to be deposited elsewhere. (2) Water currents may have been sufficiently strong to prevent the settling of eggs in the area or to have swept away recently hatched nymphs. (3) Intraspecific competition by the relatively large population already inhabiting the area may have been so great that only a few of the recently hatched individuals were able to survive. (4) Type of bottom may have influenced the size of the population. Within the acute angle on Figure 1 a large portion of the bottom is hard, with soft mud occurring only in limited areas. However, all the stations were located on mud bottom.

It is impossible at the present time to determine which of these factors, if any, was responsible for holding down the average number of nymphs in this area while the average number of nymphs outside this area was five times as great. Perhaps no one factor but rather a combination of factors may have been responsible for this difference.

Summary

1. Bottom fauna collections made in June, 1954, from areas in western Lake Erie where the Hexagenia population had been entirely eliminated by low oxygen conditions in autumn 1953, revealed that a few nymphs were again inhabiting the area.

2. It was concluded that the nymphs either migrated from shallow water or hatched from dormant eggs which had remained in the area during the short period of stratification in autumn of 1953.

3. It was shown experimentally that although most Hexagenia eggs hatched within 3 to 5 weeks at room temperature, some of the eggs did not hatch until several months later.

4. The average number of nymphs for the 61 stations in autumn 1954 was about 18.7 times the average for the same stations in autumn 1953.

5. All areas did not show the same increase in populations. In channels and near shore the average 1954 population was only 2.1 times that of autumn 1953, but in the deeper, more extensive areas, the average 1954 population was about 349 times that of 1953.

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INSECT ATTACKS ON NATIVE AND PLANTATION PINES IN CENTRAL WISCONSIN

In the spring of 1948, a tree plantation was started in Adams County on the sand plains in the bed of Glacial Lake Wisconsin. The predominant native forest species in this region are jack pine (*Pinus banksiana* Lamb.) and northern pin oak (*Quercus ellipsoidalis* E. J. Hill). Smaller numbers of red pine (*P. resinosa* Ait.), white pine (*P. strobus* L.), red oak (*Q. rubra* L.), white oak (*Q. alba* L.), and trembling aspen (*Populus tremuloides* Michx.) are also found.

The plantation site (SW ¼ SW ¼ Section 23, T17N R6E) is a level fifteen acre field which was abandoned about 25 years ago. The soil is a well-drained Plainfield sand with a water table about 5 feet below the surface.

In 1941, 7 years previous to the acquisition of the land by the authors, about 500 jack pines were planted. In the spring of 1948, 7,000 jack pines plus 10,000 trees of other species were planted. Spacing was approximately 6 ft. by 6 ft. Extending into the plantation is a belt of native jack pine reproduction ranging in age from 5 to 15 years. A few older seed trees are scattered here and there. (See Fig. 1.)

When the authors visited the plantation in November, 1952, it was immediately apparent that the plantation jack pines were much more heavily attacked by insects than was the natural reproduction. Consequently, a count