

THE OHIO JOURNAL OF SCIENCE

VOL. LIV

JANUARY, 1954

No. 1

STUDIES ON THE LIFE HISTORY OF NON-CAVE-DWELLING BATS IN NORTHEASTERN OHIO¹

ELIZABETH SMITH

Department of Biology, Kent State University, Kent, Ohio

Obtaining a few live, normal bats at different seasons for ovarian studies proved a difficult problem in northeastern Ohio. Bats were not abundant and were widely scattered in attics, barns, sheds and trees. Observations were continued since little was known about non-cave-dwelling bats and marked differences from cave-dwelling populations were found. This paper is concerned with observations on the life history of non-cave-dwelling bats in northeastern Ohio.

METHODS

With the aid of students and with a newspaper and radio request, attempts were made to locate bat sources in this area. The response and cooperation obtained have been excellent although the purpose of the investigation was often misunderstood at first. This study was often considered either a providential opportunity for the eradication of bats or an opportunity to find out if there actually were bats in an attic which the owner hesitated to enter. Work was hindered by baseless superstitions about bedbugs, lice, pinworms, hydrophobia, blindness, etc., which were more widespread than facts. These misconceptions were an understandable result of the scarcity, inaccessibility, and lack of information on bats. Practically no one had ever seen a live bat close enough to see its eyes or toenails. Reports of bats in 94 localities situated in 11 counties at distances of 3-80 miles from Kent have been investigated. Much interest has been shown and many helpful observations, which would have been impossible to obtain in any other way, have been made by the owners of the places where bats were found. In only a few cases were the superstitious fears so strong that the bats were removed.

The most frequent collections were made at the Gore's farmhouse, several miles from Burton, and at the Wayland Community Churches where the bats were the most numerous and accessible. In five years 52 trips have been made to the attic of the Gore's farmhouse and 23 to the attics in Wayland. From 2 to 10 trips have been made to a dozen other localities where collections were possible. An effort was made to collect on approximately the same date in successive years. In order to disturb the bats as little as possible, lights were kept low, loud noises were avoided and the bats handled gently with bare hands. On a few occasions bats were captured with nets or with Scudder intestinal forceps with which it is possible to get bats out of cracks without apparent injury to the animal. The bats were never stored before banding and were released at the earliest possible

¹For this paper, the author was awarded THE OHIO JOURNAL OF SCIENCE Award for Excellence in Research in Zoology for 1952.

moment. Weighing was done to the nearest tenth of a gram with a spring balance designed especially for these bats. The animals were banded with No. 0 bands supplied by the U.S. Fish and Wildlife Service. Bands were placed on different legs and wings (Trapido and Crowe, 1946) so that the year of banding could be distinguished at a glance. All banding was done by the writer. But a number of children won the privilege of keeping baby bats warm while the mother bats were banded. Many of the bats were fed pablum, milk, insects and vitamin-mineral concentrates by pipette before release. A thermometer recording the maximum and minimum temperatures reached since the previous observation has been kept in the Gore's attic for three years and another for briefer periods at Wayland.

The terms "repeat," "return," and "recovery" are used in the same sense as is done in bird banding. A "repeat" is a banded animal recaptured during the same season in the same place; a "return" is an animal recaptured in the same place during a subsequent season; a "recovery" is an animal recaptured at another locality.

OBSERVATIONS AND DISCUSSION

The bats examined during five years are listed in table 1. These include animals used as experimental material, specimens brought in by school children, animals caught by pets, etc., as well as specimens obtained in regular collections.

TABLE 1
Bats captured in Northeastern Ohio

| Species | Adults | | Young | | Total |
|-----------------------------|--------|--------|-------|--------|-------|
| | Male | Female | Male | Female | |
| <i>Myotis l. lucifugus</i> | 37 | 1854 | 509 | 741 | 3141 |
| <i>Eptesicus f. fuscus</i> | 14 | 10 | 6 | 4 | 34 |
| <i>Lasiurus b. borealis</i> | | 1 | | 1 | 2 |
| <i>Lasiurus cinereus</i> | | 1 | | | 1 |
| | | | | | 3178 |

Myotis l. lucifugus, the little brown bat, seems to be the common bat of the area; *Eptesicus fuscus*, the big brown bat, is uncommon; the two species of *Lasiurus*, the red bat and the hoary bat, are found rarely. This differs from the relative frequency of skins in the Cleveland Museum of Natural History (Bole and Moulthrop, 1942) in which *Eptesicus fuscus* is the most abundant. This difference may be attributed to the large size of the bat and to the fact that *Eptesicus* also winters in this area and often enters buildings from which it is more likely to be brought to the attention of the museum staff.

One group of 8 lactating *Eptesicus fuscus* females with 6 young males and 4 young females was found in July 1950. Unfortunately, the shed in which they were living was remodelled within a few weeks. None of these animals or any other banded *Eptesicus* have been recaptured. The other individuals were brought in singly after they took shelter in houses, usually during the winter months. One adult female *Lasiurus borealis* was found at Pricetown on June 1, 1949, and a young female in Kent on July 28, 1952. One female *Lasiurus cinereus* was captured at Aurora on July 25, 1950. The remainder of this paper concerns *Myotis l. lucifugus*.

HABITAT

The little brown bats were found singly or in small groups in attics, barns, sheds, and trees. No large groups of a thousand or more such as were reported in a

Cincinnati home (Johnson, 1952) or in the Main Building on the campus at Carbondale, Illinois (Cagle and Cockrum, 1943) have been discovered. In 55 out of 94 localities one or more bats were found after one or more trips. Some of the remaining 39 places had mice, squirrels, or birds, but in at least 20 of these cases the descriptions of the owners clearly indicated that a bat had been present previously. The collections in which bats were found in places in which more than a single bat was ever obtained are listed in table 2. Seven roosts with as many as 200 bats at the peak of abundance have been found, but two have been destroyed with the remodelling of the buildings. There were 16 known roosts of less than a hundred but more than a dozen bats. Of these groups 7 have been destroyed by remodelling or fire.

With the exception of a few places, the probability of obtaining bats was not great. The mean number of bats obtained from collections in this area was 10.7. On more than half of the trips no bats were obtained so that both the median and mode were zero. If any bats were found the most common frequency was one. In such cases the characteristic guano deposit marking occupancy of long duration was not present. About a third of the localities in which a single bat was obtained, have been discovered at the start of insulating or remodelling procedures.

Even if bats are present collections are difficult or impossible in many places. As Griffin (1940) reported, favored locations are the rafter spaces within the roof overhang at the gables of frame houses. There may be more than a dozen exits from a single attic, of which several were used at one time and different ones at other times. Bats have also been found between the double walls of houses, within unused chimneys, in window frames, and hanging in crevices near the roofs of abandoned dog houses and huge barns. In only two cases have bats been found in attics used for storage although some remained in a large barn converted to a dance hall. A wrecking bar would be the most useful collecting tool, but it has limited applicability.

Wide ranges of light and temperature were observed in the roosts. Gore's attic has large windows in three of its four gables. Bats have been observed hanging on rafters in light with an intensity of 5-10 footcandles. At the other extreme is the attic at Berlin Reservoir which has no windows and where the amount of light was too small to be recorded. Temperatures have ranged from 45° to 116° F.

In any attic a particular arrangement of bats clustered in a certain area has never been observed in a subsequent collection. For several seasons maps were made of the Gore's attic at each collection showing where the bats were hanging by numbering the rafters in each gable. Neither duplication nor any pattern could be observed. With relatively few bats in a large attic the possible arrangements would be very numerous. For the last few years there have been fewer bats near the ridge of the roof where collecting is comparatively easy and more bats near the eaves where it is necessary to crawl prone over the rafters without falling through the plaster. On one occasion the bats were not disturbed except for a brief flash of light so that a rough map could be sketched. The next observation three days later, showed no similarity in arrangement. Ear bands, on which the numbers can be read without disturbing the bats, would not be particularly helpful in this area since it is difficult to see into many of the crevices and these non-hibernating bats move after a brief exposure to light.

At Wayland on one occasion the bats were captured singly by feel, banded in the lower attic level and returned to the same position within five minutes. The next week not a single one of the banded bats was recaptured anywhere and a single bat was in the crevice from which 15 bats had been obtained the week before. The attics of the two churches at Wayland, which are located within a 100 yards of each other, are considered together. The random movements between the two are like the random movements within a single attic. Of the bats obtained

TABLE 2
Collections of Myotis lucifugus lucifugus

| Collection | Population | Bats Examined | | | | Bats banded | Bats previously banded, total | Recaptures | Previously banded bats recaptured % | Recaptures in population % | Banded bats recaptured by end of 1952, No. | Banded bats recaptured by end of 1952, % |
|-----------------|------------|---------------|--------|-------|--------|-------------|-------------------------------|------------|-------------------------------------|----------------------------|--|--|
| | | Adult | | Young | | | | | | | | |
| | | Male | Female | Male | Female | | | | | | | |
| Gore Farm, 1948 | | | | | | | | | | | | |
| 4/15 | 1 | | 1 | | | 1 | 31 | | | 1 | 100.0 | |
| 4/22 | 30 | | 19 | | | 15 | 32 | | | 13 | 86.5 | |
| 4/29 | 80 | | 63 | | | 59 | 47 | 1 | 2.1 | 22 | 37.4 | |
| 5/13 | 75 | | 62 | | | 32 | 106 | | | 11 | 34.2 | |
| 5/27 | 85 | | 8 | | | 18 | 138 | 10 | 7.2 | 10 | 55.5 | |
| 6/3 | 110 | | 28 | | | 15 | 156 | 11 | 7.0 | 9 | 60.0 | |
| 6/10 | 125 | | 19 | | | 10 | 171 | 7 | 4.1 | 5 | 50.0 | |
| 6/15 | 140 | | 13 | | 5 | 5 | 181 | 11 | 6.1 | 1 | 20.0 | |
| 6/23 | 150 | | 32 | 4 | 6 | 24 | 186 | 6 | 3.2 | 11 | 45.8 | |
| 6/29 | 150 | | 21 | 9 | 15 | 7 | 210 | 11 | 5.2 | 3 | 43.0 | |
| 7/13 | 160 | | 66 | 29 | 33 | 16 | 217 | 5 | 2.3 | 4 | 25.0 | |
| 7/27 | 140 | | 20 | 9 | 13 | 29 | 233 | 5 | 2.1 | 4 | 13.8 | |
| 8/10 | 50 | | 11 | 11 | 13 | 13 | 262 | 8 | 3.0 | 2 | 15.4 | |
| 8/23 | 30 | | 6 | 4 | 2 | 8 | 275 | 4 | 1.5 | 1 | 12.5 | |
| 9/15 | 35 | | 6 | 7 | 19 | | 283 | | | | | |
| 10/10 | 0 | | | | | | 283 | | | | | |
| Gore Farm, 1949 | | | | | | | | | | | | |
| 4/13 | 2 | | 2 | | | 1 | 283 | 1 | 3.5 | 1 | 100.0 | |
| 4/20 | 2 | | 2 | | | 2 | 284 | | | | | |
| 4/27 | 30 | | 4 | | | 3 | 286 | 1 | 3.5 | 1 | 33.3 | |
| 5/9 | 6 | | 3 | | | | 289 | 3 | 1.0 | | | |
| 5/25 | 2 | | 2 | | | | 289 | | | | | |
| 6/6 | 70 | | 33 | | | 28 | 289 | 5 | 1.7 | 9 | 32.1 | |
| 6/14 | 80 | | 31 | 14 | 10 | 16 | 317 | 6 | 1.9 | 2 | 12.5 | |
| 6/21 | 100 | | 13 | 10 | 7 | 11 | 333 | 3 | 0.9 | 1 | 9.1 | |
| 7/7 | 100 | | 15 | 18 | 14 | 45 | 344 | 3 | 0.9 | 2 | 4.4 | |
| 7/19 | 75 | | 12 | 9 | 13 | 30 | 389 | 5 | 1.3 | 1 | 3.3 | |
| 8/4 | 50 | | 3 | 7 | 9 | 22 | 419 | 2 | 0.5 | 1 | 4.5 | |
| Gore Farm, 1950 | | | | | | | | | | | | |
| 4/26 | 12 | | 7 | | | | 441 | | | | | |
| 5/15 | 20 | | 13 | | | 6 | 441 | 2 | 0.5 | 1 | 16.7 | |
| 6/15 | 45 | | | | | | 447 | | | | | |
| 7/21 | 25 | | | | | | 447 | | | | | |
| Gore Farm, 1951 | | | | | | | | | | | | |
| 4/19 | 4 | | 4 | | | | 447 | | | | | |
| 5/10 | 20 | | 10 | | | 9 | 447 | | | 1 | 11.1 | |
| 7/13 | 80 | | 29 | 26 | 22 | 69 | 456 | 9 | 2.0 | 3 | 4.4 | |
| 7/26 | 35 | | 5 | 5 | 6 | 14 | 525 | 2 | 0.4 | | | |
| 8/15 | 15 | | 3 | 2 | 2 | 5 | 539 | 2 | 0.4 | | | |
| Gore Farm, 1952 | | | | | | | | | | | | |
| 4/17 | | | | | | | 544 | | | | | |
| 4/25 | 10 | | 5 | | | | 544 | 1 | 0.2 | | | |
| 5/16 | 40 | | 8 | | | 13 | 544 | 3 | 0.6 | | | |
| 5/29 | 20 | | 8 | | | 3 | 557 | 1 | 0.2 | | | |
| 6/20 | 70 | | 20 | 24 | 8 | 41 | 560 | 7 | 1.3 | | | |
| 6/26 | 30 | | 6 | 10 | 7 | 16 | 601 | 5 | 0.8 | | | |
| 7/17 | 40 | | 6 | 6 | 6 | | 617 | 4 | 0.6 | | | |
| 8/8 | 25 | | 2 | 4 | | 5 | 617 | 1 | 0.2 | | | |
| 9/2 | 25 | | 4 | 4 | 7 | 12 | 622 | 3 | 0.5 | | | |
| 9/17 | 6 | | | 2 | | 2 | 634 | | | | | |
| Wayland, 1948 | | | | | | | | | | | | |
| 8/9 | 70 | | 17 | 21 | 27 | 65 | | | | | | |
| 9/15 | 6 | | | 1 | 2 | 3 | 65 | | | | | |

Table 2—continued

| Collection | Popula- tion | Bats Examined | | | | Bats banded | Bats previously banded, total | Recap- tures | Previously banded bats re- captured % | Recap- tures in popula- tion % | Banded bats re- captured by end of 1952, No. | Banded bats re- captured by end of 1952, % |
|------------------------|-----------------|---------------|--------|-------|--------|----------------|--|-----------------|---|--|--|--|
| | | Adult | | Young | | | | | | | | |
| | | Male | Female | Male | Female | | | | | | | |
| Wayland, 1949 | | | | | | | | | | | | |
| 5/18 | 150 | 2 | 28 | | | 10 | 68 | | | | | |
| 6/1 | 150 | 3 | 19 | | | 21 | 78 | 1 | 1.3 | 0.7 | 3 | |
| 8/30 | 10 | | | 1 | 3 | 4 | 99 | | | | 28.6 | |
| Wayland, 1950 | | | | | | | | | | | | |
| 7/19 | 100 | | 40 | 16 | 14 | 34 | 103 | 1 | 1.0 | 1.0 | 5 | |
| Wayland, 1951 | | | | | | | | | | | | |
| 5/17 | 80 | 1 | 65 | | | 63 | 137 | 1 | 0.7 | 1.2 | 22 | |
| 6/7 | 200 | 5 | 133 | | | 68 | 200 | 6 | 3.0 | 3.0 | 14 | |
| 6/27 | 200 | | 3 | 4 | | | 268 | 3 | 1.1 | 1.5 | | |
| 7/26 | 150 | | 24 | 21 | 32 | 58 | 268 | 4 | 1.5 | 2.7 | 3 | |
| 8,8 | 40 | | 6 | 2 | 3 | 6 | 326 | 1 | .04 | 2.5 | 1 | |
| 8/22 | 60 | | 15 | 1 | 24 | 34 | 332 | 1 | 0.3 | 1.7 | 5 | |
| 8/31 | 35 | | 5 | 7 | 13 | 15 | 366 | 1 | 0.3 | 2.9 | | |
| Wayland, 1952 | | | | | | | | | | | | |
| 5/9 | 50 | | 23 | | | 23 | 381 | 8 | 2.1 | 16.0 | 5 | |
| 5 23 | 70 | | 45 | | | 39 | 404 | 1 | 0.3 | 1.4 | 5 | |
| 6/6 | 90 | 2 | 61 | | | 50 | 443 | 10 | 2.2 | 11.1 | 6 | |
| 6,24 | 160 | | 61 | 26 | 20 | 80 | 493 | 8 | 1.6 | 5.0 | 10 | |
| 6/30 | 220 | | 111 | 45 | 48 | 75 | 573 | 19 | 3.3 | 8.7 | 8 | |
| 7/29 | 150 | | 8 | 17 | 14 | | 648 | 5 | 0.8 | 3.3 | | |
| 9/3 | 90 | 1 | 23 | 9 | 44 | 46 | 648 | 26 | 4.0 | 28.6 | 2 | |
| 9/8 | 70 | | 18 | 7 | 33 | 48 | 694 | 10 | 1.4 | 14.3 | | |
| Berlin Reservoir; 1949 | | | | | | | | | | | | |
| 7/30 | 60 | | 20 | 17 | 18 | 48 | | | | | 2 | |
| Berlin Reservoir, 1951 | | | | | | | | | | | | |
| 5/24 | 40 | 2 | 38 | | | 33 | 48 | 2 | 4.6 | 5.0 | 4 | |
| 6/7 | 40 | 6 | 8 | | | 12 | 81 | 1 | 1.2 | 2.5 | 1 | |
| Berlin Reservoir, 1952 | | | | | | | | | | | | |
| 6/6 | 35 | 1 | 13 | | | 8 | 93 | 2 | 2.1 | 5.7 | | |
| 7/29 | 25 | | 9 | | 1 | | 101 | 2 | 2.0 | 8.0 | | |
| 9,15 | 6 | 1 | 1 | 2 | 1 | 3 | 101 | 1 | 1.0 | 16.6 | | |
| Twinsburg, 1948 | | | | | | | | | | | | |
| 9/15 | 6 | | 1 | 1 | 2 | 4 | | | | | | |
| Twinsburg, 1949 | | | | | | | | | | | | |
| 6/30 | 18 | | 10 | 3 | 4 | 17 | 4 | | | | | |
| 8,4 | 20 | | 10 | 1 | 8 | 19 | 21 | | | | | |
| Pricetown, 1949 | | | | | | | | | | | | |
| 6/1 | 60 | 3 | 23 | | | 26 | | | | | | |
| 7/5 | 150 | | 26 | 19 | 15 | 53 | 26 | 1 | 3.8 | 0.7 | 3 | |
| 7/12 | 150 | | 22 | 13 | 8 | 30 | 79 | 1 | 1.3 | 0.7 | | |
| 8/30 | 25 | | 8 | 3 | 13 | 17 | 109 | 1 | 0.9 | 4.0 | | |
| Pricetown, 1951 | | | | | | | | | | | | |
| 6/7 | 40 | 3 | 3 | | | 5 | 126 | | | | | |
| Pricetown, 1952 | | | | | | | | | | | | |
| 6/6 | 50 | 5 | 3 | | | 6 | 131 | | | | | |
| Rex Lake, 1948 | | | | | | | | | | | | |
| 9/16 | 3 | | | 1 | 2 | 3 | | | | | | |
| Rex Lake, 1949 | | | | | | | | | | | | |
| 8/8 | 50 | | 21 | 4 | 31 | 24 | 3 | | | | 1 | |

Table 2—continued

| Collection | Popula- tion | Bats Examined | | | | Bats banded | Bats previously banded, total | Recap- tures | Previously banded bats re- captured % | Recap- tures in popula- tion % | Banded bats re- captured by end of 1952, No. | Banded bats re- captured by end of 1952, % |
|---|-----------------|---------------|--------|-------|--------|----------------|--|-----------------|---|--|--|--|
| | | Adult | | Young | | | | | | | | |
| | | Male | Female | Male | Female | | | | | | | |
| Rex Lake, 1951 | | | | | | | | | | | | |
| 4/26 | 20 | | 7 | | 0 | 27 | 1 | 3.7 | 5.0 | | | |
| Painesville, 1951 | | | | | | | | | | | | |
| 7/13 | 100 | | 16 | 1 | 8 | 8 | | | | | | |
| 8/15 | 75 | | 20 | 8 | 33 | 50 | 8 | | | 1 | | |
| Geauga Lake, 1951 | | | | | | | | | | | | |
| 7/4 | | | 10 | 1 | 1 | | | | | | | |
| Lake Milton, 1951 | | | | | | | | | | | | |
| 7/6 | 50 | | 32 | | | 32 | | | | | | |
| St. Joseph, 1951 | | | | | | | | | | | | |
| 8/31 | 50 | | 16 | 5 | 20 | 37 | | | | 3 | 8.1 | |
| St. Joseph, 1952 | | | | | | | | | | | | |
| 9/15 | 6 | 1 | 2 | | 3 | 3 | 37 | 1 | 2.7 | 16.6 | | |
| Deerfield, 1952 | | | | | | | | | | | | |
| 8/18 | 40 | | 7 | 10 | 15 | 34 | | | | | | |
| 9/3 | 8 | | 3 | 1 | 1 | 5 | 34 | | | | | |
| North Benton, 1952 | | | | | | | | | | | | |
| 7/29 | 100 | | 36 | 19 | 24 | | | | | | | |
| Other non-cave-dwelling populations in Ohio | | | | | | | | | | | | |
| Wilmington, 1948 | | | | | | | | | | | | |
| 7/17 | 50 | | 10 | 22 | 10 | 34 | | | | 2 | 5.9 | |
| Wilmington, 1950 | | | | | | | | | | | | |
| 7/24 | 50 | | 11 | 13 | 21 | 45 | 34 | | | | | |
| Put-in-Bay, 1952 | | | | | | | | | | | | |
| 8/16 | 100 | | 42 | 19 | 28 | 78 | | | | | | |
| Nearest cave populations | | | | | | | | | | | | |
| Uniontown, Pennsylvania, 1951 | | | | | | | | | | | | |
| 3/10 | 80 | 65 | 14 | | | | | | | | | |
| Uniontown, Pennsylvania, 1952 | | | | | | | | | | | | |
| 5/3 | 160 | 151 | 8 | | | 144 | | | | | | |
| Harlandsburg, Pennsylvania, 1950 | | | | | | | | | | | | |
| 10/29 | 30 | 24 | 5 | | | 28 | | | | | | |

in Wayland over three-fourths have been found in the one used as a parish house. But almost the same proportion of bats banded in the other church have been recaptured in the parish house. Random movements of bats from place to place was also observed in the huge attic in southern Illinois (Cagle and Cockrum, 1943) and to a lesser extent in caves (Guthrie, 1933; Mohr, 1952) but not in the apparently crowded tree roost observed in Chicago (Dubkin, 1952).

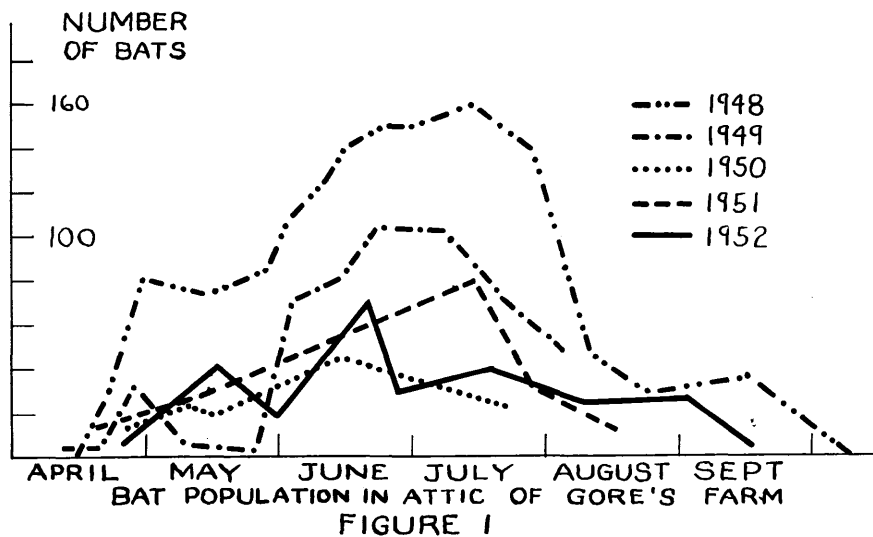
SEASONAL DISTRIBUTION

Bats are summer residents in this area. In different years the capture of the first arrivals in the spring has varied from April 10 to April 26. No correlation could be observed between the mildness of the spring and the time of arrival of the

bats. The number of bats reaches a maximum in June and July when parturition and lactation occur. Parturition extends from June 10 to July 17. By the middle of September only a few bats will be found in a given locality. Between September 22 and October 17 all of the bats have departed. There are no records for the last half of October or November, but two bats were observed on December 2, 1948. The location of the bats during the winter is not yet known although caves in Pennsylvania, West Virginia, Kentucky and Tennessee have been searched without success in recapturing any of the bats banded in this study.

POPULATION TURNOVER

The total numbers at a roost vary with the particular roost, the year and the season (table 2) although all of the roosts studied show a peak in June and July. The population at Gore's farm are plotted in figure 1 and at Wayland in figure 2. The marked scarcity of bats at Gore's farm during May, 1949, and July, 1952,



was checked by the owners between collections. The eccentric roosting behavior in northeastern Ohio is in marked contrast to the comparative stability of cave populations (Guthrie, 1933; Guthrie, Jeffers, and Smith, 1951). The reservoir of bats banded previously at Gore's farm in 1948 is plotted against the total population and the repeats in each collection in figure 3. The repeats were not proportional either to the total population or to the number of bats previously banded. Similar results were obtained in other years and in other attics.

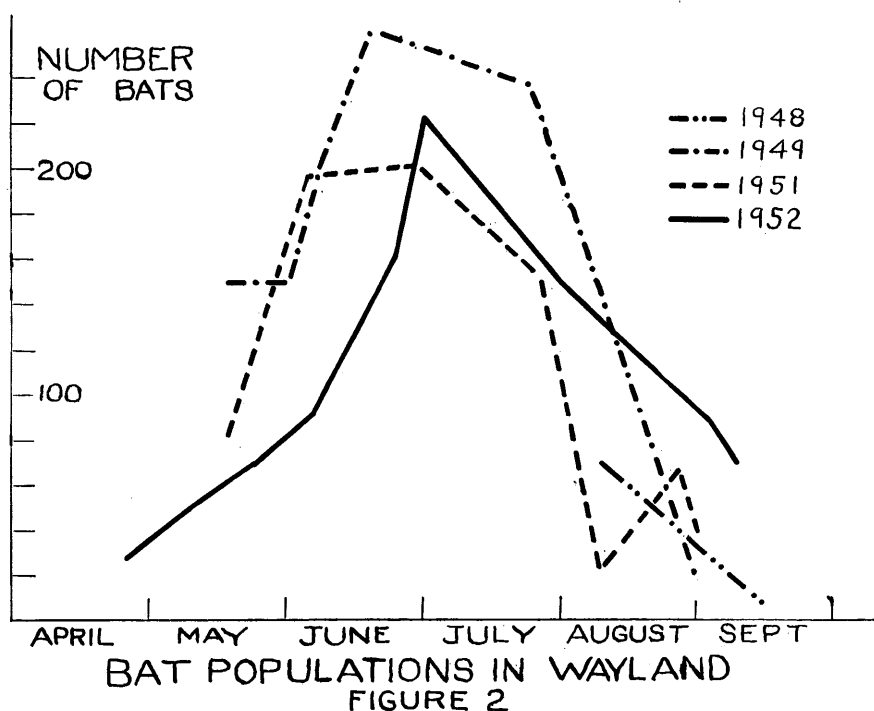
The ninth column in table 2 gives the number of bats previously banded at a particular locality that were captured in a given collection. The tenth column gives the percentage. Various possible explanations of the low recapture rate in individual collections were examined: (1) failure to capture bats that were actually present, (2) shifts to other roosts, (3) high mortality rates, (4) population spread out over a wide area.

(1) *Failure to capture bats that were actually present.* This possibility was the most obvious. In no locality is it possible to collect every bat. In three collections strenuous efforts were made to check every crevice in the Gore's attic. From 1 to 5 additional bats, none of which happened to be banded, were collected. A few bats usually leave the attic at the first disturbance and can not be collected. Even with great care all of the hiding places could not be detected, for several

bats emerged from the attic during the evenings after the special searches. Larger numbers were undoubtedly missed in other localities where collecting was more difficult. Although no collections were complete, the numbers missed were not adequate to account for the low recapture rate.

(2) *Shifts to other roosts.* No shifts from one roost to another have been observed. If bats are recaptured at all, they are captured at the place banded.

(3) *High mortality rate.* Few dead bats have been observed. About two dozen baby bats were found on the floors of roosts and half a dozen killed by household pets. In spite of the hazards of increasing age there is a definite tendency for a bat to return to its particular roost eventually. The figures for individual collections are given in the last three columns of table 2. The last



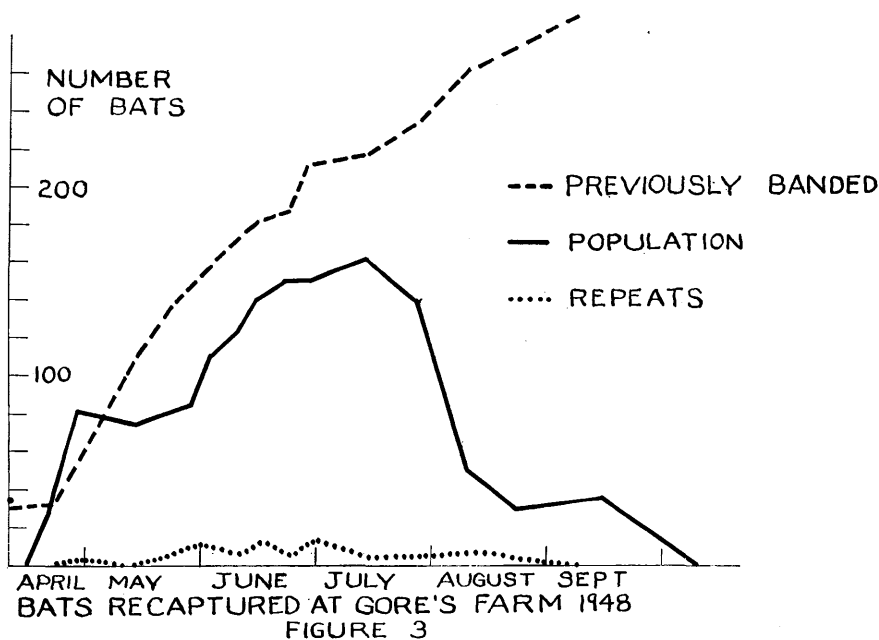
column gives the percentage of the bats banded in a given collection that have been recaptured at any time up to the end of 1952. In general more bats have been recaptured from the earlier collections.

(4) *Population spread out over a wide area.* A small but variable percentage of the population is at the roost at any given time. A particular bat does not remain long at the roost which seems to serve as the headquarters for an area. The scarcity of large roosts, the low recapture rate (table 2, column 10) and the large number of bats caught singly in locations without evidence of long occupancy suggest that the bats are spread out singly or in small groups over a wide area when they are not in the headquarters roost. In three cases, careful observers have reported that a single bat, which may have been the one subsequently collected, was seen at dusk several days before capture. The places where bats were found singly often seemed to be temporary shelters where collection was merely fortuitous. In half a dozen places where a single bat was obtained, examination in subsequent weeks and subsequent seasons showed no evidence of the

presence of another bat. Since recapture rate at a roost depends both on population turnover and mortality rate, it is difficult to estimate the relative importance of those factors. At Gore's farm more bats were recaptured for the first time during both the fourth and fifth seasons after banding than in the third season after banding.

HOMING EXPERIMENTS

The high population turnover at the roosts was reflected in the results obtained with homing experiments. Although a bat may have returned to a given area it was not likely to have been recaptured unless it came to the roost. Of 1855 banded bats, 519 were released at distances of 6 to 49 miles from the place captured in 24 different experiments and 1336 were released where captured. Only 34 (6.5%) of



those released elsewhere were recaptured; 191 (14.3%) of those released at the same place were recaptured. Furthermore, 25 of the 26 animals captured more than once had always been released at the place where originally captured. This behavior differs from that observed by Griffin (1940) and Hitchcock and Reynolds (1942) which indicated a higher percentage of returns from bats carried away from the roost than from bats released at the roost. In this area bats seemed more disturbed the longer the duration of the interference with their normal behavior.

None of the bats rushed back to the roost after release at a distance. Only 8 were repeats, the other 26 were recaptured in subsequent years. The greatest distance was covered by 2 bats which returned 228 miles to Wilmington but which were not recovered until the second season after release (Smith and Hale, 1953). The best time observed was in one bat which returned 25 miles in two weeks. In 10 of the experiments the bats were released at the writer's home in Akron. In 9 of those cases banded bats were observed flying the next evening. In each case from 1 to 3 banded bats were brought in by neighbors up to a week after the bats had been originally released. In individual experiments the recapture rate varied

from 0 to 26.6 percent. With the relatively short distances used neither the distance from the roost nor the direction seemed to affect the recapture rate.

RECOVERIES

No spontaneous shifts of bats from one roost to another have been observed over a period of 5 years. If bats reappeared in this region, they went to the same roost where they were originally banded. Over 300 bats from Wilmington, Put-in-Bay, and Dulaney's cave near Uniontown, Pennsylvania, have been released at Gore's farm and at Wayland, but none of these bats from other areas to the south, west and east have been recaptured where released. Apparently bats do not remain in a strange roost. Griffin (1945) observed three cases of bats banded on Cape Cod and recovered in later seasons each at a different roost in other parts of New England.

All of the recoveries, that is, bats recaptured at any place except where originally found, are listed in table 3. All were individuals used in homing experiments. Two had unfortunate home conditions; one was a female less than a month old; the others were merely in no hurry to get home. In 2 localities there were good

TABLE 3
Recoveries

| Number | Date Banded | Date Recovered | Place Collected | Place Released | Place Recovered | Time | Distance |
|----------|-------------|----------------|------------------|----------------|------------------|--------|----------|
| 20-64774 | 7/13/51 | 6/20/52 | Painesville | Kent | Gore Farm | 11 mo. | 20 mi. |
| 48-69708 | 5/24/51 | 7/21/52 | Berlin Reservoir | Akron | North Benton | 14 mo. | 28 mi. |
| 48-69541 | 7/ 5/49 | 7/ ?/52 | Pricetown | Kent | Rootstown Center | 3 yrs. | 6 mi. |
| 20-64866 | 8/15/51 | 8/17/51 | Painesville | Kent | Kent | 2 days | ½ mi. |
| 20-66161 | 5/ 9/52 | 5/16/52 | Wayland | Akron | Akron | 7 days | 4 mi. |

reasons for changing roosts. At Painesville the shed at the water works was torn down; at Berlin Reservoir sulfur candles were burned. Number 48-69708 had been recaptured previously at Berlin Reservoir after being released in Akron. After its second release in Akron it was recaptured near North Benton, the nearest known roost, only about 2 miles from Berlin Reservoir. Unfortunately this experienced animal was killed when captured.

Number 48-69541 had nearly reached adult weight although less than a month old when banded. She was captured at Pricetown, released at Kent, and recaptured at Rootstown Center. The distance from Kent to Rootstown is six miles, to Pricetown thirty miles. It is remarkable that such an inexperienced female survived even though confused. The other recoveries are bats that were loitering on the way home. One in Akron, had gone four miles in the wrong direction in seven days.

SENSITIVITY TO DISTURBANCE

Bats are sensitive to disturbance and handling as is shown by weight loss after banding, decrease in numbers in bat populations studied and low recapture rate of banded animals. Some weight loss occurs immediately after capture. On May 3, 1952 male bats were measured and banded at Dulaney's cave near Uniontown, Pa. between 6:00 and 8:00 P.M. The bats were transferred in cages covered with wet burlap in the trunk of a car. The trunk temperature was within 10° of the cave temperature. The bats were weighed 8 hours later in Kent before being released. The mean weight and the standard deviation of the mean of 60 male

bats when banded was 5.76 ± 0.35 gr. The weight loss in 8 hours was 0.42 ± 0.18 gr. This is an average of 7.3 percent. The maximum loss was 12.5 percent. The minimum loss was 1.8 percent. A single bat is recorded as gaining 1.8 percent which may be attributed to a personal error at the end of 25 hours of continuous activity.

The period of weight loss lasted at least 3 weeks. Sixteen bats were recaptured within 3 weeks of banding, excluding those that gave birth to young in the interval. All were females. Weight gains were shown only during the middle of pregnancy in late May and June and in each case the weight was less than the mean weight of the collection. Weight losses occurred at other seasons even during August and September when fat storage usually occurs. Bat 20-64510 was banded on May 17, 1951 then recaptured on August 8 and August 22 of the same year. By August the apparent traumatic effect of banding had disappeared and the bat gained weight in the 2 week interval between its second and third recapture. One bat recaptured 4 weeks after banding had barely regained its weight at banding. Two bats recaptured after 5 weeks showed weight gains. More than half of the bats were fed before release. Not enough repeats are available at comparable seasons to determine whether feeding had any effect on reducing the weight losses or whether the additional handling was undesirable.

The bats in summer roosts were more sensitive to disturbance than those in caves (Mohr, 1952). The effect of frequent collections, no matter how carefully done, was shown in the total population of Gore's attic over 5 years (figure 1). The numbers dropped during the second year and were so low the third year that visits were discontinued. The fourth and fifth years the numbers increased but did not reach the level of the first two years. At Wayland (figure 2) where fewer collections were made the effect was much less pronounced.

Similarly, the date of the first arrival seemed correlated with the amount of disturbance the previous year. The first specimens at Gore's farm were obtained on April 15, 1948, and April 13, 1949, but in 1950 and 1952 no bats arrived until April 26 and April 25, respectively. The percentage of banded returns also seems related to the amount of disturbance the previous year.

The future of bats in Ohio is a matter of some concern. The extermination in Cincinnati of more bats than have been found in all of northeastern Ohio (Johnson, 1952) is a discouraging indication of a common attitude toward these useful animals. No new large roosts have been discovered in the last two years. After the destruction of roosts by remodelling or fire the location of the bats is not known. Only one bat has been recovered at any other roost. Although shooting bats is indeed a test of skill, it is not a sport to be encouraged. Fortunately bats are clever at choosing crevices where capture is often difficult or impossible. Data are not yet adequate for determining population trends in this area, but the data do indicate that bats are sensitive to any sort of disturbance and that the greater the disturbance the lower the recapture rate.

SUMMARY AND CONCLUSIONS

1. The non-cave-dwelling bats of northeastern Ohio were studied from 1948 to 1952 in a total of 94 localities in 11 counties.

2. Four species were collected: *Myotis l. lucifugus* was the only common species. They were summer residents. 1855 were banded; 225 were recaptured. *Eptesicus fuscus* was uncommon. 24 were banded after capture throughout the year. None were recaptured. *Lasiurus b. borealis* and *Lasiurus cinereus* were rare.

3. The principal habitats of *Myotis l. lucifugus* were attics, barns, sheds and trees. No definite spatial arrangement of roosting bats could be observed in any habitat. The population peak was reached in June and July, but the roosting behavior was erratic. The low recapture rates were attributed to the scattering of the bats singly or in small groups over a wide area.

4. Bats showed some homing behavior, but return to the roosts was very slow. At distances of less than 50 miles neither the time of year, the distance, nor the direction affected the recapture rate. There were no shifts from one roost to another. Of the banded bats, 14.3 percent of those released at the roost were recaptured and 6.5 percent of those released elsewhere were recaptured.

5. Weight loss began immediately after banding and lasted about a month. Bats lost 7.3 percent of their weight within 8 hours after banding. Weight losses were observed during 3 week intervals after banding, but gains were recorded after 5 weeks.

6. The greater the disturbance of the bats at a roost the fewer were recaptured in the following weeks or the following year.

ACKNOWLEDGMENTS

The writer is much indebted to a great many people who have assisted in this study in one way or another but especially to Mr. and Mrs. Leland Gore, the trustees and members of the Wayland Community Church, Mrs. R. T. Shinn, Mrs. F. F. Bourne, Mr. C. F. Wallace and Mr. Hugh Smith for assistance over several years. My thanks also go to the owners of the 94 properties, which were investigated, for their cooperation. Part of this work was aided by a grant from The Ohio Academy of Science.

LITERATURE CITED

- Allen, G. M. 1940. Bats. Harvard University Press, Cambridge.
- Bole, B. P., and P. N. Moulthrop. 1942. The Ohio recent mammal collection in the Cleveland Museum of Natural History. Scientific Publications of the Cleveland Museum of Natural History, 5: 83-181.
- Cagle, F. R., and L. Cockrum. 1943. Notes on a summer colony of *Myotis lucifugus lucifugus*. Jour. Mammal., 24: 474-492.
- Dubkin, L. 1952. The white lady. G. P. Putnam's Sons, New York.
- Griffin, D. R. 1940. Notes on the life histories of New England cave bats. Jour. Mammal., 21: 181-187.
- Griffin, D. R. 1945. Travels of banded cave bats. Jour. Mammal., 26: 14-23.
- Guthrie, M. J. 1933. Notes on the seasonal movements and habits of some cave bats. Jour. Mammal., 14: 1-19.
- Guthrie, M. J., K. R. Jeffers, and E. W. Smith. 1951. Growth of follicles in the ovaries of the bat *Myotis grisescens*. Jour. Morph., 88: 127-144.
- Hitchcock, H. B., and K. Reynolds. 1942. Homing experiments with the little brown bat, *Myotis lucifugus lucifugus* (Le Conte). Jour. Mammal., 23: 258-267.
- Johnson, J. 1952. Tenants of the house. The Atlantic Monthly, 190: 39-42.
- Mohr, C. E. 1952. A survey of bat banding in North America, 1932-1951. The Amer. Caver, 14: 3-13.
- Smith, E., and K. Hale. 1953. A record of homing in the little brown bat, *Myotis lucifugus lucifugus*. Jour. Mammal., 34:122.
- Trapido, H., and P. E. Crowe. 1946. The wing banding method in the study of the travels of bats. Jour. Mammal., 27: 224-226.