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Notes on Hibernating Bats in Dubuque County Caves

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Abstract. In the fall and winter of 1958 and 1959 four species of bats, *Myotis lucifugus, Myotis sodalis, Eptesicus fuscus,* and *Pipistrellus subflavus,* were found in five Dubuque County caves. *M. sodalis* was a new species record for Iowa. Migration of bats into the caves began when the minimum temperature dropped to 24° F. The greatest increase in cave population occurred when the daytime high temperature was below freezing and nighttime lows ranged from 13° F. to 1° F. Midwinter copulation of *E. fuscus* was observed, and drinking of condensed water on cave ceilings by *M. lucifugus* was noted. No intercave movements occurred but intracave movements did occur when cave temperature reached 43° F.

The exposed limestone bluffs of the Dubuque area have numerous caves and abandoned lead mines that are suitable winter quarters for non-migrating species of bats. Since these roosting places were convenient for limited study and because of the fact that bats were under investigation as suspected reservoirs and carriers of the rabies virus in Iowa, Illinois, and Wisconsin, the junior author suggested that a biology major in the Loras College senior class of 1959 consider the study of cave bat colonies as a subject for his undergraduate thesis. The senior writer, a resident of Dubuque, who is familiar with the caves and mines in the area, undertook the study for a three month period beginning October 15, 1958, and continuing to January 9, 1959.

Investigations during the three month period included 45 trips to five caves and mines. Observations were made relative to the location and character of the caves, the species of bats present, the numbers in roosting colonies, and the presence of sick or dead bats. Outside temperature and cave temperature were recorded for each visit to a bat roost. Other ecological data included notes on choice of roosting sites, feeding and drinking activities, reproductive activities, movements into the caves from the outside, and movements within the caves as related to temperature changes. Four species of bats were identified, and measurements and sex ratios of each form were recorded.

Caves outside the corporate limits of Dubuque investigated during the course of this study were Crystal Lake Cave, located four miles south of Dubuque in Section 17, Mosalem Township; Bronze

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Bottom Cave, located one mile south of Center Grove in Section 33, Dubuque Township; and the Simpson Furnace Mine, two miles west of Dubuque in Section 16, Dubuque Township. Within the city limits of Dubuque two caves were studied. They were Becker's Quarry Cave, in the 600 block of Kaufman Avenue, and the Hill Street Cave, located near the center of the city close to the junction of Hill Street and Eighth Avenue. Four of the five caves were simple tunnels or crevices with a series of rooms separated by smaller constricted passages. Crystal Lake Cave is very deep and is formed by the action of surface drainage through sink holes and by erosion from the action of an underground stream. This cave was not practical for extensive study because of its distance and its many treacherous unexplored passages which were sealed off during the winter months by the owner of the cave.

Four species of bats were observed in these caves. They were *Eptesicus fuscus* (Beauvois), *Myotis lucifugus* (Le Conte), *Myotis sodalis* (Miller and Allen), and *Pipistrellus subflavus* (F. Cuvier). A total of 402 bats was found in the five caves by mid-January. The big brown bat (*E. fuscus*) was the most common, with 368 individuals or 91.5 percent of the total winter population. Little brown bats (*M. lucifugus*) numbered 25 specimens or 6.3 percent. *Pipistrellus* was third in numbers with six specimens making up 1.5 percent of the total. The social bat (*M. sodalis*) was the rarest member of the population with three individuals or 0.7 percent of the total.

One species, *M. sodalis,* found in the Dubuque winter population, has not previously been recorded in the fauna of Iowa. The presence of this bat in the Dubuque area was anticipated prior to its discovery in Becker's Quarry Cave because of a locality record at Beetown, Wisconsin, reported by Davis and Lidicker in 1955.

All three *M. sodalis* specimens were found in Becker's Quarry Cave. The three bats, all males, were weighed and measured; two were preserved in alcohol and the other released. All three were of identical size and weight. Measurements were: total length, 81 mm.; forearm, 34 mm.; tail, 33 mm.; hind foot, 6.5 mm. Each specimen weighed 7.5 grams. The color of the upper parts was dull grayish-chestnut and the under parts were washed with pinkish-cinnamon. The hairs on the dorsal region were deep chocolate on the basal two-thirds followed by a band of gray and a tip of cinnamon-brown.

Measurements of 20 specimens of *E. fuscus* averaged as follows: total length, 112.9 mm.; forearm, 44.5 mm.; tail, 45 mm.; hind foot, 11.5 mm. Average weight of these 20 specimens was 17 grams. Average measurements of eight *M. lucifugus* were: total length, 87 mm.; forearm, 37.2 mm.; tail, 33.1 mm.; hindfoot, 9.2 mm. The weight of these eight specimens averaged 7 grams. Measurements

of four *P. subflavus* collected at Becker's Quarry Cave averaged as follows: total length, 85.6 mm.; forearm, 32.2 mm.; tail, 39 mm.; hindfoot, 8.1 mm. The average weight of these four specimens was 4.49 grams.

Sex ratios for all species could not be determined effectively from the numbers available for study. *E. fuscus* and *M. lucifugus* were numerous enough to give an apparently reliable sex ratio. The numbers of *Pipestrellus* and *M. sodalis* were so small that any figures given here may be of dubious statistical value. The ratio for 100 specimens of *E. fuscus* examined was 60 percent males, 40 percent females; for 20 specimens of *M. lucifugus* the ratio was 75 percent males; 25 percent females. Only four specimens of *P. subflavus* were examined and they were found to be 50 percent males; 50 percent females. All three of the *M. sodalis* were males.

Aggregations of dormant bats in winter cave roosts consisted, for the most part, of clusters of two to six individuals. Sometimes occasional groups of 20 to 30 big brown bats were found huddled together with many in the cluster clinging to each other. In these clusters, consisting of two or three layers of bats, those on the outside were usually quite excitable while those in the center remained dormant. Entire clusters could be picked up and handled when cave temperatures were in the 39° F. to 43° F. range, with only two to four bats on the outside of the cluster taking flight.

The roosts selected by all four species of bats were either behind sheltered walls rising above narrow passages that opened into cave rooms or in holes and crevices in the sides of the rooms. Bats were never found roosting on the high open ceilings of cave rooms.

Intercave migration was not observed during the winter. Once the cave population had reached its peak in late December the numbers remained constant. Within the caves there was much shifting of groups of bats from one roost site to another. An attempt to determine if there was movement between caves some distance apart was made by banding 10 *Eptesicus* in a cluster of 25 with copper wire. The banding was done on December 7, and the cave was revisited December 14. A cluster of 25 *Eptesicus* was located in a branch cavern 100 yards from the original banding site in the main cavern of Becker's Quarry Cave. All ten of the banded bats were present in the cluster. It would appear, from this limited observation, that members of *Eptesicus* groups may maintain close flock or herd-like association in their intracave movements.

Outside temperature changes of 15° F. to 20° F. caused a 1° change in three of the caves. When the outdoor temperature was 40° F., or less, the bats remained dormant. On December 27 the

daytime high temperature was 52° F. At 5:30 P.M. it dropped to 35° F. On this evening six *Eptesicus* were seen flying above a "mineral hole" exit above Becker's Quarry Cave. Inside the cave, however, most of the bats were dormant. On December 28 the temperature was 51° F. and many more bats were active than on the previous day although the cave temperature was 43° F. on both days. A drop in temperature from 40° F. to 0° F. on December 29 caused a corresponding drop from 43° F. to 40° F. inside the cave. This three-degree fall in cave temperature caused all four species of bats to resume dormancy. *M. lucifugus* was slower in returning to dormancy than the other three species of bats present. This species would become restless and take flight while the others were almost unprotesting when handled.

When the cave temperature remained below 43° F., most of the bats were dormant but not in true hibernation. Even though sluggish and incapable of flight, they opened and closed their mouths and uttered faint squeaks. Groups of three to thirty remained dormant at roosting sites until the cave temperature rose to 43° F. Visits to the cave following warm days and increases in cave temperature found most bat clusters hanging in new locations.

The time required for a change from the active to the dormant state was found to be four hours for 18 of a group of 25 *Eptesicus*, when the cave temperature was rapidly changed from 42° F. to 41° F. When dormant bats were taken into a warm room (72° F.) they changed from a nearly paralyzed state to the active condition in five minutes. In caves, 15 to 20 minutes of fondling in the hands was required to produce a change from dormancy to activity.

No data on the home range of the four species of bats were obtained. Although bats had been banded at Beetown, Wisconsin, and at Backbone Park within the past five years, no marked specimens from these places were recovered from the Dubuque caves.

The mating of all species of bats found in this study is thought by most mammalogists to occur in the fall. The sperm are thought to remain viable in the female genital tract until fertilization takes place in the spring. Folk (1940) reported observing winter copulation of *Eptesicus*, and further confirming evidence to support this observation was noted when the senior writer found a copulating pair of *E. fuscus* in Becker's Quarry Cave at 3:00 P.M. on December 29. At the time of this observation the outdoor temperature was 8° F. and the cave temperature was 40° F. All other bats in the cave were dormant at the time of this observation.

Bats in winter cave shelters apparently depend upon condensed water on the cave walls. On one occasion a *Myotis* was seen drink-

ing from the cave ceiling. This bat, in an inverted position, was flapping its wings and creeping forward in short erratic spurts collecting drops of water in its mouth as it moved ahead.

Movement of bats into the caves from outside shelters did not begin until November 9. Prior to this date bats were not found in any of the caves except Becker's Quarry, where 10 individuals were in residence on October 25. All caves, except Hill Street Cave, were inspected November 9 and bats were present in all of them. The lowest temperature prior to that date was 24° F. on the morning of November 7. A gradual increase in cave populations over the next two weeks was noted. On November 22 the populations of the caves were as follows: Becker's Quarry, 51; Bronze Bottom, 8; Simpson Furnace, 7; Crystal Lake, 79. A week after this count the temperature dropped sharply and stayed below freezing from November 26 to November 30. Dubuque Weather Bureau records showed the highest reading for this period to be 23° F., and lows for the five days ranged between 13° F. and -1° F. On November 30 four of the caves were visited and the following counts obtained: Becker's Quarry, 179; Bronze Bottom, 8; Simpson Furnace, 17; Crystal Lake, 82. A re-check of these caves on December 7 indicated a significant increase in the number of bats in only two of the caves. The peak population for all five of the caves was reached by December 28 and remained unchanged up to the time of the last visit on January 11, 1959.

The final count of the midwinter bat population in the five caves was 172 *E. fuscus,* 21 *M. lucifugus,* three *M. sodalis,* and four *Pipistrellus* in Becker's Quarry Cave; 18 *E. fuscus* in Bronze Bottom Cave; 20 *E. fuscus* in Simpson Furnace Mine; 131 *E. fuscus,* and four *M. lucifugus* in Crystal Lake Caye; 28 *E. fuscus* and two *Pipistrellus* in Hill Street Cave. No losses from predation were noted during the period of the study. The only decrease in numbers between visits was a recorded loss of two individuals in the Crystal Lake roost between October 26 and November 9. No sick or dead bats were found during this investigation, although there were two news stories concerning rabid bats biting persons in neighboring southwest Wisconsin counties in this interval.

Literature Cited

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