Nyctalus (N.F.), Berlin 1 (1983), 6, S. 521–530

Field Activity of a Colony of Serotine Bats (*Eptesicus serotinus*)

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With 7 Figures

Abstract

The activity of *Eptesicus serotinus* from a nursery colony was studied in the field visually and with an ultrasonic detector. The home range was estimated to be about 2 km^2. The hunting biotope was mostly along the edges of forests and groups of trees, but they were also recorded in closed beech forests under the canopy. Utilisation of hunting localities changed rapidly during the season. In a single night several hunting localities were visited. A visit rarely exceeded $^1/_2$ hour.

A hunting locality could be used by a single individual, but sometimes even the whole colony could be found at one locality. No interference between individuals was observed. Apparently the home range was common for all members of the colony.

Bats departed from the roost during the first 40 minutes after sunset, and began returning $1^1/_2$ to $2^1/_2$ hours after sunset. In good weather bats left again later in the night and returned shortly before sunrise.

Introduction

Information about the activity of bats in the field away from the roost is rather scanty. This is due mostly to the fact that bats are flying mammals, normally active in the night. In recent years several types of useful instruments have become available, especially night vision scopes which amplify the sparse light, ultrasonic detectors which make the high-frequency echolocation sounds audible to the human ear, and light weight high-speed tape recorders (Simmons et al. 1969). The aim of this study was to describe the geographical occurrence of bats from a colony, their activity in the field, and to investigate the social structure of the colony in the field.

Material and methods

The colony investigated contained about 20 *Eptesicus serotinus*. Because the number of bats emerging nearly doubled at the time when juveniles are expected to make their first flights, the colony must have been a nursery colony. The roost was located under the roof of a building on the Krengerup estate in the western part of Fyn, Denmark (55° 18'N, 10° 08'E). The roost was hidden behind a wooden wall and was inaccessible.

The surrounding landscape is characterized by mature beech (*Fagus sylvatica*) forests a few square kilometres in area, separated by open fields of about the same area.

In the present study the ultrasonic detector constructed by ANDERSEN and MILLER (1977) was used in an attempt to follow a colony of *E. serotinus* during their nocturnal flights. The apparatus divides the frequency of sounds from 15 to 150 kHz with a factor of 10 making them audible to the human ear. The sounds of *E. serotinus* can easily be distinguished from those of other Danish bat species. When holding the microphone upright bats could be detected in all directions. The maximum distance at which this species could be detected varied according to direction of flight and type of cry (depending on activity), but was normally 15–30 m (MILLER and DEGN 1981).

Field studies were done on foot or bicycle. The observation area included the home range of the colony as determined by preliminary observations, and even greater areas outside the home range. No fixed routes were used, but an attempt was made to cover the area fairly uniformly. This applied to good bat biotopes as well as localities where the occurrence of bats would not be expected. One third of the total observation time was spent in areas where bats were never observed.

At the roost visual observations were made from sunset to sunrise in clear weather. During dark (overcast) nights in 1979 an automatic recording unit was used to obtain a rough idea of the activity. The unit consisted of a modified ultrasonic detector connected to a Miniscript-Z event recorder. The microphone was placed 0.4 m under the exit and directed away from the roost.

Data from a hunting locality lying outside the home range of the colony were included in the investigation. The locality consisted of two isolated groups of white poplars (*Populus alba*) about 120 m apart. Observations could be made up to $1\frac{1}{2}$ hour after sunset. In addition, an automatic recording unit was placed on a 9.5 m high pole in the flyway between the two hunting areas. Observations proved the unit reliable except in rainy weather, when raindrops hitting the microphone were recorded.

Observations were made from April to October, 1976 to 1979. Excluding automatic registrations, initial departures were recorded on 65 nights, later activity at the roost was tallied for 41 nights (mostly in 1979). Activity in the home range was recorded during 41 nights, and activity at the hunting locality outside the home range was recorded during 53 nights.

Results

The time of departure from the roost is shown in Fig. 1. The departure was rather regular, normally the first bat appeared within 30 minutes after sunset (mean 16.2 min, $s = 8.5$, $n = 56$). On three nights bats were observed leaving before sunset. In all three cases bats had been confined to the roost for some days due to inclement weather. On the average 90% of the bats had left the roost 29 minutes after sunset. In this study less attention has been paid to departure of the last bat, but normally departure had stopped 45 minutes after sunset.

Number of bats departing from the roost was used as a measure for seasonal activity (Fig. 2). 100% was defined as the greatest number of bats leaving in one night in June–July, before the juveniles began to appear. Only few animals left the roost before May 1st, and the normal level was reached at the middle of this month. The juveniles began to fly out in the first days of August. From the middle of August the activity began to decline, and stopped in October. Even though the roost was inaccessible, droppings suggested that the bats lived in the same building the year around.

Flight activity at the roost after the departure could be recorded visually on clear nights. Fig. 3 indicates only definite observations of departures and returns. The flights could be rather short in bad weather during the whole season, but especially at the beginning and at the end of the season. Under such conditions no indications of activity were found later in the night. In the middle of the season returns normally started about $1^1/_2$ hour after sunset. On some nights a substantial

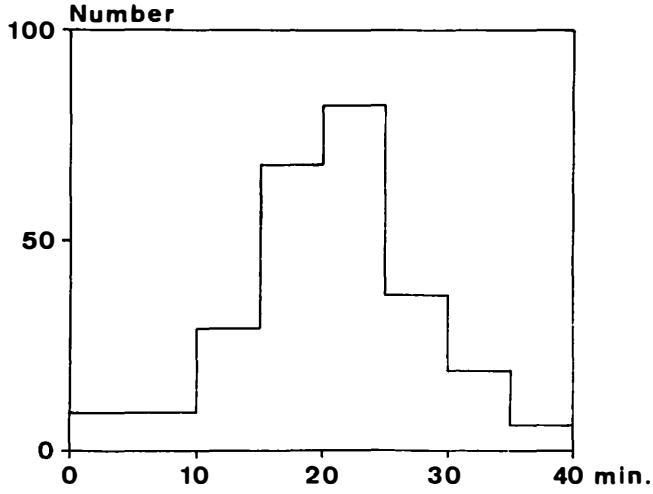

Fig. 1. Departure of *Eptesicus serotinus* during mid summer. Values indicate sum of departing bats at 5-minute intervals for 40 minutes after sunset (n = 19 nights)

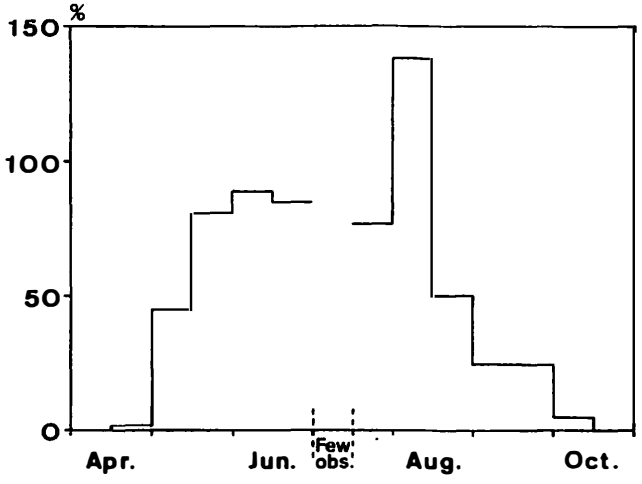

Fig. 2. Relative activity of the colony throughout the season. The greatest number of bats leaving in one night, before the juveniles began to appear is defined as 100%. The mean percentages for $^1/_2$ month periods are calculated relative to this number

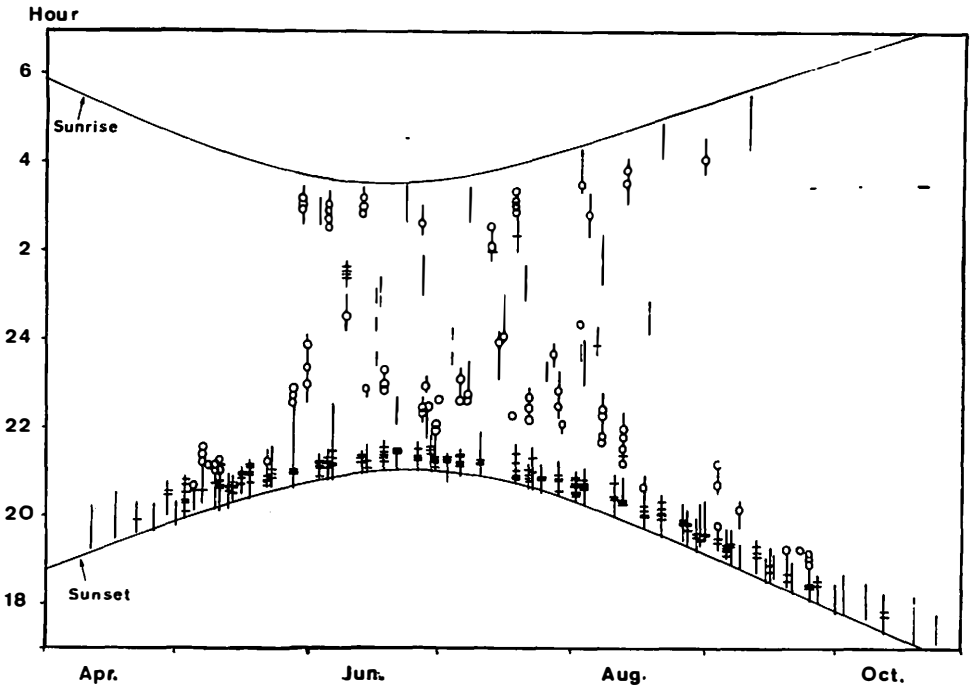

Fig. 3. Activity at the roost recorded visually. Vertical lines indicate observation periods; horizontal lines, departures; and circles, returns. The latter two symbols indicate events, not individuals. For the purposes of illustration observations shortly after sunset are omitted on some days. In the middle of the night only definite observations are indicated, not uncertain ones

part of the colony was observed returning to the roost about an hour before sunrise. Also in the middle of the night bats were sometimes observed leaving the roost. These individuals were possibly leaving for their second flight, but as the bats were not marked this can not be stated with certainty.

The visual observations reported above are supported by automatic registrations at the roost (Fig. 4). A dot represents continuous ultrasonic activity for at least $^1/_2$ minute. When the bats returned they normally flew in circles outside the entrance for a few minutes. Also they often landed briefly at the entrance and flew again. As a consequence longer series of ultrasounds during the night were normally coincident with a return to the roost, though the recording unit gave no information about flight direction. The data are used only as a rough estimate of returns to the roost. Comparing visual and automatic registrations when overlapping in time it was found that ultrasounds can account for 60% of returning bats. There are two main reasons why the two sets of data do not agree more fully. First, the microphone is fairly omnidirectional. Consequently, bats congregating and emitting ultrasounds at the entrance could be recorded. For example visual observations prove the automatic recordings around sunset to be earlier than the departure. Secondly, bats sometimes flew into the roost without circling outside the entrance.

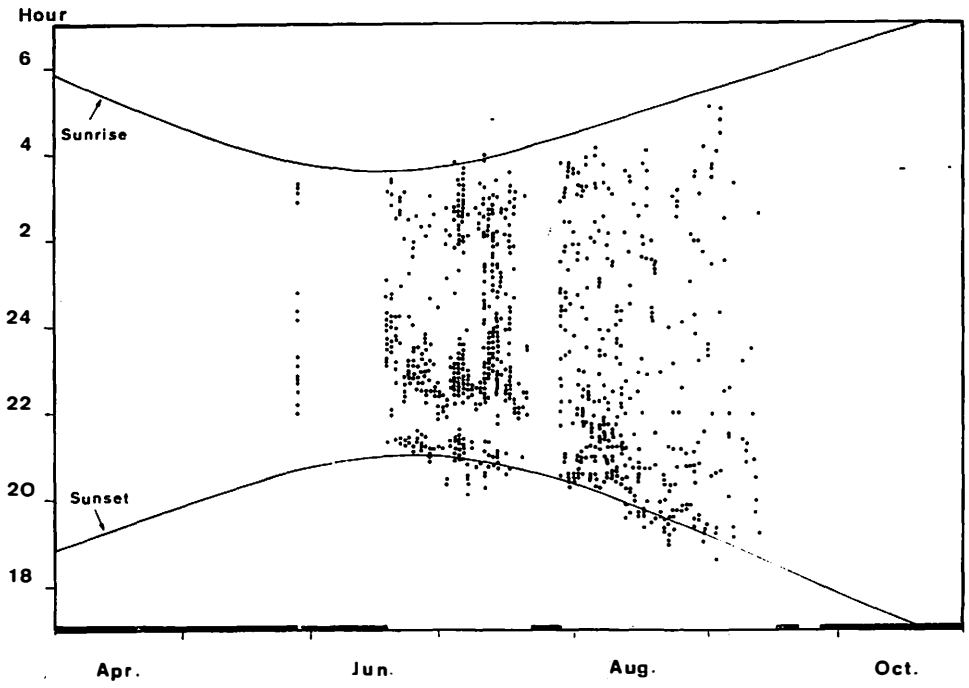

Fig. 4. Automatic registrations at the roost. Each dot represents a continuous recording of $^1/_2$–6 minutes. Recordings longer than 6 minutes are represented by contiguous dots.

At night dots are mostly coincident with returns, while around sunset ultrasounds are caused by vocalizations before leaving the exit hole. The black bars at the baseline indicate periods when the apparatus was not functioning

From the middle of June until about July 20th automatic registrations show very little activity $^1/_2$–$1^1/_2$ hour after sunset. This corresponds quite nicely with the observed activity shown in Fig. 3. High activity $1^1/_2$–$2^1/_2$ hours after sunset indicates returning bats. Scattered dots are found throughout the night. Until July 10th a smaller peak of activity is found about an hour before sunrise, suggesting a period with many returns. From the beginning of August activity is more or less continuous throughout the night. This is the case for the last part of the season. The overall activity gradually decreases in September.

When departing the bats often departed in small groups. After having left the roost the groups immediately dispersed and the individuals flew independently. The bats nearly always flew straight towards northeast, and often half the colony could be seen passing a corner of the wood nearly 400 m from the roost. This rather fixed route was used during the whole season.

Bats were recorded at a maximum distance of 1 km from the roost. Fig. 5 shows the localities where bats from the colony were observed. Based on these data the home range of the colony is estimated to be about 2 km^2. Though the animals were not marked the membership of the colony was demonstrated by following the bats a little further from the roost each night during successive nights. Determination of the boundary of the home range was facilitated by the fact that to the north, west, and south no *E. serotinus* were found in adjacent areas. Only one

adjacent colony of the same species was found in a small village to the east. Bats from the two colonies were never seen flying over the large fields between the two home ranges.

Hunting biotope was mostly along the edges of forests, along groups of trees, and to a lesser extent over ponds and open fields. Early at night they could be seen in these areas. In forests complete darkness did not allow any visual observations, but on several occasions the ultrasonic detector revealed *E. serotinus* hunting under the canopy in 50–80 years old beech forests.

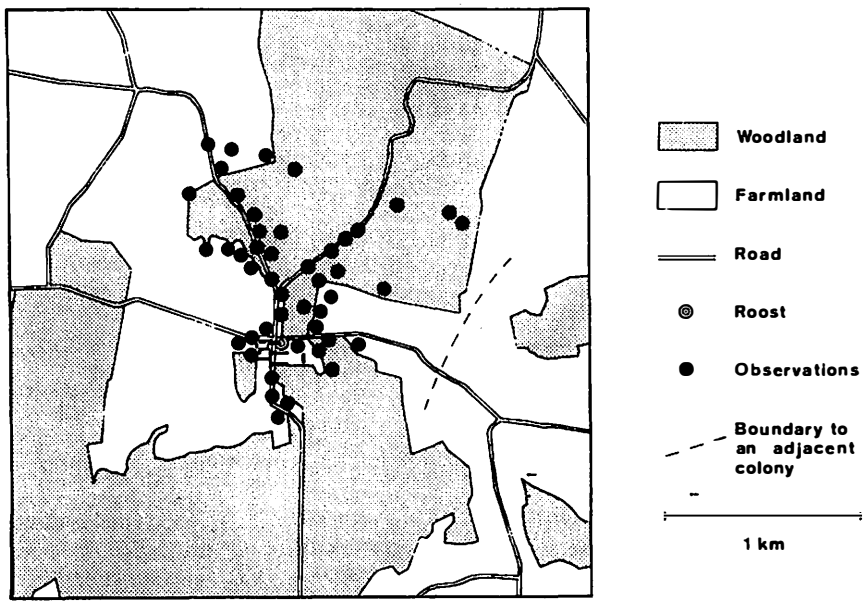

Fig. 5. Localities where bats from the colony were recorded without regard to number of records or number of bats

The use of hunting localities within the home range changed considerably. In no cases were they found in the same area during successive nights over longer periods. Some areas were intensively used for a few weeks, while others were visited more infrequently throughout the season. Even if activity was very high in an area, the bats did not stay there for the whole night. Twenty minutes to half an hour after the bats had arrived the area was abandoned again.

The bats flew to and from hunting localities individually. Mostly they hunted alone, but sometimes a few bats or even a large part of the colony hunted in the same area. For example on one occasion the whole colony hunted in an hourglass-shaped area about 150 m long. These hunting aggregations were found throughout the season.

The activity at a small hunting area in the home range of another colony was studied more in detail. Automatic registrations show that the area was visited regularly about 45–60 minutes after sunset during most of the season (Fig. 6). Activity later in the night was lower and irregular. Visual observations at the same locality (Fig. 7) confirmed the regularity of the first appearance. In addition they showed that sometimes the bats only flew a round or two before leaving again,

especially at the beginning and end of the season. In June and July they nearly always hunted for up to 20 minutes. This hunting period corresponds nicely with the period with low activity at the roost $^1/_2$–$1^1/_2$ hour after sunset (Fig. 3 and 4).

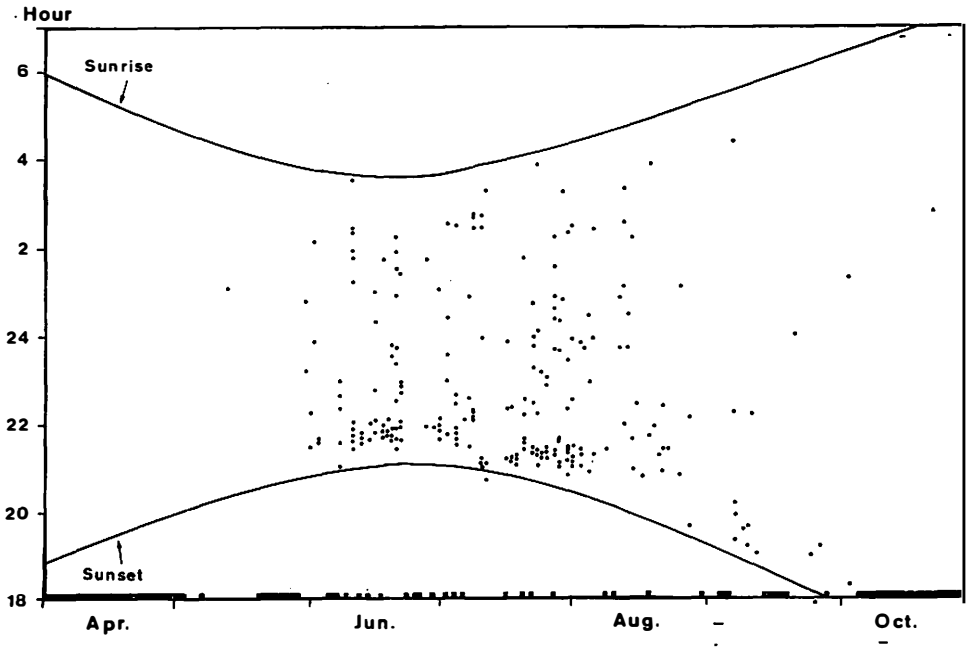

Fig. 6. Automatic registrations of bats flying to and from a hunting locality outside the home range of the colony. Passes of bats occur with intervals of several minutes, and normally a dot represents a pass. The black bars at the baseline indicate periods when the apparatus was not functioning, mostly due to rain

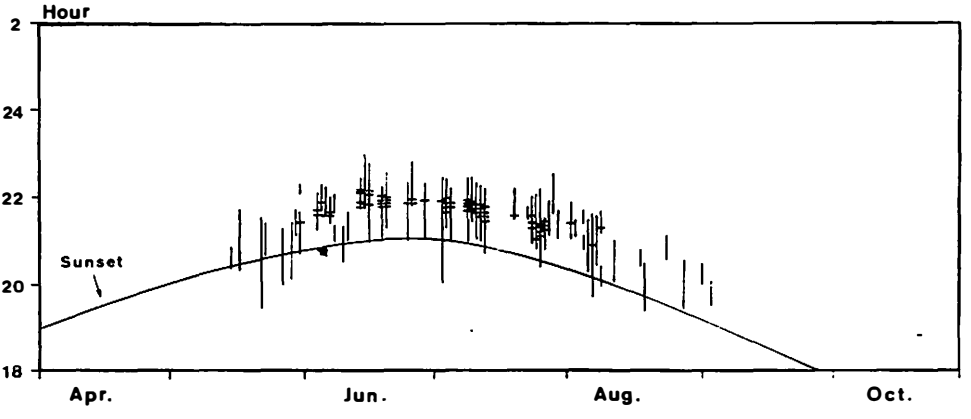

Fig. 7. Visual observations at the hunting locality for which automatic registrations are shown in Fig. 6. Vertical lines indicate observation periods, horizontal lines show bats that are present for up to 10 minutes

Discussion

It appears that the bats of the present study used whatever part of the common home range whenever they wanted without interference from other members of the colony. No indications of group behaviour was noted. According to BRÄDBURY's (1977) classification of social structure in foraging activities the case described here must be a group territory, although the response to non-members of the colony is not known.

Two facts strongly suggest that the bats comprise a nursery colony, although no bats were handled. First, it is generally accepted that colonies of *E. serotinus* nearly exclusively contain ♀♀, while ♂♂ roost alone or in small groups (e.g. GAISLER 1966). Secondly, the number of juveniles that appeared in August roughly corresponded to the number of bats previously observed.

Presumably the two sexes hunted separately in the field. At scattered localities far from the home range of this colony individuals were observed hunting alone during the whole season. They did not come from the roost and are thought to be ♂♂. This agrees with observations of CRANBROOK (1965) who caught *E. serotinus* when foraging in a group like that reported here. All adults were ♀♀.

Only two intensive studies of field activity of palaearctic vespertilionids have been made. NYHOLM (1965) found that in summer *Myotis mystacinus* and *M. daubentoni* had individual territories only about 200 m^2 and 400 m^2 in glades in woodland, where they hunted the whole night with only short pauses when they rested in trees etc. After August 1st both species flew in open areas. In *M. mystacinus* the colony had a common hunting area over meadows etc., while separate groups from colonies of *M. daubentoni* had common hunting-areas over lakes and streams. In contrast *M. dasycneme* apparently did not have individual territories (VOÛTE 1972). Mostly they hunted alone at the same place for some time before going to another locality, but the hunting area could also be shared with several other bats of the same species. Clearly the behaviour of *M. dasycneme* is comparable to that of *E. serotinus*.

The regular departure from the roost shortly after sunset is normal behaviour for most bats; some species leaving early, others late. It is generally assumed that the intensity of light is used for timing the departure, as has been shown for *M. dasycneme* (VOÛTE et al. 1974). EISENTRAUT (1952) and HANSEN (1946) found that on the average *E. serotinus* left earlier when the sky was overcast than on clear nights. They used cloudyness as a rough estimate of light conditions. In the present study the same tendency was found when comparing means, but when applying a statistical test (Mann-Whitney U-test) no significant difference was found due to a great variation from night to night. Neither did light measurements for photography support the idea that the bats appeared at a precise level of light.

Other observations also indicate that the departure depends on other factors. Clearly the bats did not fly out individually, but in small groups, suggesting there were social interactions before the bats left the roost. Under normal temperature conditions temperature and wind had no significant effect on the time of departure, while in extremely cold or windy weather the departure was delayed. Heavy rain could delay or even prevent the departure. Very early departures if foul weather had forced them to remain in the roost on preceding days suggests dependency of hunger.

The conclusion is that departure of *E. serotinus* depends on a set of factors. Light may be a timing factor, but clearly the time of departure is modified by several other factors.

Activity pattern of the colony is derived from a combination of visual and automatic registrations. In summer bats left the roost shortly after sunset and began returning $1^1/_2$–2 hours after sunset. In good weather bats were recorded leaving the roost after the initial return, and finally returned shortly before sunrise from what was no doubt their second flight. In bad weather the late activity was not found. The mean activity curve for the colony during the months of June, July, and August would therefore have a steep initial rise after sunset, a constant level for only about $1^1/_2$–2 hours, and a subsequent decrease to zero shortly before sunrise.

This activity pattern differs from that reported for other nursery colonies of European vespertilionids: *Myotis myotis* and *M. nattereri* (Böhme and Natuschke 1967), *M. myotis* (DeCoursey and DeCoursey 1964), *M. nattereri* (Laufens 1973), *M. mystacinus* and *M. daubentoni* (Nyholm 1965), and *M. dasycneme* (Voûte et al. 1974). The general picture is a rather constant activity through the night, and the bats returned to the roost 1–2 hours before sunrise. Only in certain situations (beginning and end of season, birth) bats could return earlier and eventually leave for a second flight. A laboratory study of *M. myotis* (Bay 1978), however, shows a decreasing activity through the night after an early maximum like reported in this study. The activity patterns of different species must be considered in quantitative surveys of bat faunas.

At present a general conclusion about social behaviour and activity pattern of *E. serotinus* is premature. This study indicates a greater variation in use of hunting localities as well as activity pattern than has been reported for other vespertilionid species. Fyn is near the northern boundary for the range of *E. serotinus*. This fact may affect the behaviour of local populations. Similar studies on populations from the middle of the species range would be useful for comparison.

Acknowledgements

The author is indebted to the owner and the manager of the Krengerup estate for the kind admittance to private areas at night, without which the study could not have been made. Thanks is also extended to Birger Jensen and Lee Miller for useful discussions and revisions of the manuscript.

Zusammenfassung

Die Aktivität einer Kolonie von etwa 20 Breitflügelfledermäusen wurde im Freileben 4 Jahre lang untersucht. In der Dämmerung wurde die Art visuell identifiziert, während ein Ultraschalldetektor in der Nacht eine sichere Artbestimmung gewährleistete. An der Kolonie und an einer isolierten Jagdlokalität wurde außerdem ein automatisches Registriergerät verwendet, das die Ultraschallrufe aufnahm.

Die erste Fledermaus verließ die Kolonie kurz nach Sonnenuntergang (der Durchschnitt lag bei 16 Minuten). Meistens war das Ausfliegen etwa 45 Minuten nach Sonnenuntergang abgeschlossen. Die Tiere begannen $1^1/_2$–$2^1/_2$ Stunden nach Sonnenuntergang zurückzukehren. Bei gutem Wetter flogen sie später in der Nacht erneut hinaus und kehrten erst kurz vor Sonnenaufgang zurück, während sie bei schlechtem Wetter in der Kolonie verblieben.

Der Aktionsraum wurde auf etwa 2 km² geschätzt. Die Jagdbiotope befanden sich meistens entlang der Waldränder und an Baumgruppen, in geringerem Ausmaß über Teichen und Feldern. Die Art wurde auch in dichtem Buchenwald unter den Baumkronen jagend gefunden.

Obwohl die Jagdaktivität an bestimmten Lokalitäten sehr hoch war, blieben die Fledermäuse dort nie länger als 20–30 Minuten und flogen dann wieder weg. In beträchtlichem

Umfang wechselten sie die Jagdlokalitäten im Laufe eines Sommers. Einige wurden nur wenige Wochen benutzt, aber sehr intensiv, andere die ganze Saison hindurch unregelmäßig besucht.

Eine einzige Jagdlokalität wurde normalerweise von einem einzelnen Tier oder von einigen wenigen Individuen aufgesucht, aber mitunter jagte sogar die ganze Kolonie an derselben kleinen Lokalität. Es konnten keine Anzeichen für ein Territorialverhalten beobachtet werden, und offensichtlich teilten sich alle Mitglieder der Kolonie in den gesamten Aktionsraum.

Die Abgabe der Exkremente deutete darauf hin, daß die Tiere das ganze Jahr hindurch dasselbe Haus bewohnten. Nur wenige Fledermäuse flogen früher als am 1. Mai aus dem Quartier, und das normale Niveau, d. h. die maximale Besetzung und Aktivität, wurde Mitte Mai erreicht. Die Jungen begannen ab Anfang August auszufliegen. Schon Mitte August nahm die Flugaktivität ab, und sie hörte im Oktober ganz auf.

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