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Summer Occurrence of *Vespertilio murinus* LINNÉ – 1758 and *Eptesicus serotinus* (SCHREBER – 1780) (Chiroptera, Mammalia) on Zealand, Denmark, based on records of roosts and registrations with bat detectors.

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(With 3 Figures)

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Zusammenfassung

Sowohl die Zweifarbfledermaus *Vespertilio murinus* als auch die Breitflügelfledermaus *Eptesicus serotinus* kommen als euryöke und synanthropische Arten allgemein auf der dänischen Insel Seeland vor, zeigen aber eine annähernd allopatrische Verbreitung. *V. murinus* wurde ausschließlich in der nördlichen Hälfte der Insel, besonders in Nordostseeland, festgestellt, während *E. serotinus* in den meisten Teilen Seelands ein allgemeines Vorkommen hat, jedoch nicht in Nordostseeland. Die Existenz von Grenzgebieten auf Seeland ist schwer zu erklären, da alle Regionen annähernd gleiche Habitattypen aufweisen. Für *E. serotinus* könnte eine historische Erklärung gültig sein, indem die Art erst in jüngster Zeit nach Seeland eingewandert und eine natürliche Ausbreitung noch nicht abgeschlossen sein könnte. Diese beiden Arten haben sich überlappende Quartierpräferenzen (verschiedene Häusertypen). Sie unterscheiden sich jedoch in der Flugweise und in der Auswahl von Habitattypen, wo allerdings Überlappungen vorkommen, so daß nicht ausgeschlossen werden kann, daß die beobachtete Allopatrie durch irgendeine zwischenartliche Konkurrenz entstanden ist.

Jährliche Wanderungen von *V. murinus* zwischen Sommerquartieren in niedrigen Gebäuden in offenen ländlichen und suburbanen Gebieten und Winterquartieren in städtischen Hochhäusern werden angezeigt.

Summary

The Particoloured Bat *Vespertilio murinus* and the Serotine *Eptesicus serotinus* are euryoecious and strongly synanthropic species. Both are abundant on the Danish island of Zealand but show nearly allopatric distributions. *V. murinus* was found only in the northern half of the island, especially in N. E. Zealand, whereas *E. serotinus* was abundant in most parts except for N. E. Zealand. The existence of the border areas on Zealand seem difficult to explain because all regions have almost the same kinds of habitats and roost possibilities. For *E. serotinus* the explanation may be historical as it may have entered the island recently and may still be spreading. These two species overlap in their preferences for roost sites (house types). They are different in flight modes and choice of habitats but with overlap and it cannot be excluded that the observed allopatry is due to some kind of competition.

Yearly migrations are strongly indicated for *V. murinus* between summer roosts in low buildings in open agricultural and suburban areas and winter roosts in tall town buildings.

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Introduction

The present study is part of a larger project on distribution, occurence, and habitat choice of Danish bats and on the diversity of flight modes within European bat faunas. These studies are based on field work with bat detectors and multiflash photography BAAGØE 1986 in press.

Until now only the islands of Zealand and Bornholm have been thoroughly investigated. Of special interest have been the distributions of the Particoloured Bat *Vespertilio murinus* and the Serotine *Eptesicus serotinus* on Zealand, and these will be discussed in detail in the present paper.

Materials and Methods

Bat detector registrations. All 14 Scandinavian bat species can now be identified in the field by their sound with bat detectors AHLÉN 1981 (with an unpublished addendum on *Pipistrellus nathusii)*. Exceptions are *Myotis mystacinus* and *M. brandti* which have to be grouped together. The bats were found and identified in the field according to these results (aided by a tape of reference sounds from I. AHLÉN and personal experience). A QMC100 bat detector SALES & PYE 1974 was used throughout the investigation for direct species identification in the field supplemented by a divide-by-ten detector ANDERSEN & MILLER 1977 and later also by an „Uppsala detector" D-920 AHLÉN, PETTERSSON & SVÄRDSTRÖM 1984, both mainly for recording sounds for laboratory analysis. A Sony TCD5M tape recorder was used. The procedure was a combination of driving slowly in a car with the microphone mounted on the roof and walking in selected areas carrying detectors. An effort was made to visit all kinds of habitats, and where bats occurred the habitat was noted.

About 80% of all bats found could be identified in the field, but especially in the beginning (1981) some had to be studied for a long time in different situations or to be caught or photographed to secure a definite species identification. Around 18% were discarded as unidentified mainly owing to bad observation conditions, and for about 2% tape recordings were sent to I. AHLÉN for analysis and identification.

Initially (1981) I had sometimes difficulties distinguishing *V. murinus* and *E. serotinus* (and sometimes also *Nyctalus noctula)* from each other when they hunted over street lamps, often many individuals together. Under these circumstances *V. murinus* often lacks the otherwise characteristic very regular repetition rate described by AHLÉN 1981 and appears – as heard on the QMC detector – to use a more irregular and faster repetition rate with frequent long gaps similar but somewhat slower than that of *E. serotinus* hunting under the same conditions. However, when the detector is properly tuned (25 KHz) the sound of *V. murinus* is invariably more intense and has a distinctly different tonal quality. These differences will be described in detail by I. AHLÉN.

I tested the consistency of my identifications of the two species by visual observation by using a strong lamp or from analyses of numerous photographs.

Having overcome these initial difficulties I have had few problems identifying the two species and the percentage of successful identifications has been somewhat higher (about 90%) than for all bats taken together (80%) BAAGØE 1986 in press.

Roosts. Information about roosts was obtained in the following ways: radio interviews and popular articles in newspapers and periodicals about bats included invitations to the public to report about bat roosts and to send in dead animals. Complaints about bats in houses addressed to the Danish Pest Infestation Laboratory and other organizations were referred to me. Bat roosts were found during field work with bat detectors (flight activity around the roost, social calls from juveniles in the roost, etc.).

I visited most of the roosting localities to check the species, status, etc. and if needed to try to convince the house owners to let the bats stay. Some roosts were not investigated but were identified as maternity colonies or summer roosts of a particular species on the basis of dead animals that had been sent in or photographs supplemented with information from the house owners.

All roosts were classified as summer roosts when bats were found there during the period 1 June–15 August. Most of them could be identified with certainty as maternity colonies but some had to be classified only as summer roosts because the bats could not be observed in the roost, no young bats could be heard or seen flying or roosting outside, and no dead animals could be obtained for age and sex determination.

When species determination could not be made visually the roost entrances were visited during the dark hours and the bats were identified on the basis of their sound with bat detectors as described.

Results

Distribution. During the summers of 1981 to 1985 I visited almost all the 10 km U.T.M. squares covering Zealand in the search for bats with bat detectors (Fig. 1). The squares were not visited for equally long time, some only once, others several times, but I spent a considerable time in all larger regions of the island.

V. murinus (Fig. 2) was found in many localities but only in the northern half of the island. It seems to be well established on the peninsula of N. E. Zealand, that is, north of a line between the town of Roskilde and southern Copenhagen. Of all the 54 summer roosts only one was found outside this region. At least 35 of the summer roosts could be identified with certainty to be maternity colonies, but there were probably many more.

E. serotinus (Fig. 3) was found in most quadrates except for those covering N. E. Zealand where *V. murinus* was most abundant. From that area *E. serotinus* is only represented by two bat detector registrations and one summer roost. This particular roost was exceptional since it was the only place where both species roosted in the same building. The maternity colony of about 50 *V. murinus* roosted in the gable of a two storey modern house where 3–5 *E. serotinus* of unknown sex

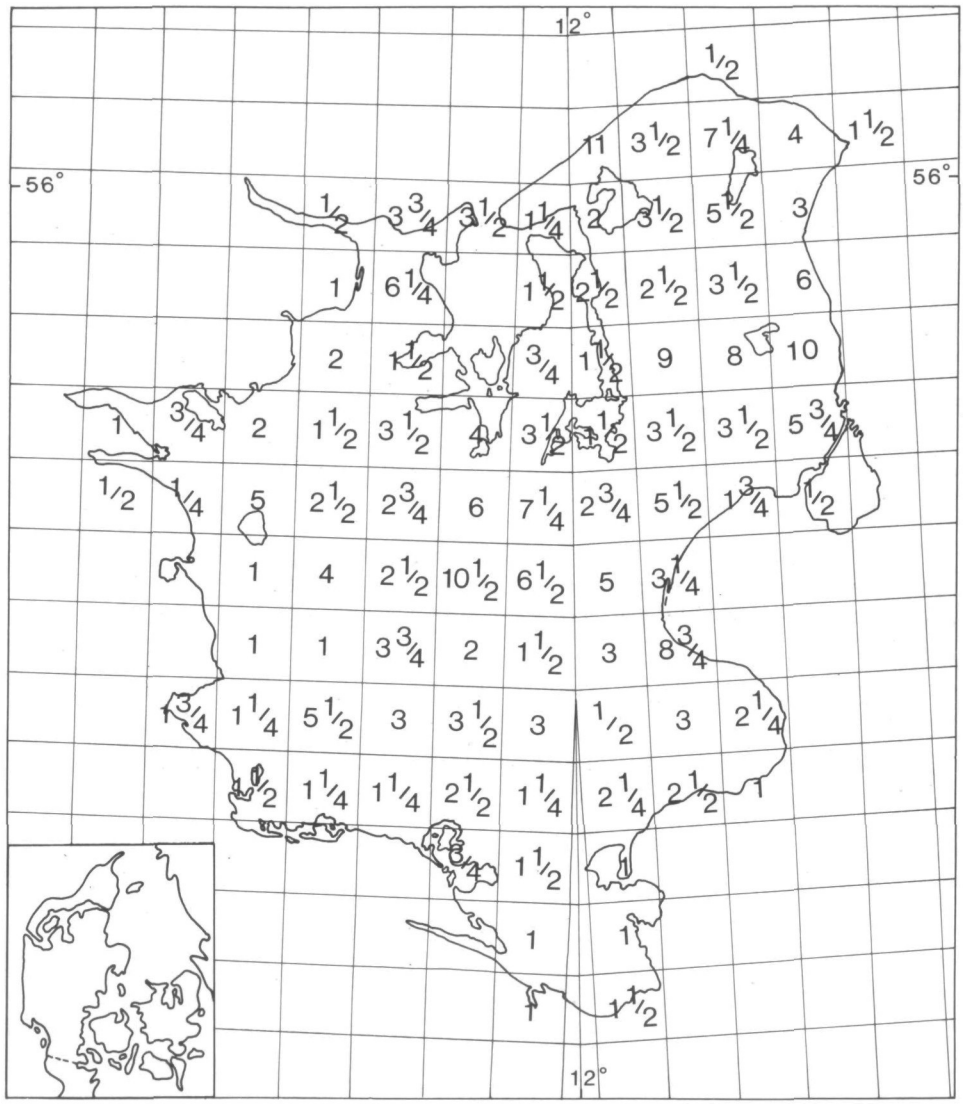

Fig. 1. Map of Zealand, Denmark, showing hours spent listening for bats with bat detectors during the summers of 1981–85 in each of the 10 × 10 km U.T.M. (Universal Transversal Mercator) squares covering the island.

and age (except for one adult female) were also found. However, it was impossible to ascertain exactly how closely the two species roosted together.

13 *E. serotinus* summer roosts were found of which 4 were identified as maternity colonies.

Notes on habitats. Especially in the last half of the summer and in early autumn both species intensively fed on large insects around and especially just above modern street lamps. Those lamps with a blueish white light were most

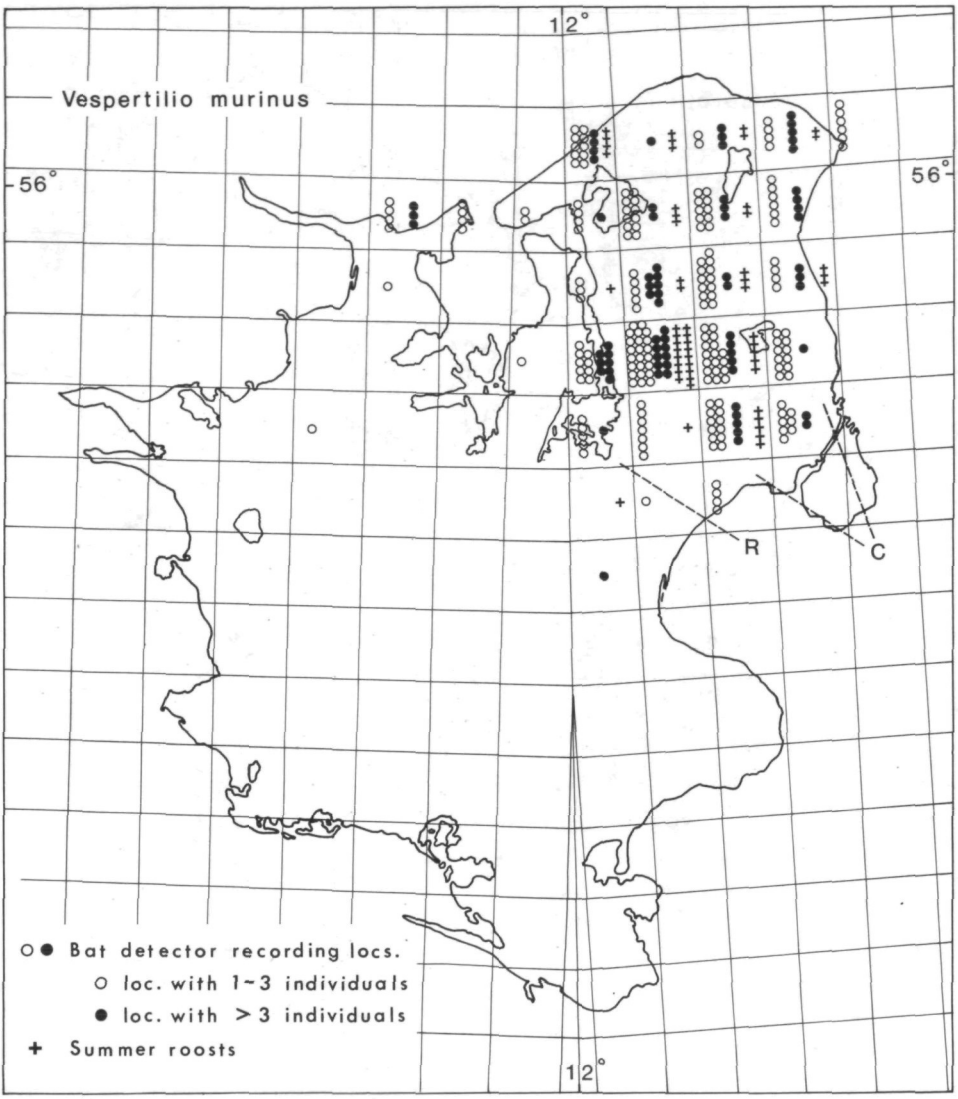

Fig. 2. Summer distribution of *Vespertilio murinus* on Zealand 1981–85. The numbers of summer roosts and detector recording localities are shown for each 10 × 10 km U.T.M. square. A detector recording locality is defined as a location where a bat of a certain species was heard and which was more than c. 200 m from another such location. Dotted lines indicate the positions of Roskilde (R) and Copenhagen (C).

frequently used, probably because they attract more insects. Most of these localities were in the outskirts of towns or along large roads with abundant vegetation near by. They were not found in urban areas with few parks. Apart from this there seems to be no correlation to the kind of surrounding vegetation (i. e., whether it was forest, gardens, or open cultivated fields).

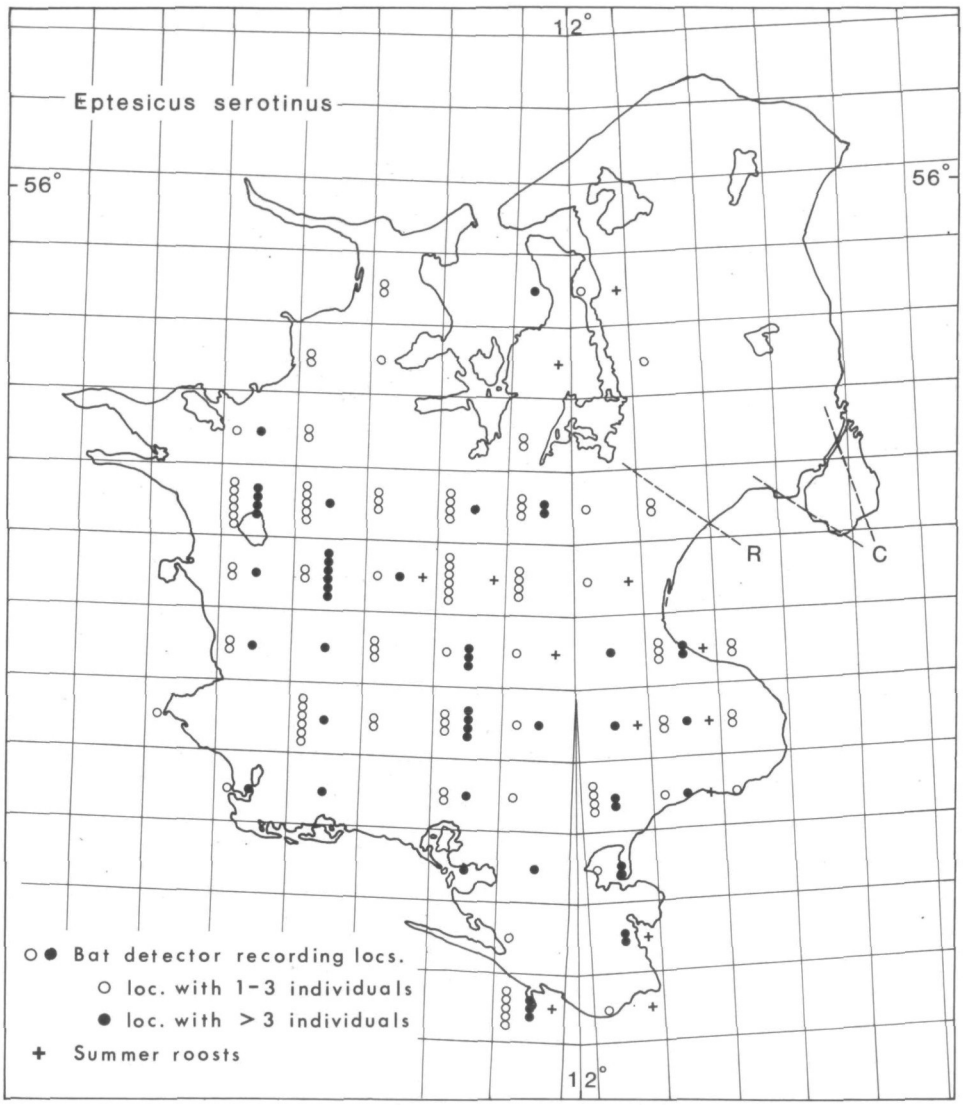

Fig. 3. Summer distribution of *Eptesicus serotinus* on Zealand 1981–85. For explanation, see Fig. 2.

When hunting away from lamps both species used a variety of habitats. *E. serotinus* showed a strong preference for larger decidious trees, hunting along forest edges, around tree groups in old gardens and parks, or along tree rows, see also HILDESHAGEN & TAAKE 1982 and DEGN 1983. *V. murinus* was sometimes observed in similar habitats but most often hunted over completely open areas such as agricultural land or newly planted forest far away from larger trees. *V. murinus* appears to be the least tree dependent Scandinavian bat species (except for *Barbastella barbastellus* which has not yet been studied).

A detailed quantification of the habitats used by all Danish bat species will be given elsewhere BAAGØE in prep.

Notes on summer roosts. All the roosts were in buildings. Of the 54 *V. murinus* roosts 51 were in one or two storey single-family houses (attic included) with a strong preference for new, low, and well isolated houses. Two colonies were in large, low factory buildings with a similar roof construction as in many of the newer houses, and one was in a larger two storey house similar to those often found as dwelling houses of Danish farms. In contrast to this *V. murinus* has often been found during autumn and winter in tall 5–30 storey town buildings (Copenhagen) and seems to choose such buildings for winter roosts BAAGØE 1980 and unpubl. But until now no summer roosts have been found in such tall buildings although the species occurs in the middle of Copenhagen also in summer (Fig. 2).

The summer roosts of *V. murinus* were predominantly found in open areas with small trees, often in new residential developments built on former farmland.

For *E. serotinus* I have added information about 39 summer roosts from other parts of Denmark to that about the 13 roosts from Zealand. Of these 52 roosts, 23 were in one or two storey single-family houses but with a preference for older, larger but well isolated villas. The 29 remaining roosts were in larger houses such as larger farmhouses, castles, old large factory buildings, or churches. The majority of the roosts were in surroundings with many large old trees (old gardens, etc.).

Within the houses both species could be found in a variety of places, most often in connection with the roof constructions. They seemed similar in their choice of these roosting places. A detailed description of the roosts of Danish bats will be given elsewhere BAAGØE unpubl.

Discussion and Conclusions

V. murinus has an eastern distribution in Europe, see for instance RYBERG 1947, BAUER 1954, BRINK 1978, STEBBINGS 1982, and is known as a long distance flier STRELKOV 1969. Vagrants have been found far to the west of its presumed normal distribution area STEBBINGS 1977, 1982, LINA 1984.

From Denmark the species has previously been recorded from the northern half of Zealand from about a dozen localities JENSEN 1969, BAAGØE & JENSEN 1973, mostly from the eastern part. On a map RYBERG 1947 shows a few records from the southern half of Zealand, but I have not been able to trace the origin of these. Concerning the rest of Denmark, one record comes from the island of Samsø and two from Jutland, probably representing vagrants BAAGØE & JENSEN 1973, BAAGØE 1981, whereas a more recently found specimen (1979) from Århus (eastern Jutland) may represent a small local population (see below).

V. murinus has a characteristic low frequency (down to 10 KHz) display song HEMMINGSEN 1922, RYBERG 1947, BAUER 1954, WALLIN 1963, AHLÉN 1981 which is heard in towns in the autumn, most often around large buildings used as winter roosts BAAGØE 1983, BAAGØE, NIELSEN & ANDERSEN unpubl. We heard this display song in numerous localities in towns of N. E. Zealand including most parts of

Copenhagen, suggesting the presence of a considerable winter population, but we failed to hear it in other Zealand towns in spite of thourough searching. A small number of displaying *V. murinus* has been heard repeatedly in Århus in the years 1979–84 JENSEN pers. comm., indicating the presence of a small (vagrant?) population.

V. murinus has recently been recorded for the first time from Bornholm – where a small population was found BAAGØE 1984. Until now only Bornholm and Zealand have been thoroughly investigated with bat detectors and with the vagrant habits of this species in mind it is not unlikely that small permanent or temporary populations may be found in other parts of Denmark.

The present results support the earlier accounts of the distribution of *V. murinus* on Zealand but show that it is much more abundant in N. E. Zealand than expected JENSEN 1969. Apparently there is a distinct difference between the summer occurence of *V. murinus* in rural or suburban environments as well as in towns, with a preference for roosting in low buildings, and the winter occurence in towns with roosts in tall buildings. Therefore the idea of this bat as a typical town bat in the north RYBERG 1947 ist only part of the truth. These findings are in accordance with the ideas of BAUER 1954, 1955.

V. murinus seems distinctly less abundant in Copenhagen during summer than during autumn and winter, and although definitive evidence is lacking all data indicate regular yearly migrations between country and town. Long distance migrations STRELKOV 1969 do not seem likely for the Danish population.

E. serotinus is widely distributed in Europe and reaches its northern borders in southern England and Denmark STEBBINGS 1977, 1982, ARNOLD 1978. It has recently been found in southern Sweden GERELL, IVARSSON & LUNDBERG 1983.

Using data from the literature, museum collections and chance observations and "cross-checking" these with data from a taxidermist, BAAGØE & JENSEN 1973 showed that in all probability *E. serotinus* had gradually colonized Denmark during the preceding c. 100 years. Except for one record from Zealand (1938) the species appeared never to have been found on Zealand and Bornholm. This was taken as a strong indication that *E. serotinus* had not reached these islands since it seemed improbable that this large, almost exclusively house-dwelling bat should have escaped notice in densely populated Denmark.

However, already in 1973 I found the first maternity colony of *E. serotinus* in mid Zealand and the present study shows that the species is well established in most of the island except for N. E. Zealand. Information from the house owners shows that 3 of the maternity colonies have existed for at least 20–25 years and it must be concluded that the species has been on the island for many years without being noticed. Similarly, *E. serotinus* has recently been found to be well established on Bornholm, also here with at least 20–25 years old maternity colonies BAAGØE 1984.

The results presented above draw the attention to the insufficiency of distribution mapping based on incidentally collected material – and indicate the potentialities of the present methods.

The problem remains whether *E. serotinus* gradually entered Denmark in the recent past (but somewhat earlier than described BAAGØE & JENSEN 1973) and is slowly spreading northwards.

Three things seem to support this idea: first, the very sparse occurrence found for N. E. Zealand may indicate that *E. serotinus* is spreading into this area. This can only be checked by future repetitions of the present study. Secondly, the number of roosts registered on Zealand is low compared to that found (with similar effort) in mid Jutland where 7 roosts were found in one small town, 5 in another. This may indicate that *E. serotinus* is less well established on Zealand because it arrived there more recently. I have a similar impression of a larger density in mid Jutland from work already done there with bat detectors, but a more standardized comparison is needed. Thirdly, Danish and Swedish RYBERG 1947 bat collecting or registration activities seem to have been high in the period c. 1880–1945, but very low in the period c. 1945–75. If. *E. serotinus* gradually colonized Zealand during the latter period, the low activity then could explain why this happened unnoticed.

The area just south of the line Roskilde – southern Copenhagen forms a border area for both species (Figs 2 and 3) – an area where they become less abundant. This gives an impression of two almost allopatric distributions.

From the available knowledge it is difficult to find any environmental differences between N. E. Zealand and the rest of Zealand that could explain the presence of this border area for these two rather euryoecious species. There are no marked differences in climate or in kind or number of suitable hunting or summer roost habitats for the two species.

The apparent dependency of *V. murinus* on tall town buildings for winter roost sites probably explains its great abundance near Copenhagen. But it also hibernates in smaller towns with only a few tall buildings in N. E. Zealand and probably also on Bornholm. Similar towns are found all over Zealand outside the distribution area and offer similar winter habitats. Thus the distribution of *V. murinus* on Zealand seems not to depend on the availability of suitable winter roosts.

For *E. serotinus* the reasons for the position of the border area may be purely historical in which case the next years will show a further spreading to the north.

Although the two species undoubtedly occur sympatrically in many regions of Europe it is little known whether they are both abundant in the same areas. Therefore it cannot a priori be excluded that the observed nearly allopatric distributions on Zealand are the result of competition.

V. murinus is medium sized and *E. serotinus* is a large bat. As to their flight modes the two species are different but they overlap and their flight speed ranges are nearly identical BAAGØE 1986 in press.

Little is known about the prey of *V. murinus,* but I have seen it take larger moths around the street lamps. *E. serotinus* is known preferably to prey on larger moths and beetles STEBBINGS 1977, KURTZE 1982.

To some degree the two species have different habitat requirements but here, too, they overlap. Their very frequent utilization of the insect abundance around street lamps is an example of the use of a common habitat and presumably a

common food source. As in fact I have never seen the two species hunting over the same lamps, I can neither say whether they actually do so, nor have I been able to observe possible interactions. Competition for food may be strongest in periods when food is scarce, in this case probably in spring, but nothing is known about the behaviour from this period.

Thus some competition for food is possible, but further research is needed.

Seemingly the two species to some degree prefer different types of houses for roosting sites, but this can just as well be correlated to differences in the surroundings (height of vegetation, etc.). Further, they are both frequently found in the same kind of houses and appear rather broad-spectered in their choice. In one case they were found to use the same roost.

Competition for roosts is possible but unlikely, especially because of the nearly unlimited availability of apparently suitable roosting sites.

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