

Population Dynamics and the Seasonal Fluctuations in Numbers of the Common Shrew in Britain

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Churchfield S., 1980: Population dynamics and the seasonal fluctuations in numbers of the common shrew in Britain. Acta theriol., 25, 34: 415—424 [With 5 Figs.].

Common shrews, *Sorex araneus* Linnaeus, 1758, were trapped in scrub-grassland at Monks Wood, Cambridgeshire and in deciduous woodland at Alice Holt Forest, Surrey, England, for 28—34 months to provide information on seasonal numbers, survival, life expectancy, and activity and movement. A seasonal cycle in numbers of captures was revealed, with high numbers in summer and low numbers in winter. Mark-recapture data revealed that only 50% of shrews survived the first two months of life but over 80% of the survivors successfully overwintered. 20—30% of shrews survived to breed. Population density estimates, based on monthly captures, are shown to be greatly underestimated in winter. Mark-recapture studies showed that activity and movement were greater in spring and summer but were much reduced in winter. It is suggested that reduced activity on the ground surface may explain the low numbers of captures in winter, and may be a strategy to assist overwintering survival by reducing heat loss.

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1. INTRODUCTION

One of the features of the ecology of shrews which has attracted considerable attention is their seasonal mortality. Amongst the first to report his observations was Adams (1910, 1913) who wrote about the habits of the common shrew (*Sorex araneus*) and the pygmy shrew (*S. minutus*) with particular reference to the rapid decline in their numbers in autumn and winter: the so-called »autumnal epidemic«. Later studies by Crowcroft (1954), Shillito (1960), Rudge (1965) and Pernetta (1973) substantiated the observations of Adams by providing numerical data based on numbers of captures. They revealed high numbers of captures in summer, a drastic decline in autumn, low numbers in winter and a sudden increase in spring, and although hypotheses have been put forward about the reasons for such fluctuations, little information is forthcoming on their true nature or cause.

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There is still comparatively little information on the population dynamics of shrews, and there has been little attempt to correlate seasonal fluctuations in numbers of captures with actual population seasonal population fluctuations of *Sorex araneus* Linnaeus, 1758, in

This paper presents an investigation of the nature and cause of the seasonal population fluctuations of *Sorex araneus* Linnaeus, 1758, in a scrub-grassland habitat and a deciduous woodland habitat in Britain.

2. THE STUDY AREAS

2.1. The Wilderness

This study area comprised undisturbed scrub-grassland of approximately 1.5 ha in size situated beside the Monks Wood National Nature Reserve, near Huntingdon, Cambridgeshire, and known as The Wilderness. It lies on heavy Oxford Clay and Chalky Boulder Clay and the site is level. It is bounded by buildings, a mown field and a road respectively on three of its sides. The fourth side is bounded by Monks Wood, a large mixed deciduous woodland where a boundary strip 20 m wide was established. The Wilderness possessed a dense vegetative cover dominated by grasses (*Deschampsia flexuosa* and *Calamagrostis epigejos*), bramble (*Rubus fruticosus*) and willow-herbs (*Epilobium* spp.), interspersed with young oak trees (*Quercus robur*) and thickets of hawthorn (*Crataegus monogyna*), blackthorn (*Prunus spinosa*) and dogwood (*Swida sanguinea*). Abundant ground cover was present at all times of year, but especially in summer.

2.2. Alice Holt Forest

This study area consisted of approximately 0.72 ha, surrounded by a border strip 5 m wide, of mixed deciduous woodland situated close to the Alice Holt Forest Research Station, near Farnham, Surrey. The area lies on Gault Clay, is well-drained, and is bounded on all sides by deciduous woodland. The dominant trees were oak (*Quercus robur*), hazel (*Corylus avellana*), and sweet chestnut (*Castanea sativa*). The ground cover was dominated by dog's mercury (*Mercurialis perennis*), bramble (*Rubus fruticosus*), nettle (*Urtica dioica*), wood sorrel (*Oxalis acetosella*) and bluebell (*Endymion non-scriptus*). During autumn and winter the main cover comprised grass tussocks, particularly *Agrostis* spp., *Brachypodium sylvaticum*, *Dactylis glomerata* and *Deschampsia* spp.

3. METHODS

Trapping was carried out using Longworth live-traps (Chitty & Kempson, 1949) provided with hay bedding. Whole oats were included for any rodents caught but no bait was provided for shrews.

In The Wilderness, 38 trap points were established at approximately 15m intervals in an area 150m by 100m. In the boundary strip in Monks Wood 20 trap points, each at 15m intervals, were set in two lines approximately 150m long. Two traps were set at each point. Each sampling period consisted of three days when trapping was carried out during daylight hours only. Shrews are active by day and by night and the difficulties of checking traps at frequent intervals

(to prevent captives from dying) during darkness in dense vegetation were dispensed with in favour of trapping in daylight only. In summer, the traps were opened at 0800 hours and closed at 1900 hours to prevent rodents entering and fouling them. In winter, they were opened at 0800 hours and closed at dusk. As few shrews were caught in winter months the discrepancy between winter and summer trapping hours was not considered to make results incomparable. Traps were visited every 2 1/2 hours during the day which resulted in a mortality of only 8% over the whole trapping programme. Shrews were rarely caught in the boundary strip in Monks Wood and so traps were left open both day and night and examined twice daily. Trapping was carried out between January 1976 and April 1978 at 4–8 week intervals.

In Alice Holt Forest, 72 trap points, established at approximately 10m intervals covering an area of 90m by 80m. Two traps were placed at each point and left open for four whole days and nights on each sampling occasion. Unlike the study in The Wilderness where shrews were caught alive, the Alice Holt Forest study area provided samples of dead shrews for autopsy and was essentially a removal trapping which was carried out in conjunction with studies on the rodents. Trapping was carried out between May 1975 and March 1978 at approximately monthly intervals.

The date, time and point of capture of each shrew was recorded and their weight and sexual condition noted. Live shrews were marked by toe-clipping before being released at the point of capture. Dead shrews were autopsied.

4. RESULTS

4.1. Seasonal Captures of Shrews

From Fig. 1 a seasonal cycle in captures is evident, with peaks of abundance in summer and a marked decrease in winter. Numbers of captures increased suddenly during the spring to a maximum between May and September/October, but in autumn declined sharply towards winter when only small numbers of shrews were trapped. These small numbers persisted to the following spring. Also evident is the magnitude of the seasonal cycle in captures which differed from year to year and between the study areas. (The low numbers of captures sustained towards the end of the sampling programme in Alice Holt Forest may have been caused by the effects of the removal trapping).

4.2. Survival and Life-expectancy

The survival of young and adult shrews from month to month in The Wilderness is shown in Fig. 2. The results take into account animals marked in previous trapping periods which may not have been captured during successive trapping periods, but were known to be alive owing to subsequent recaptures at later dates. Animals which were not recaptured may not have died but emigrated from the study area, although this is unlikely owing to the isolated nature of the study area and the

fact that no marked shrews from The Wilderness were ever caught in the boundary strip in Monks Wood.

Survival tended to be lower in summer than in winter for all shrews with a high mortality of adults following breeding. Once winter approached, monthly survival increased to 80–100% even though the numbers of captures was small. Survival decreased slightly in spring. Mature adults were present in the population for a very limited period; by May all shrews were mature and from then onwards survival decreased until

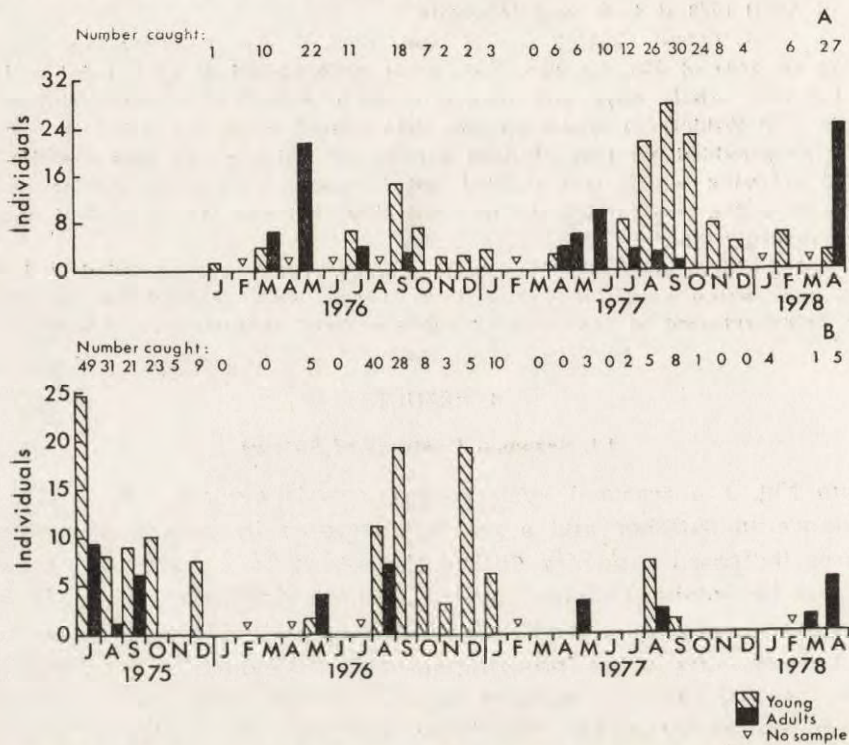


Fig. 1. The numbers of *S. araneus* caught in The Wilderness (A) and in Alice Holt Forest (B).

by October all adults had disappeared from the population. The figure for August 1977 is slightly misleading: three adults were known to be alive of which two survived until September, giving a high total survival for August. None of the September cohort of adults survived to the following month.

The comparatively high survival of shrews through the winter is further emphasised by Fig. 3 where the numbers of marked shrews known to be alive from their subsequent recapture at later dates, but which were not caught during intervening months, are shown. During

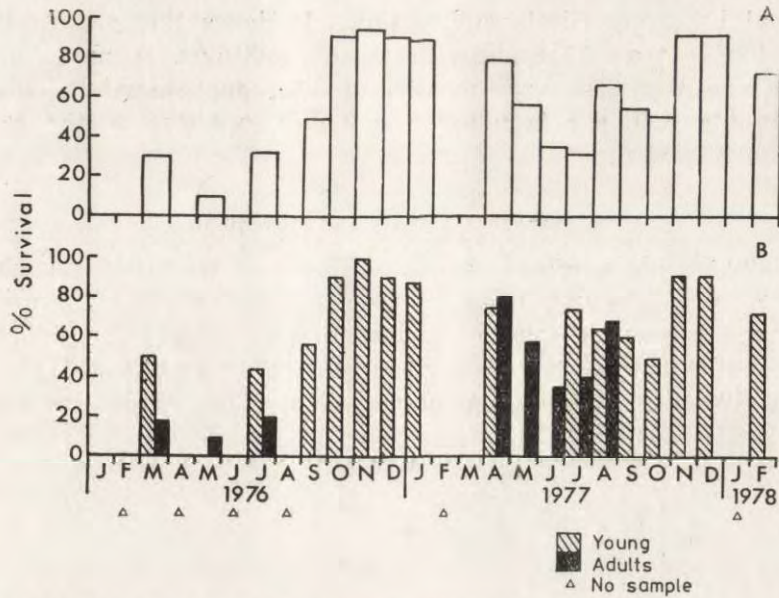


Fig. 2. The survival of *S. araneus* in The Wilderness: total survival (A), and survival of young and adults (B).

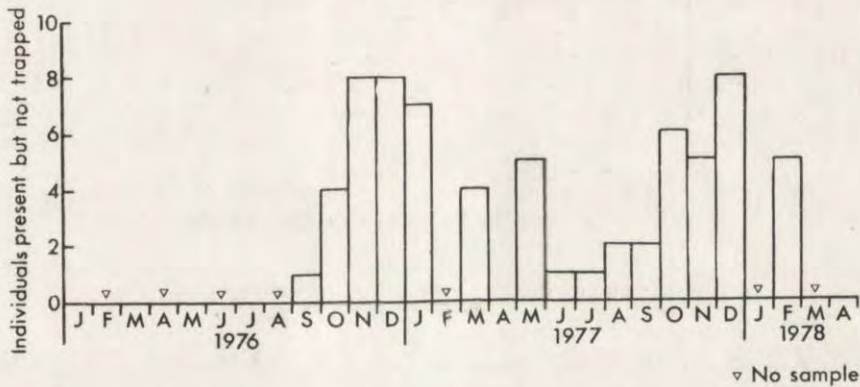


Fig. 3. The numbers of marked *S. araneus* known to be alive by subsequent recapture in The Wilderness but which were not caught during each successive trapping period.

summer months, most marked animals were recaptured during each successive trapping period, but large numbers which were known to be alive failed to be caught during winter months.

The life-expectancy of *S. araneus*, in The Wilderness is shown in Fig. 4 where the mean number of captures from each monthly cohort recaptured in successive months is expressed as a percentage of the

capture at time zero (first capture time). It shows that shrews do not survive longer than 13 months in these conditions. A mean of only 50% survive the first two months of life; approximately 40–50% survive to become six months of age and 20–30% of the original number survive to breed.

4.3. Seasonal Activity and Movement

The numbers of recaptures in The Wilderness were not sufficient to provide reliable information on the size of home ranges of shrews, and home range size has already been described by Shillito (1963), Michielsen (1966), Buckner (1969) and Pernetta (1977) for *S. araneus*. However, the ranging of shrews in The Wilderness was in-

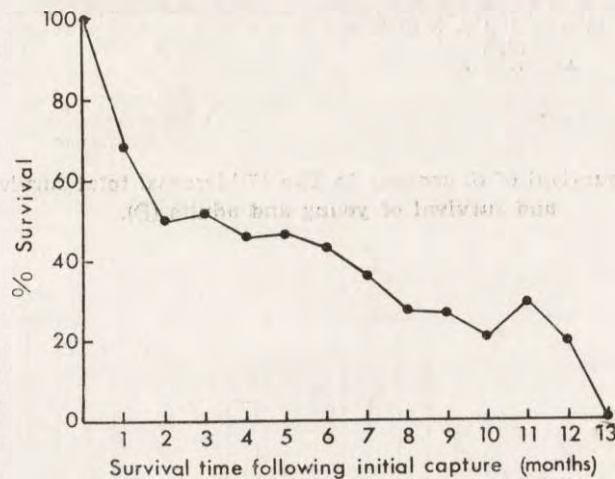


Fig. 4. The survival of *S. araneus* in The Wilderness.

vestigated by an analysis of their seasonal movements and activity revealed by mark-recapture data.

Movement by shrews (shown in Fig. 5) was greatest in spring and summer when adults were breeding, and most captures were males probably searching for mates. Juveniles were very active on the ground surface in summer but movements between trap points were limited to short distances and were less extensive than the forays made by breeding adults. The mean distance moved between captures was 34m by adults and 7m by juveniles.

In winter, activity was greatly reduced, with a mean distance travelled of only 10m. Movement decreased to a minimum in November–February. In February 1978, six recaptures were made and the greatest distance

moved within that trapping period and since the previous trapping period was 15m. Activity, both in terms of total distance moved and the mean distance moved between captures, within a trapping period in summer was more than twice that in winter, indicating that home range may also be smaller in winter.

Inter-sampling period movement, based on a comparison of the centres of activity between successive trapping periods, was found to be small, with a maximum shown by adults in spring and summer of 15m and a minimum shown by young shrews in autumn and winter of 5m. Shrews

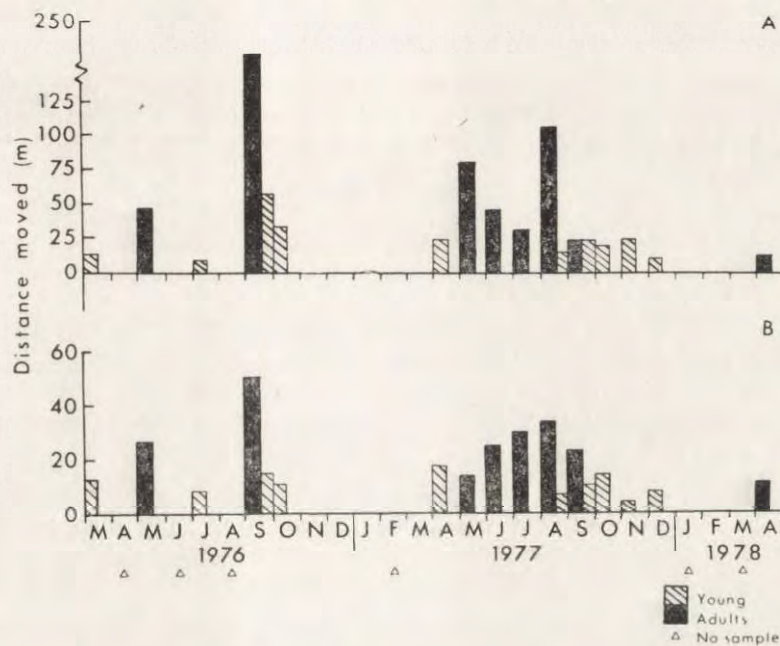


Fig. 5. Intra-sampling period movement of *S. araneus* in The Wilderness: mean total distance moved (A) and mean distance moved between captures (B).

generally failed to move far from their original sites of capture, indicating that home range remains in approximately the same location throughout life. Most shrews were repeatedly captured at the same trap point throughout their life. Moreover, home ranges were frequently found to overlap.

5. DISCUSSION

The seasonal cycle in captures of *S. araneus* in this study is similar to that recorded by Mezhzherin (1960), Shillito (1960), Buckner (1969) and Pernetta (1977) in Britain and Europe. Following

breeding, old adults disappeared from the population: this occurred throughout the summer, between July and October, but most adults probably survived to breed at least twice (Brambell, 1935) and were still alive in late August and September. Senescence may have contributed to the death of these adults. Flower (1931) suggests that tooth wear has an important influence on the mortality of mammals, and studies on shrews by Crowcroft (1956) and Pernetta (1977) show that tooth wear is marked in ageing shrews. It is unlikely that the death of old adults was hastened by climatic factors since their disappearance from the population occurred prior to the advent of harsh winter conditions (Churchfield, 1979). It may have been competition for food and nesting sites, and associated agonistic behaviour between individuals, which accelerated the death of these shrews during summer and early autumn.

The steep decline in numbers of captures cannot be accounted for by mortality of adults alone. Mark-recapture data showed that large numbers of juveniles also disappeared from the population and that approximately 50% died within the first two months of life. It has been shown that neither climatic factors, food supply nor parasitism contributed significantly to the population decline in autumn (Churchfield, 1979). However, sociological factors and predation may have had important influences on mortality. Young shrews were very active on the ground surface, making them particularly vulnerable to predators such as owls when the population density is high and the vegetative cover is dying off (Southern, 1954). Predation may also account for the increased mortality of adults in spring when the onset of the breeding season encourages activity on the ground surface. Moreover, the solitary and aggressive nature of shrews may lead to stress as a result of frequent contacts between individuals: this is particularly likely when population density is high and there is competition for resources such as food and nesting sites.

It had been assumed that low numbers of captures in winter indicates a high mortality at this time of year. However, mark-recapture data in the present study revealed that many shrews remained alive during winter but failed to be caught. These individuals either moved out of the study area temporarily or, owing to the isolated nature of the study area and the lack of marked captures in the boundary strip, they probably remained in the study area but were not trapped due to reduced activity on the ground surface. It is suggested that winter survival is high and the number present is considerably greater than the numbers of captures indicate. Shillito (1960), Michielsen (1966) and Pernetta (1977) also reported a high mortality of young shrews, with only

approximately 30% surviving to breeding age, but they did not remark upon the high rate of survival in winter.

Mark-recapture data showed that activity on the ground surface was greatly reduced in winter, resulting in a considerable underestimate of the population of shrews when based on monthly captures. The results are based upon daytime activity only, but the numbers of captures in Alice Holt Forest, where trapping was carried out for the full 24 hours, were similarly reduced in winter. Laboratory studies also indicate that activity over the 24-hour period is reduced under cold, winter conditions (L o x t o n *et al.*, 1975; C h u r c h f i e l d, 1979).

The reduced movement by shrews in winter in the present study agrees with the results of S h i l l i t o (1963) who found home ranges of *S. araneus* to be smaller in winter than in summer, unlike those of B u c k n e r (1969) who found no change in home range from month to month. A reduction in activity on the ground surface by shrews may be encouraged by the tendency for invertebrate prey species to undergo a vertical migration away from the cold and wet in winter (C h u r c h f i e l d, 1979) and could have considerable survival value for shrews by reducing heat loss in adverse weather conditions.

Acknowledgements: I am indebted to Dr. J. Gurnell for his assistance in collecting shrews, for providing access to trapping records, and for his help in the preparation of this manuscript. I wish to thank Dr. J. Griffith, Prof. J. E. Webb, the many other members of Westfield College, and the staff of the Nature Conservancy Council, all of whom have provided help and facilities. My appreciation also goes to Dr. G. K. Godfrey for providing useful discussion and criticism. This research was carried out during tenure of a postgraduate studentship (Mary Scharlieb Award) administered by the University of London, to whom I extend my thanks.

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- Accepted, June 30, 1980.

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DYNAMIKA POPULACJI RYJÓWKI AKSAMITNEJ
W WIELKIEJ BRYTANII

Streszczenie

Ryjówki aksamitne, *Sorex araneus* Linnaeus, 1758, łowione były w biotopie trawiastym i lesie liściastym przez 28—34 miesięcy. Stwierdzono istnienie wyraźnego cyklu liczebności w ciągu roku, przy czym najwyższe zagęszczenie populacji przypadało na okres lata a najniższe na okres zimy (Ryc. 1). Odławianie osobników uprzednio znakowanych wskazuje, że przeżywalność w ciągu pierwszych dwóch miesięcy życia wynosi 50%, ale z tej liczby 80% osobników przezimowuje (Ryc. 2—4). Wydaje się, że stosowane metody odłowu zaniżają rzeczywistą liczebność ryjówek w zimie a podwyższają w okresie wiosny i lata. Związane jest to ze zróżnicowaną aktywnością i ruchliwością ryjówek w poszczególnych sezonach (Ryc. 5).