

A REVIEW OF THE DORMOUSE (*MUSCARDINUS AVELLANARIUS*) IN ENGLAND AND A CONSERVATION PROGRAMME TO SAFEGUARD ITS FUTURE

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ABSTRACT – The dormouse is native to Britain, but has apparently suffered decline in both distribution and numbers over the past 100 years. Basic ecological data have been lacking, hindering understanding of the decline and preventing implementation of scientifically based conservation measures. Recent studies are reviewed which reveal that this species is a specialist arboreal feeder, critically dependent for food upon a sequence of flowers and fruits during the summer. Woodland management (or lack of it) and habitat fragmentation have resulted in habitats becoming sub-optimal, leading to piecemeal local extinctions. In addition, it is likely that the highly unpredictable maritime climate found in Britain results in very variable annual recruitment rates, increasing the vulnerability of small populations in fragmented habitats. With better understanding of the ecology of this species, a conservation strategy is being implemented. This aims to defend dormouse populations where they still occur and to attempt reintroductions to areas from which they have been lost.

Key words: Conservation, *Muscardinus avellanarius*, England.

RIASSUNTO – *Una revisione del Moscardino (Muscardinus avellanarius) in Inghilterra e un programma di conservazione per salvaguardare il suo futuro* – Il Moscardino è nativo della Gran Bretagna, ma ha subito una evidente riduzione nella distribuzione e nel numero di individui negli ultimi 100 anni. La mancanza di dati ecologici di base ha impedito la comprensione di tale declino e ostacolato la messa a punto di metodi scientifici di conservazione. Recenti studi hanno rivelato che questa specie è specialista arborea, dipendente per il cibo da una successione di fiori e frutti durante l'estate. La gestione dei boschi (o la sua mancanza) e la frammentazione dell'habitat hanno portato ad ambienti subottimali ed a frammentarie estinzioni locali. Inoltre, è probabile che il clima marittimo altamente imprevedibile in Gran Bretagna porti a tassi annuali variabili di reclutamento, aumentando la vulnerabilità di piccole popolazioni in ambienti frammentati. Con una migliore comprensione dell'ecologia di questa specie è stato possibile mettere a punto una strategia di conservazione, il cui scopo è quello di difendere le popolazioni di Moscardino dove sono presenti e di tentare reintroduzioni in aree da cui sono scomparsi.

Parole chiave: Conservazione, *Muscardinus avellanarius*, Inghilterra.

INTRODUCTION

The dormouse (*Muscardinus avellanarius*) is a native species in Britain, widely familiar yet infrequently seen even by professional mammalogists. Until recently, little was known of its biology. Apart from minor notes in local natural history publications and two small booklets by Hurrell (Hurrell, 1962; 1980), there appear

to have been only two scientific studies published about British dormice this century (Hurrell & McIntosh, 1984; Richards et al., 1984), since our studies began in 1984. Even the average body weight of a wild British dormouse appeared to be in doubt; The Handbook of British Mammals (Corbet & Southern, 1977) quoted data from captive German animals kept a century ago.

Against this background of ignorance, the dormouse was listed on Schedule 6 of the Wildlife & Countryside Act (1981), giving it partial protection, later extended to full legal protection by listing on Schedule 5. This was because the species had apparently declined in range and numbers in recent years (Hurrell & McIntosh, 1984).

There have been many suggestions that the dormouse has become a rare species, but little direct proof has been advanced, nor causes explained. However, Barrett-Hamilton & Hinton (1910) provided detailed comments about dormice at the turn of the century. Many remarks indicate that, even then, there was a scarcity of dormice in the counties of northern England (including Yorkshire and Durham, where they appear to have been thinly spread and their present status is open to question). At the edge of its range, the dormouse seems always to have been patchy and sporadically reported.

By about 1925, a typical report would say "dormice used to be quite plentiful locally but have become less and less so and now seem to have vanished. There has been no sign or sight of it for three or four years". Corbet (in Hawksworth, 1974) commented that the dormouse appeared to have declined, especially in the north: while 19th century records existed indicating distribution at least to the River Tyne, no post-1960 records had been received from north of the Humber.

Although Hurrell & McIntosh (1984) were able to confirm that dormice did still exist in two northern areas (in Cumbria and Northumberland), they provided widespread evidence of decline in the British population, including a lack of recent records from 7 counties where dormice had been reported a century earlier by Rope (1885).

Further evidence of changing status comes from a search of local mammal reports. The percentage of reports per decade that mentioned dormice shows a declining trend, from 100% in the 1930s to 46% in the 1970s, despite a 30 fold increase in the number of mammal publications (and presumably study effort) over the same period.

Thus, although legally protected, the dormouse seems to be in decline. Lack of recent records is not proof of extinction, especially in such an elusive species. Although they are 'rediscovered' from time to time, it seems clear that dormice are now less numerous and less widely distributed than hitherto.

Dormice have been traditionally associated with coppice woodland. However, until there is better understanding of the relationship between this species and different kinds of woodland management, its decline is likely to continue. Aware of this problem, the Nature Conservancy Council funded an investigation of *Muscardinus* in Britain, beginning in 1986, based on pilot studies we had initiated earlier. The purpose was to find out as much as possible about the ecology of the dormouse in order to understand why it is rare and what measures might assist its conservation.

FIELD STUDIES

The lack of detailed information about the dormouse stems largely from the fact that it is not frequently obtained by any of the methods normally used for sampling small mammals such as Longworth traps (Chitty & Kempson, 1949), domestic cats, owl pellets or discarded bottles (Morris & Harper, 1965). In a novel approach, wire cage traps, built to a simple design (Morris & Whitbread, 1986) and nestboxes (Morris et al, 1990) were used to obtain regular samples of animals for study of breeding and to assess density in relation to woodland management. It also transpires that nestboxes are potentially a valuable tool in dormouse conservation and a high proportion of the dormouse population will use them, especially in coppice woodland where few alternative secure nesting sites exist.

Radio tracking (Bright & Morris, 1991; 1992; 1993) was used to establish how dormice use their environment. They rarely travel more than 100 m from their daytime nest (mean maximum distance in coppice with standards woodland, 55.4 m; Bright & Morris, 1992). They seem very reluctant to come to the ground and cross open space. These two factors suggest that they will show poor dispersal ability and be unlikely to recolonise areas from which they have been eliminated, especially if this involves long distance travel over open terrain.

They are nocturnal in habit and wholly arboreal, spending more than 90% of their time at 2 metres or more above the ground in spring and summer. In the autumn, they will come lower, particularly to exploit bramble (*Rubus* spp) fruits, but still avoid activity on the ground (Morris & Bright, 1993). They prefer to move among trees having plenty of near horizontal branches, not in thin tall trees growing at high densities, with a predominantly upright structure. Mean home ranges (Minimum Convex Polygon) are 0.45 ha for males and 0.19 ha for females over a period of 7-10 days. The ranges of females overlap more, and more often, than those of males which appear to be territorial at least in the breeding season. Typically, a male's home range completely encompasses two female ranges and may overlap parts of others.

Dormice thrive best in diverse, low growing woodland, especially hazel (*Corylus avellana*) coppice 10-20 years old. They are less numerous in older hazel, especially where it is self-shaded or overgrown by taller trees, resulting in diminished productivity of dormouse foods (Bright & Morris, 1990). However, even in 'good' areas, the population density appears low (5-10 per hectare) in comparison with that for other woodland small mammals (Bright & Morris, 1990).

Muscardinus is a specialist feeder (Bright & Morris, 1993). It feeds on a succession of flowers (pollen and nectar) as each becomes seasonally available. Later in the year, ripe fruits are preferred. In mid summer, when flowers are finished and fruits are not yet ripe, dormice eat many insects, including aphids and lepidopteran larvae (Richards et al., 1984). Certain plants are particularly important. For example, hazel provides the principal autumnal food (nuts), bramble has a long flowering season and later provides highly desirable fruits. Honeysuckle (*Lonicera periclymenum*) is also important. Its flowers (nectaries) provide food when others are no longer available and the finely shredded bark is the preferred nesting

material. Nestboxes less than 5m from honeysuckle are more likely to be used by dormice than those further away (Morris et al., 1990).

However, individual plant species are less important than a diversity of species whose flowering and fruiting will, in combination, provide a sequence guaranteeing food availability throughout the summer. This is why dormice are most abundant in diverse natural woodlands and rare in plantations. An unshaded and very productive understorey is also important. The requirements of *Muscardinus* may be more flexible in southern European countries, but in Britain its main habitat is ancient woodland (Peterken, 1974). The total area of this habitat has declined severely and so has the traditional coppice management which maintains high quality understorey habitat for *Muscardinus* (Peterken, 1981).

Moreover, many remaining areas of ancient woodland have now become fragmented into small parts, which are now also often widely isolated from each other. Surveys suggest that both these factors appear to result in a decreased incidence of dormice, even where the habitat is otherwise suitable (Bright et al., 1994 a). While dormice are often found in small areas of woodland, and indeed these are frequently excellent habitat having many unshaded shrubs at their edges, long term survival in such sites is unlikely. Woods smaller than 20 hectares have a markedly lower incidence of dormice, probably because low population density means that such woods are too small to support a viable population. It is likely that small (e.g. dormouse) populations are often particularly vulnerable to stochastic events and consequently suffer disproportionately high extinction rates (Soule, 1987).

Until recently, little was known about the hibernation requirements of *Muscardinus*. Preliminary studies (Bright & Morris, unpublished) suggest that dormice change their arboreal habits completely and usually hibernate in a woven nest on the ground, covered by only a thin layer of leaves or moss. Here they appear very vulnerable to predation and to trampling by domestic animals. Most dormice begin hibernating with the first frosts in autumn (usually October or November), but in some years activity may continue into December. Few dormice are active again before May.

CLIMATIC FACTORS

A further dimension in the ecology of dormice is climate. It is often suggested that cold winters in the north are a reason for scarcity of dormice in northern England and their absence from Scotland. In fact, cold winters are not the problem as this species lives in eastern Europe and also further north in Sweden, areas where the winters are very much colder than in Britain.

The problem lies in the summer weather. Comparison with maps showing summer temperatures and rainfall patterns suggest that *Muscardinus* survives best in warmer and drier parts of Britain. When the weather or food supplies are poor, the dormouse frequently enters facultative torpor in summer (Bright & Morris, unpublished). This compromises its breeding potential and in most years breeding may be delayed until August or even later. (The mean birth date in south-west England is 3rd August, $n = 72$ litters; Bright, unpublished.) Young born late in the

season may not survive hibernation, especially if winter begins early. Thus total reproductive output is reduced.

It is not only absolute temperature, nor amounts of rainfall that limit dormice in Britain, but both the variability and unpredictability of our weather. In Continental Europe, the dormouse enjoys a relatively predictable climate. In Britain, the timing and duration of summer is very uncertain. The date of first flowering (crucial to dormice which feed on pollen in Spring) may vary by up to 6 weeks (Hepper, 1975). Both the beginning and end of summer may each vary separately by several weeks; summers are therefore of unpredictable duration and have no fixed point in the calendar. Breeding too early or too late will reduce dormouse numbers, yet successful timing is a matter of chance. Small populations are particularly vulnerable to a succession of bad breeding years. Weather records suggest that 3 bad years in a row may occur several times in less than 100 years, and even 5 bad years in succession is to be expected.

We suggest that in Britain *Muscardinus* is in fact a relatively K-selected species, living in a variable environment. This may often not be a viable combination, hence its decline. Its sensitivity to weather conditions makes the dormouse a particularly suitable species for long-term monitoring in relation to global warming.

DORMOUSE CONSERVATION

With a better understanding of dormouse biology and the reasons for its scarcity, a conservation programme has been established for the dormouse. English Nature (successor to the Nature Conservancy Council as the Government conservation agency) has identified *Muscardinus* as a conservation priority (Whitten, 1990) and provided funds for practical management of the dormouse, under its Species Recovery Programme. The aim is to:

1. Study methods of reintroducing dormice to areas where they have become extinct and

2. Defend dormice where they still occur.

The latter involves designating 'Key Sites' in good dormouse habitat throughout the country, and arranging for at least 50 nestboxes at each site to be monitored regularly over the next 10 years. The nestboxes will help to safeguard the animals and increase their numbers. They also provide a means of showing dormice to visitors, schoolchildren and the media. This will help to enhance public understanding of dormice and their conservation needs as characteristic species of ancient woodlands. A public participation programme in 1993, "National Dormouse Week", also stimulated interest in this species and encouraged further and wider involvement in its study and conservation.

The success of Key Sites should encourage many woodland owners to reconsider dormice in their own woods. Suggestions for appropriate woodland management have been published by Bright & Morris (1989), based upon the studies reviewed above. Tall trees should be thinned to encourage a vigorous understorey. Coppicing of hazel should be in small patches and on a long rotation (15-20 years). Arboreal access routes should be preserved to enable dormice to

forage in large trees, particularly oaks (*Quercus* spp). Domestic sheep, cattle and pigs should be excluded from dormouse sites because they damage the understorey shrubs. They are also a threat to dormice hibernating on the ground.

Further woodland fragmentation should be avoided and hedges and woodland strips linking dormouse sites should be preserved. Recent proposals by the U.K. Forest Authority to plant new woodlands (hazel especially) to link dormouse sites are encouraging signs of increased awareness of the issues in dormouse conservation.

Providing full legal protection to dormice has little direct effect, but does force a consideration of dormice when roads are widened or planning permission is sought for site development. This may save some animals, but will also help to increase awareness of the issues, benefitting many other species of animals and plants.

Nestboxes at dormouse sites will allow regular long-term monitoring of numbers and breeding success, something that is done for very few wild British mammals at present. Information is being obtained for a National Dormouse Database, about population density in different regions and the timing and success of breeding in different years. This will also help us to better understand the role of climate in the decline of the dormouse in Britain.

Reintroductions are often proposed and are particularly popular among the public seeking a 'cure' for extinction. However, the ecology of this species is complex, so that translocated animals are likely to suffer disorientation and starvation before becoming established. We have conducted experiments which show that a period of acclimatization in cages is essential before release. Animals released directly into an unfamiliar site tend to scatter and suffer high mortality rates (Bright & Morris, 1994 b). Pre-release cages allow acclimatization and orientation. They also provide a base to which the animal can return for supplementary food for as long as this is made available.

Since we have demonstrated that food for dormice may be in short supply during June and July (Bright & Morris, 1993), reintroduction might best be done in the autumn. However, overwinter mortality may be high (Bright & Morris, unpublished) thus compromising a reintroduced population before any possibility of breeding occurring. If they are released earlier in the summer, but given supplementary food (as suggested above), they may adjust to the new site and also have time to breed before the oncoming winter, greatly increasing the total population size in the first year. Adult males appear to be intolerant of each other and need to be released at least 100m apart (Bright & Morris, 1994 b).

Our experiments in 1991 and 1992 show that even captive bred dormice may manage transition to the wild if helped in this way but they travel less widely than wild-caught dormice, and may be less useful for reintroductions.

The dormouse is now much more widely known than only 5 years ago. Together with active conservation measures, based on sound ecological data, this should ensure that the British population of *Muscardinus* is secure after a long period of decline.

SUMMARY

1. The dormouse is a native British species that has apparently suffered extensive range contraction and reduction in numbers over the past 100 years.

2. This decline is due to the specialised ecological requirements of *Muscardinus* which requires a seasonal succession of flowers and fruits to sustain its wholly arboreal feeding strategy. These needs are best provided for in actively managed ancient woodland, particularly where hazel coppicing is undertaken. This activity has become uneconomic in the 20th century resulting in many woodlands becoming sub-optimal habitats for dormice.

3. Dormice rarely travel more than 100m from their nest, and are reluctant cross open ground. This limits their potential for recolonising areas from which they have been lost.

4. Extensive areas of woodland have become very fragmented, leaving dormice in small local populations where they are vulnerable to demographic stochasticity. This is especially so where the remaining woodland fragments are isolated, reducing dormouse immigration.

5. The variable and unpredictable British climate probably affects both hibernation and breeding success, leading to variable net annual recruitment, a factor to which small populations are particularly vulnerable.

6. *Muscardinus* already has full legal protection. Better understanding of its autecology has now enabled a conservation programme to be established. This aims to support dormice where they still occur (eg by appropriate woodland management and provision of nestboxes).

7. Experiments have also been conducted to discover whether reintroductions are a feasible conservation option. Given appropriate release methods and subsequent support, both captive bred and translocated wild dormice have been shown to survive in unfamiliar sites and could be used to reinstate the species in areas from which it has been lost.

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REFERENCES

- BARRETT - HAMILTON, G.E.H. & HINTON, M.A.C. 1910-1921. A History of British Mammals. Gurney & Jackson, London.
- BRIGHT, P.W. & MORRIS, P.A. 1989. A practical guide to dormouse conservation. Occasional Publication no. 11, the Mammal Society, London.
- BRIGHT, P.W. & MORRIS, P.A. 1990. Habitat requirements of dormice (*Muscardinus avellanarius*) in relation to woodland management in Southwest England. *Biological Conservation* 54: 307-326
- BRIGHT, P.W. & MORRIS, P.A. 1991. Ranging and Nesting Behaviour of the Dormouse *Muscardinus avellanarius*, in diverse low-growing woodland. *Journal of Zoology*, London 224: 177-190
- BRIGHT, P.W. & MORRIS, P.A. 1992. Ranging and Nesting Behaviour of the Dormouse (*Muscardinus avellanarius*) in Coppice-with-standards Woodland. *Journal of Zoology*, London 226: 589-600
- BRIGHT, P.W. & MORRIS, P.A. 1993. Foraging behaviour of Dormice *Muscardinus avellanarius* in two contrasting habitats. *Journal of Zoology*, London 230: 69-85
- BRIGHT, P.W., MITCHELL, P. & MORRIS, P.A. 1994 a. Dormouse Distribution: Survey Techniques, Insular Ecology and Selection of Sites for Conservation. *Journal of Applied Ecology*, 31: 329-339
- BRIGHT, P.W. & MORRIS, P.A. 1994 b. Animal translocations for conservation:

- performance of dormice in relation to release methods, origin and season. *Journal of Applied Ecology*, 31: 699-708
- CHITTY, D. & KEMPSON, D.A. 1949. Prebaiting small mammals and a new design of live trap. *Ecology* 30: 536-542
- CORBET, G.B. & SOUTHERN, H.N. 1977. *The Handbook of British Mammals*. (second edition). Blackwell Scientific Publications. Oxford.
- HEPPER, N. 1975. Cultivated plants in flower outside at Kew in early January, 1975. *Kew Bulletin* 30: 699-705
- HAWKSWORTH, D.L. (ed.) 1974. *The Changing Flora and Fauna of Britain*. Academic Press, London.
- HURRELL, E. 1962. Dormice, 'Animals of Britain' series, Sunday Times. London.
- HURRELL, E. 1980. *The Common Dormouse*. Blandford Press. Poole. Dorset.
- HURRELL, E. & MCINTOSH, G. 1984. Mammal Society Dormouse survey, January 1975-April 1979. *Mammal Review* 14: 1-18.
- MORRIS, P.A., BRIGHT, P.W. & WOODS, D. 1990. Use of nestboxes by the Dormouse (*Muscardinus avellanarius*). *Biological Conservation* 51: 1-13
- MORRIS, P.A. & HARPER, J.F. 1965. The occurrence of small mammals in discarded bottles. *Proceedings of the Zoological Society of London*, 145: 148-153
- MORRIS, P.A. & WHITBREAD, S. 1986. A method for trapping the dormouse *Muscardinus avellanarius*. *Journal of Zoology*, London 210: 642-644.
- PETERKEN, G.F. 1974. A method for assessing woodland flora for conservation using indicator species. *Biological Conservation* 6: 239-245
- PETERKEN, G.F. 1981. *Woodland Conservation and Management*. Chapman and Hall, London
- RICHARDS, C.G.J., WHITE, A.C., HURRELL, E. & PRICE, F.E.F. 1984. The food of the common Dormouse (*Muscardinus avellanarius*), in South Devon. *Mammal Review* 14: 19-28.
- ROPE, G.T. 1885. On the range of the dormouse in England and Wales. *The Zoologist* 9: 201-213
- SOULÉ, M. 1987. *Viable Populations for Conservation*. University Press. Cambridge.
- WHITTEN, A.J. 1990. Recovery: a proposed programme for Britain's protected species. CSD Report no. 1089: Nature Conservancy Council. Peterborough.