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Reasons for arboreality in wood mice *Apodemus sylvaticus* and Bank voles *Myodes glareolus*

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Abstract

Although it is broadly accepted that small mammals often climb trees, only few studies explore arboreality in woodland rodents systematically. Here, we investigate the three-dimensional habitat use of wood mice *Apodemus sylvaticus* and bank voles *Myodes glareolus* at three different sites in Wytham Woods, Oxfordshire, under varying environmental conditions. A total of 12 trapping sessions was carried out between March and September 2003 and 2004. During each session, 100 Longworth live-traps with shrew escape holes were set in a 25-point-grid for 3 succeeding nights. Each time, 50 traps were placed on the ground, and 50 in surrounding trees at heights of 30–250 cm. Wood mice were significantly more arboreal than bank voles, and male wood mice spent significantly more time in trees than did females. Arboreality in bank voles occurred only under high population densities and food shortage, and both species were significantly more arboreal in woodland with dense understorey. Thus we conclude that while arboreality is predominantly a result of inter- and intra-specific competition, of the two species we studied, only wood mice, being more agile, can afford to utilize trees without getting caught by predators, and that sex differences are due to male territoriality. Estimates of population sizes and distribution, as well as studies of inter-specific interactions and socio-spatial behaviour are presumed to be affected by these results, and are currently likely to underestimate rodent numbers considerably.

keywords: Arboreality; small mammals; habitat use; forest management; competition

Introduction

Monitoring trends in species distribution and abundance as well as understanding their habitat use and preferences is vital for effective conservation and management strategies (Macdonald et al. 1998). Small mammals are of ecological importance for two major reasons. Firstly, they support a disproportionate number of larger and often endangered carnivores (e.g. pine martens *Martes martes*, stoats *Mustela erminea*, weasels *Mustela nivalis*) and birds of prey (e.g. long-eared owls *Asio otus*, barn owls *Tyto alba* and kestrels *Falco tinnunculus*; Flowerdew, 1984, 1993) that are thus vulnerable to changes in their abundance and distribution (Harris et al. 2000); and secondly, small mammals are good environmental indicator species for agro-pollutants and pesticide residues, as well as general habitat degradation (Macdonald et al. 1998).

Currently, most studies of small mammals are conducted at ground level (e.g. Moore et al. 2003; Bellamy et al. 2000; Tattersall et al. 2002). However, anecdotal reports suggest that the common woodland

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Table 1. Site description

Exclosure	Firebreak	Marley	Swinford
Woodland type	Ancient abandoned hazel coppiced woodland with pedunculate oak stands	Ancient abandoned hazel coppiced woodland with pedunculate oak stands	Semi-natural secondary woodland regenerated from arable pasture sites over the last 200 years
Approximate area	0.3 ha	0.3 ha	0.3 ha
Tree species	Hazel *Coryllus avenula*, elder *Sambucus nigra*, ash *Fraxinius excelsior*, hawthorn *Crataegus monogyna*	Hazel *Coryllus avenula*, elder *Sambucus nigra*, ash *Fraxinius excelsior*, hawthorn *Crataegus monogyna*, oak *Quercus rober*	Silver birch *Betula pendula*, ash *Fraxinius excelsior*, sycamore *Acer pseudoplatanus*, alder *Alnus glutinosa* and a small amount of hazel *Coryllus avenula*
% Groundcover	100%	70%	40%
Groundcover			
Height	30–100 cm	25–100 cm	25 cm
Species	Tufted hair grass *Deschampsia cespitosa*, dog's mercury *Mercurialis perennis*, bramble *Rubus fruticosus*, nettle *Urtica dioicea*, bracken *Pteridium aquilinum*	Tufted hair grass *Deschampsia cespitosa*, dog's mercury *Mercurialis perennis*, bramble *Rubus fruticosus*, nettle *Urtica dioicea*, bracken *Pteridium aquilinum*	Tufted hair grass *Deschampsia cespitosa*, dog's mercury *Mercurialis perennis*, bramble *Rubus fruticosus*

species *Apodemus* sp. and *Myodes* sp. are capable of climbing, e.g. yellow-necked mice *Apodemus flavicollis* are found at heights up to 23 m (Borowski 1962) and use bird nests and boxes (Ballat and Pelikan 1959). Although *Apodemus sylvaticus sylvaticus* and *Myodes glareolus* (formerly *Clethrionomys glareolus*: see Musser and Carleton, 2005) are amongst the most common European woodland mammals, only two systematic studies investigated their arboreality (Holisova (1969), in spruce-oak woodland in the Czech Republic, and Montgomery (1980), in deciduous woodland in Woodchester Park, England). Both species occupy similar ecological niches. They weigh between 15 and 25 g, breed predominantly between April and October with females establishing mutually exclusive breeding territories (Flowerdew, 1993) and are the preferred prey of many woodland predators. However, their survival strategies differ. Whereas the predominantly herbivorous *M. glareolus* relies on dense understorey for protection, the more omnivorous diet of *A. sylvaticus* is associated with keenly developed senses and considerable agility, allowing flighty escape from predators. Thus, bank voles are active night and day, whilst wood mice are largely nocturnal.

Four main theories seek to explain arboreality in small mammals: food provision (Montgomery 1980; Holisova 1969); intra-specific competition, particularly between males (Ballat and Pelikan 1959; Montgomery 1980); predator avoidance, (Montgomery and Gurnell 1985); and inter-specific competition, particularly between *A. sylvaticus* and *A. flavicollis* (Montgomery 1980).

In this study, we investigate the role of three-dimensional habitats in the socio-spatial dynamics of woodland rodents and evaluate our results in regard to the possible effects of different habitat management strategies on forest ecology.

Material and methods

The study was carried out between 24.03.03 and 22.09.04 in Wytham Woods, Oxfordshire, UK (SP 462080). Wytham comprises approx. 415 ha of mixed deciduous forest, grasslands and conifer plantations (for site details see Kruuk, 1978). As deer grazing can affect small mammal numbers (Flowerdew and Ellwood 2001; Buesching, Jones & Newman, unpubl. data), trapping was restricted to three deer exclosures established in 1997 in different areas of the woods (Morecroft et al. 2001; Table 1). In each exclosure, a 5×5 grid was marked out with points at approximately 10 m intervals (Strachan 1995), the precise distances in the grid being determined by the availability of trees. During each trapping session, Longworth live-traps with shrew escape holes were set for 4 days (3 succeeding nights). Traps were provisioned with hay for bedding, and a mixture of bird seed and hamster crunch, as well as a piece of apple to provide a source of water (Macdonald et al. 1998). Four traps were set at each trapping point; two above ground at heights of 30–250 cm, and two on the ground, totaling 50 traps at ground level and 50 traps in trees and bushes. All traps were checked twice daily, in the morning and evening. On the final day of each trapping session, traps were checked in the morning only, and then taken in and cleaned with hot water. In order to analyse habitat use throughout the breeding season, trapping took