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Testing the effects of deer grazing on two woodland rodents, bankvoles and woodmice

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Abstract

Over the past 200 years, deer numbers have risen world-wide. The associated increase in browsing pressure and trampling often resulted in significant vegetation changes and associated conservation problems in other taxa. In this study we investigated the effects of increased deer browsing (0.4–1.5 deer/ha) on a temperate woodland ecosystem by comparing small mammal communities and vegetation characteristics in 4 deer-free exclosures with adjacent woodland transects subjected to deer grazing.

Jolly–Seber analyses of Capture-Mark-Recapture (CMR) results revealed that the significant reduction of bushes and shrubs in deer-grazed woodland was associated with significantly lower rodent densities than in deer-free exclosures at all times. However, whereas bankvoles (*Myodes glareolus*) outnumbered woodmice (*Apodemus sylvaticus*) in exclosures by 4:1, on average there were 1.6 times as many woodmice in the open woodland than bankvoles. Population structure did not differ between animals caught in exclosures vs. open woodland in terms of body weight, reproductive status, age structure nor sex ratio in either species.

Our results highlight the need of bankvoles for denser understorey as protection from predators, compared with the woodmouse's greater agility and resulting ability to escape predators in open woodland as well as the ability to exploit arboreal habitats. The study emphasises the necessity for effective and informed deer management in order to conserve forest ecosystems.

Zusammenfassung

Die Dichte von Rehen und Hirschen ist in den letzten 200 Jahren weltweit stark angestiegen. Der resultierende Verbiss führt oft zu signifikanten Veränderungen in der Zusammensetzung der ansässigen Pflanzengemeinschaften, was wiederum Auswirkungen auf andere Taxa hat. In der vorliegenden Studie untersuchen wir die Auswirkungen erhöhten Wildverbissschadens auf Wälder gemässigter Breiten, indem wir Kleinsäuger und Vegetation in vier wildfreien Gehegen mit denen im offenen, dem Wildschaden ausgesetzten Waldes verglichen.

Jolly-Seber Analyse der Capture-Mark-Recapture (CMR) Daten ergab, dass die signifikante Reduzierung von Büschen und Sträuchern im beweideten Wald mit einer signifikanten Abnahme der Nagetierdichte assoziiert war. Während jedoch in den wildfreien Gehegen die Populationsdichte der Rötelmäuse (*Myodes glareolus*) vierfach höher als die der Waldmäuse (*Apodemus sylvaticus*) war, fingen wir im offenen Wald 1,6 mal mehr Wald- als Rötelmäuse. In keiner der beiden Arten gab es einen Unterschied in der Populationsstruktur (Körpergewicht, Reproduktionszustand, Alter, Geschlechtsverhältnis) zwischen offenem Wald und wildfreiem Gehege.

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Unsere Ergebnisse unterstreichen die Wichtigkeit dichten Unterbewuchses für Rötelmäuse als Schutz vor Raubtieren. Die viel agileren Waldmäuse hingegen können Räubern auch in offenen Wäldern ohne Unterbewuchs durch Flucht entkommen, und können die dreidimensionale Struktur von Waldhabitaten durch Klettern ausnutzen.

Unsere Studie unterstreicht die Notwendigkeit effizienter und durchdachter Wildpflege im Zusammenhang mit dem umfassenden Naturschutz von Waldhabitaten.

Keywords: *Apodemus sylvaticus*; *Myodes glareolus*; Exclosures; Habitat degradation; Jolly–Seber; Inter-specific competition; Predator avoidance

Introduction

Over the past 200 years, changes in climate, farming, forestry and hunting resulted in marked increases in deer numbers across the UK, mainland Europe (Fuller & Gill 2001), and North America (McCabe & McCabe 1974), prompting a suite of associated conservation issues ranging from intra-guild competition (Bartos, Vankova, Miller, & Siler 2002), to the spread of parasites (Bindernagel & Anderson 1972), impacts on vegetation (Morecroft, Taylor, Ellwood, & Quinn 2001) and human conflicts (e.g. zoonotic diseases: Spielman 1994; agricultural damage: Putman & Moore 2002; Road Traffic Accidents: Putman 1997).

The effects of increased deer numbers on woodlands are well documented: the shrub-layer, especially brambles (*Rubus fruticosa*) and many woodland forbs, is reduced due to the increase in browsing pressure (Savill, Perrins, Kirby, & Fisher 2010), woodland plants are damaged by trampling (Gill & Beardall 2001), and forest regeneration is arrested (Morecroft et al. 2001). Thus, heavy deer grazing alters forest structure, with cascade effects on other species (Fuller & Gill 2001). Invertebrate communities change with forest vegetation (Stewart 2001), and many ground-nesting birds disappear due to a lack of understorey, and thus cover from predators (Perrins & Overall 2001).

Impacts on small mammal populations include lowered species diversity (Putman, Edwards, Mann, Howe, & Hill 1989) and abundance (Smit et al. 2001), corresponding with fewer dependent avian and mammalian predators at higher trophic levels (e.g. small mustelids: King 1985; owls: Southern & Lowe 1982). However, empirical studies comparing small mammal communities in heavily deer grazed vs. deer-free areas within the same woodland are rare (Smit et al. 2001; Flowerdew & Ellwood 2001).

Woodmice *Apodemus sylvaticus* and bankvoles *Myodes glareolus* (formerly *Clethrionomys glareolus*: Musser & Carleton 2005) are common European woodland rodents, occupying similar ecological niches. Both species typically weigh between 15 and 25 g, breed mainly between April and October with females establishing mutually exclusive breeding territories, and constitute the prey base for many woodland predators (Flowerdew 1993). However, their respective species survival strategies differ. Whereas the predominantly herbivorous and more sedentary *M. glareolus* relies on dense understorey for protection from predators (Flowerdew 1993), the more omnivorous diet of *A. sylvaticus*, which includes seeds, berries and up to 15% insects (Watts 1968) is associated with well developed olfactory, visual, and auditory senses and considerable agility, allowing expeditious escape from predators (Flowerdew 1993). Thus, bankvoles are active at night and day under the protective shrub layer, while woodmice are largely nocturnal relying on the cover of darkness to conceal them from predators (Flowerdew 1993). Therefore, deer can have an impact upon rodent numbers either through direct competition for food (Harris & Yalden 2008), or indirectly through habitat modification resulting in a reduction in available cover, affecting inter-specific dynamics (Flowerdew & Ellwood 2001).

In Wytham Woods (Oxfordshire, UK), continuous live trapping data of rodents from 1949 to 2000 indicated that a significant reduction in bankvole numbers, along with a concomitant, albeit less pronounced, reduction in woodmice (review see Buesching et al. 2010), coincided with a substantial increase in deer numbers in the 1990s (Perrins & Overall 2001; Estate Management figures courtesy of N. Fisher), suggesting a link to deer-grazing related changes in vegetation structure (Morecroft et al. 2001).

In this study we used an empirical approach, as advocated by Flowerdew and Ellwood (2001), to compare the population demographics of woodmice and bankvoles throughout the reproductive season in four woodland areas subjected to heavy deer grazing with adjacent deer-free areas (deer exclosures; see Putman et al. 1989). We hypothesised that, while both should prefer the denser habitat in deer-free areas, foraging and predator avoidance characteristics, niche-separation, inter-specific interactions and resource competition should result in *A. sylvaticus* also utilising the open forest, while *M. glareolus* should be largely restricted to areas of dense ground cover, and should thus be found predominantly in the deer-free exclosures (Southern & Lowe 1968). However, while nursing offspring, females of both species should prefer dense vegetation as protection from predators, and, due to the anticipated lower food availability in grazed areas, individuals in the open woodland should have lower body weights resulting in reduced reproductive activity compared to those in exclosures (Hansson 1992; Yoccoz & Mesnager 1998).