

Apodemus at heights: Repeated records of Apodemus mice in tree canopies

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Short Report

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Abstract

Apodemus mice are predominantly terrestrial forest rodents but are also known to use arboreal habitats, with most systematic studies focusing on the lower vegetation and tree strata, while direct observations of their movements in the forest canopy remain scarce. Using non-baited arboreal camera traps in managed forests of Lower Saxony, Germany, we recorded *Apodemus* mice on branches at three camera stations positioned 17.7, 18.4, and 21.3 m above ground. The highest observation occurred on a Douglas-fir (*Pseudotsuga menziesii*) on 8 August 2023. Additional detections were obtained repeatedly on two European beech (*Fagus sylvatica*) trees, with each camera recording mice on three separate nights. All observations occurred at night, between 22:39 and 01:57. We provide direct video documentation of *Apodemus* mice moving along natural branches at heights exceeding 20 m. The repeated detections indicate that canopy use by *Apodemus* mice is not necessarily restricted to exceptional climbing events. These records highlight the importance of considering vertical habitat use when studying forest rodents and demonstrate the value of arboreal camera traps for documenting poorly known behaviours of species usually monitored at ground level.

Introduction

Small forest rodents are usually surveyed using live traps. Although the use of camera traps to monitor small mammals has increased in recent years, these surveys generally rely on ground-based setups, including cameras directed towards the ground or associated with tunnels or boxes (Di Cerbo & Biancardi 2012 ; Gracanin et al. 2022; Hopkins 2024). Consequently, knowledge of the distribution, habitat selection, and movements of small forest rodents is largely based on observations from the forest floor. Species of the genus *Apodemus*, however, are agile climbers and can use trees, shrubs, nest boxes, and arboreal runways (Montgomery 1980; Štěpánková and Vohralík 2009).

The yellow-necked mouse (*Apodemus flavicollis*) is frequently described as more arboreal than the closely related wood mouse (*A. sylvaticus*). Nevertheless, observations from the upper canopy are uncommon. Borowski (1962) captured a yellow-necked mouse in a live trap positioned 23.3 m above ground in Białowieża National Park, and later studies and reviews have cited this observation as evidence of the climbing ability of yellow-necked mice (Hoffmeyer 1973; Karantanis et al. 2017), but direct detailed documentation of their behaviour on branches at these heights has remained limited. Here, we report repeated video records of *Apodemus* mice (likely *Apodemus flavicollis*) at elevated arboreal camera-trap stations, including an observation at 21.3 m above ground.

Material and Methods

Observations were obtained during a broader study of arboreal small mammals in forests of Lower Saxony, Germany. The full study design and camera-trapping methods are described by Mittelman et al. (2025). Briefly, 60 non-baited camera traps (Browning BTC-8A) were deployed across 20 forest plots representing pure and mixed stands of European beech (*Fagus sylvatica*), Norway spruce (*Picea abies*),

and Douglas-fir (*Pseudotsuga menziesii*). Cameras were installed on trees, with cameras in the canopy attached to tree trunks and directed towards branches. Cameras recorded 10-second videos without a delay between consecutive triggers and remained active from April to November 2023. Cameras were installed in the canopy using rope-climbing techniques, and camera height was measured using a Vertex laser hypsometer.

Results and Discussion

Apodemus mice were recorded at three elevated camera stations on six nights between 8 August and 9 September 2023 (Supplementary Table 1). The highest observation occurred at 23:45 on 8 August on a Douglas-fir in the Solling uplands, at 51.67735° N, 9.55489° E (Fig. 1a). The camera was positioned 21.3 m above ground in a tree approximately 34.4 m tall. The video showed an individual moving along the branch. Additional records were obtained from two European beech trees in different forest plots at heights of 17.7 and 18.4 m (Fig. 1b,c). 13 videos were recorded, amounting to 7 independent observations (24-hour independence criteria) of *Apodemus* sp. All observations occurred at night, between 22:39 and 01:57. Because the cameras were unbaited and no attractants were placed near them, the recordings represent natural use of the branches rather than responses to food attractants. The repeated detections at different locations and on different nights indicate that movement into elevated parts of trees was not confined to a single exceptional event or a place. Nevertheless, individuals could not be identified, and repeated recordings from the same tree may represent visits by either the same or different individuals.

We could not reliably differentiate between the two *Apodemus* species present in our surveyed forests, the yellow-necked mouse *Apodemus flavicollis* and wood mouse *Apodemus sylvaticus* based on the video footage alone. We therefore conservatively classified the recordings as *Apodemus* sp. Nevertheless, several lines of evidence suggest that the animals were *A. flavicollis*. No wood mice were captured during ground-level live trapping in 2022 or 2023 in any of the three forest plots where the arboreal *Apodemus* footage was obtained (Mittelman et al. 2024). In a broader survey of forest plots in Lower Saxony, *A. flavicollis* was also overwhelmingly more frequently captured than *A. sylvaticus* (> 90% captures, Appleby and Balkenhol, 2024). In addition, previous experimental and field observations indicate that *A. flavicollis* has a stronger tendency to climb and can use higher forest strata than *A. sylvaticus* (Hoffmeyer 1973). Experimental locomotion studies have also characterized *A. flavicollis* as the more arboreal species relative to other sympatric rodents and identified some locomotor traits associated with arboreal competence (Karantanis et al. 2017). Taken together, the live-trapping information and known climbing capability make *A. flavicollis* the most likely animal recorded here, though their species identity cannot be confirmed from the footage alone.

Our highest observation is slightly below the 23.37 m capture reported by Borowski (1962) and therefore does not constitute a new maximum verified height for the species. It differs, however, in the type of evidence provided. The earlier record used a baited live trap placed on structural beams supporting meteorological equipment. In the present study, unbaited cameras documented mice directly moving

along natural canopy branches. Together with repeated detections on beech branches at 17 meters or higher, the recordings provide direct evidence that *Apodemus* mice can and do move through elevated parts of the forest canopy.

During our study, an additional 20 cameras were placed at a height of 3 meters on a small wooden platform facing tree trunks. This lower camera setup frequently recorded *Apodemus* mice (2675 videos, comprising 295 independent records), whereas bank voles (*Clethrionomys glareolus*) were rarely recorded (5 videos, 1 independent record). This aligns with previous findings of greater arboreality of *Apodemus* mice compared to bank voles (Buesching et al. 2008; Štěpánková and Vohralík 2009).

Interestingly, one of the arboreal records comes from a Douglas-fir (*Pseudotsuga menziesii*) tree, which is non-native in Central Europe, in a pure Douglas-fir forest stand. This corroborates previous research showing *Apodemus* mice actively use Douglas-fir forests, with density and interactions dynamics comparable to forests of the more common Norway-spruce (*Picea abies*) (Appleby and Balkenhol 2024; Mittelman et al. 2024).

Several non-exclusive mechanisms may explain arboreal activity in *Apodemus*. Trees may provide food, including seeds, fruits, buds, and invertebrates, as well as safer routes for movement through forest habitat (Rosalino et al. 2011). Arboreal movement could also reduce competition with strictly terrestrial small mammals and provide temporary refuge from terrestrial predators (Buesching et al. 2008; Štěpánková and Vohralík 2009). Studies of wood mice have found that arboreality can vary with sex, population density, vegetation structure, and food availability, suggesting that climbing behaviour is context-dependent rather than a fixed habitat specialization (Montgomery 1980). Here, observations were concentrated in August and early September, a period when beech seeds are not yet available on the ground, but may already be present in tree canopies before fruit fall.

Although records of *Apodemus* at such heights remain rare, we argue that upper-canopy use may be more common than the available evidence suggests. Most small-mammal studies and monitoring are restricted to the ground or lower vegetation, meaning that activity in the forest canopy will generally remain undetected. Indeed, previous authors have already warned that studies conducted exclusively at ground level may underestimate the vertical component of rodent habitat use in forests (Buesching et al. 2008). The apparent rarity of this seemingly extreme arboreal behaviour may therefore reflect a strong vertical sampling bias rather than its true rarity. Borowski's observations more than 60 years ago already demonstrated that *A. flavicollis* could reach heights above 20 m, yet very few subsequent studies have directly sampled this forest stratum. Our repeated, unbaited camera-trap detections on natural branches provide further support for considering the canopy as a component of *Apodemus* habitat use. Arboreal camera traps offer a valuable method for addressing this knowledge gap because they can document natural canopy activity over extended periods without capturing or attracting animals.

Declarations

Supplementary Information, data, and video footage: Available at <https://doi.org/10.25625/9LJCUL>

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Author contributions: PM, SA, NB conceived the ideas. PM designed methodology. PM and MP collected the data. PM led the writing. All authors contributed to the drafts and revisions of the manuscript.

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References

1. Appleby SM, Balkenhol N (2024) Douglas fir and Norway spruce have similar effects on small mammal density, but not survival, in Central European managed forests. *Mammalian Biology* 104. <https://doi.org/10.1007/s42991-023-00384-1>
2. Borowski S (1962) *Apodemus flavicollis* (Melchior, 1834) in the tops of tall trees. *Acta Theriol* 6:314–314
3. Buesching CD, Newman C, Twell R, Macdonald DW (2008) Reasons for arboreality in wood mice *Apodemus sylvaticus* and Bank voles *Myodes glareolus*. *Mammalian Biology* 73:318–324. <https://doi.org/10.1016/j.mambio.2007.09.009>
4. Di Cerbo AR, Biancardi CM (2013) Monitoring small and arboreal mammals by camera traps: effectiveness and applications. *Acta Theriol* 58:279–283. <https://doi.org/10.1007/s13364-012-0122-9>
5. Gracanin A, Minchinton TE, Mikac KM (2022) Estimating the density of small mammals using the selfie trap is an effective camera trapping method. *Mammal Res*. <https://doi.org/10.1007/s13364-022-00643-5>
6. Hoffmeyer I (1973) Interaction and Habitat Selection in the Mice *Apodemus Flavicollis* and *A. Sylvaticus*. *Oikos* 24:108–116. <https://doi.org/10.2307/3543257>
7. Hopkins J (2024) Detecting and monitoring rodents using camera traps and machine learning versus live trapping for occupancy modeling. *Front Ecol Evol* 12:1359201. <https://doi.org/10.3389/fevo.2024.1359201>
8. Karantanis NE, Rychlik L, Herrel A, Youlatos D (2017) Arboreal gaits in three sympatric rodents *Apodemus agrarius*, *Apodemus flavicollis* (Rodentia, Muridae) and *Myodes glareolus* (Rodentia, Cricetidae). *Mammalian Biology* 83:51–63. <https://doi.org/10.1016/j.mambio.2016.12.004>
9. Mittelman P, Appleby SM, Balkenhol N (2024) Forest composition shapes seed-rodent interactions in a gradient of broadleaves and conifers. *J Appl Ecol* 1365. <https://doi.org/10.1111/1365-2664.14711>. -2664.14711

10. Mittelman P, Pineda M, Balkenhol N (2025) Mixed broadleaf-conifer forests promote coexistence of red squirrels and dormice. *Eur J Wildl Res* 71:67. <https://doi.org/10.1007/s10344-025-01947-y>
11. Montgomery WI (1980) The use of arboreal runways by the woodland rodents *Apodemus sylvaticus* (L.), *A. flavicollis* (Melchior) and *Clethrionomys glareolus* (Schreber). *Mammal Rev* 10:189–195. <https://doi.org/10.1111/j.1365-2907.1980.tb00239.x>
12. Rosalino LM, Ferreira D, Leitão I, Santos-Reis M (2011) Usage patterns of Mediterranean agro-forest habitat components by wood mice *Apodemus sylvaticus*. *Mammalian Biology* 76:268–273. <https://doi.org/10.1016/j.mambio.2010.08.004>
13. Štěpánková J, Vohralík V (2009) Vertical activity of the yellow-necked mouse (Rodentia: Muridae) at edge of a mixed forest. *Folia Zool* 58:26–35

Figures

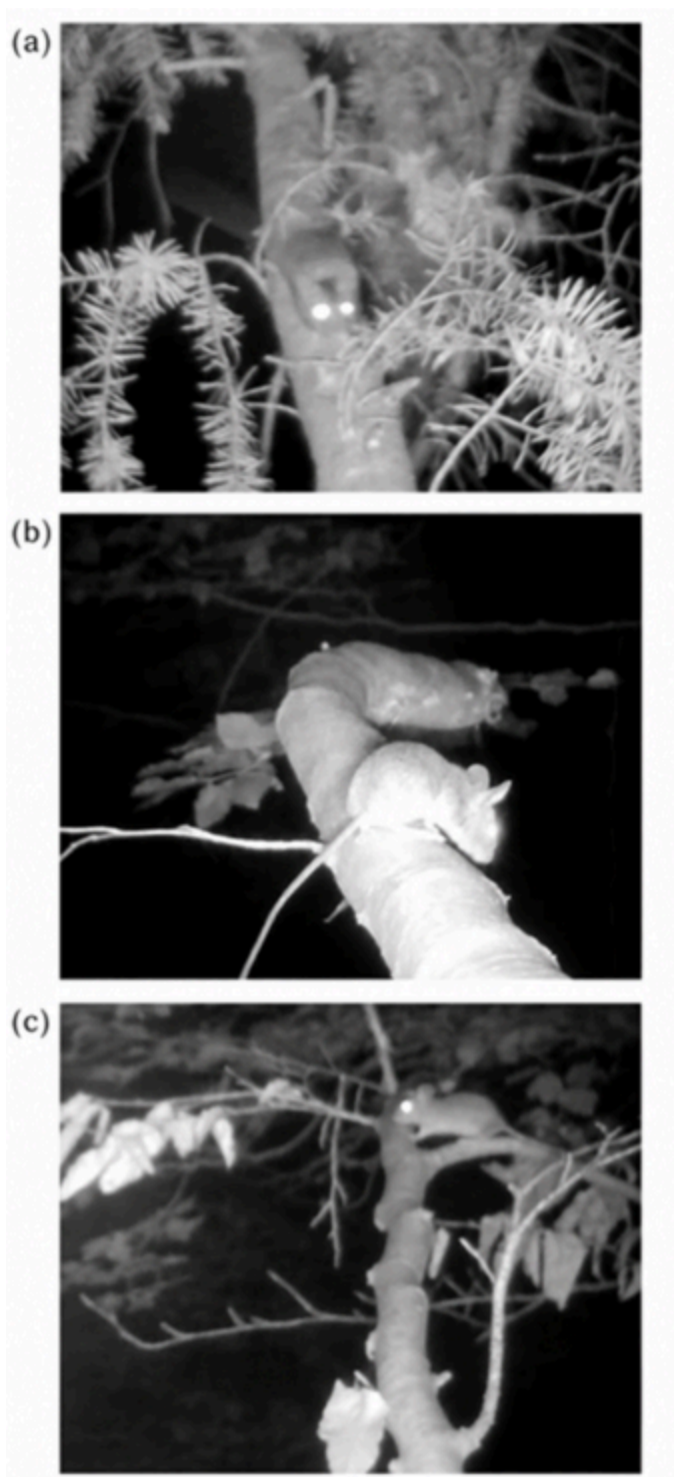


Figure 1

Video frames from arboreal cameras showing *Apodemus* use of the forest canopy. Individuals were recorded in (a) Douglas-fir at 21.3 m, (b) European beech at 17.7 m and, (c) European beech at 18.4 m above ground.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [SupplementaryTable1Infoaboutvideostreeanddeployments.csv](#)