

The use of artificial nest-boxes by *Apodemus sylvaticus dichrurus* in Sicily

Maurizio SARÀ

Department of Animal Biology, Faculty of Science, University of Palermo, Via Archirafi 18, 90123 Palermo 1, Italy; e-mail: mausar@unipa.it

Received 30 March 2007; Accepted 7 April 2008

A b s t r a c t. Reports of wood mouse arboreality are rather scarce outside Britain. I reviewed and analysed 267 visits and 16,456 checks of glirids artificial nest-boxes mounted on trees, in twelve sample areas of Meso- and Supra-Mediterranean woodlands (Sicily, 1995–2005). The wood mouse was recorded only 65 times (0.395%) using the artificial nest-boxes in nine sample areas, and based on this low frequency, the wood mouse can be considered as an occasional dweller of artificial nest-boxes. The resource selection index allowed checking the use respect to the availability of nest-boxes placed at different heights. These were likely reached by climbing the dense understorey and low tree branches up to 5 m, but nest-boxes in the two lower classes (0.5–1.0 and 1.1–1.5 m) were used more than those in the two higher classes (1.6–2.0 and 2.1–5.0 m). ANOVA results suggested that the box use was not related to any particular habitat or sample area feature, and it was slightly more pronounced from March to May. Regardless of their age and sex, individuals mostly exploited nest-boxes placed near the ground (0.5–1.5 m) and generally for 2–3 months. Nonetheless, cases of consecutive use for longer periods and instances of reproduction inside nest-boxes showed that some individuals extended their home range also to the vertical dimension.

Key words: wood mouse, arboreal activity, Mediterranean woodlands

Introduction

The wood mouse (*Apodemus sylvaticus*) is a widespread rodent species in Europe and one of the most common small mammals under the most arid conditions of Mediterranean habitats (MONTGOMERY 1999). In Sicily, it has been trapped or recorded in owl pellets in all ecosystems of the island, from open garrigues and agricultural landscapes at sea level to mixed deciduous and pine forests on the Nebrodi, Madonie and Etna Ranges up to 1800 m a.s.l. Trapping data (SARÀ & CASAMENTO 1993, MILAZZO 2006) and pellet analyses (SARÀ & ZANCA 1988, SARÀ 1998) have consistently indicated the wood mouse as a species with a round-year activity and reproduction extended until winter, and its Sicilian populations have been recorded to be more abundant in woodlands than in open areas.

Supported by their mtDNA analyses, MICHAUX et al. (1998) have recently proposed the retention of the VON LEHMANN & SCHEFFER'S (1976) taxon *dichrurus*, only at the subspecific level.

Many species of *Apodemus* are known to be good climbers (HOLIŠOVÁ 1969, NOVÁK 1999) but reports of arboreality of the wood mouse are rather scarce (e.g. TOSCHI 1965, SPITZENBERGER & BAUER 2001). Probably, this gap into our knowledge is due to the extensive use of trapping on the ground as principal method of field study. The only exception is represented by evidence from Britain where, in mixed woodland, *A. sylvaticus* has been reported using low-level branches of vegetation laying

parallel to steep slopes (Montgomery 1980). Tattersall & Whitbread (1994) have found that 20% of wood mouse captures were in the canopy and shrub layers and suggested the use of arboreal traps to adequately sample the wood mouse populations. In addition, Marsh & Morris (2000) have recorded *A. sylvaticus* as an irregular visitor to dormice nest-boxes.

Materials and Methods

From spring 1995 to spring 2005, I conducted a research on the ecology of Gliridae in the Madonie Regional Park (Palermo, Italy). Some 100–150 wooden nest-boxes for *Muscardinus avellanarius* were placed along transects or in grids in four different woodland ecosystems as reported in Table 1. Nest-boxes were mounted on tree trunks (0.5 to 5 m above the ground). I made 267 visits in twelve sample areas, on average every month, and 16,456 box-checks.

The study areas lie within two life zones and three altitudinal belts (Table 1); the Colchic belt is a localised pre-glacial association of temperate evergreen plants, characterised by *Ilex aquifolium*, *Daphne laureola*, *Taxus baccata*, *Buxus sempervirens*, and *Ruscus aculeatus*. It is the geographical vicariant of the most widespread Samnitic belt (Nebrodi and Etna in Sicily, Apennines in Southern Italy). The hazel wood represents a special case of *Quercion ilicis* woodland, where hazel cultivation (now mostly abandoned) formerly replaced the original Mediterranean vegetation. Climatic data were provided by 12 stations of the Meteorological Service of Sicily (STIR) recording rainfall and another six temperatures.

I recorded faeces, individuals, and nests of wood mice in the artificial nest-boxes appended on trees and I analysed them statistically as follows. Non-parametric Kruskal-Wallis ANOVA was used to test the design of the occurrence of wood mice in nest-boxes as dependent variable, and the sample areas' characteristics (listed in Table 1) as categorical independent variables (factors). In addition, the 65 height records fit a normality distribution after log-transformation and, consequently, they were analysed by a Main-effect ANOVA test. This design allowed to test the first-order (non interactive) effects of categorical independent variables (type of habitat, habitat structure, season, type of use, sex and age of wood mice) on the log-transformed heights.

Within each height class, the proportion between the nest-boxes colonized and those unused was tested according to the design with known proportions of available resource units (Manly et al. 1993). The resource selection index was calculated by the formula: $w_i = o_i / \pi_i$; where π_i is the percentage of nest-boxes per each height class; o_i is the used sample proportion = $u_i / \sum u_i$; u_i is the number of used nest-boxes. The index was then standardized ($B_i = w_i / \sum w_i$) to obtain the B_i index of selection (Manly et al. 1993).

Results and Discussion

I recorded the presence of the wood mouse 65 times out of 16,456 checks (0.395%) in the artificial nest-boxes in nine out of twelve sample areas. Its occurrence was statistically not significant respect to the factors related to sampling effort (n of years of sampling, n of sample areas, median n of nest-boxes in an area, etc) and also to those related to the climate and habitat (type of wood, mean altitude, mean temperature, mean rainfall, mean canopies, etc), as reported in Table 1.

Taking in consideration only the two main habitats where most of wood mice were recorded (n = 59 out of 65), the frequency of occurrence of the wood mouse was all year-

Table 1. Main features of the sample areas of the Madonie Range, where *Apodemus sylvaticus* have been recorded. (1) = Pignatti 1997, Ramondo 1998, (2) = Quze 1995. The occurrence of wood mouse was not statistically significant by the Kruskal-Wallis ANOVA and median test for all the listed features.

Habitat type and Association (1)	Sclerophyll wood (<i>Erico-Quercion ilicis</i>)	Hazel wood (ex- <i>Quercion ilicis</i>)	Holly forest (<i>Ilici-Quercetum petraeae</i>)	Beech forest (<i>Anthriscio-Fagetum aceretosum</i>)
Life Zone (2)	Meso-Mediterranean	Meso-Mediterranean	Supra-Mediterranean	Supra-Mediterranean
Altitudinal belt (1)	a2; Mediterranean	a2; Mediterranean	b1; Colchic	b2; Subatlantic
n of sample areas	6	1	3	2
Period and years of sampling	1999-05; (n =7)	1995-98; (n =4)	1995-03; (n =9)	1997-99; (n =3)
n of nest-boxes	36-142	25-46	18-108	19-50
n visits	69	36	136	26
n checks	6682	1317	7653	804
Altitude m a.s.l.	430-650	960-1000	1300-1330	1420-1530
Average minimum T°	16.43±5.46	8.92±3.32	8.12±6.04	6.61±5.20
Average maximum T°	22.83±5.57	19.45±6.67	17.38±8.77	14.20±7.23
Average rainfall (mm)	60.38±36.51	72.50±41.07	113.16±75.90	80.81±56.45
Tree canopy coverage (%)	20	45	68	78
Bush canopy coverage (%)	85	55	52	40
Average height of trees (m)	5	12	16	16
n of tree species	7	5	4	3
n of bushes species	13	15	9	4

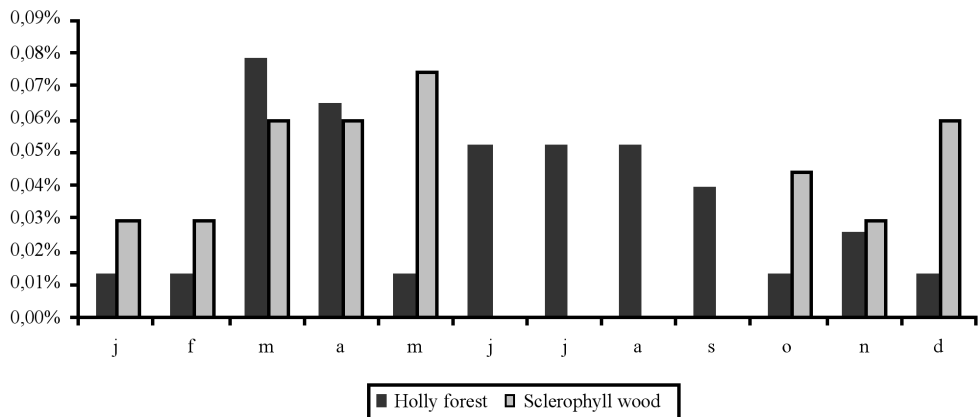


Fig. 1. Frequency of wood mouse in nest-boxes (number of records divided per number of checks) around the year in the two habitats were most of mice (n = 59 out of 65) were recorded.

round in the holly forest with most records falling in late winter and summer; whereas in the sclerophyll wood the wood mouse used nest-boxes from October to May deserting them during summer (Fig. 1). The checks gave evidence of wood mouse activity in the middle of low bushes and understorey, as the average height of used nest-boxes was 1.60 ± 0.68 m (range: 0.5–5.0; n = 65) and nearly 52% of the wood mice were recorded in boxes at around 1.5 m (Table 2). The resource selection index (Table 3) confirmed this height preference as nest-boxes placed at the two lower classes were used more than the higher ones. Most wood mice seemed to occupy the nest-boxes temporarily (individuals and faeces found in empty boxes), however, some individuals built loose nests of leaves and others used boxes formerly occupied by nests of *M. avellanarius* and then abandoned (Table 2). The consecutive occupation of a nest-box lasted 3.22 ± 1.48 months (range: 2–6; n = 9). On overall, male adults and juveniles seemed to use nest-boxes more than females (Table 2) but the test on

Table 2. Characteristics of the occurrences of the 65 *Apodemus sylvaticus* records found in artificial nest-boxes. The number of records per type of habitat was divided per the number of checks in every habitat to account for sampling effort. The number of records in sex and age classes is n = 41 because some individuals were not analysed.

Type of habitat	Sclerophyll wood	Hazel wood	Holly forest	Beech forest
n of records	26 (0.39%)	3 (0.23%)	33 (0.43%)	3 (0.37%)
Type of use	Empty nest-box	<i>M. avellanarius</i> nest	<i>A. sylvaticus</i> nest	Tracks, faeces
n of records	21 (32.31%)	13 (20.00%)	23 (35.38%)	8 (12.31%)
Sex and Age classes	Male Adult	Male Juvenile	Female Adult	Juvenile Female
n of records	13 (31.71%)	12 (29.27%)	8 (19.51%)	8 (19.51%)
Height class (m)	0.5-1.0	1.1-1.5	1.6-2.0	2.1-5.0
n of records	16 (24.62%)	34 (52.31%)	10 (15.38%)	5 (7.69%)

Table 3. The standardized selection index (B_i) of nest-boxes at different height classes in the sample areas of Madonie.

Height class (m)	Availability of nest-boxes n	Availability proportion π_i	Sample count u_i	Used sample proportion o_i	Selection index w_i	Standardized selection index B_i
0.5-1.0	61	0.11	16	0.25	2.15	0.44
1.1-1.5	150	0.28	34	0.52	1.86	0.38
1.6-2.0	132	0.25	10	0.15	0.62	0.13
2.1-5.0	189	0.36	5	0.08	0.22	0.04
Total	532	1	65	1	4.84	1

difference between proportions was not statistically significant (males vs females, $P = 0.088$; and adults vs juveniles, $P = 0.439$). There were at least five instances in which females reproduced inside the nest-boxes as in 4 nests they were found with weaning pups and in another a female was found in lactation.

According to Main-effect ANOVA results, the log-transformed heights of the used nest-boxes were not significantly related to the habitat ($F_{(3)} = 1.502$; $P = 0.224$), the habitat structure ($F_{(4)} = 1.405$; $P = 0.245$) or to the type of use by the wood mouse ($F_{(2)} = 2.294$; $P = 0.111$). Nonetheless, heights were significantly related to the season ($F_{(3)} = 3.423$; $P = 0.023$) as wood mice occurred in nest-boxes at relatively higher height (2.09 ± 0.99 m) during winter than in other seasons. Although based on limited data of reproduction, ANOVA results excluded any differential use of the boxes at different heights by sex ($F_{(1,9)} = 0.112$; $P = 0.745$) and age ($F_{(1,9)} = 0.546$; $P = 0.479$).

Concerning its frequency of use, in the Madonie sample areas, the wood mouse can be considered as an occasional dweller of artificial nest-boxes. These are likely reached by climbing the dense understorey and low tree branches. Results suggested that the nest-box use was not related to any particular habitat but it seemed rather influenced by the season, being winter the most preferred period of use. Regardless of their age and sex, individuals mostly exploited nest-boxes placed near the ground (0.5–1.5 m) and generally for 2–3 months. Although data indicated an occasional use of these artificial shelters, the exploitation of higher nest-boxes along with the records of their longer use for 5–6 months, and the reproduction cases, all above suggested that part of the populations extended its home range into a vertical dimension. *Montgomery & Gurnell* (1985) have already suggested that low vegetation may be another part of this species' home range and arboreality can be explained as an anti-predator strategy. Data from the present study in Mediterranean woodlands agree with previous results in Britain (*Montgomery* 1980, *Tattersall & Whitbread* 1994, *Marsh & Morris* 2000) indicating that wood mice might extend into the vertical stratum of the vegetation the area used for food and shelter exploration. Accordingly, future studies ought to consider also this vertical dimension of the home range of the wood mouse to warrant a better description of its ecological niche.

Acknowledgements

I wish to thank *Werner Haberl*, *Daniela Campobello* and two anonymous referees for comments on early drafts of this paper.

LITERATURE

- Holišová V. 1969: Vertical movements of some small mammals in a forest. *Zool. Listy* 18: 121–141.
- Manly B., McDonald L. & Thomas D. 1993: Resource selection by animals – statistical design and analysis for field studies. *Chapman & Hall, London*.
- Marsh A. C. W & Morris P.A. 2000: The use of dormouse *Muscardinus avellanarius* nest-boxes by two species of *Apodemus* in Britain. *Acta Theriol.* 45:443–453.
- Michaux J., Sarà M., Libois R. & Matagne R. 1998: Is the Woodmouse (*Apodemus sylvaticus*) of Sicily a distinct species? *Belg. J. Zool.* 128: 211–214.
- Milazzo A. 2006: La perturbazione da incendio nella comunità di vertebrati terrestri dei boschi Mediterranei [Wildfire perturbations in a vertebrate community living in Mediterranean woodlands]. *Università degli Studi Palermo, Phd Thesis (in Italian)*.
- Montgomery W. I. 1980: The use of arboreal runways by the woodland rodents, *Apodemus sylvaticus* (L.), *Apodemus flavicollis* (Melchior) and *Clethrionomys glareolus* (Schreber). *Mammal Rev.* 10: 189–195.
- Montgomery W. I. 1999: *Apodemus sylvaticus* (Linnaeus, 1758). In: Mitchell-Jones A. J., Amori G., Bogdanowicz W., Kryštufek B., Reijnders P. J. H., Spitzenberger F., Stubbe M., Thissen J. B. M., Vohralík V. & Zima J. (eds), *The Atlas of European Mammals. T & Ad Poyser, London: 274–275*.
- Montgomery W. I. & Gurnell J. 1985: The behaviour of *Apodemus*. In: Flowerdew J. R., Gurnell J. & Gipps J. H. W. (eds), *The Ecology of Woodland Rodents Bank voles and Wood mice. Oxford Science Publication, Oxford: 89–108*.
- Novak R. M. 1999: *The Walker's Mammals of the World. The John Hopkins University Press, Baltimore*.
- Pignatti S. 1997: *Ecologia del Paesaggio [Landscape Ecology]. Utet, Torino (in Italian)*.
- Quézel P. 1995: La flore du bassin Méditerranéen: origine, mise en place, endémisme. *Ecologia Mediterranea* 21: 19–39.
- Raimondo F. M. 1998: Carta del Paesaggio e della Biodiversità vegetale della Provincia di Palermo [Maps of the Landscape and Vegetation Biodiversity in the Palermo Province]. *Quaderni di Botanica Ambientale e Applicata* 9: 3–160 (in Italian).
- Sarà M. 1998: I Mammiferi delle isole del Mediterraneo [Mammals of Mediterranean Islands]. *L'Epos, Palermo (in Italian)*.
- Sarà M. & Zanca L. 1988: Nicchia trofica di *Tyto alba* in ambienti insulari del Mediterraneo [Trophic niche of *Tyto alba* in insular Mediterranean habitats]. *Naturalista sicil.* 12 (suppl.): 173–180 (in Italian).
- Sarà M. & Casamento G. 1993: Analisi del popolamento di topo selvatico (*Apodemus sylvaticus*) in un querceto mediterraneo (Sicilia) [Population analysis of the wood mouse (*Apodemus sylvaticus*) in a Mediterranean oak-wood (Sicily)]. *Hystryx* 4: 17–27 (in Italian).
- Spitzenberger F. & Bauer K. 2001: Waldmaus *Apodemus (Sylvaemus) sylvaticus* (Linnaeus, 1758). In: Spitzenberger F. (ed.), *Die Säugetierfauna Österreichs. Grüne Reihe des Bundesministeriums für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, Wien, Vol. 13: 510–515*.
- Tattersall F. & Whitbread S. 1994: A trap based comparison for the use of arboreal vegetation by populations of bank vole (*Clethrionomys glareolus*), wood mouse (*Apodemus sylvaticus*) and common dormouse (*Muscardinus avellanarius*). *J. Zool.* 233: 314–317.
- Toschi A. 1965: *Apodemus sylvaticus*. In: Toschi A. (ed.), *Mammalia. [Mammals]. Calderini Ed., Bologna, Vol. 7: 185–195*.
- Von Lehmann E. & Scheffer H. E. 1976: Kreuzungsergebnisse mit Waldmäusen (*Apodemus*) der Insel Sizilien. *Säugetierkd. Mitt.* 24: 180–184.