An Experimental Test of Factors Attracting Deer Mice into Buildings

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Abstract

Deer mice (*Peromyscus maniculatus*) are the principal reservoir host of Sin Nombre virus (SNV). Deer mice use a wide variety of habitats including peridomestic settings in and around human dwellings, their presence in and around homes has been implicated as a risk factor for acquiring Hantavirus Pulmonary Syndrome. Deer mice are believed to enter buildings in order to gain access to a variety of resources including food, bedding material, and better thermal microclimates. However, no one has experimentally tested which factors influence mice use of buildings. We conducted experiments using small simulated buildings to determine the effects of two factors, i.e., food and bedding material, on mouse activity in these buildings. We also examined if these effects varied with time of year. We found that deer mice entered our buildings regardless of the presence or absence of food or bedding. However, the amount of activity in buildings was affected by what they contained. We found significantly higher indices of activity in buildings containing food compared to both empty buildings (control) and buildings containing bedding material. Time of year did not affect activity in buildings .

Key words: deer mice, hantavirus, Montana, *Peromyscus maniculatus*

Introduction

Deer mice (*Peromyscus maniculatus*) are the principal reservoir host of Sin Nombre virus (SNV), the etiologic agent of hantavirus pulmonary syndrome (HPS), which was initially described in the southwestern United States (Childs et al. 1994; Nichol et al. 1993). Deer mice are also one of the most widely distributed mammals in North America (Baker 1968). They occur in a wide variety of natural habitats but they are also known to enter human dwellings in both rural (Glass et al. 1997) and urban areas (Kuenzi et al. 2000). Deer mouse presence in and around homes has been implicated as a risk factor for acquiring HPS (Armstrong et al. 1995).

Speculation holds that mice enter buildings to gain access to a variety of resources including food, bedding material, and better thermal microclimates. Whereas several studies have evaluated methods to exclude rodents from human dwellings (Glass et al. 1997, Hopkins et al. 2002), no experimental tests have been completed pertaining to what factors influence mice use of buildings. To design public health measures intended to avoid or decrease human exposure to hantaviruses, information on what factors attract mice into buildings is needed. The purpose of this study was to determine the effects of two factors, i.e., food and bedding material, on mouse activity in buildings and if these effects varied with time of year or surrounding habitat.

Methods

This study was conducted near Gregson, Silver Bow County, Montana, from August 1998 through July 1999. Data from a previous study (Kuenzi et al. 2001) indicated that deer mice were the most common small mammal in the area and that these mice frequently lived in and entered outbuildings within the study site.

To determine what factors attract mice to buildings, we established two sets of three experimental buildings. These experimental buildings were designed to simulate typical outbuildings, such as sheds, that may attract mice. Buildings were small

4 x 8 x 4-ft structures made of wood with 3.8-cm (1.5-in) diameter circular openings in each of the four corners. A 23 X 11 grid of 10.6 X 10.6-cm (4.17 X 4.17-in) squares was permanently drawn on the floor of each building, for a total of 253 squares. We placed one set of buildings in a pasture lightly grazed by cattle hereafter referred to as grazed pasture and the other set in ungrazed bitterbrush (*Purshia tridentada*) and sage (*Artemesia* spp.). Individual buildings in each set of buildings were placed in a row with ~ 20-m spacing between buildings.

We monitored mouse activity in the buildings for 9 consecutive nights during each experimental trial. At the start of each trial, we randomly assigned three different treatments to each of the three buildings within each set. Treatments included food (a mixture of oatmeal and peanut butter), bedding material (cotton batting), and control (nothing added to the building). Food and bedding treatments were placed in the middle of the buildings. Buildings were opened in the evening and small petri dishes of fluorescent powder (Radiant Color, Richmond, California) were placed at openings in the corners of each building. Buildings were checked each morning for presence of mouse tracks using a black light. As mentioned previously, the floor of each building was marked with a 23 X 11 grid of 10.6 X 10.6-cm (4.17 X 4.17 in) squares for a total of 253 squares. We used the number of grid squares containing mouse tracks as our index of mouse activity. Floors were then cleaned using a mixture of viral disinfectant and water. Buildings were closed during the daytime to limit access by diurnal rodents, e.g., chipmunks and voles.

We monitored mouse activity for 3 nights before reassigning each treatment to a different building. By the end of the 9-night experimental trial, each building had received all three treatments. We classified each trial as falling into one of the four seasons (spring, summer, fall and winter) depending upon dates during which the trial was conducted. We used standard dates for determining season (Spring = 21 Mar - 20 Jun, Summer = 21 Jun - 20 Sep, Fall = 21 Sep - 20 Dec, and winter = 21 Dec - 20 Mar). For each building in the study, we calculated a seasonal average of activity for each treatment condition.

Data were analyzed using a two-way (Season X Treatment) repeated measures ANOVA with repeated measures on both factors. Buildings were treated as our subjects and the dependent measure was mouse activity level within a building. Data were analyzed from the grazed pasture and bitterbrush/sage habitats separately. Because there were statistical concerns regarding the sphericity assumption underlying the use of our repeated measures analyses, all repeated measures ANOVA statistical results were reported using the Greenhouse-Geisser adjustment (Maxwell and Delaney 1990). Statistical analyses were done with the SPSS v11.0 (SPSS Inc., Chicago, IL).

Results

We conducted 22 experimental trials during the course of this study; 16 of these trials were conducted in the experimental buildings located in the grazed pasture and six trials were conducted in the buildings located in the bitterbrush/sage habitat. The number of trials conducted during each season varied due to logistical constraints. In the pasture habitat, we conducted six trials during summer, five during fall, two during winter, and three during spring (Table 1). In the bitterbrush/sage habitat we conducted two trials during fall, winter and spring but no trials during summer (Table 2). Mean activity varied by season and treatment for both the buildings in the pasture habitat (Table 1) and those in the bitterbrush/sage habitat (Table 2).

In buildings located in the bitterbrush/sage habitat we detected no significant Season X Treatment effect (Table 3) indicating that the effect of treatments (food, bedding, control) on mean activity level was the same across seasons. We also detected no statistically significant season effect on mean activity levels in both habitats indicating that activity levels were similar among seasons. However, there

Table 1. Average index of mouse activity in buildings located in the pasture habitat by season, Silver Bow County Montana, August 1998- July 1999.

	Spring (3 trials)			Summer (6 trials)			Fall (5 trials)			Winter (2 trials)		
Building	Food	Bedding	Control	Food	Bedding	Control	Food	Bedding	Control	Food	Bedding	Control
1	71.1	51.4	58.4	213.3	98.0	73.0	181.3	64.9	77.2	83.0	37.8	52.8
2	184.2	50.9	31.6	119.5	56.5	87.0	152.7	67.7	43.7	112.2	50.5	40.7
3	149.6	147.6	44.4	204.8	75.2	75.0	128.9	91.3	69.9	130.7	10.3	30.0
Average	134.9	83.3	44.8	179.2	76.5	78.3	154.3	74.6	63.6	108.6	32.8	41.2
St. Dev	57.9	55.7	13.4	51.9	20.8	7.6	26.2	14.5	17.6	24.0	20.5	11.3

Table 2. Average index of mouse activity in buildings located in the bitterbrush-sage habitat by season, Silver Bow County Montana, August 1998- July 1999.

	Spring (3 trials)			Fall (2 trials)			Winter (2 trials)		
Building	Food	Bedding	Control	Food	Bedding	Control	Food	Bedding	Control
1	188.2	64.2	52.5	218.5	12.3	41.8	125.5	45.5	43.2
2	215.2	39.2	84.0	84.5	80.3	33.8	121.2	36.8	32.0
3	198.8	60.3	76.2	130.3	58.2	7.7	110.8	24.2	36.0
Average	200.7	54.5	70.9	144.4	50.3	27.8	119.2	35.5	35.1
St. Dev	13.6	13.4	16.4	68.1	34.7	17.8	7.5	10.7	5.7

was a significant treatment effect (Table 3). The mean activity level in buildings containing food (Mean = 154.8, SE = 11.5) was statistically higher than mean mouse activity levels in control buildings (Mean = 45.2, SE = 2.9) or buildings that contained bedding (Mean = 46.8, SE = 3.3). Activity in control buildings versus those that contained bedding did not differ from one another.

We obtained similar results for the buildings located in the grazed pasture habitat. We detected neither a significant Season X Treatment effect nor a significant Season effect (Table 3). There was a significant Treatment effect. Similar to buildings in the bitterbrush/sage habitat, mean activity level in buildings in the grazed pasture containing food (Mean = 144.3, SE = 4.8) was statistically higher than mean mouse activity levels in control buildings (Mean = 56.9, SE = 4.4) or buildings that contained bedding (Mean = 66.8, SE= 7.4). Activity in control buildings versus those that contained bedding did not differ from one another.

Discussion

A common belief holds that mice enter buildings to gain access to food. However, in a study of rodent exclusion techniques, Glass et al. (1997) demonstrated that *Peromyscus* spp. invaded rural housing that had not been rodent proofed but in which all food had been removed. We also found that deer mice entered buildings regardless of the presence or absence of food. During all seasons, and in both ungrazed pasture and bitterbrush/sage habitats, we documented some deer mice activity in all experimental buildings. However, the amount of activity in buildings was affected by what they contained. We found significantly higher indices of activity in buildings containing food compared to both empty buildings (control) and buildings containing bedding material. This pattern was consistent in both the grazed pasture and the bitterbrush/sage habitats. Thus, buildings that contain accessible food resources are likely to be used for longer periods of time and possibly by more individuals than buildings without food.

We detected no statistically significant seasonal differences in activity levels in buildings across seasons in either of the two habitats examined. Intuitively it makes sense that more mice might enter buildings in the fall to gain access to the better thermal microclimate afforded by housing. Our experimental buildings were not heated and were structurally very simple, so our lack of seasonal differences may be due to our buildings not providing microclimates any different than outside. However, other studies have documented mouse presence in homes throughout the year. Glass et al. (1997) captured mice inside National Park Service dwellings during all seasons and Kuenzi et al. (2000) captured mice inside of homes in Montana throughout the year except during January. Thus, mice appear to enter buildings opportunistically.

Our results indicate the importance of rodent-proofing homes to protect humans from exposure to SNV. Recommendations on how to rodent proof homes are available (Centers for Disease Control and Prevention 2002) and effectiveness of several different rodent exclusion methods has been evaluated (Glass et al. 1997, Hopkins et al. 2002). In buildings that are impossible to rodent proof, our results indicate the importance of eliminating rodent access to food resources and taking

Table 3. Results from the two-way (Season X Treatment) repeated measures ANOVA assessing the effects of building treatment and season on mouse activity.

	Grazed Pasture			Bitterbrush/sage		
	df	F	P	df	F	P
Season	3,1.6	3.67	0.151	2, 1.05	14.95	0.057
Treatment	2, 1.4	88.8	0.003	2, 1.05	63.3	0.013
Season * Treatment	6, 1.9	0.417	0.677	4, 1.10	0.849	0.460

personal precautions to avoid contact with contaminated (by mouse urine and feces) dust or other particulate matter.

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