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Characteristics of Small Rodent Populations in Different Forest Types

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Abstract: The characteristics of small rodent populations were studied using live trappings conducted in a natural deciduous forest and a Japanese larch *Larix leptolepis* plantation on Mt. Maehwa, Hongcheon, Gangwon Province, South Korea. Foliage profiles of understory (1-2 m), mid-story (2-8 m) and overstory (20-30 m) vegetation coverage were higher in the Japanese larch plantation than in the natural deciduous forest. The distribution of diameter at breast height of trees did not differ between study areas. Similarly, the species richness of small rodents did not differ between areas. The number, age structure and sex ratio of captured individuals varied between months. An understanding of habitat characteristics and small rodent population dynamics is essential for forest management. Long-term ecological studies of changes in small rodent populations and their habitat that are caused by thinning and forest tending are needed.

Key words: Forest management, forest tending, small rodents, thinning, population dynamics

INTRODUCTION

Forest floor-dwelling small rodents provide a measure of forest ecosystem function (Sullivan and Sullivan, 2001). These mammals fulfill numerous ecological roles such as serving as prey for predators, consuming flora and fauna and distribution of fungi (Carey and Johnson, 1995; Carey *et al.*, 1999). Therefore, the characteristics of small rodents may be used as indicators of forest ecosystem functioning.

Small rodents may be influenced by habitat features at different spatial scales. The structural heterogeneity of vegetation including vertical layers and species diversity has been increasingly used as a biodiversity indicator (Lindenmayer and Franklin, 2006; Sullivan and Sullivan, 2001). Forest management may influence small rodent populations through changes in conditions within forest stands (Bowman *et al.*, 2001).

Many studies have shown that ecological attributes are important when examining the responses of small rodents to habitat changes such as fragmentation, forest fires and urbanization (Witt and Huntly, 2001; Van der Ree *et al.*, 2004; Silva *et al.*, 2005). Changes in small rodent abundance may alter certain processes within the forest ecosystem and cause changes in biodiversity (Peterson *et al.*, 1998; Martin and McComb, 2001). The primary anthropogenic change to forest ecosystems in South Korea is the change from mature, natural forests to young fragmented stands (Rhim, 2006; Lee *et al.*, 2010). Most of the forested areas in South Korea are young-growth stands (<50 years old) including natural deciduous forests and coniferous plantations.

MATERIALS AND METHODS

The study was carried out between August and November 2013 in a natural deciduous forest and a Japanese larch plantation located within the national forest of Mt. Maehwa (37°39'43"N to 37°40'14"N and 127°52'11" to 127°52'34"E), Hongcheong, Gangwon Province, South Korea. The altitude of the study area ranged between 200 and 300 m.a.s.l. The dominant tree species in the natural deciduous forest was Mongolian oak *Quercus mongolica*. The Japanese larch stand was planted in the 1960s. One 100×100 m study plot was selected in each stand type. Study plots were divided into grid patterns that consisted of 15×15 m arrays (Kang *et al.*, 2013).

Circles measuring 5.64 m in diameter were established at each trapping station (Lee *et al.*, 2008). The stand characteristics within each circle were recorded including species and Diameter at Breast Height (DBH) for each tree and snag, number of downed trees, volume of downed trees and volume of coarse woody debris. Researchers also categorized the vertical layers within the circles into overstory (20-30 m), sub-overstory (8-20 m), mid-story (2-8 m), understory (1-2 m) and ground (0-1 m) (Kang *et al.*, 2013). Coverage was classified into the four categories on the basis of the percentage of cover in each vertical layer according to the method described by Rhim and Lee (2001). The categories were: 0 (percentage coverage = 0%), 1 (1-33%), 2 (34-66%) and 3 (67-100%).

Researchers used a capture-mark-release technique to trap small rodents for three consecutive nights each

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month between August and November 2013. Traps were baited with peanuts and checked each morning (Lee *et al*., 2012). For each trapped mammal, researchers recorded species, sex, weight and reproductive condition. Toe clippings were used for individual identification and individuals were immediately released in the same trap station where they had been captured (Lee *et al*., 2008).

Wilcoxon rank sum tests and t-tests were used to analyze stand structure by comparing the number of standing trees, basal area, vegetation coverage (overstory, sub-overstory, mid-story, understory and ground), number of downed trees, volume of downed trees and number of captured small rodents between study areas (Lee *et al*., 2012).

RESULTS AND DISCUSSION

Stand structural attributes and characteristics of downed trees were surveyed in a natural deciduous forest and a Japanese larch *Larix leptolepis* plantation. Basal area (t-test, t = -2.39, p = 0.05) and vegetation coverage of the understory (t = -2.82, p = 0.01), mid-story (t = -5.09, p = 0.001) and overstory (t = -2.06, p = 0.05) were greater in the Japanese larch plantation than in the natural deciduous forest. However, the number of standing trees per ha (t = -0.50, p = 0.62), coverage of the sub-overstory (t = -0.09, p = 0.93) and understory vegetation (t = -0.74, p = 0.46), number of downed trees per ha (t = -1.38, p = 0.17) and volume of downed trees (t = -0.32, p = 0.75) did not differ between forest types (Table 1).

Small trees whith a DBH of <20 cm were abundant in both study areas. In both study areas there were fewer than 20 trees per hectare with a DBH >40 cm. There was no difference in DBH distribution between the natural deciduous stand and the Japanese larch stand (Wilcoxon rank sum test, Z = -0.066, p = 0.95, Fig. 1).

Three species of small rodents were captured in the study areas: striped field mouse *Apodemus agrarius*, Korean field mouse *Apodemus peninsulae* and Korean red-backed vole *Myodes regulus*. A total of 31 small rodent captures were made and 27 individuals were captured during the study period. The abundance of small rodents was low and similar in both stands (Table 2). Moreover, there was no difference in the species richness of the study areas. The number of captured small rodents in each month did not differ between the stands (Z = -0.29, p = 0.89).

For striped field mice, total number of individuals, number of adults and sex ratio were similar in the natural deciduous forest and Japanese larch plantation. Striped field mice were captured in August and September in the natural deciduous forest but this mammal was not captured in September and October in the Japanese larch plantation (Table 3). In the natural deciduous forest, Korean field mice were abundant in August, however, more of these mice were captured in October and November in the Japanese larch plantation. The total number of small rodents, number of adults and sex ratio did not differ between study areas (Table 4). In both stands most of the Korean red-backed voles were captured in November, however, more were captured in the Japanese larch plantation than in the natural deciduous forest (Table 5).

Improvements in the understanding of habitat structure and function have implications for the conservation of wildlife and wildlife habitat

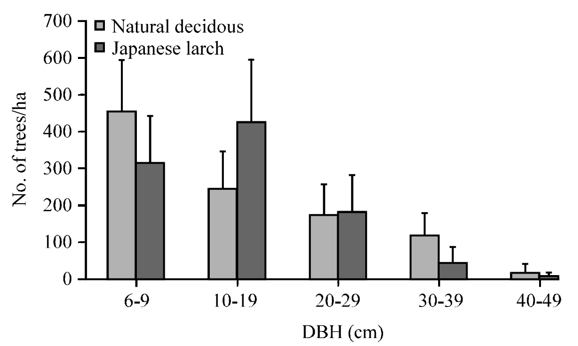

Fig. 1: Diameter at Breast Height (DBH) distributions of standing trees in a natural deciduous forest and a Japanese larch *Larix leptolepis* plantation, Mt. Maehwa, Hongcheon, South Korea

Table 1: Summary of stand structure attributes (density, basal area and coverage) and characteristics of downed trees (volume and number of trees) in a natural deciduous forest and a Japanese larch *Larix leptolepis* plantation, Mt. Maehwa, Hongcheon, South Korea

	Stands			
Variables	Natural deciduous	Japanese larch	t	p
No. of standing trees/ha	976.24±544.01	1011.61±432.67	-0.50	0.620
Basal area (m^2/ha)	21.64±16.370	26.86±14.090	-2.39	0.050
Coverage of overstory (20-30 m) vegetation	0.28±0.4900	0.54±0.7900	-2.82	0.010
Coverage of sub-overstory (8-20 m) vegetation	1.27±0.9300	1.28±0.7000	-0.09	0.930
Coverage of mid-story (2-8 m) vegetation	1.79±0.9800	2.41±0.7200	-5.09	0.001
Coverage of understory (1-2 m) vegetation	1.27±0.4400	1.45±0.5800	-2.06	0.050
Coverage of ground (0-1 m) vegetation	1.59±0.7000	1.67±0.8300	-0.74	0.460
No. of downed trees/ha	288.86±191.26	339.84±182.84	-1.38	0.170
Volume of downed trees (m^3/ha)	15.18±12.950	14.90±12.940	-0.32	0.750

Data are reported as mean±SD; results of t-tests are shown

Table 2: Total number of small rodents captured in a natural deciduous forest and a Japanese larch *Larix leptolepis* plantation, Mt. Maehwa, Hongcheon, South Korea

	Stands		
Species	Natural deciduous	Japanese larch	Total
Striped field mouse	5 (5.0)	6 (5.1)	11 (10.1)
Korean field mouse	7 (5.2)	5 (5.0)	12 (10.2)
Korean red-backed vole	2 (2.0)	6 (5.1)	8 (7.1)
Total	14 (12.2)	17 (15.2)	31 (27.4)

Data in parentheses are the total number of individuals and the number of recaptures

Table 3: The number, age and sex ratio of striped field mice *Apodemus agrarius* captured during each month between August and November 2013 in a natural deciduous forest and a Japanese larch *Larix leptolepis* plantation, Mt. Maehwa, Hongcheon, South Korea

Variables	Aug.	Sep.	Oct.	Nov.	Total
Natural deciduous					
No. of mice (adults)	3 (3)	2 (1)	0 (0)	0 (0)	5 (4)
Sex ratio (males:females)	2:1	2:0	0:0	0:0	4:1
Japanese larch					
No. of mice (adults)	1 (1)	0 (0)	0 (0)	5 (3)	6 (4)
Sex ratio (males: females)	1:0	0:0	0:0	4:1	5:1

Table 4: The number, age and sex ratio of Korean field mouse *Apodemus peninsulae* captured during each month between August and November 2013 in a natural deciduous forest and a Japanese larch *Larix leptolepis* plantation, Mt. Maehwa, Hongcheon, South Korea

Variables	Aug.	Sep.	Oct.	Nov.	Total
Natural deciduous					
No. of mice (adults)	4 (4)	1 (1)	0 (0)	2 (0)	7 (5)
Sex ratio (males:females)	4:0	1:0	0:0	2:0	7:0
Japanese larch					
No. of mice (adults)	1 (1)	0 (0)	2 (1)	2 (1)	5 (3)
Sex ratio (males:females)	1:0	0:0	2:0	1:1	4:1

Table 5: The number, age and sex ratio of Korean red-backed vole *Myodes regulus* captured during each month between August and November 2013 in a natural deciduous forest and a Japanese larch *Larix leptolepis* plantation, Mt. Maehwa, Hongcheon, South Korea

Variables	Aug.	Sep.	Oct.	Nov.	Total
Natural deciduous					
No. of mice (adults)	0 (0)	0 (0)	0 (0)	2 (1)	2 (1)
Sex ratio (males:females)	0:0	0:0	0:0	1:1	1:1
Japanese larch					
No. of mice (adults)	1 (0)	0 (0)	0 (0)	5 (2)	6 (2)
Sex ratio (males:females)	1:0	0:0	0:0	3:2	4:2

(Cadenasso *et al*., 1997). The structure of small rodent habitat has received little attention. The presence of small rodents may be a function of landscape structure, social interactions and resource distribution (Mitchell and Powell, 2004).

Heterogeneity of microhabitat such as forest gaps, downed trees and tree diversity are important determinants of small rodent diversity (Bellows *et al*., 2001). Moreover, microhabitat variables tend to be important for small rodents at the level of population (Silva *et al*., 2005). Microhabitat characteristics determine the patterns of habitat use by small rodents within their home ranges (Castleberry *et al*., 2002).

Generally, there is a positive relationship between understory coverage and small rodent populations (Bowman *et al*., 2001). Woody debris removal could be deleterious to small rodents because dead logs and ground materials are sources of invertebrates and fungi that are consumed by small rodents (Maser and Trappe, 1984; Bowman *et al*., 2000).

In this study, the number of small rodents captured fluctuated greatly between months although, the study period was not sufficiently long to enable an investigation of the characteristics of small rodent population dynamics. The study is accordingly limited by the short study period. This study was undertaken as a baseline survey of small rodents and their habitats that will serve as a point of comparison for future studies to be conducted following the implementation of forest management practices. If similar surveys are regularly conducted in conjunction with forest management practices, researchers will be able to gain a better understanding of the responses of small rodent populations and habitats to these practices.

Recently, huge forest areas have been thinned and tended in South Korea. These forest practices have been associated with changes in small rodent habitat structure and function (Korea Forest Service, 2012). However, there have been few studies in South Korea that have evaluated the effects of thinning and forest tending on small rodents. Therefore, long-term ecological studies of the changes in small rodent populations and their habitats that are caused by thinning and forest tending should be conducted in the future.

CONCLUSION

In this study, researchers examined the richness and abundance of small rodents inhabiting different temperate forest types in South Korea. The study was conducted in order to obtain quantitative information about habitat variables and small rodent populations in a natural deciduous forest and a Japanese larch plantation for the purpose of forest conservation.

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