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Differences in Small Mammal Populations Due to Different Habitat Structure in Natural Deciduous Forest[1]

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闊葉樹 天然林 地域에서 棲息地 構造에 따른 小型 哺乳類 個體群의 差異[1]

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ABSTRACT

This study was conducted to clarify the differences in small mammal populations due to habitat structure caused by different forest practices within natural deciduous forests at National Forest, Pyoungchang, Kangwon Province, Korea from May to November, 1996. Three sites, 1ha each, were selected as cutting, thinning, and control for live trapping of small mammals. Total captures of small mammals in all sites were combined *Apodemus peninsulae*(45.1%, n=64) and *Eothenomys regulus* (54.9%, n=78). *A. peninsulae* was captured in the cutting and the control site. And *E. regulus* was captured in the thinning and the control site. The number of captured small mammals in a month were the highest in the control site and the lowest in the cutting site. *A. peninsulae*'s mean body weight of adult individuals was more higher in the control site than in the cutting site. And *E. regulus*'s mean body weight of adult individuals was more higher in the control site than in the thinning site. Habitat structure seems to be an important factor in abundance and species composition of small mammals.

Key words : Apodemus peninsulae, Eothenomys regulus, *forest practices, habitat structure, small mammal population*

要 約

이 연구는 강원도 평창군 내 국유림의 활엽수 천연림 지역을 대상으로 하여 산림 작업에 의해 변화된 서식지 구조에 따른 소형 포유류 개체군의 차이를 파악하고자 1996년 5월에서 11월까지의 기간 동안 조사를 실시하였다. 소형포유류를 4주 간격으로 생체포획용 덫을 사용하여 7회에 걸쳐 포획-재포획법을 통해 포획을 실시하였다. 조사지역에서는 흰넓적다리붉은쥐(45.1%, n=64)와 대륙밭쥐(54.9%, n=78)의 2종이 포획되었는데, 흰넓적다리붉은쥐는 벌채지와 비벌채지에서, 대륙밭쥐는 간벌지와 비벌채지에서 각각 포획되었다. 월별 포획된 소형 포유류의 개체수를 비교한 결과 비벌채지에서 가장 높았으며, 벌채지에서 가장 낮은 것으로 나타났다. 또한 월별 포획된 지역별 개체군의 동태 역시 같은 경향을 나타내었다. 조사지역별로 성숙 개체들의 체중에 차이가 있는 것으로 나타났는데 흰넓적다리붉은쥐의 경우 벌채지보다 비벌채지에서, 대륙밭쥐의 경우 간벌지보다 비벌채지에서 포획된 개체들의 체중이 무거운 것으로 나타났다. 서식지 구조에 따라 소형 포유류 개체군의 차이가 있는 것으로 나타났는데 이를 통해 서식지의 산림환경구조가 소형 포유류의 종 구성 및 서식에 큰 영향을 미치는 것으로 판단된다.

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INTRODUCTION

Forest cutting seems to give profound effects on forest dwellers providing with environmental (both physically and biologically) changes. Forest animals must have limits of physiological tolerance and fundamental niche with sufficient breadth to encompass the altered conditions by logging. To serve as habitat for a particular species, a site must fulfill the species' requirement for food, moisture, cover, and other species specific requirement(Kirland, Jr., 1990).

Habitat selection by wildlife is largely a function of habitat structure(Anderson and Shugart, 1974; Crawford *et al.*, 1981). In many studies on habitat structure of forest inhabitant small mammals, stand age, plant species composition, and other within stand features were usually used to describe the habitat features(Rhim, 1997).

Forest practices often results in drastic changes in the relative abundance of small mammals in the community, and that shift may have a significant influence on the succession regeneration of those forest(Pank, 1974) and in turn on fluctuation patterns of small mammal populations(Martell, 1983). It is important to understand the changes in small mammal communities resulting from forest practices.

This study was conducted to clarify the differences in small mammal populations due to habitat structure caused by different forest practices with respect to monthly captured number and mean body weight of adults individuals in natural deciduous forest.

STUDY AREA

This study was conducted at the National Forest (N 37° 27′, E 128° 29′) in Pyoungchang, Kangwon Province, Korea. The study area was located in a natural deciduous forest and about 1,100m from sea level. *Quercus mongolica*, *Ulmus davidiana*, *Acer mono*, and *Fraxinus rhychophylla* were the dominant tree species in the study site(Table 1).

Three different sites, 1ha each(100×100m), were selected as cutting, thinning, and control for survey of small mammal population. The forest practices was done in 1992. Cutting site was the area where 80% of trees were removed. And there were remained so much coarse woody debris caused by forest practices in cutting site. Thinning sites was the area where 30% of the trees were thinned, and control site was intact as a natural deciduous forest. There were some fallen trees and piles of stones in forest floor in control site. Each study site was divided by grids. Each grid, marked with flagging, consisted of a 10×10m array of trapping station for live trapping of small mammals.

METHODS

Habitat structure was measured into 3 categories; diameter at breast height(DBH), coverage of understory vegetation(<1.5m) and the depth of soil litter layer. In each grid(10 × 10m), 5m diameter imaginary cylinders were randomly drawn and habitat structure was surveyed within the cylinders. Coverage of understory vegetation was calculated as fractions of the total sampling circles

Table 1. The description of three study sites

	Cutting site	Thinning site	Control site
Altitude(m)	1,080	1,060	1,130
size of forest(ha)	10	13	12
Forest practices	80% trees removed	30% trees thinned	none
Dominant tree species	*Fraxinus rhynchophylla* *Acer mono* *Ulmus davidiana*	*Quercus mongolica* *Tilia amurensis* *Betula costata*	*Qurecus mongolica* *Ulmus davidiana* *Maackia amurensis*
Dominant understory species	*Tripterygium regelii* *Sasa borealis* *Rubus crataegifolius*	*Sasa borealis* *Tripeterygium regelii* *Schizandra chinensis*	*Sasa borealis* *Pteridum aquilinum* *Dryopteris crassirhizoma*

with 4 categories as following : 0(coverage percent : 0%), 1(1~33%), 2(34~66%), 3(67~100%)(Lee, 1990). The understory vegetation coverage value was made by the mean of the coverage value of every cylinders. Thirty points were selected within each study site by random. At each point, the depth of soil litter layers was measured.

Capture-mark-release studies was conducted on one hectare in each grid of the three sites using live traps. Each grid consisted of a 10×10 array of trapping stations with 10m spacing. Sherman collapsible trap(7.5×9.2×29.0cm) was placed at each station for a total of 100 traps per a grid. Rolled rice grains were used for bait. Small mammals were toe-clipped for individual identification. On first capture in each site, each small mammals were weighed to the nearest 0.5g using a spring balance. Animal number, sex, reproductive condition, and location were recorded and animals were released at the point of capture(Saitoh, 1991). The records for adults(*A. peninsulae* ; over 25g in body weight and *E. regulus* ; over 20g in body weight) were analyzed differences in mean body weight of adults animals among sites. Small mammals were captured for one day in each month during the snow free seasons from May to November, 1996.

RESULTS

As measured by the techniques of Lee(1990), the average understory(<1.5m) vegetation coverage was different in three sites(Fig. 1). In cutting site, canopy layer was removed so that understory vegetation coverage was relatively well developed by the increase of amount of sunlight penetration to the ground(Kang, 1997). Since the mid(1.5~6 m) and high(6~12m) layer were removed in thinning site, the canopy became more open then that of control site so that coverage of understory was more increased. The foliage profile was more developed in high layer but poorly developed in understory vegetation than other sites.

The DBH distribution in three study sites was presented(Fig. 2). There were various size of trees in control site. DBH distribution was simple and number of large size trees were less numerous in cutting site than in thinning site.

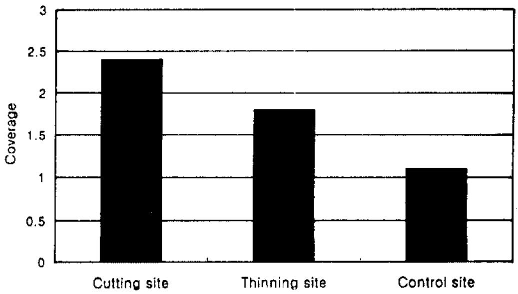

Fig. 1. Average understory vegetation coverage in three study sites

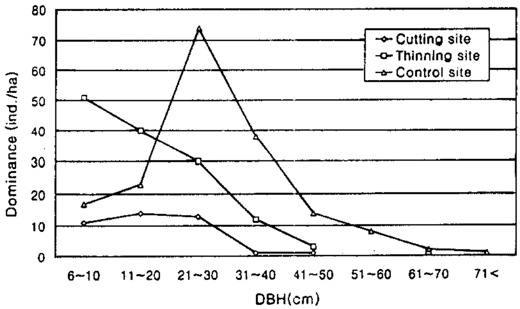

Fig. 2. The distribution of DBH in three study sites

Table 2. The depth of soil litter layer in study sites (unit : cm)

	Cutting site	Thinning site	Control site
Mean±SE	3.05±1.23	6.30±2.33	8.07±2.47

The depth of soil litter layer was different in each site(Table 2). Fallen leaves were decreased by the logging. In cutting area, the litter layer was washed out so that litter layer was least developed. The litter layer was the most developed in control site.

Total captures of small mammals in all site combined comprised *Apodemus peninsulae*(45.1%, n=64) and *Eothenomys regulus*(54.9%, n=78). *A. peninsulae* was captured in cutting and control site, whereas *E. regulus* was captured in thinning and control site. Especially most of *A. peninsulae* was captured near fallen trees and piles of stones in control site and near coarse woody debris caused by forest practices in cutting site. The number of captured small mammals was the highest in control site and lowest in cutting site.

Table 3. Monthly captured number of *A. peninsulae* in cutting and control site

	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
Cutting site	0 (0 : 0)*	2 (2 : 0)	4 (3 : 1)	4 (3 : 1)	5 (3 : 2)	5 (4 : 1)	3 (3 : 0)	23 (18 : 5)
Control site	2 (2 : 0)	3 (2 : 1)	9 (5 : 4)	7 (4 : 3)	9 (5 : 4)	7 (4 : 3)	4 (3 : 1)	41 (25 : 16)
Total	2	5	13	11	14	12	7	64

(no. of adults : no. of juveniles)*

Table 4. Monthly captured number of *E. regulus* in thinning and control site

	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
Thinning site	1 (1 : 0)*	2 (2 : 0)	7 (5 : 2)	9 (5 : 4)	7 (5 : 2)	11 (7 : 4)	7 (6 : 1)	44 (31 : 13)
Control site	2 (2 : 0)	1 (1 : 0)	3 (2 : 1)	7 (4 : 3)	6 (3 : 3)	9 (5 : 4)	6 (5 : 1)	34 (22 : 12)
Total	3	3	10	16	13	20	13	78

(no. of adults : no. of juveniles)*

The monthly captured number of *A. peninsulae* was increased steady from June and reached at the peak in September within cutting site, whereas reached at the peak in July within control site. The number of monthly captured *A. peninsulae* was higher($p<0.005$) in control site than in cutting site(Table 3).

The monthly captured number of *E. regulus* was dramatically increased in July and reached at the peak in October within thinning site, whereas changed in monthly captured number and reached at the peak in October within control site. The number of monthly captured *E. regulus* was higher($p<0.047$) in thinning site than in control site (Table 4).

There was higher number of juveniles *A. peninsulae* in control site than in cutting site. The presence of juvenile animals was the greatest from July to September and declined in October. Over the whole period the number of juvenile animals were significantly higher in control site (Table 3). According to this data, age structure of *A. peninsulae* population was different between control and cutting site due to different habitat structure. Also, differences in number of juvenile animals could be estimated that reproductively active animals were higher in control site than in cutting site(Rhim, 1997). But there was no differences in number of juvenile animals *E. regulus* in thinning and control site(Table 4).

Table 5. Differences in adult individuals' body weight of *A. peninsulae*

Site	Mean	SE	T value	p value
Cutting site	28.69	0.635	-2.976	0.0066
Control site	30.76	0.281	-2.374	0.0015

$F'=3.18$ DF=(17, 24), Prob>$F'=0.0066$

Table 6. Differences in adult individuals' body weight of *E. regulus*

Site	Mean	SE	T value	p value
Thinning site	24.37	0.380	-2.458	0.0167
Control site	26.08	0.238	-2.447	0.0163

$F'=2.56$ DF=(30, 21), Prob>$F'=0.0167$

Monthly mean body weight of adults was analyzed using the Wilcoxon test. It was significantly different in mean body weight among sites in both, *A. peninsulae* and *E. regulus*. The mean body weight of *A. peninsulae* was higher($F'=3.18$, $p<0.0066$) in control site rather than in cutting site (Table 5). In case of *E. regulus*, the mean body weight was higher(F′=2.56, p<0.0167) in control site(Table 6).

DISCUSSION

The actual response likely depends on the exert composition of the stand before forest practices, the amount of disturbance caused by the logging operation, and the subsequent succession on the sites.

Small mammals showed a decrease of avoidance on cutting site. This may indicated that small mammal populations were less stable on cutting site, as compared with the other sites(Walkowa *et al.*, 1982). The general population responses of small mammals to cutting suggest that the environmental changes may create change of habitat or habitat quality. This may be due to the abundance of shelter by logging residue, increased availability of tree seeds, and increases in the abundance of invertebrate population and understory vegetation coverage(Lovejoy, 1975; Monthey and Soutiere, 1985).

A. peninsulae was captured in control and cutting site. Control site has good habitat quality, that is, large size trees, deep soil litter layer, and piles of stones. It would be good habitat condition for inhabitation of *A. peninsulae* and *E. regulus* (Won and Lee, 1981). And there were amount of coarse woody debris in cutting site. Moreover most of *A. peninsulae* were captured near coarse woody debris caused by forest practices in cutting site. The presence of coarse woody debris seems to influence in the inhabitation of *A. peninsulae* because of specific habitat preference on coarse woody debris in spite of poor habitat condition in cutting site(Lee, 1995).

Each species may have different habitat preference. *E. regulus* is a forest dwelling species, and the structure of the tree and bush layer is a factor influencing its distribution(Rhim, 1997).

Micro-distribution of *E. regulus* was strongly correlated with amount of debris cover, shrub cover, and litter layer(Yoon, 1992). It is the lack of litter layer that makes cutting site unsuitable for *E. regulus* and that the presence of litter layer allows the persistence of *E. regulus* in thinning and control site(Martell, 1983; Rhim, 1997).

Habitat structure was altered by forest practices in study sites. Therefore habitat quality was altered due to changes in habitat structure. Monthly captured number of small mammals and adults individuals' mean body weight were decreased by the decreased of habitat quality in study sites. Habitat structure seems to be an important factors in fluctuation patterns, species composition, age structure, and nutrition status(body weight), and reproductive activity of small mammals. The deep soil litter layer could maintain a lot of invertebrate in soil and high moisture contents for inhabitation of small mammals. And the presence of large tree stumps, space in the roots, fallen trees, piles of stone, and coarse woody debris would be good at small mammals for their nesting and foraging resources.

Forests, with greater structural complexity and diversity, offered a greater variety of cover resources(nest and shelter) and foraging opportunities for small mammals. The greater availability of food permitted greater diversity of wildlife because there were simply more ways to subdivide the environment.

Forest structure seems to be an important factor presence of speices. Therefore, forest structure and wildlife for the need to be considered interchangeably in forest management.

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