

## Animal Behaviours Related to Pine Seeds on the Forest Floor

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**ABSTRACT:** Main attackers on pine seeds on the forest floor were investigated in Korea. Damage on pine cones begins in early stage of cone formation, especially by squirrel and Korean squirrel. The above animals left Kayak-like hulls of seed on rocks and fallen tree trunk. Field mice also left the same shape of Kayak-like hulls. But birds including doves and peasants left large shreds with longitudinal cracks or seed cup trace. Most of seeds on the leaf litters as well as under the fallen leaf were consumed by field mice and birds. Especially field mice found the seeds under fallen leaves and consumed all of them.

**Key words :** Attacker, Korean squirrel, Life history, Squirrel

### INTRODUCTION

Pine seeds produced in pine forest were lost through various process and seeds of remain germinated to participate into regeneration(Rim and Shidei 1974, 1975).

The survival of the offspring in a pine forest is associated with some factors such as internal or external ones. For example, physiological and hereditary factors seem to be internal factors and abiotic and biotic factors as external ones.

As a portion of the above factors, attack by animals on pine seeds on the forest floor was suggested(Clarence and Shaler 1947, Baker 1950, Hosoi and Matsumoto 1954, Ashby 1959, Leslie 1966, Gashwiller 1967, Barber and Lange 1967, Stanley and Thomas 1969, William 1972, Rim and Shidei 1974, 1975, Hong and Rim, 1997).

Forest animals have important roles in vegetation development and maintenance by dispersal of seeds around forest floor(Rim and Shidei 1974, Ida and Nakagoshi 1996). Movement of animals depends on the spatially heterogeneous structure and pattern of vegetation landscapes because each animal has special habitats on the forest(Hong and Rim, 1997).

Seed of *Pinus densiflora* is wind-dispersed, therefore most of seeds fall close to the parent plant. However, various forest animals controlled the seed population size at the pre- and post-dispersal stages by cache(Rim and Shidei 1975). Animal effects and their behavioural characteristics are significantly related to the patterns of regeneration and vegetation development of pine forest. A post-dispersal predator finds seeds in a pattern determined by the dispersal system and leaf residue with a pattern determined by his behavioral characteristics of choice and search. Predation on seeds before dispersal has some obvious advantages to the predators; he has jumped a queue of seed feeders most of which wait for seed to fall to the ground.

However, pre-dispersal predation demands a degree of specialization, in particular the ability to fly or to climb(Harper, 1977).

In this study, feeding style and rate of main attackers on pine seeds on the forest floor were investigated as one of the method monitoring the animal activity. The seed loss due to animal behaviour was investigated qualitatively. For this study two sites, which are comparatively stable, were selected(Fig. 1).

### The life history of *Pinus densiflora* and *P. thunbergii*

Seasonal growth is commonly thought to begin when the vegetation buds burst in the spring, about mid-May at lower elevation in most of Korea. However, considerable growth occurs within the bud scales prior to flushing and in fact, it is this growth that is responsible for flushing. Pollination usually occurs in late April and involves the shedding of pollens from the pollen cone and the transfer of pollen by wind to the receptive seed cones.

Embryo development takes place within the female gametophyte tissue of the ovule and begins immediately after fertilization. Embryos are well developed by late July but continue to enlarge slightly and mature about the end of August. The ovule develops into the seed. Seed coat and seed-wing development occurs throughout late spring and summer. From this stage animal attack begins. And seeds are generally mature by early September.

Cones begin to dry and turn brown by late August. Continued drying causes the cones to open and the seed is released in September(Rim and Shidei 1975).

### MATERIALS AND METHODS

Animals influences on the pine seeds on the forest floor were studied in the pine-dominated vegetation at Yangdong-myon and

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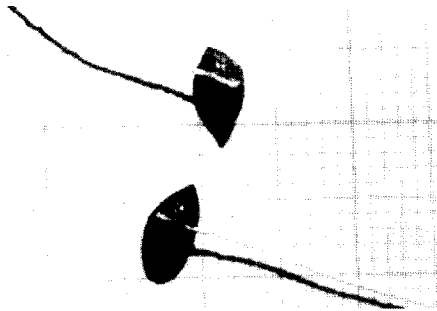


**Fig. 1.** The map showing study sites.  
1. Yangpyung-gun Yangdong-myon, 2. Yangpyung-gun Danwol-myon

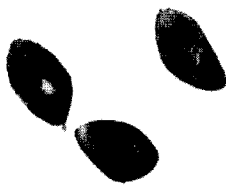
Danwol-myon in Gyunggido, from 1999 to 2001(Fig. 1).

Damage due to Siberian chipmunk is observed by eye or binocular. The behaviour of Siberian chipmunk was observed for 10hrs each month from spring to winter through year round.

To trace the behaviour of concerned animals, seed-glueing method(Rim and Shidei 1974)was adopted. The pine seed was glued to the thin thread with emulsion of polyvinylacrylate(PVC).



**Fig. 2.** Pine seed before attacked.



**Fig. 3.** Hulls of pine seeds destroyed by Siberian chipmunk.

Seed-beds(1.0 × 1.0m<sup>2</sup>) of dispersed 50 pine seeds were randomly set up at forest floor. With these seeds, changes of seed number were checked. Wire traps were used to catch the animals responsible for eating pine seeds. Pine seeds were fed to the animals caught to identify the clues for the animal agents.

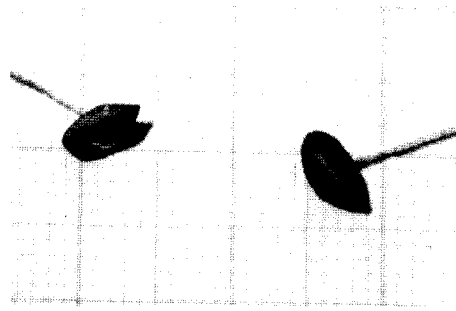
Various conditions of seed-bed are supposed; on the naked soil, on the leaf litter of pine tree, on the broad-leaved litter, under the litter of pine tree and under the broad- leaved litter. Various kinds of seed-bed are made as above conditions. Seed density of artificial seed-bed was fifty per square meter, because natural density of fallen pine seeds was similar to one.

**RESULTS AND DISSCUSSION**

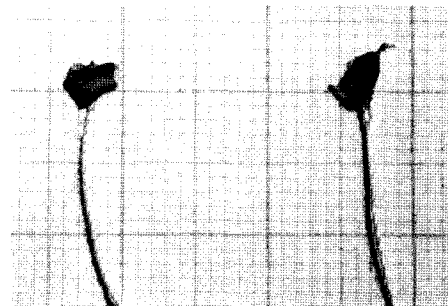
Siberian chipmunks attacked pine cone at early stage even before mature and left naked cone without scales(Fig. 6). This animals also destroyed mature cone and left hulls of pine seeds(Fig. 3). In this case the animals take seeds on rocks and on fallen tree trunk.

Siberian chipmunk generally get rid of scales from cone and take seeds and leave the hulls of seeds. Sometimes this animals attack young cone even before unmaturing state of cone(Fig. 7).

Black-striped field mice are mainly active in night and left the hulls of pine seeds(Fig. 4). This animals also made Kayak-like hulls of seeds after attacking. There are some studies on the



**Fig. 4.** Hulls of pine seeds attacked by Black-striped field mice.



**Fig. 5.** Large shreds with longitudinal cracks or seed cup trace attacked by doves and ring-necked pheasants.



Fig. 6. Cone without scale attacked by Siberian chipmunk.



Fig. 7. Unmature cone attacked by Siberian chipmunk.

relationship between activity of small mammals and the regeneration of Japanese deciduous broad-leaved forests specially regarding dispersal and disappearance of acorns and nuts by acorn-feeding rodents such as field mice(Kikuzawa 1988, Ida and Nakagoshi 1996).

Generally, doves and ring-necked pheasants are active in day and they left the large shreds with longitudinal cracks or seed cup trace(Fig. 5).

Predation rate due to animals, including Black-striped field mice, doves and ring-necked pheasants, showed in Fig. 8.

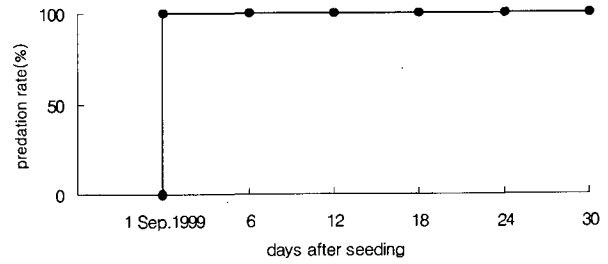


Fig. 8. Predation rate after seeding.

Most of pine seeds of seed-bed on the forest floor in the pine forest as well as broad-leaved forest were destroyed by animals including Black-striped field mice, doves and ring-necked pheasants.

Various seed-bed conditions are supposed; on leaf litter, open space between leaf litter and under litter. Fallen seeds on the forest floor are relocated more or less by wind, rain drops or other physical factors. But authors observation confirmed that most of seeds were stable in spite of various conditions of seed-bed.

In a pine forest most of seeds are found at once by animals and destroyed by them. But seeds under litter with net were safe about for fourteen days. After that pine seeds disappeared(Table 1).

In a broad-leaved forest(dominant sp : *Quercus dentata*) the seeds on A1 layer with net were safe only for one day, after that most of seeds were attacked by black-striped field mice. Black-striped field mice dig a hole under net and attacked the seeds. This results was similar to the seeds on litter with net.

The most stable seeds were shown under the litter of broad-leaved forest. But most of seeds were found by animals and consumed finally.

Table 1. Changes of seed number on the forest floor (The figure shows percent of remaining seeds)

Area	Wire net	1999							Animal concerned
		Sep. 5.	Sep. 6.	Sep. 10.	Sep. 19.	Oct. 25.	Nov. 3.		
Pine forest	on A <sub>1</sub>	net	100	100	3	1.5	1.5	1.5	M
		no cover	100	3	1	1	0.5	0.5	M, D
	on litter	net	100	10	2	2	0.5	0.5	M
		no cover	100	0	0	0	0	0	M, D
	under litter	net	100	100	62	40	3	1	M
		no cover	100	100	10	4	3	3	M, D
Broad-leaved forest ( <i>Quercus</i> sp.)	on A <sub>1</sub>	net	100	100	24	22	0	0	M
		no cover	100	0	0	0	0	0	D
	on litter	net	100	100	100	10	10	10	M
		no cover	100	40	10	0	0	0	M, D
	under litter	net	100	100	100	100	20	20	M
		no cover	100	48	2	0	0	0	M

50 pine seeds were seeded within wood frame sized 1 × 1m with or without polythene net cover. M : fieldmice, D : Dove

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