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Differences in Artificial Nest Boxes Use of Tits Between Deciduous and Coniferous Forests

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Abstract : This study was conducted to describe the differences in artificial nest boxes use of tits between deciduous and coniferous forests at 2nd campus of Chung-Ang University (37°00'04"N, 127°13'96" E), Ansung, Korea from January to August 2005. Tree species richness, tree species diversity index (H') and total basal areas were higher in deciduous forest than in coniferous forest. High, middle, low and understory canopy layers were more developed in deciduous forest, except the coverage of bush-ground layer. Varied tit *Parus varius*, marsh tit *P. palustris* and great tit *P. major* used the artificial nest boxes in this study. Number of breeding pairs of tits used artificial nest boxes, clutch size, and weight and size of eggs were higher in deciduous forest than in coniferous forest. The differences in habitat structure between study sites are very likely to have influenced how breeding birds used the available habitat. Artificial nest boxes could be used as management and conservation tool for birds, particularly in areas, where the availability of natural cavities and coverage of higher layer are limited.

Key words : *artificial nest boxes, breeding, coniferous forest, deciduous forest, tits*

Introduction

Where an animal lives is influenced by a number of factors including habitat structure, floristics, food availability, conspecifics, interspecific competition, predation risk and phylogenetic constraints (Rotenberry, 1985; Muller *et al.*, 1997). Studies of habitat use by birds often demonstrated the importance of vegetation and abundance (Tibbettes and Pruett-Jones, 1999). The structural characteristics of a habitat provide a bird with nest and roost sites, perches, foraging substrates and protection from predation (Recher, 1991).

Many researchers have use artificial nest boxes to examine the breeding ecology of birds (Matthew *et al.*, 2002). Nest box programs are normally considered an effective conservation tool for bird species (Park *et al.*, 2004). Despite the utility of nest boxes for birds, researchers, and managers, the behavior and demographics of birds nesting in boxes are likely to differ from those of birds nesting in natural sites (Nilsson, 1986).

Population studies of tits carried out different habitats in evergreen woodland, gardens and hedgerows, deciduous forest, coniferous forest and mixed forest in the world. There were differences in breeding success and ecology of the birds, which have been attributed to differences in food availability and characteristics of habitats (Riddington and Gosler, 1995; Nour *et al.*, 1998; Park *et al.*, 2004).

Pine forest and oak forest are major forest types in South Korea. But there were a few studies on breeding ecology of tits using artificial nest boxes in forests. This paper examines the differences in artificial nest boxes use of tits between deciduous and coniferous forests. We investigate whether there are differences between areas in clutch size, and weight and size of eggs.

Methods

This study was conducted in coniferous and deciduous forests at the 2nd campus of Chung-Ang University (37°00'04"N, 127°13'96"E), Ansung, Korea from January to August 2005. In deciduous forest, Mongolian oak *Quercus mongolica* and serrata oak *Q. serrata* were dominant tree species. Pitch pine *Pinus rigida* was dominant species in coniferous forest.

We have selected two study sites (120×240 m) in deciduous and coniferous forests. Each study site was divided into grids consisting of a 30×30 m array marked with flags, facilitating accurate nest boxes location (Park, 2003). Forty five nest boxes were located in each study site from January to February 2005. Nest boxes

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varied in their entrance diameter such as 30 mm, 35 mm and 40 mm for different body size of cavity nesting birds. We located 1.5-2 m above ground in various diameter of trees.

In order to describe quantitative the habitat, variables of the forest structure, such as foliage height profile, DBH and tree species, were recorded in areas of woodland five meters in diameter in each 30×30 m square. Foliage height was classified into five vertical layers. The high canopy layer was 10-14 m above the ground, the middle layer at 6-10 m, low canopy layer at 2-6 m, the understory layer at 1-2 m and the ground-bush layer was less than 1m high (Korea Forest Research Institute, 1996; Rhim and Lee, 2000; Park *et al.*, 2004). Numeric values were assigned to percentages of foliage cover, e.g. foliage cover of 0% was 0, 1-33% was 1, 34-66% was 2 and 67-100% was 3 (Lee, 1996; Rhim and Lee, 2000). DBH was measured for all trees exceeding 6cm in DBH within each circle. Forest structure was investigated in August 2005.

Tree species diversity value was calculated by the following equation (Shannon and Weaver, 1949).

$$H' = -\sum_{i=1}^{s} (P_i) \times \ln(P_i)$$

where s is the number of categories and P_i is the portion of individuals in the ith category.

From April to June 2005, the status of artificial nest boxes used by birds were investigated in every week. Length of major and minor axis, weight of eggs were measured.

Results and Discussion

Tree species richness, tree species diversity index (H') and total basal areas were higher in deciduous forest than in coniferous forest. But tree density was higher in coniferous forest (Table 1). The average foliage profiles were different between study sites. High, middle, low and understory canopy layers were more developed in deciduous forest than in coniferous forest. Coverage of bush-ground layer was greater in coniferous forest (Figure 1).

Table 1. Tree species composition of two study sites.

	Deciduous forest	Coniferous forest
Tree (> 6 cm DBH) density (no. of trees/ha)	764	1,048
Tree species richness (no. of tree species)	18	6
Tree species diversity index (H')	2.35	1.21
Total basal area (m^2/ha)	58.42	40.87

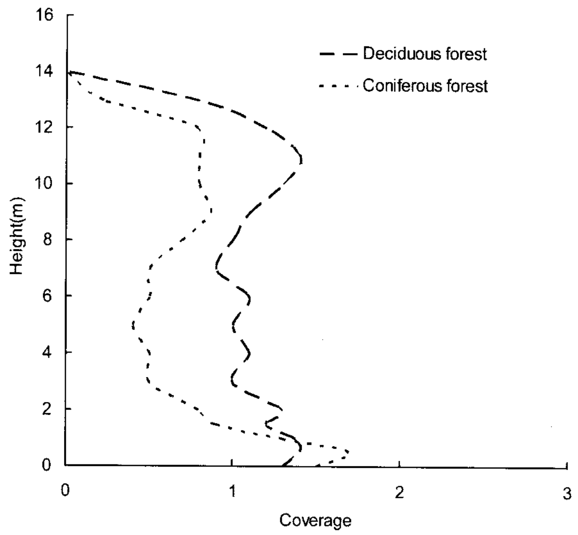

Figure 1. Average foliage profiles of the two study sites.

Tree species richness, tree species diversity index (H') and total basal areas were higher in deciduous forest than in coniferous forest. But tree density was higher in coniferous forest (Table 1). The average foliage profiles were different between study sites. High, middle, low and understory canopy layers were more developed in deciduous forest than in coniferous forest. Coverage of bush-ground layer was greater in coniferous forest (Figure 1).

Three species of tits bred in artificial nest boxes in this study. Varied tit *Parus varius*, marsh tit *P. palustris* and great tit *P. major* did in nest boxes of deciduous forest. In coniferous forest, various tit and great tit did in nest

Table 2. Differences in number of breeding pair of three tits species using artificial nest boxes with different entrance diameter between deciduous and coniferous forests.

	Deciduous forest			Coniferous forest		
	30 mm (n=15)	35 mm (n=15)	40 mm (n=15)	30 mm (n=15)	35 mm (n=15)	40 mm (n=15)
P. varius	1	2	-	-	2	-
P. palustris	3	1	-	-	-	-
P. major	-	1	2	-	-	2
Total no. of breeding pairs in nest boxes	4	4	2	-	2	2

Table 3. Differences in clutch size of three tit species using the artificial nest boxes between deciduous and coniferous forests.

	deciduous forest	coniferous forest	Z-value	P-value
P. varius	10.33±1.15*	8.00±2.83	−2.43	< 0.01
P. palustris	8.25±2.22	-	-	-
P. major	10.33±2.31	8.50±2.12	−1.85	< 0.05

*Mean±SE

boxes. There was more number of nest boxes which were used by tits in deciduous forest than in coniferous forest (Table 2).

Numbers of breeding pair of three tits species were different in each entrance of nest boxes of both study sites. Most of varied tits bred in 35 mm entrance diameter nest boxes, marsh tits did in 30 mm and great tits did in 40 mm (Table 2). Body size of bird is one of the factors contributing to the separation of ecological niches among birds including tits (Jablonski and Lee, 1999; Krebs, 2001). The different breeding number of tits in each size of nest box entrance diameter seemed to be related to body size of three tits species (Lee *et al.*, 2000; Park *et al.*, 2004).

Clutch size of varied tits (Mann-Whitney U-test, $Z = -2.43$, $P<0.01$) and great tits ($Z = -1.85$, $P<0.05$) were significantly higher in deciduous forest than in coniferous forest (Table 3). The weight of eggs of three tits species (varied tits; $Z = -3.15$, $P<0.01$, great tit; $Z = -2.98$, $P<0.01$) were more heavier in deciduous forest. Also, The length of major axis (varied tits; $Z = -2.47$, $P<0.02$, great tit; $Z = -2.15$, $P<0.005$) and minor axis (varied tits; $Z = -2.39$, $P<0.01$, great tit; $Z = -2.84$, $P<0.05$) of eggs were longer in deciduous forest (Table 4).

Number of breeding pairs of tits using artificial nest boxes, clutch size, and weight and size of eggs were higher in deciduous forest than in coniferous forest. Tree species richness and diversity index, total basal area and foliage coverage of higher layers were also higher in deciduous forest. Tits are canopy forging species (Lee *et al.*, 2000; Park *et al.*, 2004). In coniferous forest, number of tits using artificial nest boxes, clutch size, and weight and size of eggs were lower, because of the simple habitat structure there, especially in higher foliage layer. The differences in habitat structure between study sites are very likely to have influenced how breeding birds used the available habitat (Lee, 1996).

Forest structure is clearly very important for forest breeding birds and it appears to be an important factor in determining whether certain species are either present or absent (Rhim and Lee, 2000). Thus, forest structure and its interactions with birds should be a consideration in forest management of birds and their habitat.

More information on birds nesting in artificial nest boxes will allow further understanding of the factors that regulate populations of cavity nesting birds (Purcell *et al.*, 1997). Artificial nest boxes could be used as management and conservation tool for birds, particularly in areas, where the availability of natural cavities and coverage of higher layer are limited (Eadie *et al.*, 1998).

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Table 4. Differences in egg measurement of three tit species using the artificial nest boxes between deciduous and coniferous forests.

	Deciduous forest	Coniferous forest	Z-value	P-value
P. varius				
Weight (g)	1.38±0.14*	1.17±0.08	−3.15	< 0.01
Major axis (mm)	16.29±0.34	15.84±0.52	−2.47	< 0.02
Minor axis (mm)	13.16±0.29	12.37±0.37	−2.39	< 0.01
P. palustris				
Weight (g)	1.12±0.18	-	-	-
Major axis (mm)	15.47±0.46	-	-	-
Minor axis (mm)	11.94±0.31	-	-	-
P. major				
Weight (g)	1.49±0.09	1.27±0.12	−2.98	< 0.01
Major axis (mm)	17.15±0.27	16.24±0.53	−2.15	< 0.005
Minor axis (mm)	13.04±0.39	12.58±0.31	−2.84	< 0.05

*Mean±SE

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