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백로과 조류의 둥지수종 유형 선호도

Nesting Vegetation Preferences of Tree-nesting Ardeidas

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Ⅰ. Introduction

Many herons and egrets nest together in large aggregations called breeding colonies. Nest site characteristics of various Ardeidae species have been quantified and discussed by several authors (Burger, 1979; Gibbs *et al*., 1987; Fasola and Alieri, 1992; Avaş, 2008). The safe nest site is a fundamental requirement for successful breeding in birds. Colony sites generally provide protection against predators including humans and adverse weathers, nesting material to construct and support the nest, and available feeding areas within foraging range (Hafner, 2000).

Objective of this study is to describe vegetation types used for nest sites and compare the preference of each species. Six tree-nesting ardeids were included in this study: Grey Herons (*Ardea cinerea*), Great Egrets (*Egretta alba*), Intermediate Egrets (*E. intermedia*), Little Egrets (*E. garzetta*), Cattle Egrets (*Bubulcus ibis*), and Black-crowned Night Herons (*Nycticorax nycticorax*), the most common tree-nesting ardeids in Korea.

Ⅱ. Methods

The study was carried out from late May and middle June in 2006 and 2007 at central-west area of Korea (36° ~38° N, 126°~128° E). During the survey, the following information was recorded for each colony: (1) geographical data, (2) species composition, (3) nest abundance, (4) forest type and nest tree species.

Information of nest tree was collected during the colony survey: forest type (coniferous, broadleaf, or mixed), canopy height (low, tall, or both), tree species, tree height (m) and diameter at breast height (DBH, cm). With respect to canopy structure and forest type, six vegetation type were determined: (1) low coniferous (LC), (2) low broadleaf (LB), (3) low mixed (LM), (4) tall coniferous (TC), (5) tall broadleaf (TB), and (6) tall mixed (TM).

Vegetation selectivity by a nesting ardeid was compared using the Ivlev's electivity index: $E = (r-p)/(r+p)$ (Krebs, 1989), where r is the ratio between the number of nests in the given vegetation and the total number of nests in all the colonies, and p is the ratio between the surface area of the given vegetation type and the total surface area of all the colonies. The index value tends to +1.0 for increasing preference, and to −1.0 for increasing avoidance. The difference of the use of each vegetation type from a distribution proportional to its availability was tested using Bonferroni confidence intervals (Byers and Steinhorst, 1984).

Ⅲ. Results

The canopy height might be the determinant on selection of the heron's nest site than the forest type. Although the mean nest abundance was not differed between forest types (H_2=1.600, n.s.) (Table 1), the total number of nests was more in colonies (low or both canopy types) with low tree heights than in colonies (tall canopy type) with tall tree heights (Kruskal-Wallis test, H_2=25.616, $P<0.001$) (Table 2). There was the significant difference in average abundance of Grey Heron nests

Table 1. Comparison of the number of nests according to forest types. Values are mean and SE, with number of colonies in parenthesis.

Forest	Number of nests						All species
	GH	GE	IE	LE	CE	NH	
Coniferous	64.3±19.8 (17)	48.4±5.4 (25)	53.3±9.6 (20)	79.2±13.1 (21)	54.3±6.9 (21)	34.9±4.7 (23)	279.0±26.3 (25)
Broadleaf	89.2±21.7 (13)	57.8±25.9 (9)	43.4±18.8 (7)	54.1±17.2 (7)	45.6±15.6 (7)	53.7±18.6 (9)	243.5±59.6 (13)
Mixed	65.8±11.3 (17)	59.4±10.2 (19)	45.5±8.3 (15)	73.2±12.1 (17)	44.5±6.6 (15)	35.0±6.1 (16)	284.3±31.5 (19)
Statistics[1]	H_2=1.864 n.s.	H_2=1.081 n.s.	H_2=0.549 n.s.	H_2=0.831 n.s.	H_2=1.130 n.s.	H_2=0.321 n.s.	H_2=1.600 n.s.

Species code: GH, Grey Herons; GE, Great Egrets; IE, Intermediate Egrets; LE, Little Egrets; CE, Cattle Egrets; NH, Black-crowned Night Herons.
[1] Kruskal-Wallis tests. All tests were not significant.

between three canopy type (H_2=11.792, P<0.01) and they choose taller canopy (tall and both types) in preference to low canopy. Great Egrets had more nests in low canopy type colonies (H_2=7.858, P<0.05) than in tall and both types. Intermediate Egrets (H2=21.230, P<0.001), Little Egrets (H_2=21.923, P<0.001), Cattle Egrets (H_2=17.334, P<0.001) and Black-crowned Night Herons (H_2=20.684, P<0.001) all had more nests in low and both canopy types than did in tall types. However, the mean nest number of none of species was differed between forest types.

Grey Herons showed significant preference for TC and TB vegetation types and avoided LC and LM types (Fig. 1). They never used LB type. Great Egrets used 6 vegetation types. They had the preference for LC, LM, and TM types and had the avoidance for LB, TC and TB (not significant) types (Fig. 1). Intermediate Egrets, Little Egrets and Cattle Egrets was the species with same preferences and they used 6 vegetation types; all of them

Table 2. Number of nests in relation to canopy height of Ardeidae colonies. Values are mean and SE, with number of colonies in parenthesis.

Canopy type[1]	Number of nests						All species
	GH	GE	IE	LE	CE	NH	
Low	8.8±3.5^{b} (6)	63.3±5.9^{a} (15)	74.3±10.0^{a} (15)	107.9±14.2^{a} (15)	70.1±6.2^{a} (15)	48.7±4.3^{a} (15)	367.8±25.6^{a} (15)
Tall	82.2±15.5^{a} (26)	50.1±13.1^{b} (22)	11.1±3.4^{b} (11)	24.6±19.8^{b} (14)	21.5±6.4^{b} (13)	17.3±3.8^{b} (18)	165.2±21.2^{b} (26)
Both	78.9±13.1^{a} (15)	50.5±7.7^{ab} (16)	50.9±8.4^{a} (16)	82.8±10.6^{a} (16)	53.0±8.0^{a} (15)	53.7±11.2^{a} (15)	358.1±37.6^{a} (16)
Statistics[2]	H_2=11.79 P<0.01	H_2=7.85 P<0.05	H_2=21.33 P<0.001	H_2=21.92 P<0.001	H_2=17.33 P<0.001	H_2=20.68 P<0.001	H_2=25.61 P<0.001

Species code: GH, Grey Herons; GE, Great Egrets; IE, Intermediate Egrets; LE, Little Egrets; CE, Cattle Egrets; NH, Black-crowned Night Herons.
[1] Canopy height: Low, the height of trees is below 10 m; Tall, the height of trees is over 10 m; Both, the colony is consisted of two different canopy heights (=heterogeneous type).
[2] Kruskal-Wallis tests. For each species, the canopy type with the same letter was not significantly different based on multiple comparison tests of Dunn procedure (P > 0.05).

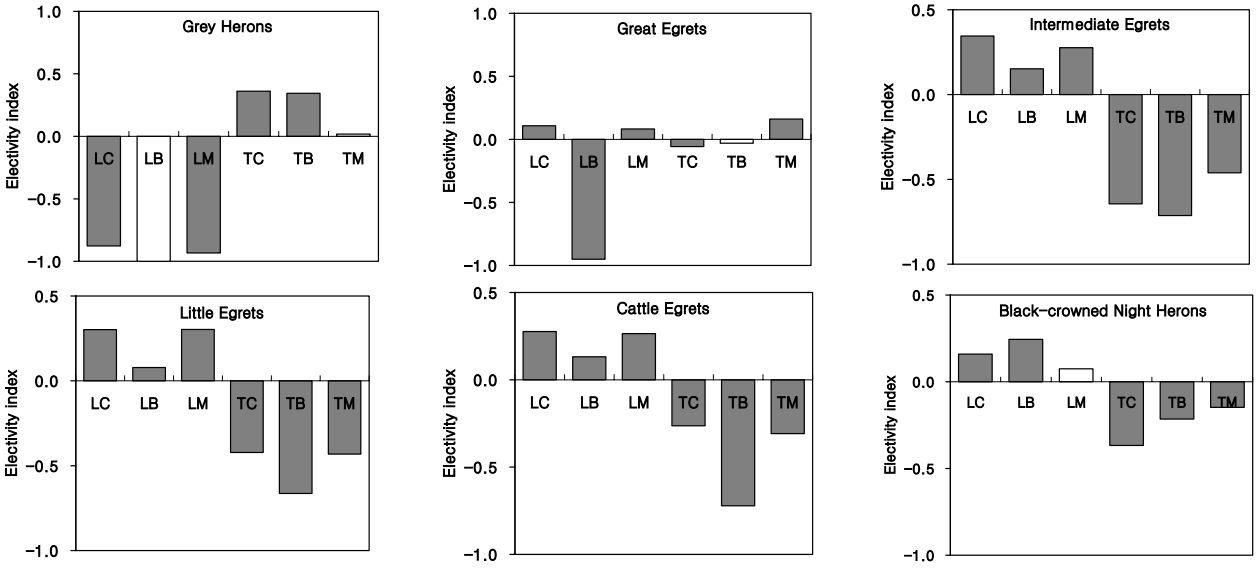

Figure 1. Preference by the nesting Ardeidae for six vegetation types. Dark grey columns indicate significant preference (values > 0) or avoidance (values < 0) for a given type, tested using Bonferroni confidence intervals. Vegetation types: LC, low coniferous; LB, low broadleaf; LM, low mixed; TC, tall coniferous; TB, tall broadleaf; TM, tall mixed.

showed the significant preference for LC, LB and LM types and the significant avoidance for TC, TB, and TM types (Fig. 1). Black-crowned Night Herons also used all vegetation types; they showed the significant preference for LC and LB types and avoided TC, TB and TM types significantly (Fig. 1). They also had some preference for LM type but not significant.

Ⅳ. Discussion

The presence and absence of species at a colony is probably depended on requirements of nesting sites of each species, although the availability of feeding areas nearby the colony is also an important factor. In the present study, the composition of nesting ardeid species at a colony was related to the canopy structure rather than the forest type. The largest species, Grey Herons selected dominantly on tall tree for their nest sites, whereas four smaller species (Intermediate, Little, and Cattle Egrets, and Black-crowned Night Herons) chose the forest with low canopy heights. Great Egrets nested evenly both low and tall canopy type, though of more slightly on forests with low canopy. Of six vegetation types shown by the present study, Grey Herons had the strong preference on tall coniferous and tall broadleaf type but had strong avoidance on low coniferous and low mixed type. On the contrary, smaller species had the reverse pattern: they had significant preferences on three low vegetation types but avoidance on three tall vegetation types. This suggested that there was the resource partitioning for nest site selection among ardeid species. Burger(1979) inferred that where there are physiognomic differences in the vegetation, heron species use these differences to select nest sites. In colonies with the homogenous canopy structure (either tall or low), the tall vegetation colony was occupied primarily by larger species while the low vegetation colony was occupied by smaller species. This finding was more obvious in heterogeneous colonies. The Grey Heron nest located entirely in one subarea of tall vegetation within a heterogeneous colony; most of smaller species nested in other subarea of low vegetation. Possibly, the nest concentration of smaller ardeids on low vegetation

probably is associated with Grey Herons. Grey Herons were the earliest breeding species in Korea: they arrived and nested in early March but other ardeids arrived after late March or April. Because the upper levels was occupied and saturated by early-breeding Grey Herons (Fasola and Alieri, 1992; Avaş, 2008), the late-arriving smaller ardeids arriving lately might be forced to nest in low vegetation nearby or to establish a new colony site.

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