Nest Site Selection and Breeding Success by Cattle Egret and Little Egret in Amroha, Uttar Pradesh, India

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Abstract.—The breeding success of the Cattle Egret (*Bubulcus ibis*) and Little Egret (*Egretta garzetta*) was studied in relation to nest site selection. Average nest abundance for the Cattle Egret was 0.045 ± 0.041 (95% CI) nests.m^{-3} of canopy volume, and 0.026 ± 0.019 (95% CI) $nests^{-1}$ $volume^{3}$ of canopy volume for the Little Egret. Total estimated population size was 882 nesting pairs (Cattle Egrets = 550; Little Egrets = 332). Cattle Egrets occupied higher trees for nesting than Little Egrets. Both species nested above the middle of the nesting trees. The clutch size of Cattle Egrets averaged 3.03 eggs whereas mean clutch size of Little Egrets was 3.22 eggs. A higher hatching success in the Cattle Egret than in the Little Egret suggested a relationship between nest selection and hatching success. *Received 25 November 2002, accepted 7 May 2003.*

Key words.—Nest site selection, colony size, nest densities, clutch size, incubation period, hatching success and chick survival.

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Although different species of herons vary in their habitat preferences, diet and behavior, they have certain common fundamental requirements for nesting (Hafner 2000). A good nesting site generally provides protection against predators, offers adequate stability and materials to support and construct the nest, and there is access to adequate feeding areas within foraging range (Thompson 1977; Beaver *et al.* 1980; Hafner and Brittin 1983; Gibbs *et al.* 1987; Hafner *et al.* 1987; Hafner and Fasola 1992; Hafner 2000). Further, the nest site also promotes hatching success (Ludwig *et al.* 1985) and successful rearing of young, which is important for survival of individuals and the species (Buckley and Buckley 1980).

Studies pertaining to nest site selection by the Cattle Egret (*Bubulcus ibis*) and Little Egret (*Egretta garzetta*) (Arendt and Arendt 1988; Kazantzidis *et al.* 1996; Hilaluddin *et al.* com. b) and its affect on breeding success (Hafner 1977; Kazantzidis *et al.* 1997) have been conducted but factors governing breeding success vary between the regions. However, data on the breeding success of the two species remain fragmentary across the world and is lacking in India although they breed throughout the country. Further, apparent loss of nesting sites (woodlands to agriculture, and wetlands to urbanization and industrialization) in Amroha may compel the two species to utilize alternate nesting habitats, which in long run may affect their abundance. We, therefore, conducted this study with the aims of determining nest site selection and breeding success of the Cattle Egret and Little Egret.

STUDY AREA AND METHODS

The study area is located 131 km Northwest of Delhi between 28°26' and 29°26'N longitude and 78°04' and 78°39'E latitude and falls under Biogeographic Province 7A of India (Rodgers and Panwar 1988).

We studied an active nesting colony at the Railway Station, Amroha from late May to end of August 2001. Most nesting trees in the colony were within a 300 m radius, and nesting pairs were thus close enough to interact socially among themselves. An active nest was one that contained at least one egg or nestling in it. We sampled 882 nests on 20 trees belonging to seven species.

The nests in the colony were counted in mid June whereas observations on breeding biology were initiated with the onset of nesting period between 26 May and 30 August. The number of breeding pairs of Cattle Egrets and Little Egrets were estimated following tally counts (Copper *et al.* 1982).

Nesting trees were identified to species and were measured for their structural features specifically bole height, girth at breast height, canopy diameter and canopy height. The canopy shape of each tree was also recorded. In addition, canopy of each nesting tree was divided vertically into three equal parts (top, middle and lower) and horizontally into two equal halves (inner and outer), thus each tree providing a total of six canopy portions for nest counts. The number of nests of each species was counted separately within each part of the canopy for each nesting tree.

The nests in selected parts of the colony were checked every week with binoculars from vantage points from the beginning of egg laying. We marked a total of 52 nests (Cattle Egret = 29; Little Egret = 23), by small numbered labels placed below nests. All these nests were near or above the roofs of an adjoining Mosque and the Municipal Tax Collection Post, from where we made observations. We recorded number of eggs and hatchlings[1] nest and number of chicks surviving in each nest until they were approximately 15 days old.

Data Analysis

The canopy spread i.e., vertical proportion of canopy onto ground of each nesting tree, was computed following Muller-Dombois and Ellenburg (1974), whereas canopy volumes of nesting trees were calculated using standard algebraic notions. The nest abundance i.e., number of nests.m^{-3} of canopy volume of each species was calculated separately for each nesting tree. The data were pooled together for the colony for estimating mean abundance of each nesting species.

We examined the relationship between number of nests and distances from the top of the tree and the ground. Comparisons of the location of nests of the two species were made using t-tests. Statistical differences in clutch size percentage of hatching success and percentage fledgling survival[1] nest were investigated using chi square test.

All statistical tests were performed following Dytham (1999). All the variables (where appropriate) were transformed using standardization transformation due to normalize the distributions (Zar 1984).

RESULTS

Colony Size

We estimated a mean of 0.045 ± 0.041 (95% CI) nests.m^{-3} of canopy volume for Cattle Egrets and average 0.026 ± 0.019 (95% CI) nests[1].m^{-3} for the Little Egret. Total estimated colony size was 882 nesting pairs (Cattle Egret = 550; Little Egret = 32).

Nest Site Selection

Cattle Egrets used higher trees for nesting (mean 10.69 m ± 1.38 m, 95% CI) than Little Egrets (mean 8.34 m ± 1.37 m, 95% CI) and the differences in the height usage by the two were statistically significant (t_{23} = 3.35, P < 0.001). Both species nested above the middle of the trees (Cattle Egret t_{16} = 3.86, P < 0.001; Little Egret t_7 = 2.42, n.s.), having greater mean distances from the ground than from the top of the trees.

A majority of nests of both species were found on *Ficus benjamina* (40%) followed by *F. glomerata* (29%) and *F. religosa* (10%). Several nests were also positioned on *Mangifera indica* (10%) and *Pithecellobium dulce* (10%) and occasionally on *Azadirachta indica* and *Delonix regia* (1%). With the exception of *Eucalyptus* species, Cattle Egrets used all the available tree species in the locality whereas Little Egrets nested exclusively on *Ficus benjamina*, *F. glomerata*, *F. religosa* and *Pithecellobium dulce*.

Clutch Size and Brood Size

The mean clutch size of the Cattle Egret was lower than the Little Egret (Table 1) in Amroha, with the majority (76%) of nests containing three or fewer eggs. Thirty nine percent clutches of Little Egrets contained more than four eggs, 39% with three eggs and 22% with two or one eggs. Clutch size (χ^2_1 = 46.8, P < 0.001), % hatching success (χ^2_1 = 41.2, P < 0.001) and % chick survival per nest (χ^2_1 = 80.8, P < 0.001) of the two species varied significantly between the species.

The period of nest construction lasted for 9 days. In both species, eggs were incubated by both parents. The mean incubation peri-

Table 1. Average breeding success by Cattle Egret and Little Egret in Amroha.

Species	Clutch size	Eggs hatched	Survival[1] nest
Cattle Egret (N = 29)	3.03 (88)*	2.48 (72, 82)**	1.93 (56, 78)***
Little Egret (N = 23)	3.22 (74)*	2.21 (51, 69)**	1.74 (40, 78)***

*Number of eggs after clutch completion.
**Number of eggs hatched (first number) and % survival (second number).
***Numbers of nestlings at approximate age 15 days (first number) and % survival from them (second number).

od of the Cattle Egret was 23 days and 21 days for the Little Egret. The fledglings were seen in the nests until they were 15 days old, and their parents fed them during this period.

DISCUSSION

The nest abundance of both species derived from our study cannot be directly compared to other studies conducted elsewhere. Here, the abundance index is based on number of nests per unit volume of tree canopy rather numbers per unit geographical area as used in previous studies (e.g., Kazantzidis *et al.* 1997). This approach provides a more realistic view of the available resources and thus is a better indicator of nest abundance. With some shortcomings (Hilaluddin *et al.* com. a), our method serves as an appropriate way of assessing the abundance index and establishing the status of nesting ardeids in an area.

Our data indicated that *Ficus* species is one of the main criteria for nest site selection. Although vegetation structure is an important criteria for the choice of a specific nesting site among ardeids (Baxer 1994; Subramanya 1996), the presence of large *Ficus* trees within one km of wetlands (presumably suitable foraging areas) is important in nest site selection by the two species in Amroha (Hilaluddin *et al.* com. b).

Multiple species of ardeids often vertically stratify the placement of their nests, with larger species nesting highest and smaller species nesting lowest (Burger 1982). In our study colony, nest building was initiated by Cattle Egrets who had the advantage of choosing from all the potential nest sites and the opportunity to occupy the ones most suitable. Perhaps saturation at upper canopy levels by early-breeding Cattle Egrets forced late-nesting Little Egrets to nest on lower portions of canopies in nesting trees. Our analysis, supported by field observations that late nesting Little Egrets placed nests on the upper parts of the smaller trees in the colony at a consistent height confirmed the findings by Naugle *et al.* (1996), that vertical and horizontal orientation of nests within a multi-species heronry may be a function of timing of nest initiation, nest abundance in different areas of the heronry and inter-specific and intra-specific competition.

The mean clutch size of Cattle Egrets in Amroha was higher than reported by McKilligan (1.5 eggs; 1990) and Jha and Sarkar (2.2 eggs; 2000). Previous workers (Singh and Sodhi 1985; Ali and Ripley 1987; Singh *et al.* 1988) found clutch size of the Cattle Egret to be 3-5 eggs per nest, but we also recorded six eggs in a nest. The mean clutch size of Little Egrets in our study area was conspicuously lower than the recorded 4.9 eggs (Inoue 1985), 4.7 eggs (Tsahalidis 1990), 4.1 eggs (Kazantzidis *et al.* 1996), 4.3 eggs (Kazantzidis *et al.* 1997) and 3.80 eggs (Bennetts *et al.* 2000). Similarly, hatching success was lower than reported by Kazantzidis *et al.* (77%; 1997) whereas chick survival percentage[1] nest was similar to their findings (76%). Although clutch size in birds is often dependent on the age of the parents, with younger parents laying smaller number of eggs (Coulson 1966; Klomp 1970; Coulson and Porter 1985) and territory quality (Mogstedt 1980), clutch size of Little Egrets depends on the quality of diet and the body condition of the female (Hafner *et al.* 1994). The chick survival is presumably dependent on the quality of diet, mainly during the peak of their development period (Kazantzidis *et al.* 1996).

Our data indicated a higher hatching success among Cattle Egrets as compared to Little Egrets, supporting a relationship between nest site selection and hatching success. Although nest site selection affects breeding performance in several species (Coulson 1968; Hafner 1977; Ludwig *et al.* 1985; Bosch and Sol 1998; Larison *et al.* 2001), some studies suggest that breeding success may be independent of nest site (Hustler and Howells 1989; Ferguson 1994; Harris *et al.* 1997; Kazantzidis *et al.* 1997). Nest site selection confers selective advantages on breeding birds by making use of the best available areas in terms of abundant food supply and minimizing predation pressures (Perrins and Birkhead 1983) while raising the brood, which is advantageous for the survival of individuals and species.

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