NOTE BRÈVE

BREEDING PRODUCTIVITY OF EGRETS AND HERONS AT SIX SITES IN ASIA

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RÉSUMÉ. — *Productivité des aigrettes et hérons nicheurs en six sites asiatiques*. — La production, la taille des œufs et les conditions corporelles des poussins ont été étudiées chez le Héron garde-bœufs (*Bubulcus ibis*), l'Aigrette intermédiaire (*Egretta intermedia*), l'Aigrette garzette (*Egretta garzetta*), le Crabier chinois (*Ardeola bacchus*) et le Bihoreau gris (*Nycticorax nycticorax*) en deux sites de Chine centrale et dans quatre autres au Pakistan. La production en Chine s'est avérée très forte, plus importante qu'au Pakistan, probablement en relation avec une grande disponibilité de zones humides pour l'alimentation. La forme sombre de l'Aigrette garzette de la côte du Pakistan présentait une productivité significativement plus faible que celle des formes blanches.

Abundant data exist on breeding productivity of several species of Ardeinae for Europe and for America (Rubolini & Fasola, in press), whereas scanty information is available for continental Asia, where breeding was studied only in Israel (Askenazi & Yom-Tov, 1997) and at a few other sites (Longsheng *et al.,* 1994; Lizhi *et al.,* 1998; Hilaluddin, 2003). Almost unknown are the breeding parameters of some species, such as the Chinese Pond Heron *Ardeola bacchus* (no detailed study known to us) and the Intermediate Egret *Egretta intermedia* (only studied by Baxter, 1994 and Maddock & Baxter, 1991 in Australia; and by Morel & Morel, 1961 in Senegal).

We aim to fill this gap by describing the breeding productivity of five Ardeinae, Chinese Pond Heron, Intermediate Egret, Cattle Egret (*Bubulcus ibis*), Little Egret (*Egretta garzetta*), and Black-crowned Night Heron *(Nycticorax nycticorax*), at two sites in Central China on the border of Poyang Lake and of Tai Lake, and at four sites in Pakistan, the inland agricultural areas near Multan, near Lahore, and near the Taunsa barrage on the River Indus, and the coastal area near Karachi.

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Still unclear is the species or subspecies status of the Little Egret morphs, the nominate *garzetta*, and the *dimorpha*, *gularis*, and *schistacea*. Some authors identify the dark egrets breeding on the Indian Ocean coast as a separate species, the Western Reef Heron (*Egretta schistacea*), while we consider all the white and dark morphs as belonging to a single polymorphic species (Hafner *et al.,* 2002), and we designate the dark egrets studied at Karachi as Little Egret, dark morph *Egretta garzetta schistacea*.

We studied breeding productivity as part of a research on egrets as monitors of environmental contamination. The level of persistent contaminants, both organic and inorganic, was found to be low at the areas studied both in China and in Pakistan, and well below the levels that may affect egret reproduction (Boncompagni *et al.,* 2003; Sanpera *et al.,* 2003; Zhang *et al.,* 2006). China holds very large numbers of several species of egrets and herons (Fasola *et al.,* 2004), while in Pakistan the most abundant species is the Cattle Egret.

STUDY AREAS

We studied a sample of nests at one colony, usually the largest, at each of the following six areas (Fig.1).

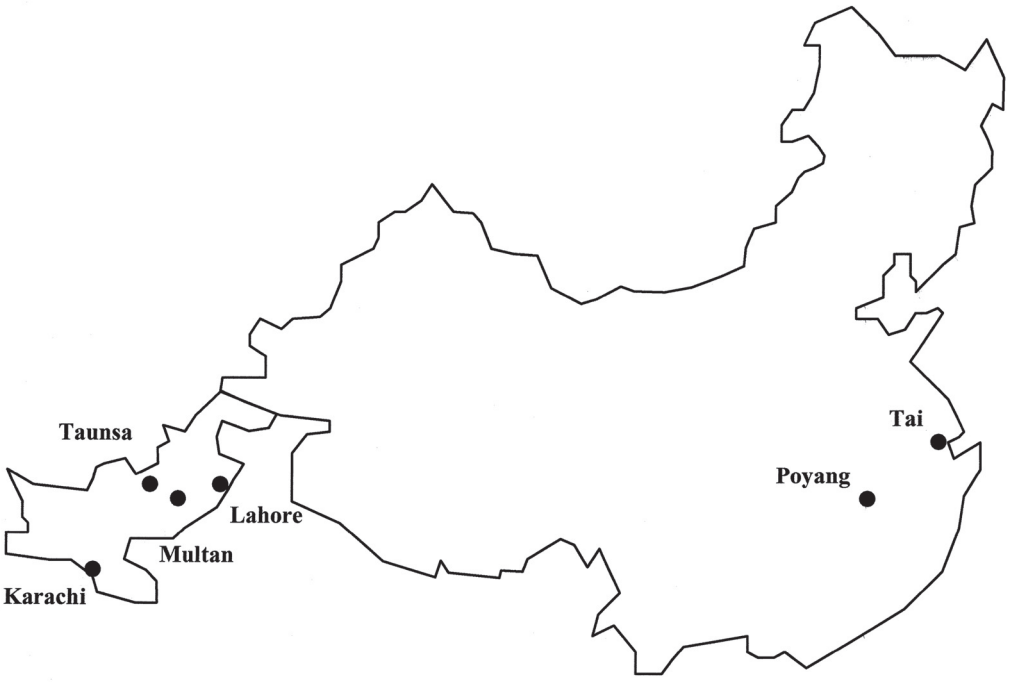

Figure1. — The six study areas in Pakistan and China.

(1) Poyang Lake, Jiangxi Province, the largest freshwater lake (3283 km^2), still in a near-natural state, and the most important site for waterfowl in China. From 15 May to 10 June 1999, we studied a heronry located in a mixed wood near Gongqing (29°13'N, 115°49'E), with 580 nests of Little Egret, 165 of Intermediate Egret, 50 of Great White Egret, 420 of Cattle Egret, 70 of Chinese Pond Heron, and 715 of Black-crowned Night Heron. Breeding of the Black-crowned Night Heron was already described for a subset of these nests (Fasola *et al.,* 2001).

(2) Tai Lake, Jiangsu Province, one of the largest freshwater lakes in China (2425 km^2), located in a highly productive agricultural area, with rice fields over 90% of farmed land. From 20 April to 10 June 2000, we studied a very large colony in the Yuantouzhu Park (31°31'N, 120°13'E) near Wuxi. The colony stretched over several hectares within a large woodland, and included 30,100 nests of Black-crowned Night Heron, 4,200 of Little Egret, 1,000 of Chinese Pond Heron, and 1,100 of Cattle Egret.

(3) Taunsa Barrage, Punjab, a storage reservoir behind a barrage on the River Indus in Pakistan. Adjacent areas are cultivated with cotton, sugar cane, wheat, and the barrage is used also for power generation. From 5 May and 15 June 2000, we studied a heronry placed 5 km west of the barrage (30°42'N, 70°50'E), with 26 nests of Little Egret, 22 of Intermediate Egret, 305 of Cattle Egret, and 15 of Black-crowned Night Heron.

(4) Multan agricultural areas, Punjab Province in Pakistan, with mango orchard, wheat, fodder, cotton and rice. From 20 May to 15 June 2002, we studied a colony on acacias along a canal near Sardarpur (30°32'N, 71°45'E), 60 km North of Multan and about 1 km from River Indus, with 1500 nests of Cattle Egrets.

(5) Lahore, Punjab in Pakistan, an area from 31°47' to 32°33'N and from 73°42' to 74°35'E, cultivated mainly with rice, wheat and fodder. Three heronries with hundreds of nests of Cattle Egrets, at sites called Rehman, Rajanpur, and Chack Bhulian-Nordwal Rd, were studied from 2 June to 19 July 2003.

(6) Karachi Harbor, Sind Province in Pakistan, an area of tidal creeks, mangroves and intertidal mudflats, around the harbor of Karachi. From 3 to 30 May 2000, we studied a heronry in the Ghas Bunder lagoon (24°47'N, 67°11'E), with 115 nests of Little Egret, all dark morphs, 20 nests of Intermediate Egret, and 10 nests of Indian Pond Heron *Ardeola grayii*.

METHODS

We aimed to sample at least 20 nests per species at the peak of the reproductive period, but scarce species permitted only smaller samples. In order to avoid disturbing the breeding birds, we sampled the nests that were relatively accessible amid the intricate vegetation of the colonies, and those placed from 3 to 6m above ground. We had no evidence that the sample nests were biased for any feature related to their productivity. Nest content was checked at least twice per week to ascertain the number of eggs, hatched chicks, and "fledged" chicks. The chicks cannot be tracked after about 20 days old, therefore the number "fledged" refers to the number surviving at 20 days, a measure commonly employed in heron nesting productivity studies, and that approaches the final fledging productivity, since most mortality occurs during the first 20 days (Bennetts *et al.,* 2000). The nests that failed completely were not included in the calculations.

For a sub-sample of nests, we measured egg diameters. When the oldest chick was 20 days old, tarsus length and body mass were measured for each chick. Since tarsus length depends mainly on age, except in cases of severe malnutrition, while mass is largely influenced by the amount of food received, the mass in relation to tarsus length reliably indicates chick condition (Jacobs, 1996; Fasola, 1998). A "condition index" was calculated for each chick as ratio between its mass and its tarsus length.

The differences among sites within each species, were tested using non-parametric Kruskal-Wallis test for non-continuous variables (i.e. number of eggs, number hatched, and number fledged), and univariate ANOVA for the other data (i.e. egg size, condition index) that were normally distributed. When a significant difference was found among sites, Bonferroni post-hoc tests were performed for both normal and non-continuous variables, in order to identify the pairs of sites that contributed to the difference.

RESULTS

The breeding productivity (Table I) showed few significant differences among areas within a species, in the following cases. In the Cattle Egret, both the number hatched, and the number fledged differed (Kruskal-Wallis, $\chi_2^2 = 14.3$, $P = 0.01$, and $\chi_2^2 = 11.9$, $P = 0.03$, respectively) and particularly they were lower in Multan than at Taunsa and Poyang. In the Little Egret, all the variables differed among areas, (number of eggs: $\chi_3^2 = 48.3$, $P = 0.0001$; number hatched: $\chi_2^2 = 14.5$, $P = 0.001$; number fledged: $\chi_3^2 = 18.9$, $P = 0.0001$). These differences for Little Egret were due to a much lower productivity of the dark morph in Karachi than at the two sites in China (post-hoc tests). In general, there was a constant tendency for the breeding productivity to be higher, and similar, at the two Chinese sites, Poyang and Tai, than at the three Pakistani sites.

TABLE I

*Egg and nestling production, as number of nests recorded for the five egret and heron species at the six study areas. Little Egrets at Karachi belonged to the dark morph. The figures that differ significantly (P<.01) from the values for the other areas within the same species, are marked by **

			Number / nest							
			1	2	3	4	5	6	7	Mean
Eggs										
	Cattle Egret	Poyang	0	0	4	3	3	0	0	3.90
		Multan	0	1	25	44	10	3	0	3.87
		Tounsa	0	1	30	26	6	1	0	3.63
		Lahore	1	12	55	93	33	5	1	3.82
	Intermediate Egret	Poyang	0	1	7	6	5	0	0	3.79
		Tounsa	0	1	6	1	0	0	0	3.00
	Little Egret	Poyang	0	1	4	18	33	7	0	4.65
		Tai	0	1	6	15	36	25	2	4.99
		Tounsa	0	0	3	1	2	0	0	3.83
		Karachi	0	3	10	17	3	0	0	* 3.61
	Chinese Pond Heron	Poyang	0	0	0	1	0	1	0	5.00
		Tai	0	0	0	2	3	1	0	4.83
	Black-crowned Night	Poyang	0	0	9	4	1	0	0	3.43
	Heron	Tai	0	17	116	94	7	0	1	3.40
Hatched										
	Cattle Egret	Poyang	0	2	2	4	1	0	0	3.44
		Multan	7	34	21	4	1	0	0	* 2.37
		Tounsa	1	12	14	9	0	0	0	2.86
		Lahore	9	20	22	6	0	0	0	2.44
	Intermediate Egret	Poyang	0	3	8	8	1	0	0	3.35
		Tounsa	2	1	2	0	0	0	0	2.00
	Little Egret	Poyang	0	5	7	22	24	0	0	4.12
		Tounsa	0	1	0	0	1	0	0	3.50
		Karachi	2	4	6	5	1	0	0	* 2.94
	Chinese Pond Heron	Poyang	0	0	1	1	0	0	0	3.50
	Black-crowned Night Heron	Poyang	0	0	12	3	0	0	0	3.20
Fledged										
	Cattle Egret	Poyang	0	2	1	2	1	0	0	3.33
		Multan	15	32	17	2	1	0	0	* 2.13
		Tounsa	4	11	10	9	0	0	0	2.71
		Lahore	11	22	20	6	0	0	0	2.36
	Intermediate Egret	Poyang	0	5	9	3	1	0	0	3.00
		Tounsa	1	1	1	0	0	0	0	2.00
	Little Egret	Poyang	1	5	13	24	11	0	0	3.72
		Tai	0	5	15	13	26	8	1	4.30
		Tounsa	0	1	1	0	0	0	0	2.50
		Karachi	2	2	5	3	1	0	0	* 2.92
	Chinese Pond Heron	Poyang	0	0	1	1	0	0	0	3.50
		Tai	0	0	1	2	2	0	0	4.20
	Black-crowned Night	Poyang	0	1	10	1	0	0	0	3.00
	Heron	Tai	14	41	73	38	2	0	0	2.84

Egg size (Table II) did not differ among sites within a species. The "condition index" of the chicks, that could be compared between sites for the Little Egret only, differed among sites ($F = 47.2$, d.f. 3, 265, $P < 0.0001$), due only to the dark morph in Karachi, where the ratio between mass and tarsus length averaged 5.7, and was higher than at the other three sites, where the averages ranged from 4.1 to 4.5.

TABLE II

Length and width of eggs for the five species in the six study areas. Each entry is: mean value (standard deviation, minimum-maximum, sample size).

Species	Study area	Length (mm)				Width (mm)			
Cattle Egret	Tounsa	44.5	(2.4,	40.9-48.8,	10)	34.1	(0.6,	32.9-34.7,	10)
	Lahore	43.6	(1.9,	41.0-50.0,	30)	33.5	(1.3,	32.0-36.0,	30)
Intermediate Egret	Poyang	45.9	(0.4,	45.6-46.3,	2)	33.2	(0.5,	32.7-33.7,	2)
Little Egret	Poyang	44.1	(1.8,	38.8-48.6,	38)	32.5	(0.8,	30.9-34.1,	38)
	Tai	44.5	(2.0,	40.6-48.1,	13)	32.2	(1.1,	30.0-33.5,	13)
	Tounsa	44.4	(0.9,	43.2-45.7,	4)	32.5	(0.7,	32.0-33.8,	4)
Black-crowned Night Heron	Tai	46.9	(2.9,	38.3-52.3,	41)	33.9	(2.2,	25.3-38.6,	41)

DISCUSSION

The higher breeding productivity of Cattle and Little Egrets at the two Chinese sites, Poyang and Tai, than in Pakistan could be generally related to the larger availability of foraging habitats in China, where wet habitats were very widespread. Actually, the productivity of Cattle Egret, Little Egret, and Black-crowned Night Heron in China was at the top end of the range of values recorded in various parts of their range, while their productivity in Pakistan ranged among mean values (review by Rubolini & Fasola, in press). This high productivity suggests that no adverse agent (e.g. contaminants, Boncompagni *et al.,* 2003; Sanpera *et al.,* 2003) affected reproduction, and that breeding conditions (e.g. food availability) are very good.

The dark morph of the Little Egret in Karachi differed from the other, white morphs we studied, in chick condition, and breeding productivity, although some differences could be due to habitat since the dark morph was the only coastal population we studied.

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