

# Nesting ecology of the Painted Stork *Mycteria leucocephala* at Sultanpur National Park, Haryana, India

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The Painted Stork *Mycteria leucocephala* is a prominent species of Indian heronries and wetlands. Given that this stork is listed as Near Threatened (BirdLife International 2001), it is worrying that its nesting ecology, especially the factors affecting nesting success, is poorly understood. While a relationship between rainfall and nesting intensity has long been known (e.g. Ali and Ripley 1987), this has not been investigated in detail. Previous observations have also indicated that many more individuals are present at colonies at the beginning of the breeding season than actually breed (Ali and Vijayan 1983), but this phenomenon has not been investigated further. To address these issues, we studied reproductive output, causes of nest failure, the number of adults in nesting colonies, and factors associated with yearly variation in nesting densities of the Painted Stork at Sultanpur National Park (henceforth Sultanpur), in Haryana, India.

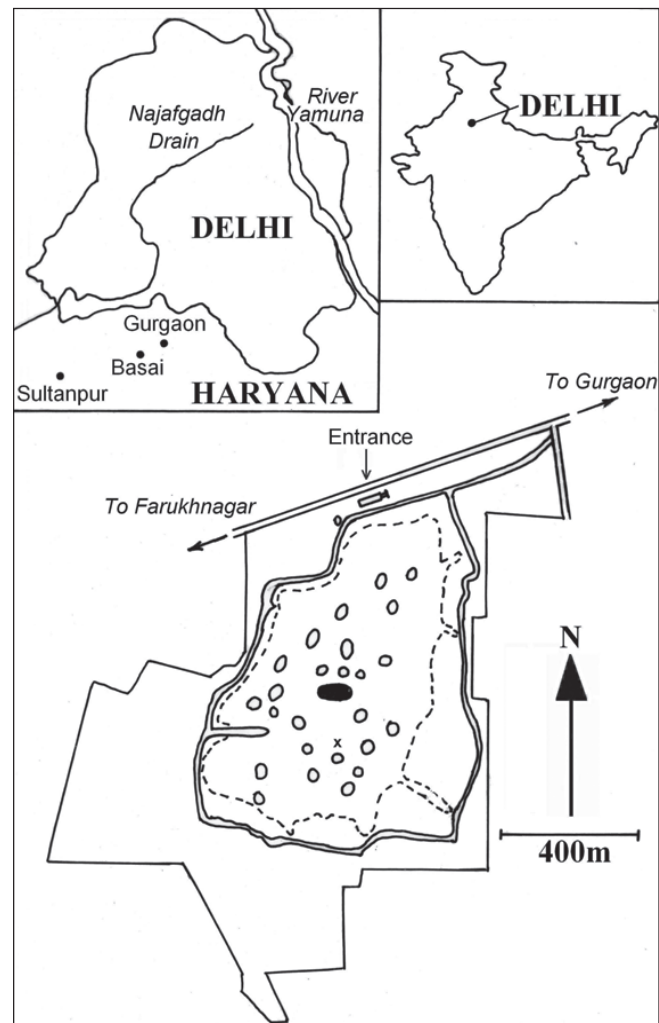
## STUDY SITE

Sultanpur (28°28'N 76°53'E, c.25 km south-east of Delhi) is located in a predominantly agricultural landscape, crisscrossed by irrigation canals (Fig. 1). The national park covers an area of 13,727 ha (Islam and Rahmani 2004) and includes as its core c.143 ha of low-lying marshes, which were notified as a bird sanctuary by the Haryana state government in 1971 (Kalpavriksh 1994). The dominant terrestrial vegetation in this area consists of trees of *Prosopis juliflora*, *Acacia nilotica*, *Tamarindus indica* and *Azadirachta indica*, and grasses such as *Vetiveria zizanioides* and *Erianthus ravennae*. Plants recorded in the marshy areas of the park include submerged vegetation such as *Vallisneria natans* and *Ceratophyllum demersum*, emergents such as *Typha angustata*, *Saccharum munja* and *Cyperus rotundus*, and surface vegetation such as *Nymphaea stellata*, *N. nouchali* and *Ipomoea reptans* (Kalpavriksh 1994). As a part of its management policy, the park authorities embarked upon a tree plantation programme during the 1980s. Several mounds were created in the lake and *Acacia nilotica* trees planted on them. There are now about 50 islands, including one large island (c.100×40 m) in the centre of the marsh (Fig. 1). Painted Storks nest on this island and on some smaller islands with canopy diameter <10 m, together with Indian Cormorant *Phalacrocorax fuscicollis*, Cattle Egret *Bubulcus ibis*, Black-crowned Night Heron *Nycticorax nycticorax*, Black-headed Ibis *Threskiornis melanocephalus* and Asian Openbill *Anastomus oscitans* (Urfi *et al.* 2005a).

## METHODS

We visited Sultanpur once each in October and November 2002, and on an average of once per fortnight from August

2003 to December 2005. Painted Storks visit Sultanpur to breed between August and January and are typically absent in other months. We recorded the arrival date of Painted Storks each year by consulting park staff. Roost counts were made between 17h00 and 19h00, using binoculars (7×50) and a telescope (15×). A sample of nests (Table 1) was monitored on a regular basis during 2004–2005 from an elevated spot, approximately 50 m from the south-eastern edge of the heronry (Fig. 1). The nests were located on subsequent occasions by



**Figure 1.** Map of Sultanpur National Park Haryana, India. Detailed observations of the main heronry (black oblong) were made from a point due south (marked 'x'). The solid single line indicates the park boundary, the double line indicates paths, the dotted line denotes the edge of the marsh, and small circles represent islands. The top left inset shows the location of Sultanpur in relation to Delhi and the Najafgadh drain. The smaller inset (right) shows the location of Delhi within India.

**Table 1.** Dates of arrival and nesting, and nesting intensity of Painted Stork at Sultanpur National Park, Haryana, India, during 2002–2005.

Year	First arrival	First eggs	Last eggs	No. colonies	No. nests
2002	-	-	-	1	26
2003	20 Aug	1 Sept	5 Nov	5	96
2004	28 Aug	12 Sept	17 Oct	1	57
2005	8 Aug	17 Aug	8 Nov	2	79

identification marks in their vicinity, including the shape of branches and the number of neighbouring nests. To assist repeated identification of pre-selected nests on successive visits, rough sketches were made from photographs and used for reference in the field.

The dates when first eggs were laid were determined by direct observation (whenever possible) by ourselves or park staff. Clutch size was taken as the number of eggs in a nest after the last egg had been laid. Percent hatching success for each nest was calculated as the number of eggs that hatched divided by the clutch size (Desai *et al.* 1977, Coulter and Bryan 1995). We followed the procedure used by Desai *et al.* (1977) for calculating percent nesting success by dividing the number of chicks fledged in a nest by its clutch size. We noted instances of egg or chick loss in all nests in view, including the sample nests described above. Each chick that was observed to be attacked by a raptor was placed in one of the three age categories (1–30 days, 30–45 days and >45 days) determined by its morphology and plumage, following Shah and Desai (1975). Data on rainfall patterns were obtained from the Indian Meteorological Department, Delhi. Monsoon rainfall was taken as the sum of rainfall (in mm) recorded at Delhi from June to September. We used linear regression to investigate the relationship between monsoon rainfall and number of nests built each year.

During the period of their residence in Sultanpur, Painted Storks make foraging flights out of the park and their numbers in the park are highly variable at different hours of the day (Urfi *et al.* 2005b). However, the storks return to roost in the park, so we made evening counts, which we assume included both individuals of all nesting pairs. Nesting activity continued until November (in 2005). In order to examine seasonal differences we classified nests built in August and September as ‘early’ and those built in October and November as ‘late’. We tested for differences in clutch size between early and late nesters using two-tailed t-tests. Statistical analyses were carried out in Minitab (version 11.0). Summary statistics are presented as mean  $\pm$  SE.

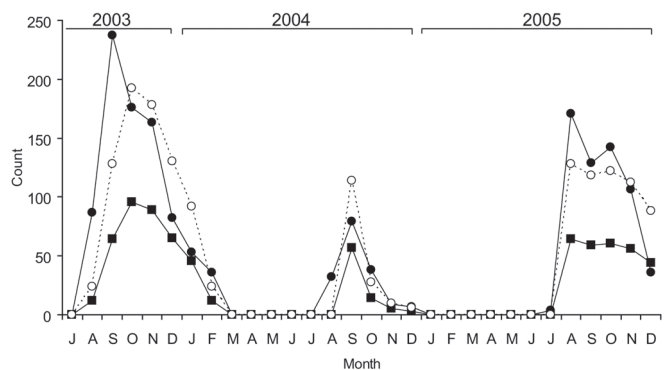
## RESULTS

The average arrival date of the first Painted Stork at Sultanpur during 2003–2005 was 18 August and the first eggs were laid between 17 August and 23 September (Table 1). While most nests were built in the main heronry on the largest island, a few (15 in 2003 and four in 2005) were built on the smaller islands nearby. During the course of a day, Painted Storks were observed flying in and out of the park, especially in the direction of the Najafgadh drain, which is located 6 km north of Sultanpur (Fig. 1) and has a number of associated marshes. However, we

were unable to confirm whether these marshes were indeed the main foraging destination for the storks.

Linear regression analysis revealed a positive, although non-significant relationship between the number of nests built in a year and the total rainfall (in mm) during the monsoon (slope =  $0.079 \pm 0.024$ ,  $N=4$ ,  $r^2=0.8174$ , NS).

In September 2002, 2003 and 2005, the number of adult storks present at Sultanpur was, respectively, 28%, 19% and 8% greater than would be expected from the nest counts (assuming each active nest is occupied by a monogamous breeding pair; Fig. 2). This suggests that non-breeding individuals were present in the colony in the initial phase of nesting. However, this pattern was not observed in 2004, possibly because many birds abandoned their nests and left Sultanpur early in the season owing to a sudden shortage of water in the park that year (Saxena 2004).



**Figure 2.** Monthly counts of adults (●) and active nests (■) of Painted Stork, plus expected number of adults (○) based on the number of nests at Sultanpur National Park during 2003–2005. Note that in 2004 the birds abandoned nesting owing to changes in the water levels in the park (see text).

## Nesting success

The modal clutch size for all months and years combined was two (range 1–4). The frequency of different clutch sizes was approximately normally distributed (Kolmogorov-Smirnov tests; early season 2004:  $P>0.15$ ,  $N=25$ ; 2005:  $P>0.15$ ,  $N=32$ ; late clutches 2005:  $P>0.15$ ,  $N=8$ ). Early nests had significantly larger clutch sizes in 2005 (early nests: mean =  $2.03 \pm 0.15$ ,  $N=32$  nests; late nests: mean =  $1.37 \pm 0.18$ ,  $N=8$  nests;  $t=2.81$ ,  $P=0.012$ ). The mean clutch size for early nests in 2004 and 2005 was  $2.04 \pm 0.17$ ,  $N=25$  nests and  $2.03 \pm 0.15$ ,  $N=32$  nests, respectively ( $t=0.04$ ,  $P=0.97$ ).

In October 2004, 18 marked nests with eggs were found abandoned. The eggs ( $n=37$ ) in these nests were presumably predated by House Crows *Corvus splendens* after abandonment. It is likely that nest abandonment was brought about by a sudden shortage of water in the park which happened because the Haryana Urban Development Authority cut off the water supply to the park (Saxena 2004). In October 2004 and September 2005, we recorded at least 12 cases in seven active nests of egg predation by House Crows, indicating that this species can be a major predator of Painted Stork eggs. In addition, nine eggs were found lying unattended in five nests in 2005, but the reason for these instances of nest failure could not be ascertained. During 2004–2005, eight chicks in eight different nests were observed being predated by Greater Spotted Eagles *Aquila clanga*. Of

these, three chicks were <30 days old, two were 30–45 days old and three were >45 days old. During the same period Eurasian Marsh Harriers *Circus aeruginosus* were observed to prey upon seven nestlings (all <30 days old) in six nests. In addition, ten chicks in 2005 were found dead from unknown causes between 11 September and 3 December 2005. There were other, minor, causes of egg and chick loss: in one case, an egg was observed to roll off the nest during the course of a territorial fight between two adults, and in another, an egg rolled out of its nest following a strong gust of wind. The mean hatching success in 2004 ( $27 \pm 8.8\%$ ,  $N=25$  nests) was significantly lower than in 2005 ( $65 \pm 6.9\%$ ,  $N=32$  nests;  $t=3.38$ ,  $P=0.001$ ), with nesting success showing a similar pattern ( $9.0 \pm 5.3\%$ ,  $N=25$  nests in 2004;  $46 \pm 7.4\%$ ,  $N=32$  nests in 2005;  $t=4.09$ ,  $P<0.001$ ).

## DISCUSSION

Painted Storks were first observed breeding in Sultanpur in 1993, when 40 nesting pairs were found (Poole 1994). Thereafter, their nesting here was sporadic, until around 2000, after which it occurred annually. The arrival dates at the colony and the nest initiation dates are similar to those reported for this species nesting in the wild within the premises of Delhi zoo (Desai *et al.* 1977). Painted Storks congregate at Sultanpur only during the nesting season, and they are absent from this site during the rest of the year. A similar pattern has been observed at Delhi zoo (Urfi 1997) and Keoladeo Ghana National Park, Bharatpur (Ali and Vijayan 1983).

Rainfall during the breeding season might be expected to explain annual variation in nesting intensity (i.e. number of nests), because monsoon rains produce high food abundance and create safe nesting islands by flooding surrounding lower-lying areas (Urfi 1998). We found a positive but non-significant relationship between rainfall and nesting intensity, so this requires further study.

We observed that more birds are present at the colony at the beginning of the season than would be expected from the number of nests. In seabirds, non-breeding individuals, both immature and adult, may be permanent residents within a colony, defending territories, constructing rudimentary nests and even assisting in raising young (Kharitonov and Siegel-Causey 1988). In many colonial waterbirds, the nesting site may also serve as a roosting site, so the occurrence of additional individuals may be coincidental or related to opportunities for obtaining food while chicks in the colony are being fed (Burger 1981). However, Painted Storks congregate only during the nesting period, so this explanation is unlikely. The extra individuals could be helpers, perhaps genetically related to the nesting pair (Skutch 1976), they could be individuals attempting to enhance their fitness through extra-pair copulations (Westneat *et al.* 1990), or they could breed in polygynous trios as has been recorded in 7.7% of Cattle Egret nests in one study (Fujioka 1986). Further studies on Painted Storks using marked birds are necessary to examine these possibilities.

We found that early nests had larger clutches than late nests in at least one year (2005). Such a difference has also been recorded in other birds (McNeil and Leger 1987), and may arise because low-quality individuals

breed later or because later nests are dominated by smaller replacement clutches. The average hatching success reported for Painted Stork at Delhi zoo during 1966–1971 was 68% (Desai *et al.* 1977), which is higher than our estimates at Sultanpur (27% in 2004 and 65% in 2005). The nesting success at Sultanpur (9% in 2004 and 46% in 2005) was also lower than that recorded at Delhi zoo (34–54%). Predation by raptors, particularly *Aquila* spp. eagles, is a major factor responsible for chick loss at north Indian heronries (Naoroji 1990, Sundar 2005) and may explain the greater nestling losses here compared with Delhi zoo, where these predators are absent.

## CONSERVATION

Sultanpur is listed as an Important Bird Area (Islam and Rahmani 2004) and 322 bird species have been recorded from here (Harvey 2003). Other than at Delhi zoo, suitable nesting sites for Painted Stork are becoming scarce in the region. MacDonald (1962) described a nesting colony close to Faridabad (c.25 km south of Delhi), but this has probably disappeared. Another colony was recorded near Bijana village close to Sonapat, Haryana, in 1992, with about 40 active nests (Urfi 1993) but here too no nesting activity has been recorded during the last decade. These losses underscore the regional importance of the remaining sites at Delhi zoo and Sultanpur.

The nesting habitat at Sultanpur appears to be improving. The trees of the heronry have become larger and mature, and are now more effectively isolated by floodwater than they were in the past. However, several other issues are a matter of concern. Painted Storks and other heronry birds are strongly dependent on areas outside the national park for foraging, and there is considerable pressure on this land. In Gurgaon region, where Sultanpur is located, built-up areas increased dramatically between 1971 and 2002, leading to a reduction in open spaces, including agricultural lands, waterlogged areas and scrublands (Gupta and Nangia 2005). In the future, Sultanpur will become even more isolated by development and many of the prime foraging sites outside the park will most likely disappear. The original complex of marshes and wetlands, of which Sultanpur was a part, has already been lost (Gaston 1994). To safeguard Sultanpur and the nesting birds which it supports, steps need to be taken to curb the expansion of development in the areas around the park, especially in the buffer zone surrounding it. Field studies aimed at determining important foraging sites for the heronry birds of Sultanpur are required. There is also an urgent need to closely monitor these birds and to implement conservation action plans, for which volunteers and birdwatchers from Delhi and Haryana can be an asset.

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## White-winged Duck *Cairina* (= *Asarcornis*) *scutulata* and Blue-tailed Bee-eater *Merops philippinus*: two new country records for Bhutan

ANWARUDDIN CHOUDHURY

In this note I report the recent addition of two new species to the list of Bhutan’s avifauna.

WHITE-WINGED DUCK *Cairina* (= *Asarcornis*) *scutulata*  
This is an Endangered species (BirdLife International 2004), occurring from north-eastern India to Indonesia (Green 1992, Choudhury 1996, 2000, BirdLife International 2001). In north-eastern India, it is mainly known from the rainforests of eastern Assam (Ali and

Ripley 1987, Choudhury 2002). In Assam, the bird has not been recorded from areas close to the India-Bhutan international boundary. The nearest record was from near Barpeta (c.26°25'N 91°02'E, c.50 km south of the nearest point on India-Bhutan international boundary) in 1886 by Stuart Baker (Green 1992). It is resident in its range across South-East Asia with some local movement depending on water conditions (Choudhury 2000, BirdLife International 2001).