Aspects of the breeding biology of Abdim's Stork *Ciconia abdimii* in Nigeria

by Samuel T. IVANDE[1,2], Shiiwua A. MANU[2], Zingfa J. WALA[2,3], Joseph D. ONOJA[2] & Talatu TENDE[2,4]

[1]School of Biology, University of St Andrews, Bute Building, St Andrews, Fife KY16 9TS, U.K. <sti2@st-andrews.ac.uk>
[2]A.P. Leventis Ornithological Research Institute, University of Jos Biological Conservatory, P.O. Box 13404, Laminga, Jos, Nigeria
[3]Animal Demography Unit, Zoology Department, University of Cape Town, Rondebosch 7701, Cape Town, South Africa
[4]Department of Biology, Lund University, Sweden

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Summary

Breeding distribution, arrival dates, nesting tree preferences, incubation and fledging periods, and clutch and brood sizes of Abdim's Stork *Ciconia abdimii* in Nigeria are described based on data collected during a study from 28 April to 19 August 2010. Earliest laying dates were at the end of March to early April, with fledging dates from mid- to late July. Nesting materials, average clutch size (2.7 ± 0.11 eggs, n = 57 nests) and brood size (2.47 ± 0.07 chicks, n = 76 nests) of this population were similar to those of other populations studied in West Africa. A population of at least 538 birds was estimated for the 77 villages searched in Adamawa, Bauchi and Kano States, of which Abdim's Storks were found nesting in 53 villages. All nests in the areas searched were in villages. Baobabs *Adansonia digitata* appear to be a preferred nest-tree species out of 12 tree species used for nesting.

Résumé

Aspects de la biologie de la reproduction de la Cigogne d'Abdim *Ciconia abdimii* au Nigeria. Les zones de reproduction, les dates d'arrivée, les arbres préférés pour la nidification, les périodes de couvaison et des premiers envols, ainsi que le nombre d'œufs et de poussins de la Cigogne d'Abdim au Nigeria sont décrits sur la base de données collectées au cours d'une étude effectuée du 28 avril au 19 août 2010. Les dates des premières pontes se situaient de fin mars à début avril, avec les premiers envols de poussins de mi-juillet à fin juillet. Les matériaux pour la construction du nid, la taille moyenne de la

nichée (2.7 ± 0.11 œufs, n = 57 nids) et le nombre moyen de poussins (2.47 ± 0.07 poussins, n = 76 nids) de cette population étaient similaires à ceux d'autres populations étudiées en Afrique de l'Ouest. Une population d'au moins 538 oiseaux a été estimée pour les 77 villages étudiés dans les Etats de l'Adamawa, Bauchi et Kano, parmi lesquels des Cigognes d'Abdim ont été observées nichant dans 53 villages. Tous les nids des zones étudiées se trouvaient dans des villages. Le Baobab *Adansonia digitata* parait être l'arbre préféré de nidification, parmi 12 espèces d'arbres utilisés.

Introduction

Abdim's Stork *Ciconia abdimii* is an intra-African trans-equatorial migrant, breeding during rainy seasons in many human settlements across the Sahel (Brown *et al.* 1982). It arrives on its West African breeding grounds between March and April, breeds between May and August, then moves south at the onset of the dry season (Brown *et al.* 1982, Borrow & Demey 2004). Its arthropod prey also becomes abundant with the rains (del Hoyo *et al.* 1992), which makes it a potentially suitable species to investigate seasonal changes in behaviour and possible effects of the changing climate on this behaviour. Its migratory strategy has led African tribesmen to use it as an indicator of rainfall, where it is welcomed as the "harbinger of rains" (Brown *et al.* 1982). In northern Nigeria, where the species is a common breeding visitor, local farmers have planned their agricultural calendars according to its seasonal movements (Ezealor 2002). Despite its importance to African people and the opportunities it presents for climatic studies, data on its population size and general behaviour are still limited in West Africa and especially in Nigeria. In West Africa, study of the species has been carried out in Benin (Adjakpa 2000) and Niger (Christensen *et al.* 2008, Petersen *et al*. 2008).

The A.P Leventis Ornithological Research Institute (APLORI) has attempted the first large scale distributional survey of this species in northern Nigeria, as the start of a long-term study to understand the effect of the changing climate on its ecology. This article presents findings from the survey, which was carried out from 28 Apr to 19 Aug 2010.

Methods

Surveys were carried out in seven states in northern Nigeria: Adamawa, Bauchi, Gombe, Kano, Sokoto, Taraba and Zamfara States (Fig. 1). These states, mostly within the Sahel and Sudan savannah ecological zones, occur between 9° and 13°N and 4° and 13°E. Mean annual rainfall in the region ranges between 400 and 1000 mm during the wet season (May–Sep) with heaviest rainfall in August. Temperature ranges from 12 to 36°C in the dry season and 18–43°C in the rainy season.

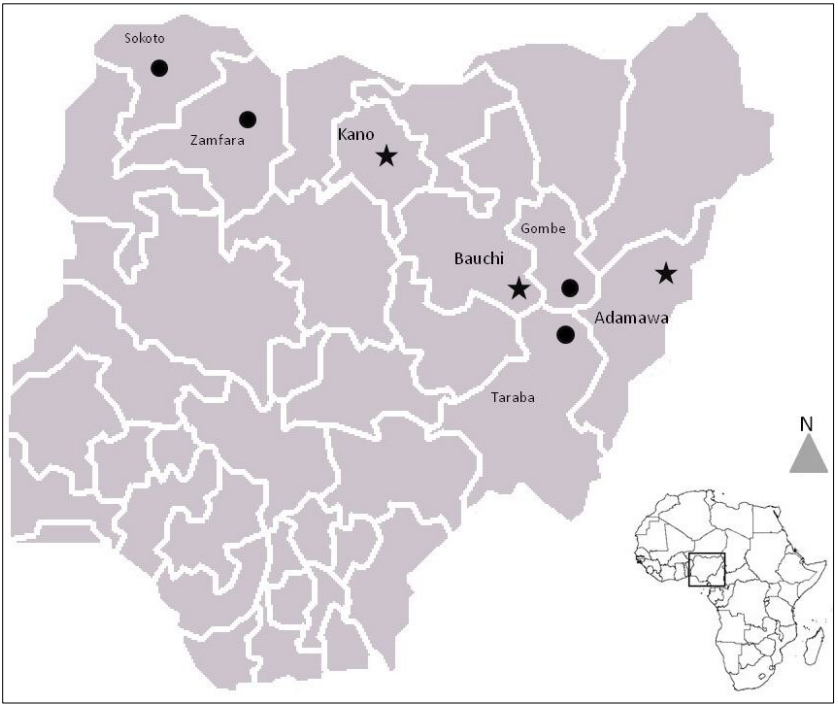

Figure 1. Map of Nigeria showing states visited during the survey. Stars = extensive survey in at least one Local Government Area; dots = casual surveys.

Extensive surveys were carried out in one Local Government Area (LGA) in each of Adamawa, Bauchi and Kano States, including: three survey visits to Alkaleri LGA in Bauchi State from 29 Apr to 2 May, 26–29 May and 29 Jun to 6 Jul 2010; two survey visits to Fufore LGA, Adamawa State, 19–21 Jul and 16–19 Aug 2010; one survey visit to Rano LGA in Kano State on 9–10 Jun 2010. On the first survey visit to these states, a systematic search of villages was carried out by driving along major routes in the area. We stopped at every village along the route to record numbers of Abdim's Storks and nests, nest contents and characteristics of nesting trees. Geographical coordinates of all trees where Abdim's Storks' nests were seen were taken with a Garmin 60 GPS so that nests could be re-located in areas where more than one survey visit was made, *i.e.* Adamawa and Bauchi States. Casual surveys (without stops to observe nests) were done in Gombe, Sokoto, Taraba and Zamfara States during this phase of the project. We also looked for nests outside villages as we drove between them, and although we did not search woodlands between villages,

we believe that we would have detected some nests outside villages had there been many.

All trees where Abdim's Stork nests were seen were identified to species. They were climbed with a ladder and the nests were observed for general structure, nesting materials and contents. Frequency of use of such tree species for nesting, tree height, and diameter at breast height (DBH) estimated by eye to the nearest 1 metre were recorded. Permission was sought from the village head in order to climb any trees.

The number of home clusters in each village was estimated in order to group villages into settlement size categories and hence investigate the relationships between settlement size and number of birds and nests. Villages were classed as small (1–30 houses) and large (> 30 houses). Whether the tree was fenced in within a home or not was also recorded, to assess birds' preferences for nesting on trees within home settlements and if this provided protection. We assessed local knowledge and beliefs about the species via unstructured interviews with local people.

The breeding population was estimated from the number of nests counted, where each active nest represents a breeding pair. Information on breeding phenology was estimated by comparing our observations of breeding Abdim's Storks in Bauchi State on the three visits there, with breeding observations reported by Bigalke (1974 *in* Brown *et al*. 1982) and Adjakpa (2000). Mean clutch size was calculated from clutch sizes recorded during the survey period preceding first observation of chicks. Mean brood size was estimated from data collected on the subsequent visit. This is when the highest number of chicks was observed. A Mann-Whitney test was used to compare the average number of nests per tree in small and large villages and between trees that were fenced in or not. Means are given ± S.E.

Results

Breeding phenology, clutch and brood size

A total of 188 nests was recorded from all villages visited in Bauchi State from 29 Apr to 2 May 2010. The contents of 88 (47 %) of these nests were recorded, of which 57 (65 %) contained 1–4 eggs (mean 2.7 ± 0.11). Eggs were mostly white, sometimes looking stained and with light brown spots. No chicks were found during this survey visit and the earliest possible date for the start of incubation in Bauchi State in 2010, calculated by subtracting a 28–30 day incubation period (Bigalke 1974, Adjakpa 2000) from the date of our earliest visit (29 Apr to 2 May), must therefore have been between the last week in March and the first week of April.

Our second survey, 26–29 May (27–30 days later), revealed that 80 % of the eggs had hatched and brood size was 2.47 ± 0.07 chicks (n = 76 nests). Based on the descripttion in Brown *et al*. (1982) we estimate that the chicks were a few days to about two weeks old at the most (see Fig. 2 A-D). Assuming a 50–60 day fledging period (Brown *et al*. 1982) we therefore estimate fledging dates to be sometime between mid- and late July.

Figure 2. Abdims Stork chicks observed in Bauchi State, Nigeria, 26–29 May 2010. A–B: chicks probably up to a couple of days old. C–D: more developed chicks, probably 7–15 days old.

The third survey visit to Bauchi State (29 Jun to 6 Jul, 30–36 days after the second visit) was earlier than the estimated fledging dates, and the chicks observed were more developed. We observed two failed flight attempts by chicks during this visit and, on both occasions, the chicks were picked up and returned to the nests. Flights that were more successful were observed during a later visit to breeding colonies in Adamawa State (19–21 Jul), when on sighting climbers some young birds made short flights from the nest to nearby trees and returned to their nests later. About 90 % of 80 nests were empty when we visited Adamawa State 16–19 Aug, and we assume that most of the chicks had fledged.

Breeding distribution and population size

Abdim's Storks were sighted in all the seven states visited during this survey (Fig. 1). In Adamawa, Bauchi and Kano States, of 77 villages searched, breeding was observed in 53 (69 %) in Fufore and Alkaleri LGAs (Adamawa and Bauchi States respectively), in none in Rano LGA (Kano State). In the 53 villages, 269 nests with breeding evidence were recorded. Taking each nest to represent a breeding pair, we estimate a

breeding population of at least 538 individuals for this area. However, we directly counted *c*. 412 birds as we drove through villages, including birds seen in flight, perched on trees, foraging or gathering nesting materials on the ground. The highest number of Abdim's Storks seen at one time was a group of *c.* 86 soaring birds in Adamawa State. A group of *c.* 56 birds was also recorded in Bauchi State, where we estimated an average group size of 7.6 birds. We counted only four birds in the 12 villages surveyed in Rano LGA, where local reports suggest fewer Abdim's Storks in this area than about 15 years ago.

Nesting tree characteristics and other nest observations

The 269 Abdim's Stork nests observed were on a total of 144 trees belonging to 12 species. The average tree height and DBH irrespective of tree species were 19.5 ± 0.57 m and 1.1 ± 0.06 m respectively (Table 1). The most common tree for nesting was Baobab *Adansonia digitata* with 91 records (63 %), probably because it has large branches providing adequate support for the nests. The nests on other tree species mostly occurred in villages with few or no Baobab trees.

Table 1. Tree species used for nesting and their characteristics.

	N trees (% of total)	Mean height (m)	Mean DBH (m)
Adansonia digitata	91 (63)	18.1	1.3
Azadirachta indica	18 (12)	23.4	0.7
Borassus aethiopum	13 (9)	24.9	0.4
Ficus sp.	5 (3)	17.6	0.8
Parkia clappertoniana	4 (3)	19.3	0.7
Prosopis africana	3 (2)	11.3	-
Tamarindus indica	3 (2)	23.0	1.3
Mangifera indica	2 (1)	28.0	1.5
Acacia albizioides	1 (1)	12.0	0.3
Gmelina arborea	1 (1)	20.0	0.2
Khaya senegalensis	1 (1)	28.0	2.3
Vitellaria paradoxa	1 (1)	24.0	0.8
Unidentified dead tree	1 (1)	-	-

Nests were usually built with dry sticks and grasses (Fig. 3A). The twigs were piled together and usually supported in portions of the tree where many branches formed multi-forked and cupped hollows that provided good support for the nests (see Fig. 3A). A few birds were seen collecting twigs for nest repairs and building, and locals reported cases where such materials were taken from conspecifics or other species. In some villages, Abdim's Stork nests were observed on trees where White-billed Buffalo Weaver *Bubalornis albirostris* nests also occurred. Locals reported that

Abdim's Storks take twigs from these nests when they breed and these materials are reclaimed by the Buffalo Weavers when they also return to breed. Other materials including pieces of clothes and rags, sacks, polythene bags and in one case, human hairs, were also observed to make up nesting materials (see Fig. 3 B–D).

Figure 3. Nest building and nesting materials in Abdim's Storks in Nigeria. A: a breeding pair still building with dry twigs and grass. B: nest with rags. C: nest with hair. D: nest with PVC bag and rags.

Anthropogenic associations and possible threats

All colonies and trees with Abdim's Stork nest were recorded within villages and settlements or at the outskirts, and interviews with villagers indicated that birds were hardly ever found nesting outside villages. Out of the 33 villages where breeding activity was evident in Alkaleri, 23 were small settlements while another ten were large. Although on average there were more nests and birds per tree in larger settlements, these differences were not significant (Mann Whitney tests: $Z = -1.3$, $P = 0.21$ and $Z = -1.4$, $P = 0.15$ respectively). There was also no significant difference in the average number of nests per tree irrespective of whether trees were fenced in or not (Mann Whitney test: $Z = -0.6$, $P = 0.56$).

Residents of Duguri Village (Bauchi State) reported a case of unintentional poisoning of storks leading to mass mortality in the breeding season preceding our survey, after storks fed on insects in farmlands where pesticides had been used. Only a single breeding pair was recorded in this village where residents claimed > 20 pairs had bred in the previous year. In one village in Rano LGA, a pair that had consistently bred there was reportedly last seen about five years previously when one of the pair was shot. We also observed a wind storm destroy a nest in a village in Bauchi State although this nest was reconstructed on our next visit.

Discussion

Many of the breeding parameters of the population we studied were similar to those of other populations of the species. Nest materials observed by us are consistently reported for this species (Brown *et al*. 1982). Similar clutch sizes were reported by Brown *et al.* (1982) (1–3 eggs, mean 2.2, maximum 3, n = 16 nests), Adjakpa (2000) (1–5, mean 3.2) and Christensesn *et al*. (2008) (1–4, mean 2.78, n = 36). Our estimated start date of incubation, late March to early April, is comparable with dates for populations in the far north of Benin (Adjakpa 2000), at about the same latitudes (*i.e*. 10–12°N), where rainfall pattern is similar. Populations in Niger however start incubation later, around early May (Christensen *et al.* 2008), probably because of their more northerly latitudes with the corresponding later start of rainfall.

The average size of groups of Abdim's Storks in Bauchi State (7.6) is lower than that of not less than ten birds reported previously (Brown *et al.* 1982, Hoyo *et al.* 1992). Foraging densities of *c.* 80–90 Abdim Storks per ha have also been estimated in Kano State (Amatobi *et al*. 1987).

Various factors, including habitat degradation for urban development, agricultural activities, overgrazing and reduced food availability due to pesticides might have caused population declines in this species. Given the agrarian nature of most surveyed villages, a possible decline due to pesticides deserves further investigation. Other threats reported by Adjakpa (2000) include hunting of birds for meat, egg removal, and destruction of nests and nesting trees during violent storms. These were observed and reported in some of the villages we surveyed. Although some of our results may appear to indicate a declining Abdim's Stork population, our survey is not sufficient or extensive enough to be sure. Abdim's Stork populations have not been well studied in Nigeria and we hope that as this project continues, more informed conclusions will be made about population status and dynamics of the species in Nigeria.

The association of this bird with humans was evident as all records of the birds were within human settlements, with more nests and birds recorded in the larger villages. The slightly higher number of nests observed on trees fenced within compounds rather than outside also seems to suggest that this association with humans may be of some benefit to the species.

The association between Abdim's Stork and Baobabs may be partly due to the fact that Baobabs are common, gregarious and widespread in the savannas of Nigeria, and are often planted and protected by people, so often associated with human settlements (Keay *et al.* 1960, Arbonnier 2004). They and the storks thus both enjoy some form of protection in this area. Also, the other nest-tree species often appeared freshly trimmed and the locals reported that such trees, especially Neem *Azadirachta indica*, were trimmed regularly, in most cases for firewood and fencing material. This is likely to disturb any bird that may be breeding or intending to breed in such trees and may reduce their attractiveness for the storks. The species is reported to reuse nests repeatedly (not necessarily by the same pair) and we hope to confirm nest fidelity from tagged storks in the next phase of this project.

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References

ADJAKPA, J. (2000) The breeding biology of Abdim's Storks *Ciconia abdimii* in the far north of Benin. *Ostrich* 71: 61–63.

AMATOBI, C.I., APEJI, S.A. & OYIDI, O. (1987) Effect of some insectivorous birds on populations of grasshoppers (Orthoptera) in Kano State, Nigeria. *Samaru J. Agric. Res.* 5: 43–50.

ARBONNIER, M. (2004) *Trees, Shrubs and Lianas of West African Dry Zones*. CIRAD MAGRAF, Paris.

BORROW, N & DEMEY, R. (2004) *Birds of Western Africa*. Christopher Helm, London.

BROWN, L.H., URBAN, E.K. & NEWMAN, K. (eds) (1982) *The Birds of Africa*, vol. 1. Academic Press, London.

CHRISTENSEN, K.D., FALK, K., JENSEN, F.P. & PETERSEN B.S. (2008) Abdim's Stork *Ciconia abdimii* in Niger: population size, breeding ecology and home range. *Ostrich* 79: 177–185.

EZEALOR, A.U. (ed.) (2002) *Critical Sites for Biodiversity Conservation in Nigeria*. Nigerian Conservation Foundation, Lagos.

HOYO, J. DEL, ELLIOT, A. & SARGATAL, J. (eds) (1992) *Handbook of the Birds of the World*, vol. 1. Lynx, Barcelona.

KEAY, R.W.J., ONOCHIE, C.F.A. & STANFIELD, D.P. (1960) *Nigerian Trees*, vol. 1. Federal Department of Forest Research, Ibadan.