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Breeding requirements of Nahan's Francolin, *Francolinus nahan*, in Budongo forest reserve, Uganda

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Abstract

The Nahan's Francolin *Francolinus nahani* is a globally threatened species associated with remnant forests of the eastern equatorial lowlands of the Democratic Republic of the Congo and Uganda. We studied the species in the Budongo Forest Reserve during March 1998 to January 2000 in an attempt to document some aspects of breeding requirements. We located nests by physically searching the forest and through following radio-tagged adults. We measured demographical and habitat parameters associated with each nest. Our data suggest that trees of large diameter at breast height with appropriate buttress formation are important for long-time survival of Nahan's Francolins.

Key words: Budongo Forest, Nahan's Francolin, nesting

Résumé

Le francolin de Nahan *Francolinus nahani* est une espèce menacée au niveau mondial qui est liée à des forêts résiduelles dans les plaines équatoriales de l'est de la République Démocratique du Congo et d'Ouganda. Nous avons étudié cette espèce de mars 1998 à janvier 2000 dans la Réserve forestière de Budongo pour tenter de documenter certains aspects de ses exigences en matière de reproduction. Nous avons localisé des nids en fouillant la forêt et en suivant des adultes équipés de radio-émetteurs. Nous avons mesuré des paramètres démographiques et de l'habitat associés à chaque nid. Nos données laissent penser que les arbres qui ont un grand diamètre dbh avec une formation de soutien appropriée sont importants pour la survie des francolins de Nahan à long terme.

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Introduction

The breeding biology of francolins has not been well studied. Urban, Keith & Fry (1986) in their general review of the African francolins only documented the developments of downy chicks for seventeen francolin species. The breeding ecology of Swierstra's Francolin *Francolinus swierstai* is virtually unknown, yet it is a globally threatened species (Birdlife International, 2008a). Nahan's Francolin *Francolinus nahani* is a forest species (Bennun, Dranzoa & Pomeroy, 1996) only found in a few forests in Uganda and the Democratic Republic of Congo. Prior to this study, only three nests of Nahan's Francolin had been described (Urban *et al.*, 1986; Plumptre, 1996a). Being a globally endangered species (Birdlife International, 2008b), the conservation of the Nahan's Francolin is a global priority. Knowledge on the breeding requirements of the Nahan's Francolin is essential in designing appropriate conservation and monitoring measures.

This study's main aim was to document the breeding requirements of Nahan's Francolin. The specific objectives were to:

1 Determine nesting microhabitats.
2 Identify nesting trees.
3 Determine incubation behaviour.
4 Determine the breeding season of Nahan's francolin.

Methods of study

This study was carried out in Budongo Forest Reserve in three compartments: the unlogged Nature Reserve (777 ha), the once-logged compartment between 1947 and 1952 (620 ha) and the twice logged compartment between 1963–1964 and 1996–1997 (1116 ha) (Fig. 1).

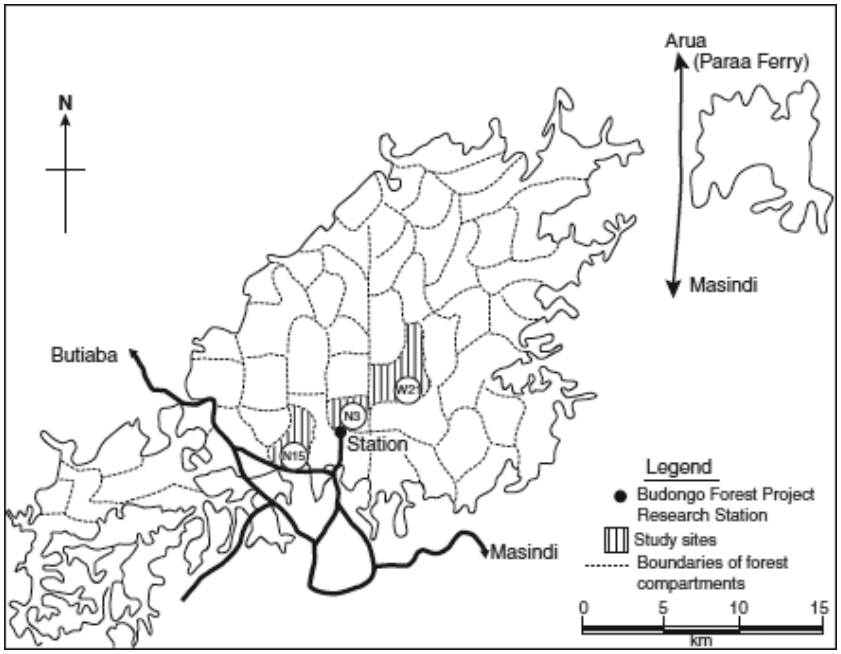

Fig 1 Map of Budongo Forest Reserve showing the sites where the study was performed: the unlogged compartment (N15), the once logged compartment (N3) and the twice logged compartment (W21)

The breeding requirements of the Nahan's Francolin were studied by a combination of locating nests by means of physical nest searches and monitoring radio-tagged adults.

Systematic and opportunistic nest searching

Existing transects measuring 8 km long were randomly selected from each of the three study compartments. Systematic searches were carried out once every month for 10 months, from March to December 1998. We then reduced the transect length by half and searched once every month for another 12 months. The buttressed trees located within 50×8 km transects were searched for Nahan's Francolin nests.

During the study, when moving in the study sites and while monitoring the radio-tagged birds, we checked the potential breeding sites for nests. Nests, recorded using this method, were regarded to have been found through opportunistic searching.

Monitoring Radio-tagged individuals

Nahan's Francolins were located by the use of playback (Sande, Dranzoa & Wegge, 2001a) and were trapped using a mist-net. One 18-m mist-net would be set along the trail perpendicular to the direction from where the birds were responding. The cassette would then be played about 10 m from the mist-net in the direction of about 180° from where the birds responded to attract them towards the playback and trap them as they tried to cross the net.

Radio transmitters that weighed 9 g (about 3% of the bird's body weight), with frequencies ranging from 150.5 to 151.0 MHZ were attached to the birds using a harness (backpack) with cords passing round the base of the wings without meeting ventrally (Kenward, 1987). The radio-tagged birds were released from where they were trapped and were followed using a Telonix receiver and a three element Vagi antenna.

Nesting trees and their preference

All tree species where nests were found were identified, their diameter at breast height (dbh) and the distance from the nest to the nearest trail measured. Taking the nest tree to be the centre, all those trees within a radius of 10 m and of ~14 em dbh (the size of the smallest nesting tree recorded) were identified and their dbh measured. This approach addressed the question whether specific tree species of size classes were preferred or not.

Results

Overall, 40 and 20 ha were searched monthly in the 10 months of 1998 and the subsequent 12 months in

1999 respectively. In this period, a total of 58 nests were recorded; 40 by searching and 18 by radio tracking.

Nesting microhabitats

Nahan's Francolin used four microhabitats: buttresses, holes, crevices and on the open ground. Nest crevices were defined as those nests found in cavities in tree trunks about 0.3–0.4 m above the ground (n = 3), while the nest holes were defined as those in ground cavities located about 0.1 m underground (n = 1). All the other nests were found between buttresses. The number of nests found between buttresses and other microhabitats using searching and radio tracking is shown in Fig. 2. There were no differences in nest microhabitats found using searches and radio telemetry ($\chi^2 = 2.4$, 2 df, $P = 0.3$).

Nest site characteristics

Sampling was carried out at 58 nesting sites that were used as tree sampling plots. All tree species whose buttresses were used as nest sites by the Nahan's Francolin are shown in Table 1. The five most common nest trees were *Cynometra alexandrii*, *Alstonia boonei*, *Celtis zenkeri*, *C. durandii* and *C. mildbraedii*. Forty percentage of all the nests found (n = 58) and 50% of those found by radio tracking were in buttresses of *C. alexandrii*, although *C. mildbraedii* was the most abundant tree species in the area where sampling was carried out (Table 1, Fig. 3). The numbers of five commonly preferred tree species was significantly lower than what was available in the cumulative sampled area (about 1.5 ha) ($\chi^2 = 18.1$, 4 df, $P = 0.003$). On the basis of relative abundance of the nesting trees, *C. alexandrii* and *A. boonei* were used more than *C. zenkeri*, *C. durandii* and *C. mildbraedii*.

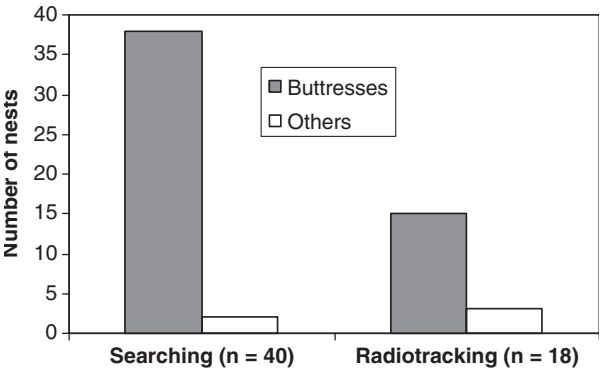

Fig 2 Nesting locations of Nahan's Francolin in Budongo Forest Reserve and the method by which they were discovered

Table 1 Tree species used by Nahan's Francolin as nesting sites in Budongo Forest Reserve

Tree species	No. trees used for nesting	Relative abundance[a]
Cynometra alexandrii	23	37
Celtis mildbraedii	6	52
Alstonia boonei	5	9
Celtis zenkeri	5	17
C. durandii	5	16
Ficus sur	3	3
Dead stump (crevices)	2	4
Sterculia dawei	1	1
Ficus varifolia	1	4
Khaya anthotheca	1	6
Trichilia dragaegiana	1	2
Total	53	151

[a]The total number of individuals of each species (dbh ~15 cm) that were available in the sampled area.

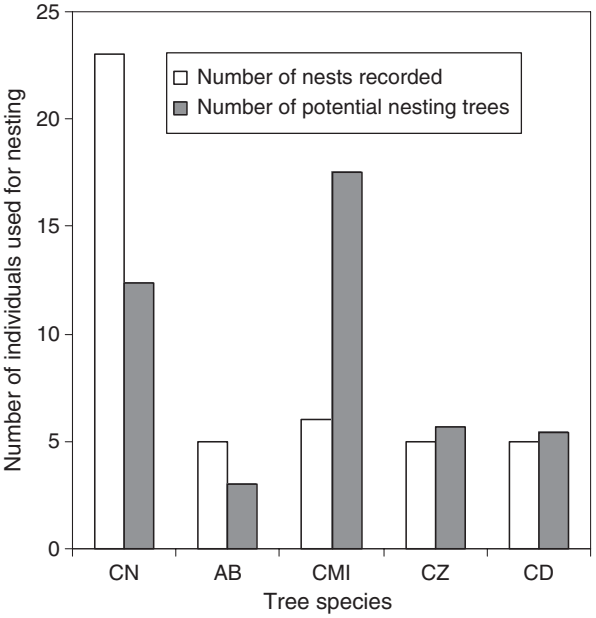

Fig 3 Trees most commonly used by Nahan's Francolin for breeding in Budongo Forest Reserve

The microhabitats preferred for egg laying were fairly open with less dense under-storey vegetation. Fifty percentage of all the nests were found <3 m from the

Table 2 Showing the radio-tracking periods, group sizes and nesting attempts of radio-tagged groups

Tag no.	Date tagged	Tracking period (months	No adults in group	No. adults tagged	No. young chicks in group	No. nesting attempts by the same individual	No. nests that succeeded
#34	7 September 1999	3.4	2	1		3	0
#55	8 May 1999	7.3	2	2		4	0
#83	28 September 1998	11.0	3	3		4	2
#85	7 Octber 1998	11.6	2	2	2	4	2
#87	20 July 1999	2.7	3	1	3	2	1
Total						17	5

nearest trail. The nest search and radio-tracking results did not yield any significant differences with respect to the distances from the trails ($\chi^2 = 7.0$, 5 df, $P = 0.18$).

The trees with dbh more than 50 cm were used for nesting more than those smaller trees ($\chi^2 = 88.0$, 5 df, $P < 0.001$). Trees with dbh classes 51–100, 101–150, 151–200 and >200 cm were commonly used compared with dbh class 15–50 cm. This implies that the birds preferred large trees for nesting. Fifty-four percentage of all the tree individuals used for nesting were more than 100 cm dbh, and 79% of these were *C. alexandrii* and *A. boonei.*

Incubation behaviour: Who incubates?

Five radio-tagged individuals attempted nesting more than once. Two of the attempts were after a successful breeding (because at least some chicks of the previous generation were still alive at the time of next nest initiation) and 15 were cases of re-nesting after nest failure (Table 2). At least four of the five nests of the radio-tagged individuals that succeeded were continuously monitored up to hatching and it was observed that only one individual incubated the eggs throughout the entire incubation period. A group that was radio-tracked for about 1 year attempted breeding four times and it was only the individual tagged #85 that incubated the eggs showing that only the female incubates.

Nest initiation

Nest initiation was defined as the time birds started incubating, and it was determined either by noting the dates when nesting individuals started incubating or by subtracting 27 days from the hatching date for nests where only the hatching dates were observed. (The incubation period of Nahan's Francolin had previously been found to be 27 days by Sande *et al.*, 2001b.) Figure 4 shows the proportion of nests initiated during 1999 in relation to the monthly rainfall totals. The largest proportion of nests was initiated in February (at the end of the dry season). The peaks of breeding were January to March, and then August to November. The intervals of successive normal nest initiations were about 5 months after a successful first attempt (n = 1) and 18 days (n = 2) after the eggs of the first attempt were lost.

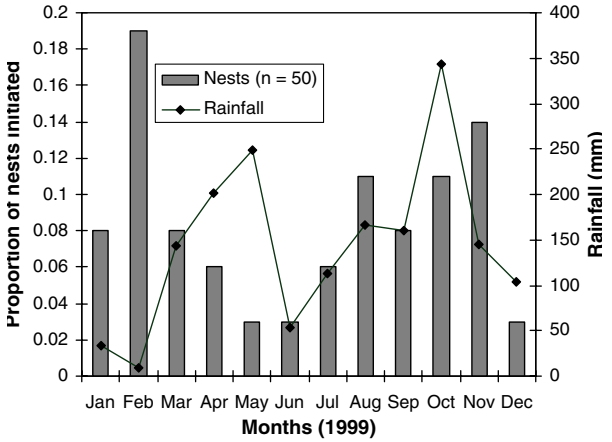

Fig 4 Months when nests were initiated with the respective amounts of rainfall received

Discussion

Nesting microhabitats

It was an interesting revelation to establish that Nahan's Francolin can nest in holes or underground depressions, in

crevices and on the bare ground away from trees although they commonly use buttresses. The fact that there were no differences between the numbers of nests found in the different microhabitats using nest searching and radio tracking indicated that we did not miss many nests hidden in crevices or under ground using the nest search method which we commonly used. With both nest searching and radio tracking, a high percentage of nests were found between buttresses which shows that maintenance of larger trees with buttresses is very important for the survival of Nahan's Francolin.

Nest trees

Celtis alexandrii was the most preferred nest tree species probably because the mature trees have large buttress roots which provided better nesting conditions. *Celtis alexandrii* was not harvested for timber in the 1940s (Plumptre, 1996b) in the logged compartments and many individuals that were treated with arboricides resisted dying. However, despite *C. mildbraedii* being more abundant than any of the five preferred species, it was used less frequently for nesting probably because its buttress roots were smaller than the other trees mentioned above. The fact that Nahan's Francolin preferred nesting in cleavages created by large trees with large buttresses explains the importance of a mature forest for the survival of the species.

Breeding season

The breeding data for 1998 and 1999 were not comparable because radio tracking in 1998 started in July, while it was carried out throughout the year in 1999. In addition to making it possible to see nests that are hidden or in unusual locations, radio tracking showed that at the peak of the breeding season, two females re-nested about 3 weeks after the predation of the previous ones. Thus, during the peak of the breeding season, one is able to discover more nests per individual female, which was the case in 1999. Intensive radio tracking in 1999 showed that nests were initiated throughout the year. Thus, we were not able to determine a distinct nesting season during this study, a subject which future studies should investigate.

Although Nahan's Francolin bred throughout 1999, data for only 1 year (50 nests) were probably not sufficient to determine the breeding season and to confirm that breeding occurs throughout the year. Many nests were initiated towards the end of a dry season probably as a strategy for the eggs to hatch in the beginning of rainy season when there is presumably more food for the chicks, especially arthropods. Potts (1986) quoted by Little & Crowe (1993) found that breeding in game-birds is timed to take advantage of a seasonal flush of arthropods although the theory needs to be tested with Nahan's Francolin.

Conclusions

The study has gone some steps towards understanding some aspects of the breeding requirements of the species and has demonstrated that Nahan's Francolin almost entirely relies on buttresses of large trees for breeding. Removal of large mature trees by the logging process (legal or illegal) reduces suitable nesting sites of Nahan's Francolin. Given the limited global distribution of Nahan's Francolin, logging should be discouraged to save the species.

More work is however still required on the breeding biology of Nahan's Francolin. As they can breed when they are six members in a group, there is need to study the natal relationship between the group members and assess their dispersal mechanism. The sexes and natal relationships can be determined by DNA analysis and the birds monitored for a long period of time. Monitoring a large number of individuals can generate useful information on breeding biology of Nahan's Francolin.

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