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Observations on the breeding behaviour of the Stripe-breasted tit (*Parus fasciiventer*) in Bwindi Impenetrable National Park, Uganda

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Abstract

The motivation of this study was to investigate some hitherto unknown information on the breeding ecology of the Stripe-breasted Tit (*Parus fasciiventer*) in Bwindi Impenetrable National Park, south-western Uganda. *Parus fasciiventer* is one of the least studied and endemic bird species restricted to the montane forests of the Albertine Rift. Regionally, it is classified as near-threatened. The study was carried out around the Institute of Tropical Forest Conservation Ruhija camp and the period of study was from January to June 2003. Data were generated through direct observation at the nest box sites of three active nests. Each of the nest boxes was monitored from the time of nest building to the time the chicks fledged. Results and comparative assessments from this study demonstrate that *P. fasciiventer*, compared with its temperate congeners like Great Tits (*Parus major*), Marsh Tits (*Parus palustris*), Crested Tits (*Parus cristatus*), Coal Tits (*Parus ater*) and Blue Tits (*Parus caeruleus*), raised small broods and had longer nestling period. The findings further revealed that the species is capable of raising more than one brood in a single breeding season and provide further evidence that it is a cooperative breeder. Parents participated equally in raising the young, an indication of pure parenting in the species.

Key words: breeding behaviour, nest box, *Parus fasciiventer*

Résumé

La raison de cette étude était de rechercher certaines informations jusqu'alors inconnues sur l'écologie de la reproduction de la mésange à ventre strié, *Parus fasciiventer*, dans le Parc National de la Forêt impénétrable de Bwindi, dans le sud-ouest de l'Ouganda. *Parus fasciiventer* est une des espèces d'oiseaux endémiques les moins étudiées; elle se limite aux forêts de montagne du Rift Albertin. Au niveau régional, elle est classée comme quasi menacée. L'étude s'est réalisée autour du camp de Ruhija de l'*Institute of Tropical Forest Conservation* de janvier à juin 2003. Les données furent obtenues par des observations directes sur les sites de trois nichoirs actifs. Chaque nid a été suivi depuis sa construction jusqu'à la mue des oisillons. Les résultats et des évaluations comparatives de cette étude ont montré que *P. fasciiventer*, comparé à ses congénères des régions tempérées comme la mésange charbonnière *Parus major*, la mésange nonnette *Parus palustris*, la mésange huppée *Parus cristatus*, la mésange noire *Parus ater* et la mésange bleue *Parus caeruleus*, élevait de plus petites nichées et avait une plus longue durée de nidification. Les résultats ont aussi révélé que cette espèce est capable d'élever plus d'une nichée au cours d'une même saison de reproduction et apportent de nouvelles preuves du fait que c'est une espèce qui pratique la reproduction coopérative. Les parents participaient de façon équitable à l'élevage des jeunes, un signe de parenté directe chez cette espèce.

Introduction

Successful conservation of any species requires an adequate knowledge of its ecological requirements (Williams & Adott, 1980). Comparatively, few studies have been conducted on the ecology of tropical birds although they are more representative of avian adaptations worldwide (Stutchbury & Morton, 2001). Most threatened bird

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species include those with restricted distribution or within vulnerable habitats (Kalina & Butynski, 1996). The Stripe-breasted Tit (*Parus fasciiventer*) is restricted to the Albertine Rift and is one of the rift endemics whose biology and ecology is still scanty (Harrap & Quinn, 1996). It belongs to family *Paridae* and it is a restricted range, and regionally classified as a near-threatened species. In Uganda, it occurs in the Rwenzori, Bwindi Impenetrable, Echuya and Mgahinga montane forest of the Albertine rift stretch of forests (Byaruhanga, Kasoma & Pomeroy, 2001; Shaw & Shewry, 2001; Terry & Fanshawe, 2002).

Breeding strategies of this species remain a matter of speculation (Fry, Keith & Urban, 2000; Wiggins, 2001), hence the need for further studies into its breeding ecology to develop better conservation strategies. With the alarming loss of tropical habitats mostly forests (Hamilton, 1984; Kayanja & Byarugaba, 2001), we lose not only the individuals of a given species, but also the ability to study and understand some peculiar ecological adaptations represented through such species. The bird species from genus *Parus* are among the best-studied groups of birds in the Holarctic region, especially with respect to their breeding ecology (Wiggins, 2001). However, little is known about the same subject elsewhere. Comparative studies on the ways tropical birds differ from their temperate congeners using tits provide a powerful test because the species occurs both in tropical and temperate regions. So far, Wiggins (2001) and Tarboton (1981) remain the only detailed studies into the breeding ecology of three African Parids. The data on breeding ecology from this study can be used for direct inference with that in the sub-tropical regions and the well-studied and phylogenetically similar temperate parids. Through this study, inferences will be drawn on the ecological adaptations *Parus fasciiventer.*

The findings will contribute to the development of better conservation strategies and to the less known life-history theory of tropical bird species (Stutchbury & Morton, 2001). The study aim was to find out information about the breeding biology of this species, assess its reproductive effort through observations of parental investment in incubation, brooding and nestling feeding as well as other breeding strategies in the species.

Materials and methods

The study was conducted between December 2002 and June 2003 in Bwindi Impenetrable National Park (BINP) *longitude 29°35′ and* 29 0 *50′* East; *latitudes 0°53′ and 1°8′* South, at Ruhija, around the Institute of Tropical Forest Conservation (ITFC) station (Fig. 1). Ruhija lies at an altitude between 2030 and 2520 M and is located to the South-Eastern part of BINP, (Butynski, 1984; Shaw, 2003).

Data were collected by direct observation (by the author and two ITFC field assistants) on three pairs breeding in artificial nest boxes established in 1995 (Shaw, 2003) at ITFC Ruhija camp ground. Of the three broods, two belonged to the same pair of parents. The nest boxes were equipped with a perch at the forefront and a smooth metallic plate around the entrance hole to keep out crawling and gnawing predators. To avoid biased results, observations were carried out at a distance of about 15 or more metres and under cover of surrounding bushes or nearby buildings. Close presence has been known to influence avian behaviour during breeding (Wiggins, 2001). To establish nest initiation and occupancy, all the nest boxes were inspected once a week for any possible nesting attempts or nesting behaviours. Boxes found with some nesting material were checked daily for any possible progress in the nesting attempt. When egg-laying began, active nests were checked on a daily basis to monitor the egg-laying process and to finally establish the clutch size at the end of the egg laying process. This was carried out when the parents were away from the vicinity of the nest to avoid possible nest abandonment. Both parents often left the nest mid morning.

Nest boxes were not opened during the first 12 days of incubation to minimize interference with the breeding female (Bolund, 1987). However 2 days after commencement of incubation, a final check was made (when the female was away), to establish the exact clutch size. Incubation period was calculated as the period between laying of the last egg and hatching of the first egg, as this was the period when the incubating female began to spend long hours on the nest. The mean incubation intensity was calculated as the time (minutes) spent by the female in the nest per hour of observation. The incubation feeding rate was determined as the number of feeds delivered to the incubating female per hour of observation.

From incubation to fledging, each of the three active nests was continuously watched for an average of 8 h day^{-1}. During the nestling period, the parents and fledglings were captured and individually colour ringed for individual identification. Six days after hatching, nestlings' weight was taken (with a pesola balance) at a 2-day interval. Weighing stopped at 20 days to avoid the risk of

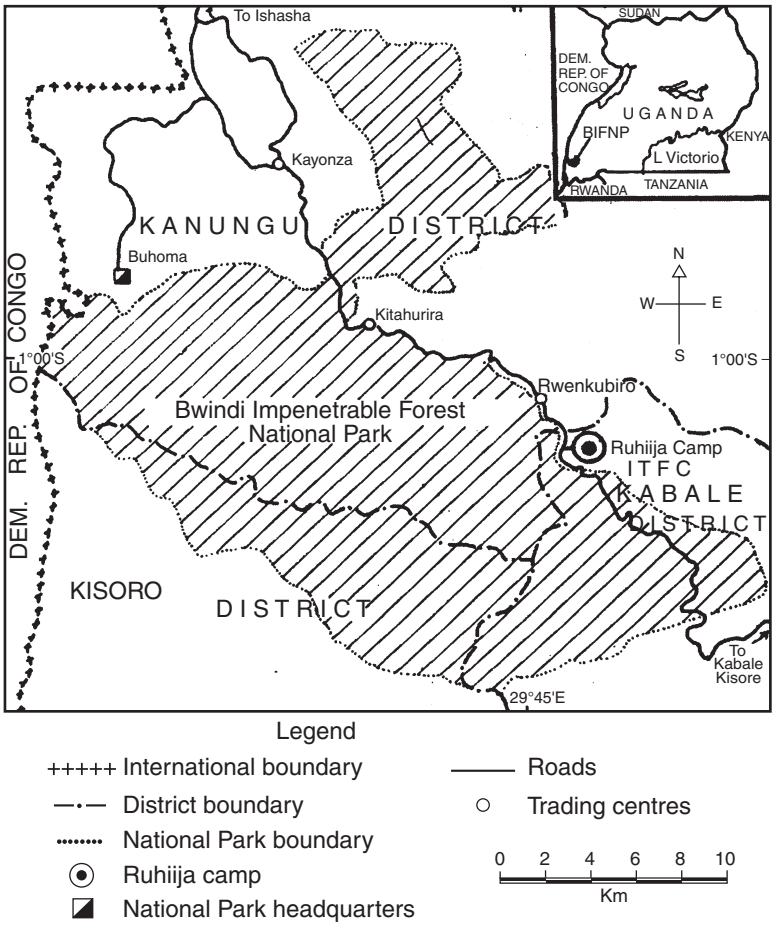

Fig 1 Location of Ruhija on Bwindi Impenetrable National Park (BINP) map

nestlings exploding (premature fledging), and the weight at that age was taken as the fledging weight.

Results

Nest initiation

Five complete nests were found, two in clumps of dead leaves of *Hagenia abyssinica* (Family *Rosaceae*), and three in artificial nest boxes. Both the natural and artificial nests were cup shaped and predominantly built with green moss and lichens and lined with bird feathers, reptile skins and seed heads especially of *Sericostachys scandens* (Family *Amaranthacae*). During the egg laying period, only the female carried the final soft materials. The female birds laid the soft nest linings. These were put during incubation and early nestling period most likely as needs for extra warmth arose.

Clutch initiation and incubation

Parus fasciiventer lays white eggs with brown speckles. Table 1 gives a summary of the findings on the observed activities. Males visited nests carrying food to the incubating female in all the three attempts. Sometimes the food was delivered inside the nest and at other times outside the nest. Nestlings had a fast increase in weight between the 6th and 12th day. Body weight levelled off towards fledging time.

Categories of food for nestlings

It was possible to distinguish between the three categories of food items fed to the nestlings:

Larvae (mainly of *Lepidoptera*); adult stages of several insect groups (e.g. moths and butterflies, crickets) and other items (e.g. Plant seeds and other items difficult to

Table 1 Summary of results

	Mean	Range	n
Clutch size	4	–	Three nests
Egg weight	1.46 g	–	Six eggs
Incubation period	15.7	15–16 days	Three broods
Incubation intensity	35.7 min h^{-1a}		161 h of observation
Incubation feeding rate	0.77 feeds h^{-1a}		124 h of observation
Hatching success	75%		Three nests, 12 eggs
Nestling period	23 days		Two broods
Nestling weight gain	1.35 g day^{-1b}		Two-nestling brood
Nestling weight gain	1.16 g day^{-1b}		Four-nestling brood
Fledging weight		22–25 g	Six fledglings

[a]Mean is calculated from the mean values for each the three nests.
[b]The chick measurement was performed during the age range of 4 and 20 days.

identify due to their small size or nature of delivery). Larvae were the most frequently delivered food items with a proportion of 64%, exceeding the rest of the other food items (Fig. 2). The male parent did most of the feeding during the first nestling days. Generally, the frequency of food deliveries increased as the nestlings grew (Fig. 2).

Cooperative breeding

During the incubation period for one of the nests, an extra male was seen feeding the incubating female. This was only identified whenever it visited the nest in the presence of the prime male. The male helpers' contribution could not be accurately quantified because it was not possible to tell the prime male from the helper when the two arrived at the nests at different times. However, the involvement of helpers was proved in the second brood of one of the nests where the parents and young adults had all been colour ringed.

The breeding pair of one of the nests, which were previously colour ringed, re-nested in the same nest box and initiated a second clutch of four eggs. This was 24 days after fledging of their initial brood. Three out of the four eggs hatched, one chick died 1 day after hatching, most likely from coldness, and the remaining two were invaded and killed by safari ants 10 days after hatching. Although mortality sources were not studied in detail, the invasion by red ants (which were plentiful during the rainy season) and opportunistic observations of hawks and rats around active nests were pointers to potential sources of nestling predation in *P. fasciiventer*.

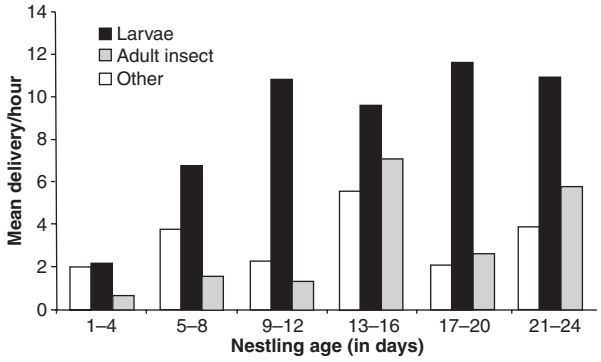

Fig 2 Frequency of delivery of different types of food by both parents to their nestling

Discussion

Parental investment in the breeding activities was almost equal between the male and female parents. This happens in monogamous species, so the species is most likely monogamous, that is, a male and a female form life-long pair bonds and raise young together. Unlike Palaearctic Blue and Great tits, in *P. fasciiventer*, both parents cooperated in nest building, with males initiating the process and the females complete nest constructions.

The clutch size in this study closely resembles that of other tropical tit species (Table 2) and differs significantly from the Palearctic species (Harrap & Quinn, 1996; Snow & Perrins, 1998; Fry *et al.*, 2000; Wiggins, 2001; Shaw, 2003). A small clutch size is thought to be a breeding strategy that evolved to reduce predation pressure. The relatively stable tropical climate strains adequate food supply because the population at any given time may be

Table 2 Comparison of breeding parameters of tropical and Palaearctic tit species

Parameter		n	Source
Clutch size range	Palaearctic 4–12 eggs	9 species	Snow & Perrins (1998)
	Tropical 2–6 eggs	9 species	Harrap & Quinn (1996); Fry, Keith & Urban (2000); Shaw (2003); This study
Mean incubation period	Palaearctic 13.7 days	7 species	Cramp & Perrins (1993)
	Tropical 15.0 days	2 species	Snow & Perrins (1998)
	Stripe-breasted tit 15.7 days	1 species	This study

close to its carrying capacity (Stutchbury & Morton, 2001). BINP fits in the setting; the findings of this study show relatively fewer feeds per nestling compared with the temperate species in spite of the small brood size. This shows the possibility that parental time is divided to forage and watch over the nest at the same time, and it also means that the feeds may not be as plentiful compared with temperate regions.

A comparison between the mean incubation period for the three clutches in this study, for Ashy tits and Carp's tits, and seven well-studied European Parids (Cramp & Perrins, 1993; Snow & Perrins, 1998), (Table 2) shows a similarity in the pattern of incubation between the north temperate, southern Africa and Eastern Africa Parids.

Shaw (2003) describes a single instance of cooperative breeding in the stripe-breasted Tit. Although it was not possible to accurately establish the contribution of non-breeding adults in the breeding activities of this study, the presence of more than one male at the active nest and the participation of the fledglings in tending the second brood of their parents provide further evidence of cooperative breeding in *P. fasciiventer*. The extra male participated in feeding the incubating female and a pair of newly fledged young made a contribution, by way of frequenting the nest of the new brood with food.

This study confirmed that *P. fasciiventer* is capable of laying two clutches in one season; a phenomenon that have not been proved in this species. In Parids, there are still few studies on cooperative breeding (Tarboton, 1981). However, studies on cooperative breeding in other bird species link its evolution and survival to the benefits acquired from group living and the high cost of living alone. The benefits include resource defence, increased predator detection, greater reproductive output and energetic savings (Ridley and Raihani, 2008). In this study, the fledged young stayed with parents for a period of more than 3 months after fledge. The bond that exists between the fledged nestlings with their parents could reflect the occupancy of permanent territories by this species. The findings of Woolfenden & Fitzpatrick (1984) show that avian cooperative breeding is common in tropical or subtropical, long-lived and sedentary species, which occupy and defend permanent territories. However, not all cooperative breeders occupy permanent territories, although many do. Cooperative breeding in *P. fasciiventer* requires a more lengthy study to get more reliable data on the contribution of helpers and the degree of relatedness between the helpers and their breeding parents. Multiple broods were clearly manifested in this study. Re-nesting of a breeding pair in the previous nest confirms an earlier assumption by Dowsett, 1990 that *P. fasciiventer* is actually multiple brooded. Multiple brooding has not been seen in any of the well-studied African *Parus* species (Tarboton, 1981; Wiggins, 2001). Although extensive rains are thought to trigger multiple broods, Carp's tits and Ashy tits could not raise them despite the heavy rains as reported by Wiggins, 2001. Multiple brooding is considered a reproductive strategy, an adaptation against predation; however, short intervals between the first and second brood could have a negative effect on the survival of the first brood fledglings. In this study, the fledglings of the first brood were seen begging to be fed by the male parent who at the same time was feeding the incubating female. Kluyver, van Balen & Cave (1977) reported the negative effect on just fledged young in the multi-brooded Great tits. The findings of this study suggest that *P. fasciiventer* has the capacity to raise multiple broods and is a cooperative breeder. The study also confirmed that the species shares similar life-history traits with some studied tropical avifauna such as small clutch size and broods. These traits are contrary to the ones exhibited by temperate Parids. For example, results from this study show less food deliveries during breeding compared with findings from the north temperate zone.

Small clutches and slow nestling growth are likely adaptations to these scenarios.

A longer study into the details of the mating system of this species would reveal more interesting results. We are yet to know, for example, whether this seemingly monogamous sedentary species has got incidences of extra-pair paternity as seen in some other socially monogamous bird species. Having colour ringed the members of the breeding attempts encountered during the study, follow-up would answer more questions about the species like age of sexual maturity, duration of male/female pair bond, whether families occupied permanent territories, longevity of the species and type of pair bond practiced, whether short-term, long-term, life-long, or clandestine pair bond (Barash & Lipton, 2001).

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