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Source: Bulletin of the British Ornithologists' Club, 138(3) : 238-243

Published By: British Ornithologists' Club

URL: https://doi.org/10.25226/bboc.v138i3.2018.a4

Nesting biology of Squirrel Cuckoo *Piaya cayana* at two localities in eastern Brazil

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Received 21 April 2018; revised 25 June 2018; published 24 September 2018

http://zoobank.org/?urn:lsid:zoobank.org:pub:A30D20C6-0C77-4D64-A030-50C08A34EDB9

Summary.—We provide new information on the breeding and feeding behaviour of Squirrel Cuckoo *Piaya cayana*, describing 16 nests found in 1987–2017 at two Atlantic Forest localities, in Minas Gerais and Alagoas (Brazil). In these areas, the species was observed at edges of primary and secondary forests, and beside rivers and wetlands. Nests were placed in the forest understorey in bushes or trees, and were camouflaged by lianas or dry branches. Clutch size varied from one to three eggs. Chicks had white mouth markings, described herein for the first time, and fledged before being able to fly. The breeding season varied between localities. In Minas Gerais, Squirrel Cuckoo appears to breed during the rainy season, while in Alagoas it may nest year-round.

Squirrel Cuckoo *Piaya cayana* is widely distributed from central Mexico to northern Argentina (Skutch 1966, Payne & Kirwan 2018) in upland forests, forest edges and patchy woodland (Oniki & Willis 1999). Aside from some ecological details presented by Skutch (1966) based on observations in Costa Rica and by Oniki & Willis (1999) from Espírito Santo (Brazil), there are few data on its breeding behaviour from anywhere within its extensive range. Here, we provide data on breeding and feeding behaviour at 16 nests of Squirrel Cuckoo at two Atlantic Forest localities in eastern Brazil.

Material and Methods

All of the nests were found between 1987 and 2017 in the municipalities of Arcos, Minas Gerais (20°17'S, 44°55'W) and Quebrangulo, Alagoas (09°14'S, 36°25'W). In these areas, Squirrel Cuckoo was observed in areas of dense vegetation, such as edges of primary and secondary forests, and at river and wetland margins. When an active nest was found, it was visited every 3–4 days, or every second day near hatching or fledging (Lara *et al*. 2012). When the exact date of fledging or hatching could not be determined, we recorded it as the median date of the two most recent visits (Dudley & Saab 2003).

Results

Arcos.—We found nine nests, all in October–January. Two nests were successful, whereas three failed during incubation, two during the nestling period, and two had an unknown fate, but certainly reached the nestling stage. Main cause of failure was predation (n = 4). One nest was abandoned during the nestling period. Nests were open cups, mainly constructed of dry twigs and lined with green leaves that were regularly renewed by the adults (Table 1). Measurements of two nests were: outer diameter 25 and 23 cm ($\bar{x}$ = 24 cm ± 1.45 SD); external height of cup 8 and 17 cm ($\bar{x}$ = 12.5 cm ± 6.36 SD); internal cup diameter 15 cm in both nests; depth of cup 4 and 7 cm ($\bar{x}$ = 5.5 cm ± 2.12 SD). Mass of one nest the day after the chicks fledged was 98 g (Table 1).

ISSN-2513-9894 (Online)

Nests were placed in the forest understorey in a bush or tree and were camouflaged by lianas or dry branches. They were placed 5–8 m above ground ($\bar{x}$ = 6.5 m ± 1.29 SD) in a *Pisona* sp. (*n* = 1), *Mangifera indica* (*n* = 1), unidentified palms (*n* = 2) and bushes (*n* = 5). On hatching chicks had blackish-purple skin and beige-yellowish trichoptiles on the body-sides (Fig. 1). The bill was grey with white flanges. The gape was red with a series of white knobs in the centre of the palate, and the tongue had a central white spot and a black spot at its tip (Fig. 2). Eggs were white but sometimes were stained greenish due to leaves in the nest's lining decomposing. Clutch size was 1–3 eggs (*n* = 7; $\bar{x}$ = 2.14 ± 0.69 SD). Mean measurements of six eggs were: 33.75 × 24.48 mm; mass 10.45 g ± 0.15 SE.

TABLE 1
Cup composition of a 98 g nest of Squirrel Cuckoo *Piaya cayana* in the municipality of Arcos, Minas Gerais, Brazil.

Exterior	**Number**	**Mass**
Leaf petioles and veins 1–10 cm	68	12 g
Twigs of 10–20 cm	78	50 g
Twigs of 20–30 cm	18	21 g
Interior		
Dry leaves of 1–10 cm	53	8 g
Leaf veins of 1–15 cm	25	5 g
Other plant material	-	2 g

Incubation lasted 17 days (*n* = 1) and the nestling period was 13 (*n* = 1) or 16 days (*n* = 1). Due to the small size of the nest compared to the adults, the latter incubated with the tail raised. Provisioning behaviour was observed at two nests over a total period of 250 minutes. Adults visited the nest at regular intervals of *c*.30 minutes. Diet consisted mainly of caterpillars and grasshoppers, as well as crickets, cicadas and other insects. Both adults contributed to incubation and nestling care. Chicks were fed whole prey items (Fig. 3) and if they had difficulties to swallow them, the adults assisted by crushing prey in their bills or presented the item several times until the nestling managed to consume it. Adults ate or removed faecal sacs from the nest (Fig. 4) and during the early stages of development (<1 week) one adult would brood the young until the other returned. On fledging, the young had a short tail, with rusty plumage, a grey bill and brown eyes (Fig. 5). Chicks left the

Figure 1. Squirrel Cuckoo *Piaya cayana* nestlings at seven days of age, Arcos, Minas Gerais, Brazil, February 1988 (Anita Studer)

Figure 2. Interior view of a Squirrel Cuckoo *Piaya cayana* nestling's gape, Arcos, Minas Gerais, Brazil, February 1988 (Anita Studer)

ISSN-2513-9894 (Online)

Figure 3. Adult and nestling Squirrel Cuckoo *Piaya cayana* while eating a whole caterpillar, Arcos, Minas Gerais, Brazil, November 1988 (Anita Studer)

Figure 4. Adult Squirrel Cuckoo *Piaya cayana* removing a faecal sac, Arcos, Minas Gerais, Brazil, December 2000 (Anita Studer)

ISSN-2513-9894 (Online)

Figure 5. Young Squirrel Cuckoo *Piaya cayana* two days before leaving the nest, Arcos, Minas Gerais, Brazil, December 2000 (Anita Studer)

nest before they could fly, hopping between branches through the trees and bushes. Songs were loud but seldom heard, and characterised by short disyllabic cries or long stanzas of detached notes. Near the nest, the adults gave rough snore-like sounds. Vocal activity was greater during the breeding season.

Quebrangulo.—Seven nests were found, in January, February, April, May, August and October. Five nests succeeded while two failed due to predation at the nestling stage. Nest, eggs and nestlings had the same features as at Arcos. Adults behaved similarly too. Mean measurements of five nests were: outer nest diameter 21.4 cm ± 6.22 SD; external height of cup 14.4 cm ± 5.68 SD; internal cup diameter 10.2 cm ± 3.03 SD; depth of cup 5 cm ± 2.71 SD. Mean mass of three nests was 110 g ± 2.22 SE. Nests were sited 4–7 m above ground (n = 6; $\bar{x}$ = 541.66 cm ± 102.06 SD) in a *Cordia trichotoma* (n = 1), *Myrcia guianensis* (n = 1), *Mangifera indica* (n = 2), *Citrus* sp. (n = 2) and in an unidentified bush (n = 1). Clutch size varied from one to three eggs (n = 4; $\bar{x}$ = 2.00 ± 0.57 SE). Mean measurements of three eggs were 33.43 × 24.63 mm ± 0.14 SE and mass was 10.77 g ± 0.13 SE. Incubation lasted 14 days (n = 1) and nestling period varied between 13 (n = 1), 14 (n = 3), 15 (n = 1) and 16 (n = 1) days. An overview of the species' diet was made based on 750 minutes of observation at four different nests. Food consisted mainly of arthropods (79%) and frogs (21%).

Discussion

Breeding information for *P. cayana* is scarce, but its diet was described by Repenning *et al*. (2009), who found only arthropods in stomach contents, whereas we also recorded frogs. Although fruits have been reported in the diet of some cuckoos (Rosenberg *et al*. 1990, Payne & Kirwan 2018), Repenning *et al*. (2009) did not record any for Squirrel Cuckoo, and neither did we. In Arcos, Minas Gerais, Squirrel Cuckoo appears to breed during the rainy season,

ISSN-2513-9894 (Online)

in October–January, whereas in Quebrangulo it may breed year-round, probably with repeated nesting attempts (Payne & Kirwan 2018). Long breeding seasons overlapping both the wet and dry seasons have been reported for many species that occur at Quebrangulo, e.g. Short-tailed Antthrush *Chamaeza campanisona* (Studer *et al*. 2018), Scalloped Antbird *Myrmoderus ruficauda* (Studer *et al*. 2017) and Black-cheeked Gnateater *Conopophaga melanops* (Studer in prep.), among others (Studer *et al*. 2015). Skutch (1966) reported active nests during the wet season in April–June in Costa Rica, although others were found between January and October.

Ingels & Fernandez (2014) described the nest of the congeneric Black-bellied Cuckoo *P. melanogaster*, from which it is apparent that nest sites are similar for the two species, although Black-bellied Cuckoo appears to place its nests higher above ground (*c*.8 m). Their nests are also similar in shape and size. Nests of other non-parasitic cuckoos, e.g. Guira Cuckoo *Guira guira*, Smooth-billed Ani *Crotophaga ani* and Greater Ani *C. major* share similar forms and materials. However, nests of *G. guira* are sited anywhere between 2 and 8 m above ground in less sheltered areas, whereas those of *C. ani* and *C. major* are usually sited 1–3 m above ground in marshy areas (pers. obs.).

Chicks of the above-mentioned species also possess markings on the palate and tongue. Indeed, nestling mouth ornamentation is present in the majority of cuckoo groups (Crotophaginae, Centropodinae, Couinae and Cuculinae; Payne 2005a) as well as in nestling viduids and estrildid finches (Neunzig 1929a,b, Nicolai 1964, Lahti & Payne 2003). Such ornamentation might attract their parents, as bright colours and structures are more visible to adults (Payne 2005b, Spottiswoode *et al*. 2012), thereby facilitating food delivery (Friedmann 1960). Appert (1967) illustrated the bright markings and colours of Red-capped Coua *Coua ruficeps* (of Madagascar) and suggested that these markings aid the adults to locate the chicks' gapes in dark cavities. Similarly, Friedmann (1960) stated that estrildid mouth markings serve to guide the adults inside dark nests. Swynnerton (1916) on the other hand, suggested that the bright gapes of nestlings represent warning colours, and deter nest predators.

Acknowledgements

We thank Nordesta Reforestation & Education for supporting our field work and IBAMA/ICMBio for cooperating with conservation measures. We are grateful to Felino Pedro Celestino, Luis Batista de Freitas and Manoel Nunes de Farias for their long-term assistance and collaboration in locating nests of this species. We also thank Marco Aurélio Crozariol for his advice during the preparation of this paper. Finally, we thank the editor and our referees for providing helpful comments on the submitted manuscript.

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ISSN-2513-9894 (Online)