

## Observations on the breeding behaviour of Snowy Cotinga *Carpodectes nitidus*

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Tres nidos de la Cotinga Nivosa *Carpodectes nitidus* muestran un diseño muy simple, que consiste en una plataforma construida de ramitas y zarcillos, similar al descrito previamente para esta especie y para otras cotingas. La alimentación del pichón (en uno de los nidos) consiste en artrópodos, ranas y frutos, con una mayor proporción de dieta animal. El plumaje del pichón es muy críptico, difícil de discernir del material del nido y de las ramas circundantes. En uno de los casos, la hembra destruyó el nido después de que el pichón lo abandonara; esto ha sido descrito para otras cotingas como una estrategia para disminuir la depredación.

Knowledge of breeding biology in the Cotingidae is fragmented and scarce for most species<sup>10,22</sup>. For instance, descriptions of the nest and eggs are known for only two-thirds of the species in the family<sup>16,21,22</sup>. Information on parental care and provisioning behaviour is known for several species and genera (e.g., Guianan Cock-of-the-Rock *Rupicola rupicola*<sup>10</sup>, Bearded Bellbird *Procnias averano*<sup>20</sup> and Long-wattled Umbrellabird *Cephalopterus penduliger*<sup>6,7,9</sup>), but in general this information is incomplete for most species.

The breeding biology of the genus *Carpodectes* is almost completely unknown. There are descriptions of two nests and the egg of Snowy Cotinga *C. nitidus*<sup>11,15</sup>, and a brief description of the nest of Yellow-billed Cotinga *C. antoniae*<sup>8,12</sup>, but nothing else is known<sup>10,22</sup>. Our goal here is to describe female brood care, nestling feeding behaviour and nestling development of Snowy Cotinga. Additionally, we complement the previous nest descriptions with information for another three nests (one of which was collected).

### Methods

We collected data on breeding biology of Snowy Cotinga between 2005 and 2014 at two localities on the Caribbean slope of Costa Rica. We found nests opportunistically by observing females carrying nest material, food, or defending them against predators. For each nest we recorded its height (m), position on the tree and nest material if possible. For the one nest collected, we describe in detail the design, diameter of the entire nest and depth of the egg cup. Additionally we measured the diameter of eight twigs and tendrils of the external wall of the nest and eight of the egg cup. This nest is deposited at the Museo de Zoología Universidad de Costa Rica, San José (MZUCR-N308).

We placed a Bushnell HD trap camera (Model 119455) at 2.25 m in front of one of nests. The camera was set to record for 24 hours over three consecutive days, beginning on the 12th day after

the chick hatched. The camera recorded 20 seconds of footage each time the female arrived or the chick moved. We used video recordings to describe nest attendance, feeding behaviour and diet, cleaning behaviour, and characteristics of the nestling. In addition we observed (using binoculars) the nest from the ground, 25 m from the nest, for 30 consecutive days over a total of 80 hours, and based on these observations we estimated the minimum fledging period of the chick.

### Results

**Nest locations and breeding season.**—We found the first nest on 20 March 2005 at San Carlos, prov. Alajuela (10°27'48.6"N 84°35'40.3"W; 125 m). The nest was c.15 m above ground, positioned on the proximal extreme of three adjacent branches and the main trunk of a leafless tree, in the middle of a pasture. We could not see the interior of the nest from the ground, but the female was perched on a branch next to the nest. We found the second nest with a nestling on 6 September 2013, at Tirimbina Biological Reserve, Sarapiquí, prov. Heredia (10°24'56.9"N 84°07'16.1"W; 148 m). The nest was constructed on top of the dead roots of a bromeliad at the distal extreme of a branch of an *Erythrina cochleata* (Fabaceae) tree, 17 m above ground. We found the third nest on 8 January 2014, again at Tirimbina Biological Reserve. It was sited on the distal section of a branch of another *E. cochleata* at 20 m (Fig. 1). The nest held a white egg when found. Both the second and third nests were within an old secondary rainforest at the edge of the Sarapiquí River.

All three nests were constructed higher above ground than those previously described, but in trees with similar characteristics<sup>11,17</sup>. Our data and those of previous studies<sup>10,11,15</sup> indicate that the species' breeding season in Costa Rica occupies at least January–September, i.e. throughout most of the rainy season in the Caribbean lowlands of Costa Rica<sup>17</sup>.



Figure 1. Nests of Snowy Cotinga *Carpodectes nitidus* at La Tirimbina Biological Reserve, Costa Rica: (a) nest found on 6 September 2013 and collected after the chick fledged (MZUCR-N308); (b) nest found on 8 January 2014, with the white arrow indicating fruit of *Cedrela odorata* (Meliaceae).

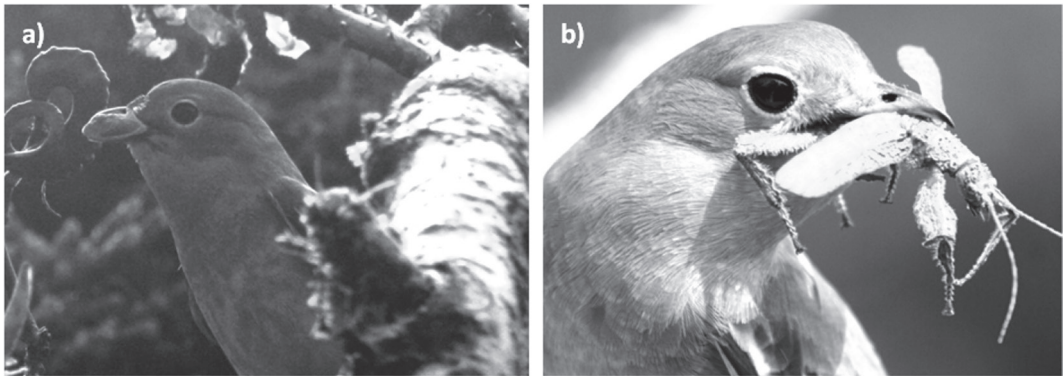


Figure 2. Food items brought by the female Snowy Cotinga *Carpodectes nitidus* to feed the chick: (a) juvenile hylid frog (Hylidae); and (b) stick-insect (Phasmidae).

**Nest description.**—The nest collected was a platform of dry fine twigs mainly of *Cedrela odorata* (Meliaceae) and dead vine tendrils. The diameter of the external twigs and tendrils was larger ( $n = 8$ ;  $1.9 \pm 0.6$  mm) than the diameter of those used for the cup ( $n = 8$ ;  $0.6 \pm 0.1$  mm). From the outside, the platform was asymmetric, the highest section measured 78 mm and the lowest 30 mm. The platform's longest diameter was 88 mm and the shortest 57 mm (Fig. 1b). From photographs of the third nest found at La Tirimbina, we determined that at least part of it also comprised twigs of *C. odorata* (Fig. 1). Nest dimensions of the collected nest were similar to those reported by Sánchez<sup>15</sup>.

**Nest attendance and exit strategy.**—From the period 14–17 February 2014, we analysed 197 minutes of video recordings made at the third nest. The first recording was made at 13h48 on the first day and the last finished at 20h12 on the last day. The female attended the nest (e.g., feeding and cleaning the nestling) for periods of  $7.63 \pm 13.06$  minutes (mean  $\pm$  SD;  $n = 30$ ). After each of these visits she flew away, leaving the nest unattended

for periods of  $17.81 \pm 13.62$  minutes ( $n = 33$ ). We recorded the female six times as she left the nest after feeding the chick. Five times she dived down and only once she flew horizontally; diving behaviour is probably a strategy to avoid detection by aerial predators, as has been suggested for other bird species that nest in the canopy<sup>1,3</sup>.

**Feeding behaviour and diet.**—On all occasions ( $n = 30$ ) in which the female arrived with food she initially perched c.5–15 cm from the nest. Sometimes the female then hopped immediately towards the chick, but in most cases she moved her head in different directions and then moved to the nest. During all such visits the female vocalised before feeding the chick and just twice the chick produced a begging call (see below). We recorded nine feeding events at the second nest: six fruits (*Simarouba glauca*: Simaroubaceae), one juvenile frog (Hylidae), one stick-insect (Phasmidae) and one unidentified item (Fig. 2). We registered a total of 31 feeding events at the third nest from video recordings: seven ripe fruits of *S. glauca*, ten arthropods (one moth, one katydid, three stick-

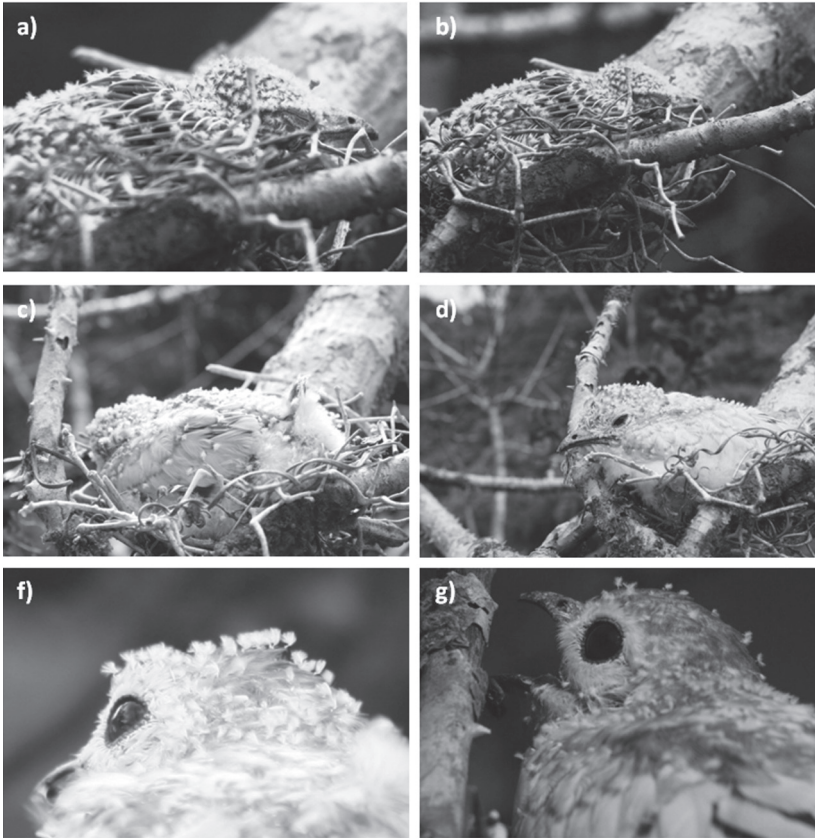


Figure 3. Snowy Cotinga *Carpodectes nitidus* chick at different stages: (a–b) eight days old, with highly developed wing feather quills that resemble the nest materials, but eyes still closed; (c–d) 22 days old, with black secondaries, white down feathers and open eyes; (f) close up at same age, showing the elongated rachis and diamond-shaped brush at the apex of the down feathers; and (g) 26 days old, with body covered with darkish and white feathers.

insects and five unidentified arthropods), and 15 unidentified items.

The female regurgitated all items provisioned to the chick. During this process the female first partially opened her bill, and nearly immediately began to raise her head as she pointed her bill upwards. When the female raised her head and bill, the gular area vibrated rapidly, a movement similar to that observed when birds ventilate, and the food appeared inside the bill, near its proximal section. The item was moved forward to the bill's distal section and then the bill introduced into the wide open mouth of the chick.

**Cleaning behaviour.**—The female collected a faecal sac ( $n = 12$ ) a few seconds after feeding the chick ( $34.83 \pm 25.46$  seconds). The chick raised the cloaca and swayed its body to defecate, and almost immediately the female seized the dropping. We also recorded the female collecting chick faeces and seeds at the nest, and parts of an arthropod from the chick's bill. This behavior may reduce detection by predators and the occurrence of parasites<sup>3</sup>.

**Plumage development.**—We followed plumage development of the chick for 19 days, beginning on day eight, at which point the chick was covered with white down and had pinkish

wing feather quills. Its bill was black and body skin blackish, and its eyes were closed (Fig. 3). By day 22 the wing feathers were well developed (Fig 3), with whitish primaries and black secondaries as in adults. The body was completely covered in white down feathers with an unusual structure. At least some of these feathers had an elongated rachis and barbs at the apex formed a diamond-shaped brush (Fig. 3). Eyes were completely open. By day 26, the chick was completely feathered, darkish on its head and back, and white on its breast, abdomen and tail (Fig. 3); by day 30 the chick had left the nest, after a minimum fledging period of 26 days.

**Vocalisations.**—We recorded two types of vocalisations, one produced by the female and one by the chick. The female produced a short broad-frequency call (Fig. 4), just before feeding the chick. On average ( $n = 263$  calls), the duration of female calls was  $0.03 \pm 0.01$  seconds (range =  $0.01$ – $0.05$  seconds), with a min. frequency of  $1,458 \pm 218$  Hz (range =  $699$ – $2,272$  Hz), a max. frequency of  $3,924 \pm 522$  Hz (range =  $2,404$ – $4,987$  Hz) and max. amplitude of  $2,583 \pm 457$  Hz (range =  $1,292$ – $3,618$  Hz). The chick produced a frequency-modulated call, which commenced with a section during which the frequency gradually increased, followed by a

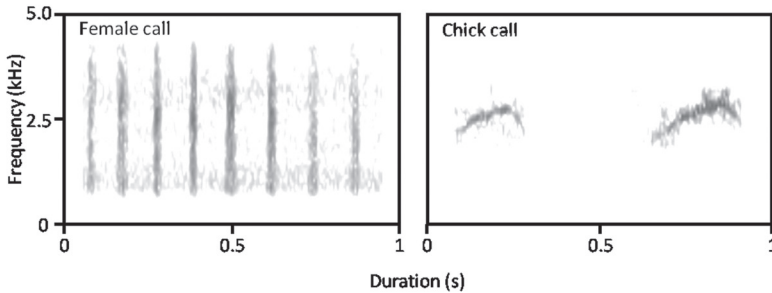


Figure 4. Sonograms of Snowy Cotinga *Carpodectes nitidus* female (left) and chick calls (right) recorded during feeding events at a nest in Tirimbina Biological Reserve, Costa Rica.

short section in which it decreased rapidly (Fig. 4). On average ( $n = 14$ ), duration was  $0.21 \pm 0.06$  seconds (range = 0.14–0.31 seconds), with a min. frequency of  $2,174 \pm 271$  Hz (range = 1,819–2,767 Hz), a max. frequency of  $3,093 \pm 423$  Hz (range = 2,586–4,116 Hz) and max. amplitude of  $2,633 \pm 263$  Hz (range = 2,240–3,101 Hz).

**Other observations.**—At the first nest the female attacked a squirrel (*Sciurus variegatoides*) climbing the main trunk towards the nest. The female flew from the nest directly at the squirrel's back. After the first attack, the female perched on a branch 2 m below the nest but above the squirrel. During the next c.1.5 minutes the female attacked the squirrel twice more, returning to the same perch used after the first attack. After the third attack, the squirrel descended the tree, and the female flew to a riparian forest 50 m away.

At the second nest, the female perched upright on the nest during sunny days for c.3 hours, beginning approximately one hour before noon, when raining, or at night. The body of the chick was positioned at c.90° relative to the body of the adult female, with the female's legs below the chick's body. This position was possibly adopted due to the small area of the nest platform, which precluded both individuals lying in the same direction. Chicks at La Tirimbina were observed close to the females in the forest canopy near their nests after fledging. We observed the female of the third nest destroying its nest after the chick had fledged, using its bill to pick up each twig and throw it to the ground until the nest had been completely dismantled.

## Discussion

The architecture of nests described here was similar to the two previous nests reported for Snowy Cotinga<sup>11,15</sup>, and to those of other Cotingidae<sup>9,16,19,21</sup>. The platform of twigs and tendrils constructed by Snowy Cotinga presumably represents an ancestral state in the 'core cotingas' clade<sup>24</sup> in which species basal to *Carpodectes* such as pihás<sup>2</sup> (*Lipaugus* sp.) build similar nests using similar materials<sup>10</sup>. Destruction of the nest after the chick has fledged has also been reported for other cotingas (e.g., Rufous Piha *Lipaugus rufus*), and supports the

hypothesis of Snow<sup>21</sup> that destroying the nest reduces the ability of potential predators to acquire a search image.

The diet of Snowy Cotinga chicks consisted of a large proportion of arthropods with fruits in lower proportion, which suggests the importance of animal protein for development<sup>14</sup>. On the contrary, the diet of adult cotingas consists primarily of fruits<sup>10,21</sup>, although arthropods are at least occasionally taken by adults<sup>5,23</sup>, but their canopy behaviour might have precluded additional observations. Other frugivorous bird species also feed their nestlings with a diet based on arthropods<sup>13</sup>, which is congruent with the hypothesis that nestlings require more protein for rapid development<sup>13</sup>.

The wing feathers were the first to appear on the chick of Snowy Cotinga and they had pinkish quills, producing a pale appearance to the upperparts. This in turn may camouflage the chick against aerial (visual) predators, because its colour and form blended with the colour of the nest materials. This cryptic condition is shared with chicks of other cotingas<sup>1</sup> (e.g., Bare-necked Fruitcrow *Gymnoderus foetidus*), but quite different from the conspicuous plumage coloration of the chicks of Cinereous Mourner *Laniocera hypopyrra* and Elegant Mourner *Laniisoma elegans*<sup>4</sup>. In ground-dwelling birds, the early development of wing feathers has been proposed as an adaptation to escape from predators<sup>16</sup>. In canopy species the early development of wing feathers may fulfil the same function, but against a different set of predators<sup>3</sup>: monkeys, squirrels and raptors.

Snowy Cotinga produces few vocalisations as does Yellow-billed Cotinga<sup>12</sup>. It appears that species of *Carpodectes* have a reduced repertoire<sup>10</sup>. Ours is the first report of vocalisations in *C. nitidus*, and the female call apparently signals to the chick that it is about to receive food. Chick calls possibly served to beg and were recorded only rarely.

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