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Breeding biology of Hooded Tanager *Nemosia pileata* in Brazil

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Summary.—The Neotropical genus *Nemosia* comprises just two species, Hooded *N. pileata* and Cherry-throated Tanagers *N. rourei*, and their breeding biology is poorly known. Here we provide new information based on five nests of *N. pileata* and review existing data in the literature. When an active nest was found, it was visited every 3–4 days, or every second day near hatching or fledging. Monitoring was conducted by direct observation from hides sited 4–8 m from the nest. We estimated nest height above ground by eye to the nearest 0.5 m. Nestling period was estimated from hatching of the last chick to fledging of the first chick. Three nests had two eggs each, one nest had two nestlings, and one nest had one egg and two nestlings when found. Eggs were pointed, ovoid, and greenish with purplish-black spots all over. Eggs from four nests measured 20.5 ± 0.6 × 15.4 ± 0.3 mm and had mass 2.17 ± 0.22 g (n = 7). Five nestling from two nests were monitored. They hatched with a little white down covering the brown-orangey skin, a salmon-coloured bill, a red mouth, and orangey-brown legs and feet. A pair brought six food items (three each) in 100 minutes (to a nest with two nestlings). Of three of the five nests monitored, one fledged two young and the other two were predated. The nesting period (October–April) overlaps the dates of other published records, but differs between regions and shows a complex relation to rainfall. Our data on nests, eggs and nestlings of *N. pileata* improves our understanding of its reproductive biology and could assist in conservation measures for the Critically Endangered *N. rourei*.

The Neotropical genus *Nemosia* (Thraupidae) comprises only two species, Hooded Tanager *N. pileata* and Cherry-throated Tanager *N. rourei*. *N. pileata* is not threatened and is widely distributed across South America (Lindenblatt & Burns 2020), whereas *N. rourei* is Critically Endangered, has a tiny distribution in south-east Brazil and is poorly known (IUCN 2018). *N. pileata* is small (body mass 12.0–20.7 g), mostly insectivorous but also takes fruit and nectar (Penard & Penard 1910, Isler & Isler 1999), occurs in small groups of 2–6 birds (Isler & Isler 1999, Hilty 2003, Ridgely & Tudor 2009) and joins mixed-species flocks (Maldonado-Coelho & Marini 2003, Di Giacomo 2005, Vasconcelos *et al*. 2006). It occurs mainly in the upper strata of forest borders, *caatinga*, *cerrado* and clearings (Sick 1985, Hilty & Brown 1986, Di Giacomo 2005).

The breeding biology of both species is poorly known (Lindenblatt & Burns 2020). For *N. pileata*, there is scattered information describing the open-cup nest, nestbuilding by the pair (Haverschmidt & Mees 1994, Isler & Isler 1999) and incubation behaviour by the female (Renaudier *et al*. 2008). The species lays two bluish eggs with dark spots, mean size 19 × 14 mm (Penard & Penard 1910), but apparently no eggs are deposited in museums (Kiff & Hough 1985; MÂM, pers. obs.). Its breeding period covers nestbuilding in July in Colombia (Hilty & Brown 1986) and August in Suriname (Haverschmidt & Mees 1994), to nestlings in February in Suriname (Haverschmidt & Mees 1994). It has been parasitised by Shiny

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Cowbird *Molothrus bonariensis* in Minas Gerais, Brazil (Lopes *et al*. 2013), despite not being listed in Lowther's (2018) review of the latter's hosts.

Despite a growing body of information on several aspects of the natural history of both *Nemosia* species, many aspects remain poorly documented (Lindenblatt & Burns 2020). Whilst *N. pileata* is not threatened, some aspects of its natural history may inform the conservation and management of the Critically Endangered *N. rourei*. Here we provide new information based on five nests of *N. pileata* and review existing data in the literature.

Methods

The Arcos site (20°18'S, 45°30'W), in the state of Minas Gerais, in south-east Brazil, is in the Cerrado biome and is characterised by secondary forest, as well as a few small patches of Atlantic Forest. Alto Parnaíba (0915'S, 45°59'W), in Maranhão, is in the northern part of the Cerrado biome; and Quebrangulo (09°16'S, 36°25'W), Alagoas, lies in the Atlantic Forest biome (Studer *et al*. 2017).

When an active nest was found, it was visited every 3–4 days, or every second day near hatching or fledging. When the exact date of hatching or fledging could not be determined, we recorded it as the median date between the two most recent visits. Eggs were weighed prior to the third day after laying using a spring scale (to 0.5 g) since they dehydrate during incubation, and measured (width and length) using a ruler (to 0.5 cm). Nest dimensions were measured with callipers (to 1 mm) and mass with a spring scale (to 0.1 g). Nest description was based on Simon & Pacheco (2005). Monitoring was conducted by direct observation from hides installed 4–8 m from the nest. Five nestlings at two nests were monitored in detail. We estimated nest height above ground by eye to the nearest 0.5 m. Nestling period was estimated from hatching of the last chick to fledging of the first one.

We used a backdating method to estimate egg laying at four nests where the precise date of the full clutch was unknown (Marini *et al*. 2012). This method consists of counting backwards from the date the nest was found to estimate when eggs were laid. Although we do not know the incubation period, we assumed it is *c*.12–14 days as in most Thraupidae (Winkler *et al*. 2020). Also, we used our estimate of the nestling period (14 days) at one nest.

Results

The five nests were found in Minas Gerais (n = 3), Maranhão (n = 1) and Alagoas (n = 1). They were constructed in forks close to the end of branches, type 'low cup/fork' (Fig. 1A–B), composed of grasses, small roots and fine lianas, and lined with spider webs. Nestbuilding occupied nine days at a nest started by a female on 24 December and finished 2 January. The male remained nearby but did not participate in construction. Although well attached to branches, the structure is partially transparent from below. Nests were built 4 (n = 1), 5 (n = 2) and 6 m (n = 2) above ground, on *Bowdichia virgiloides* (Fabaceae) (n = 2), *Bauhinia cheilantha* (Fabaceae) (n = 1), *Tibouchina glanulosa* (Melastomataceae) (n = 1) and an unidentified tree (n = 1). Two nests had an external height of 5.0 and 6.0 cm, internal height 3.5 and 4.5 cm, external diameter 7.0 and 8.0 cm, internal diameter 4.5 cm, and nest mass was 3.0 g in both cases.

Three nests had two eggs each; one nest held two nestlings, and another three nestlings (initially two, plus one egg). Eggs were pointed, ovoid, and greenish with purplish-black spots scattered across the entire surface. Eggs at four nests measured 20.5 ± 0.6 × 15.4 ± 0.3 mm and weighed 2.17 ± 0.22 g (n = 7).

Nestlings hatched with sparse white down covering the brown-orangey skin, a salmon bill, red mouth, and orangey-brown legs and feet (Fig. 1B). One pair delivered six food items

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Figure 1. Nests of Hooded Tanager *Nemosia pileata*: (A) constructed in a fork at the end of a branch; (B) nestling being fed with an insect by the male, watched by the female (Anita Studer)

(three each) in 100 minutes (mean 3.6 items/hour) to a nest with two nestlings, which were fed green caterpillars, unidentified insects, and fruits of *Selenicereus setaceus* (Cactaceae) and *Rapanea* sp. (Myrsinaceae) (Fig. 1B).

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The period of nesting activity at the five nests in this study was estimated at October–April. However, nesting activity was observed October–February in Minas Gerais, October and November in Maranhão, and March and April in Alagoas (Table 1). Egg laying dates in Minas Gerais were estimated as being in the first half of October (n = 2) and first week of January (n = 1), in Maranhão during the last week of October, and in Alagoas during the middle of March.

At three of the five nests monitored, one fledged two nestlings and the other two were predated. At one the two eggs were predated by a Curl-crested Jay *Cyanocorax cristatellus* (Corvidae), and at the other the two nine-day-old nestlings were filmed being predated by an unidentified hawk (Accipitridae).

Discussion

The nesting trees we report are pioneer species, like those reported by Renaudier *et al*. (2008) in French Guiana (*Cecropia* sp.), and by Marini *et al*. (2012) in south-east Brazil (*Persea americana*). These indicate that *N. pileata* nests in disturbed areas with regenerating forest or edges. Heights above ground were similar to those reported by Di Giacomo (2005) and Marini *et al*. (2012) (6 m in both cases), but lower than that in French Guiana (8.5 m)

TABLE 1
Review of breeding records of Hooded Tanager *Nemosia pileata* by locality* and type (BC = breeding-condition birds; BP = brood patch; BR = unspecified evidence of breeding; EG = eggs; FL = fledglings; IN = incubating; JU = juvenile; NB = nestbuilding; NE = nestlings; ON = occupied nest). The local wet season months are shaded grey (https://en.climate-data.org/).

Study site*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
César, Colombia (08–11°N, 73°W)[1]			BC	BC	BC	BC						
Apure, Venezuela (08°N, 69°W)[2]										FL		
Suriname (02–06°N, 54–58°W)[3]		FL						NB				ON
French Guiana (05°N, 53°W)[4]		NB/EG	JU							IN		
Leticia, Colombia (04°S, 70°W)[1]							NB					
Alagoas, Brazil (09°S, 36°W)[5]			EG	NE								
'Tocantins', Brazil (not accurately known)[6]												BR
Maranhão, Brazil (09°S, 46°W)[5]										EG	NE	
Minas Gerais, Brazil (16°S, 40°W)[7]											BP	
Distrito Federal, Brazil (15°S, 48°W)[8]										IN		
Minas Gerais, Brazil (20°S, 46°W)[5]	EG									EG	NE	NB
São Paulo, Brazil (23°S, 48°W)[9]										NB		
Formosa, Argentina (26°S, 59°W)[10]												NB/EG

* [1]Hilty & Brown (1986); [2]Cruz & Andrews (1989); [3]Haverschmidt & Mees (1994); [4]Renaudier *et al*. (2008); [5]this study; [6]Snethlage (1928); [7]M. Â. Marini (pers. obs.); [8]Marini *et al*. (2012); [9]Oniki & Willis (2003); [10]Di Giacomo (2005).

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(Renaudier *et al*. 2008). Materials are similar to those previously reported (Renaudier *et al*. 2008). Once, a *N. pileata* reused material from a Great Kiskadee *Pitangus sulphuratus* nest (Oniki & Willis 2003). Our data contradict the observation that nests are constructed by the pair (Hilty & Brown 1986, Haverschmidt & Mees 1994), as at our nest the male remained close to the female but never brought material.

The eggs we observed resembled the two-egg clutches reported by Penard & Penard (1910), which were bluish, spotted with brown or lilac gray. Egg size was also similar to the 19 × 14 mm reported by Penard & Penard (1910). Clutch size is typically two, occasionally three, with incubation by the female alone. A pair was mist-netted on 2 November 2001 at Salto da Divisa, Minas Gerais, but only the female had a brood patch (MÂM pers. obs.). The mixed fruit and insect diet of nestlings resembles the arthropod / fruit diet of adults (Isler & Isler 1999, Lopes *et al*. 2005).

The nesting period during our study (October–April) overlaps the dates of other published records, but breeding activity differs between regions and exhibits a complex relation to rainfall (Table 1). It is clear that nesting activity in central Brazil (southern Maranhão, Tocantins, Distrito Federal, Minas Gerais) to south-east Brazil (São Paulo) and Argentina occurs from October to February and coincides with the wet season. Nesting records from the north of the range are available almost year-round, also coincident with the wet season in Alagoas, Venezuela, and at Leticia (southernmost Colombia), but during both the rainy and dry seasons in César (northern Colombia), Suriname and French Guiana. Penard & Penard (1910) stated that *N. pileata* breeds especially during the short dry season or long rainy season in Suriname. Overall, quite different climatic regimes occur at the 13 sites with records of breeding activity, which makes preliminary any interpretation of climate / breeding association, especially considering the still-small sample sizes.

The nesting periods of *N. pileata* and *N. rourei* partially overlap given that the two breeding records of *N. rourei* (nestbuilding in November; Venturini *et al*. 2002, and young being fed in October; Venturini & Paz 2007) suggest it may start nestbuilding in August and still be feeding nestlings in December. Predation of nests by a hawk and a jay were expected as these are common nest predators in the Neotropics (see Menezes & Marini 2017).

The data on nests, eggs and nestlings reported here contribute to a better understanding of the reproductive biology of *N. pileata*. They also may prove useful in reaching conservation decisions for the Critically Endangered *N. rourei*.

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