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Breeding biology and morphometrics of Common Pauraque *Nyctidromus a. albicollis* in south-west Amazonia, and the species' breeding season and clutch size in Brazil

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SUMMARY.—We present data on the breeding and biometrics of Common Pauraque *Nyctidromus a. albicollis*, a species found virtually throughout Middle and South America, including Brazil. We made observations on this species in a forest fragment in south-west Amazonian Brazil, and we evaluated the breeding season in Brazil based on citizen science data. Our field studies between 2011 and 2020 produced 25 nests each with a clutch of one egg. The minimum incubation period was 13 days. Nestling mass was c.8 g on hatching. Searches of the citizen science platform Wikiaves resulted in 253 photographic records of active nests throughout Brazil. These data together indicate that Common Pauraque breeds almost year-round in Brazil, albeit with a peak between the dry/rainy seasons (September–November).

Common Pauraque *Nyctidromus albicollis* is a medium-sized, relatively common, sedentary nightjar that occurs from Texas in the southern USA to north-east Argentina (Latta *et al.* 2020). In Brazil, it is one of the commonest nightjars (Sick 1997) and two subspecies occur: *N. a. albicollis* and *N. a. derbyanus* (Piacentini *et al.* 2015, Latta *et al.* 2020). Like other caprimulgids, Common Pauraque does not build a nest, but lays its eggs in leaf litter on the ground (Latta *et al.* 2020). Their nests are often discovered when the adult is flushed by an approaching observer, thereby revealing the eggs. Despite being common and widespread, there are relatively few detailed studies of the species' breeding biology, especially in Amazonia (Snethlage 1935, Oniki & Willis 1982, Lima *et al.* 2019). We report nesting data for Common Pauraque from an urban forest fragment in south-west Amazonian Brazil and provide new information on its breeding season in Brazil based on citizen science data.

Methods

Study area.—Nests reported here were found during non-systematic observations made between 2011 and 2020 at the Campus and Zoobotanical Park of the Universidade Federal do Acre (UFAC) (09°57'03.22"S, 67°52'30.65"W) in Rio Branco, Acre, while adults were trapped, measured and ringed annually in 2010–17. A detailed description of the habitats and avifauna of the study area was presented by Guilherme (2001).

Trapping and biometrics.—During 2010–17, we trapped adults of *N. a. albicollis* using mist-nets, 12 m long and 2.5 m high, with a 36-mm mesh. Trapping effort was c.4,000 net/hours/year, and we marked birds using numbered metal rings supplied by CEMAVE (Centro Nacional de Pesquisa e Conservação de Aves Silvestres), under the scope of project 1099, coordinated by EG (senior bird bander, reg. no. 324654). We assessed adult and nestling body mass to the nearest 1 g with a Pesola scale in 2010–14, and a digital scale (0.05 g precision) in 2015–17. We collected standard morphometric data (flattened wing

length, bill length from tip to feathers, and total length) following the protocols outlined by Proctor & Lynch (1993). We used a ruler (accurate to the nearest 1 mm) to measure wing and total length, while to measure bill length and head size we used analogue callipers (accurate to the nearest 0.05 mm) in 2010–14, and digital callipers (to the nearest 0.01 mm) in 2015–17. We measured cloacal temperature using a digital thermometer (32.0–42.9°C, to the nearest 0.1°C).

Citizen science data.—We searched for photographs of Common Pauraque eggs and nestlings archived on the Wikiaves platform prior to 23 March 2020 (Wikiaves 2020). The date, location (state and nearest town), author, and nest contents (eggs or nestlings) in each photo were recorded in an Excel spreadsheet. For this study, we considered only one photo of each nest per site, i.e. we did not record photos of the same nest on the same or subsequent days. We organised records by month, to investigate the species' breeding season in Brazil. We also used the active nests documented in Wikiaves to check for differences in clutch size in relation to latitudinal gradient in Brazil, by dividing records into two ranges: 0–10°S and 11–30°S. We calculated the percentage of the number of nests with clutch size one or two eggs, separately, in both latitudinal categories, in relation to the total number of nest records.

Results

Between 2011 and 2020 we found 25 active nests, of which 12 were monitored (Table 1). Among active nests (Figs. 1A–C), 24 each had one egg and one contained a recently hatched nestling (Table 1). Nests with eggs were in different stages of incubation, and the longest minimum incubation period was observed at nest 8, namely 13 days from the date the adult was first observed incubating until the nestling hatched (Table 1). Of the 12 monitored nests, four were predated, three abandoned, and at five the chicks hatched (Table 1).

Eggs and nestlings.—All of the eggs observed were cream-buff with scattered brown spots (Fig. 1B). Eggs measured a mean 30.2×22.3 mm (range $28\text{--}34 \times 21\text{--}25$ mm; $n = 10$) and mean mass was 7.8 g (range 6.9–9.0 g; $n = 9$). Nestlings were covered in down (Fig. 1C). The mass of the nestling at nest 8 (Table 1) on the day it hatched was 8 g; two days later it weighed 13 g, representing a gain of 2.5 g per day. The nestling at nest 18 (Table 1) weighed 10.3 g when it was 1–2 days old, on 5 August 2019 (Fig. 1C). We could not relocate either nestling on the following days to continue monitoring mass gain.

Morphometrics.—We trapped and measured nine adult Common Pauraques between 2010 and 2017. Mean and standard deviation were: mass 62.8 ± 11.4 g (range 45–77 g, $n = 9$); wing 163.8 ± 7.6 mm (range 155–176 mm, $n = 9$); tarsus 23.7 ± 2.8 mm (range 20.0–28.6 mm, $n = 9$); bill 12.7 ± 2.1 mm (range 10–16 mm, $n = 7$); head length 41.2 mm ($n = 1$); tail length 154.3 ± 10.2 mm (range 143–170 mm, $n = 9$); total length 261.5 ± 60.8 mm (range 118–310 mm, $n = 8$); cloacal temperature $38.7 \pm 1.3^\circ\text{C}$ (range $37.8\text{--}39.6^\circ\text{C}$, $n = 2$).

Breeding season in Acre.—The 25 active nests were found in a total of eight different months, but mostly in July and September–November (Fig. 2).

Breeding season in Brazil.—We found 253 records of active nests of *N. albicollis* at Wikiaves, photographed between 2003 and 2019, in the Distrito Federal and in 25 of the 26 Brazilian states. A total of 152 photos documented eggs (58 were of one egg and 94 of two eggs); 88 photos were of nestlings (51 of one and 37 of two nestlings) and 13 photos were of an egg and a newly hatched nestling. The 253 records were distributed over 11 months of the year, the exception being May (Fig. 3). Most photos were taken between September and November (71.9%; $n = 113$ of photos with eggs and 77.14%; $n = 81$ of photos with nestlings) (Fig. 3). The remainder of the photos were distributed across other months (Fig. 3). Most photos were from south-east Brazil ($n = 119$), followed by the north-east ($n = 48$), south (n

TABLE 1
Active nests of Common Pauraque *Nyctidromus a. albicollis* in a forest fragment in south-west Amazonian Brazil between 2011 and 2020.

Nests	Date of discovery	Contents	Observations
1	20 October 2011	1 egg	Not monitored. Adult incubating.
2	20 February 2012	1 egg	Nestling hatched 27 February 2012.
3	10 July 2012	1 egg	Not monitored. Adult incubating.
4	5 September 2012	1 egg	Not monitored. Adult incubating.
5	6 November 2012	1 egg	Predated 9 November 2012.
6	18 September 2013	1 nestling	Not monitored. Nestling moved into forest on same day it was discovered.
7	27 August 2014	1 egg	Nestling hatched 1 September 2014.
8	25 September 2014	1 egg	Nestling hatched 8 October 2014.
9	2 September 2015	1 egg	Predated 23 September 2015.
10	14 September 2015	1 egg	Predated 21 September 2015.
11	14 September 2015	1 egg	Predated 23 September 2015.
12	13 October 2016	1 egg	Not monitored. Adult incubating.
13	14 October 2016	1 egg	Not monitored. Adult incubating.
14	15 October 2016	1 egg	Nestling hatched 20 October 2016.
15	2 April 2017	1 egg	Not monitored. Adult incubating.
16	17 June 2017	1 egg	Not monitored. Adult incubating.
17	1 November 2018	1 egg	Not monitored. Adult incubating.
18	25 July 2019	1 egg	Nestling hatched between 2 and 5 August 2019.
19	26 July 2019	1 egg	Nest abandoned 7 August 2019.
20	26 July 2019	1 egg	Not monitored. Adult incubating.
21	26 July 2019	1 egg	Nest abandoned 5 August 2019.
22	29 July 2019	1 egg	Nest abandoned 7 August 2019.
23	30 October 2019	1 egg	Not monitored. Adult incubating.
24	19 November 2019	1 egg	Not monitored. Adult incubating.
25	26 February 2020	1 egg	Not monitored. Adult incubating.

= 35), north ($n = 31$) and central west ($n = 20$). Of the 253 records at Wikiaves, a total of 47 nests was recorded in the latitudinal range 0–10°S, wherein clutch size was one in 15.01% of the total number of records ($n = 38$) and in 3.55% clutch size was two ($n = 9$), whereas in the range 11–30°S we found photos of 206 nests, and in 28.45% of the overall total clutch size was one ($n = 72$) and in 53% it was two ($n = 134$).

Discussion

N. a. albicollis is a common resident at UFAC. It is usually found in forest, near edges, but also along the main trails in the Zoobotanical Park and wooded areas elsewhere (e.g. rubber tree plantations). Our records indicate that it regularly breeds at the study site. Some of the areas chosen for nesting by the species are subject to intense anthropic activity, indicating an adaptability to these areas (Ingels *et al.* 1999). A recent study found that the species also breeds in another forest fragment 30 km from Rio Branco (Lima *et al.* 2019), indicating reasonable adaptation to the fragmented landscape of eastern Acre.



Figure 1. Active nest of Common Pauraque *Nyctidromus a. albicollis* in a forest fragment in south-west Amazonia (nest 18, Table 1): (A) adult incubating; (B) view of the egg; (C) nestling on the day it was weighed (Edson Guilherme)

The shape and colour of the eggs were compatible with previous descriptions from various regions (Ihering 1900, Hellebrekers 1942, Thurber 2003, Vasconcelos *et al.* 2003). Egg measurements were similar to those presented by Ihering (1900) and Alvarenga (1999) from São Paulo, Vasconcelos *et al.* (2003) in Minas Gerais, Haverschmidt (1968) in Suriname, Ingels (1975) in French Guiana, and Thurber (2003) in El Salvador. However, the eggs we measured averaged larger than those presented by Euler (1900) in Brazil (locality unknown) and Luz *et al.* (2011) in Rio de Janeiro. Mean egg mass was compatible with the averages presented by Latta *et al.* (2020) from several countries, including Brazil. However, the mass of eggs and newly hatched chicks were greater than those presented by Luz *et al.* (2011) from Seropédica, Rio de Janeiro. It is unknown whether these differences would prove consistent given large sample sizes, and if they are related to latitude or subspecific differences (*N. a. albicollis* vs. *N. a. derbyanus*). Unfortunately, we were unable to weigh nestlings older than two days after hatching because they move and remain hidden

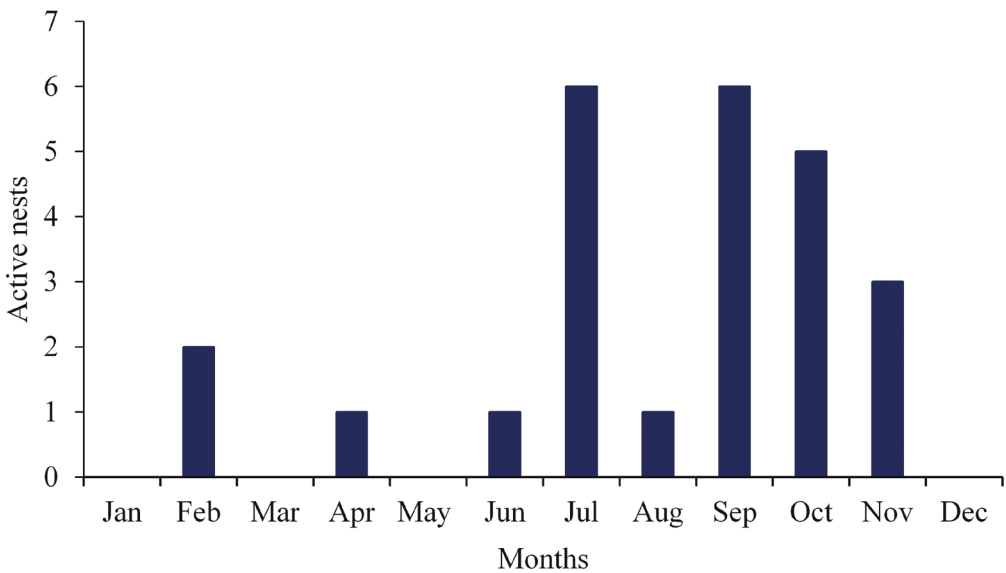


Figure 2. Monthly distribution of active nests of Common Pauraque *Nyctidromus a. albicollis* in a forest fragment in south-west Amazonia between 2011 and 2020.

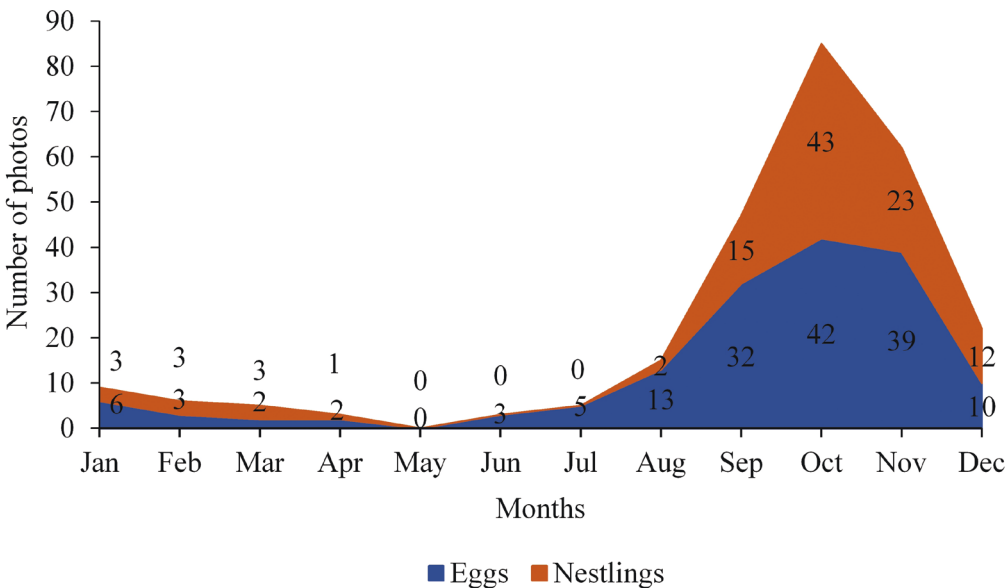


Figure 3. Monthly distribution of 253 documented active Common Pauraque *Nyctidromus albicollis* nests from the Wikiaves portal (www.wikiaves.com.br) captured on 23 March 2020. Numbers inside the graph indicate the precise number of photos with eggs (below) and nestlings (above) per month of the year.

(Alvarenga 1999, Vasconcelos *et al.* 2003, Luz *et al.* 2011). Usually displacement of the young, behaviour typical of nidifugous birds, occurs from the forest edge to the interior (EG pers. obs.), making it difficult or impossible to locate nestlings subsequently.

Clutch size.—The number of eggs laid by the species is one or two, according to region (Latta *et al.* 2020). In our study area, all nests contained just one egg, unlike clutches reported at other locations, where two eggs are common, but similar to data from Suriname

(Latta *et al.* 2020). That all nests contained just one egg might indicate that local predation rates are not high, but we recommend further studies to verify this hypothesis. Citizen science records revealed that at latitudes nearest the equator (0–10°S) there was a higher percentage of nests with one egg, but this percentage was reversed in favour of two-egg clutches at higher latitudes towards the south. Previous studies indicate variation in the clutch size of birds in relation to distance from the tropics (Lack 1947, Wagner 1957, Ricklefs 1980, Murray 1985), and this clearly appears true for *N. albicollis*. One of the hypotheses to explain an increase in clutch size at higher latitudes is that longer days provide more time for birds to find food for their young (Lack 1947, Wagner 1957, Ricklefs 1980). According to Wagner (1957), for nightjars this hypothesis would work in reverse, i.e. clutch size increases as latitude decreases, because brighter nights in the tropics provide more time to forage. However, for Common Pauraque Wagner's arguments does not appear true. Although clutch varies only between one or two eggs, as in almost all nightjars (Ingels *et al.* 2017), size increases with latitude. This leads us to consider that other factors may influence clutch size in Common Pauraque, such as resource seasonality, rainfall, population density and predation (Ricklefs 1980, Murray 1985, Skutch 1985), which will need further study to clarify.

Morphometrics.—All morphometric data including cloacal temperature were compatible with that of a male measured by Oniki & Willis (1999) in Mato Grosso, and with two unsexed individuals measured by Piratelli *et al.* (2001) in Mato Grosso do Sul. Mean mass was also compatible with that presented by Graves & Zusi (1990) for three males trapped along the rio Xingu, Pará.

Breeding season.—The literature reveals that the species' breeding season throughout its distribution is quite varied and lacks a clearly defined pattern (Ihering 1900, Snethlage 1935, Hellebrekers 1942, Ingels 1975, Alvarenga 1999, Thurber 2003, Vasconcelos *et al.* 2003, Luz *et al.* 2011, Latta *et al.* 2020). Compilation of photos of active nests in Brazil revealed breeding activity in almost all months of the year. However, there is a peak between August and December, i.e. at the end of the driest period and the start of the wet season in most regions of Brazil, especially concentrated in the transition between the dry and wet months (September–October) (Gan *et al.* 2004). This contradicts the hypothesis that the species prefers to nest at the height of the dry season (Ingels 1975). By laying in the late dry season, it avoids rains that could hinder incubating the eggs, but chicks hatch at the start of the wet season when food availability is greater (Baldrige *et al.* 1980, Nascimento *et al.* 2011). Many tropical insects fluctuate in abundance with climatic conditions (Kishimoto-Yamada & Itioka 2015). A study in the Brazilian Cerrado found that Hymenoptera, Coleoptera, Lepidoptera, Isoptera, Hemiptera and Trichoptera increased in abundance during the dry / wet transition period, in September–November (Silva *et al.* 2011). Thus the breeding peak of *N. albicollis* in this period may well be linked to the abundance of food to provision the young.

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