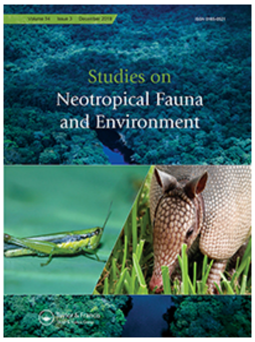


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# Breeding biology and nesting success of the endemic Black-cheeked Gnateater (*Conopophaga melanops)*

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# Breeding biology and nesting success of the endemic Black-cheeked Gnateater (*Conopophaga melanops*)

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**ABSTRACT**

Life history traits are essential for better understanding avian populations. In some cases, timing of the breeding season depends on external environmental factors such as photoperiod, rainfall, food availability and temperature. Here we describe the life history traits of a northeastern population of Black-cheeked Gnateater and we aim to understand the factors behind fluctuations on life-history traits. Breeding was quite seasonal, with the core of the breeding season right before the beginning of heavy rains. Highest numbers of active nests occurred in April and nesting activity was lowest from July to September, a period matching the shortest and coldest months of the year. Daily survival rate (DSR) for the whole nesting cycle was 0.883 $d^{-1}$, giving a Mayfield nest success of 12.9%. Our data suggest that this population uses environmental factors as cues to modulate breeding activity.

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Neotropical bird; avian reproduction; latitudinal gradient; tropical photoperiod; rainfall; Mayfield

## Introduction

Knowledge of life history traits is essential for understanding population dynamics, demographic traits and differences between temperate and tropical birds (Martin 1996). Such data are extremely important for planning accurate conservation strategies; however, for most Neotropical birds this information is particularly limited.

Birds in the tropics present a series of common traits comprising long breeding seasons (Baker 1939), small clutch sizes (Ricklefs 1968, Mason 1985), long nesting periods (Ricklefs & Brawn 2013) high nest predation and low survival rates (Griebeler et al. 2010). These traits belong to the slow-paced category in the slow–fast continuum of life-history traits (Ricklefs 2000, Wiersma et al. 2007, Hille & Cooper 2014). Unlike tropical birds, temperate species fall into the fast-paced category, presenting large clutch sizes, short nesting period, short breeding seasons and high survival rates (Ricklefs 2002).

Although tropical birds may not show the same marked breeding seasonality as temperate birds (Stouffer et al. 2013), in some cases timing of the breeding season depends on external environmental factors such as photoperiod (Hau et al. 1998, Wikelski et al. 2000), rainfall (Cavalcanti et al. 2016), food availability (Salgado-Ortiz et al. 2009) and temperature.

Black-cheeked Gnateater (*Conopophaga melanops* (Vieillot, 1818)) is a member of the Conopophagidae family endemic to the Brazilian Atlantic Rainforest (Whitney 2017). Its distribution includes the tropics and subtropics, ranging from northeastern Brazil down to Santa Catarina (Whitney 2017). It inhabits the forest understory (Straube 1989, Sick 1997) and, as with other gnateaters, is mainly terrestrial and feeds exclusively on insects (Ridgely & Tudor 2009). The nest is an open cup of leaves and twigs, commonly placed on bushes at low heights above the ground (Stenzel & Souza 2014). Although little is known on its dispersal behavior, it is believed that Black-cheeked Gnateater is a relatively sedentary species dependent on the forest interior (Lunardi et al. 2007). Life history traits of a southern population of Black-cheeked Gnateater have been described as atypical for tropical species, presenting a short breeding season, high breeding success and low adult survival (de Lima & Roper 2009).

At a global scale, the population is in decline due to habitat destruction and fragmentation (Del Hoyo et al. 2003). Today, only about 11.7% of the Atlantic Rainforest original extent remains in Brazil (Ribeiro et al. 2009). Given the past and present fragmentation of the Atlantic Rainforest, the endemism and natural sedentary behavior of Black-cheeked Gnateater, this species may be vulnerable to extinction of populations in local fragments (Davies et al. 2004, Isaac et al. 2009). Here we describe the life history traits of a northeastern population of Black-cheeked Gnateater in an Atlantic Rainforest enclave.

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## Material and methods

We studied a population of northeastern Brazil in a 4469 ha forest, the Pedra Talhada Biological Reserve (Figure 1). The reserve is located on a granitic multi-convex relief hill reaching 883 m above sea level in the massif of Serra das Guaribas, between the states of Alagoas and Pernambuco (09°14.00′S; 36°25.00′W). The forest is an enclave of the Atlantic Rainforest biome, consisting of sub montane and montane semi-evergreen seasonal woodland, regionally known as 'brejo de altitude', far more humid than the surrounding lowland areas. Ranging from 300–1500 mm of accumulated annual precipitation (SEMARHN/AL 2017), the area presents great year-to-year variations on accumulated annual rainfall. However, the rainy season usually falls between the months of April and August. Vegetation includes forest on flatlands, slopes, and rocky terrain, with evergreen and deciduous trees up to 35 m high, as well as open vegetation on rocky outcrops, clearings and marshes (Studer et al. 2015). The pristine vegetation that formerly surrounded the forest has been nearly entirely logged, and today the forest is surrounded by private cattle ranches.

Fieldwork was conducted in the southern part of the forest from April 1985 to June 2017, excluding the period 2010–2015, covering a surface of 350 ha. Nest search intensity was higher during the potential breeding season (February–May; ~20 days per month) and lower during the rest of the year (~10 days per month). Nests were located either by observing conspicuous adult behavior (Martin & Geupel 1993) or direct inspection of known, previously active nests, understanding an active nest as one with eggs or young. When an active nest was found, it was visited every three to four days and every second day when near hatching or fledging (Lara et al. 2012). If the exact date of nest failure/success could not be determined, we recorded the median date between the two last visits (Dudley & Saab 2003). When feasible, a leaf-camouflaged blind was installed 6–8 m away from nest, providing a good view of the surroundings. Observations were made with binoculars and video images were recorded.

Nesting cycle was determined by the sum of incubation and nestling periods. Nest construction and post-fledging parental care were not examined. Incubation was estimated from the complete posture of the entire clutch to the hatching date of the first chick. Nestling period was estimated from hatching of the last chick to fledging of the first chick.

To determine the breeding season length, we took into account all the years fieldwork was conducted and breeding season was calculated by the first date an active nest was encountered to the fledging date of the latest nest. To study the relationship between breeding activity with weather, we collected rainfall, temperature and photoperiod data. Rainfall data was obtained from the 'Agência Pernambucana de Águas e Clima' (APAC) in the meteorological station of Correntes (~30 km from the reserve). Temperature data was obtained from the "Instituto Nacional de Meteorologia (INMET) in the meteorological station of Palmeira dos Indios (~50 km from the reserve).

Reproductive success was given as daily survival rates (DSR) for incubation and nestling periods (Mayfield 1961, (Mayfield 1975). Nest success from the start of incubation to fledging was calculated as the product of both DSRs (Mayfield 1961, 1975). A nest was considered successful when at least one of the chicks fledged. As generally the entire content of the nest disappears during predation,

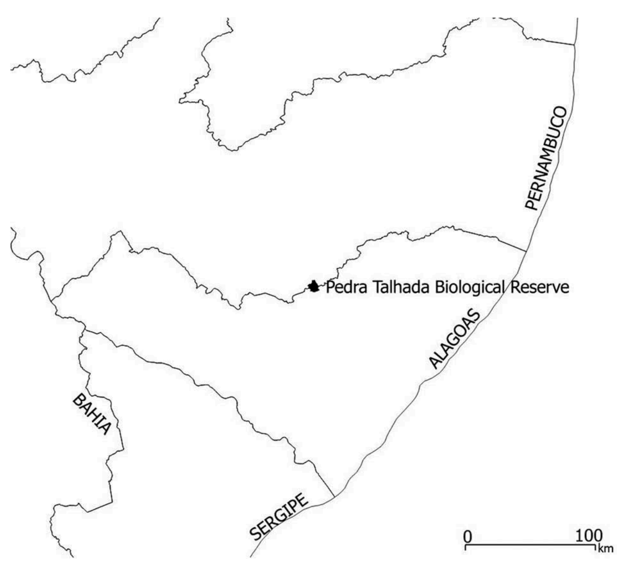


Figure 1. Location of the study area in northeastern Brazil (09°14.00′S; 36°25.00′W).

partial losses were ignored (Ricklefs 1969, Martin 1993). Predation was considered the cause of nest failure when eggs vanished before hatching or nestlings disappeared prior to the estimated fledging date. Chi-square test following Dow's method was used to determine the significance of differences between both DSR (Dow 1978).

## Results

We monitored 114 nests of the Black-cheeked Gnateater. Clutch size was invariably two eggs (N = 114), incubation period varied between 17 and 18 days ($\bar{x}$ = 17.4 days ± 0.14 SE; N = 7) and nestling period between 13 and 16 days ($\bar{x}$ = 14.6 days ± 0.17 SE; N = 21). Complete nest cycle interval lasted a maximum of 32 days (N = 2).

With a rainy season from April to August (Figure 2), rainfall varied seasonally over the years of the study period. 1998 was the driest month with 500 mm of cumulative rainfall. With 1500 mm of cumulative rainfall, 2004 and 2017 were the wetter months. Over the study period, average cumulative rainfall was 1000 mm.

Breeding season of the target population started around the vernal equinox, with the earliest clutch initiation being recorded on 17 September. The latest clutch initiation was recorded on 13 June, giving a breeding season length of 269 days. The core of the breeding season ranged from March to May, a period right before the arrival of heavy rains (Figure 2). Highest numbers of active nests occurred in April and nesting activity was lowest from July to September, a period matching the shortest and coldest months of the year.

Of 114 nests found, 23 nests were successful (20.2%), 82 failed (71.9%) and nine had an unknown fate (7.9%). Out of the 82 nests that were unsuccessful, 74 were due to predation (64.9% of all nests, 90.2% of all failures). Contents of nests disappeared after predation and predators rarely left signs of their passage. During incubation, 63 nests failed and only eight losses could be attributed to some cause other than predation: five were abandoned and three were destroyed by adjacent branches. All losses during the nestling period were due to predation. DSR during incubation and nestling periods were 0.922 $d^{-1}$ and 0.958 $d^{-1}$ respectively, statistical differences were significant ($\chi^2$ = 8.64; *p*-value < 0.005). DSR for the whole nesting cycle was 0.883 $d^{-1}$, giving a Mayfield nest success of 12.9%.

## Discussion

Black-cheeked Gnateaters extend over a wide latitudinal gradient, inhabiting different climatic regions. Life history traits of this population of Black-cheeked Gnateaters are typical for tropical species, presenting a long breeding season, low nest success and small clutches. On the other hand, a southern population of Black-cheeked Gnateaters in subtropical Brazil presents temperate-like life history traits with a short breeding season from October to January (100 d), and high survival rates (de Lima & Roper 2009). de Lima and Roper (2009) observed a nest-cycle interval of 41 days on average, differing by 10 days from our study. This may be a result of the high nest predation pressure Black-cheeked Gnateaters are suffering in our study area. By shortening the nesting period, adults can prolong the post-fledging care and therefore avoid nest predators. The 12.9% nest success of Black-cheeked Gnateater by means of the Mayfield (1975) method is among the lowest success rate observed for Neotropical passerines. It is lower than for the same species in southern Brazil (24%; de Lima & Roper 2009) and Rio de Janeiro 23% (apparent estimator method; Stenzel & Souza 2014). Such low nest success may imply a decline in the population; however, this does not appear to be the case, as Black-cheeked Gnateaters are one of the most abundant species in the area (pers. obs.). As birds were not banded, we could not identify renesting attempts of unsuccessful nests. However, we believe that unsuccessful Black-cheeked Gnateaters carry several nesting attempts throughout the breeding season, resulting in an underestimation of nest success.

Gnateaters in general are socially monogamous with both parents contributing to incubation and nestling care (Willis et al. 1983, Straube 1989, Alves et al. 2002, Whitney 2017). During incubation the Black-cheeked Gnateater showed a statistically lower DSR than during nestling period. Lower survival during incubation could be attributed to the fact that under high predation pressure, more susceptible nests may be destroyed early in the nesting cycle, while those nests that survive are the ones more difficult to be detected by predators (Nolan 1978). Yet, as predation events are usually unexpected and fieldwork conditions do not favor predator–prey interaction studies, we could rarely witness such events. In the future, the use of camera-trap devices could be of high value in order to bring light to these questions.

Our data suggest that this population of Black-cheeked Gnateaters uses environmental factors as cues to modulate breeding activity. The core of the breeding season matched the onset of the wet season, a period that is known for its increase in food abundance (Immelmann 1971). Moreover, nesting activity was lower or even absent during the shortest and coldest months of the year.

Tropical birds use rainfall and food abundance as short term cues for tuning reproductive activities (Wikelski et al. 2000), as they indicate good conditions for breeding. On the other hand, it has been suggested that photoperiod and

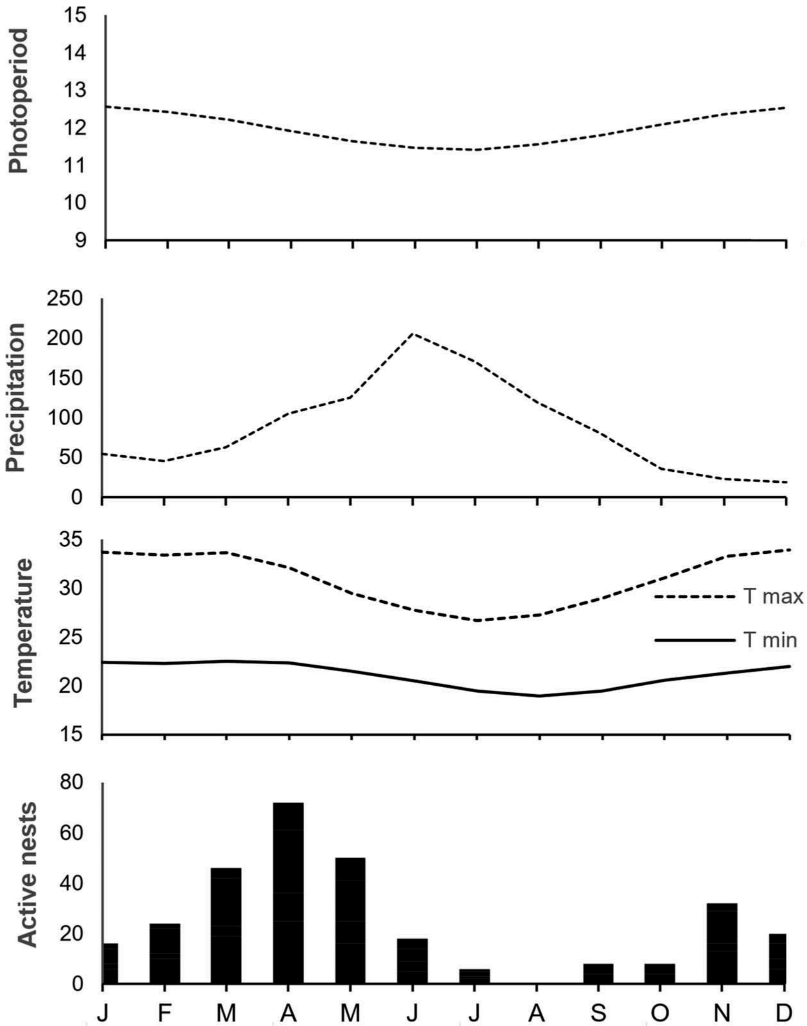


**Figure 2.** Number of active nests/month, max and minimum temperature (°C), precipitation (mm) and photoperiod (hours).

its correlated temperature present the best long-term signal about environmental changes, even in the tropics, where changes in day length are very small (Hau et al. 1998, Wikelski et al. 2000).

In this study we show that breeding activity in Black-cheeked Gnateaters is not only modulated by climate but that photoperiod and temperature also play important roles. A hypotheses already suggested by de Lima and Roper (2009). Next, by comparing our data with that of de Lima and Roper (2009) we show that timing and length of the breeding season of this endemic species is affected by the latitudinal gradient. Finally, we suggest that to better understand nest success, capture–recapture studies are needed as territoriality and renesting attempts can lead to nest success miscalculations.

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## Disclosure statement

No potential conflict of interest was reported by the authors.

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## Notes on contributor

*Anita Studer* conceived the ideas and designed methodology; AS and MCS collected the data; BB analyzed the data; AS, BB and MCS led the writing of the manuscript. All authors contributed critically to the drafts and gave final approval for publication.

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## Appendix

The nest of *C. melanops* belonged to the low/cup base nest category according to Simon and Pacheco (2005). Nests were highly visible and were placed on top of shrubs, on broken tree trunks and on accumulation of lianas or fallen branches. Nests were very exposed in the forest understory, with no vegetation above the nest. Eggs were especially visible in the absence of incubating adults. Heights above ground ranged from 30 to 265 cm ($\overline{x}$ = 69.4cm; ± 4.33 SE; N = 99). Mean measurements of nests were: 13.6 cm ± 0.54 SE external diameter (N = 58); 6.11 cm ± 0.14 SE internal diameter (N = 58); 3.78 cm ± 0.25 SE for depth of nest cup (N = 58); 8.6 cm ± 0.35 SE for cup height (N = 58) and 16.4 g ± 1.71 SE in weight (N = 45). The outer structure of nests consisted of dried leafs interspersed with dry twigs, whereas the inner surface was predominantly made of fine twigs and grass stems.

Eggs were oval, light salmon in color with small reddish/brown spots, sometimes presenting a surrounding crown. Average dimensions were 17.03 mm ± 0.08 SE wide and 22.41 mm ± 0.07 SE long (N = 41). Eggs weighed on average 3.21g ± 0.1 SE (N = 40). Both parents contributed to incubation and nestling care. Food consisted of insects, including locusts, beetles and crickets. Fecal sacs were always removed.

Chicks hatched naked, with no down feathers. Skin was purple-black on the back and purple-red on the abdomen. Beak was brown with white flanges. Flanks, tibia and tarsus were brown and nails gray. After three to four days, skin was covered with fine gray down. When near fledging, the plumage of the head and back was dark brown, wings light brown and beak was black.