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New Breeding Information on the Endangered Pinto's Spinetail *Synallaxis infuscata* in the Atlantic Rainforest of Northeastern Brazil

Anita Studer † **and Leïla Perroulaz** *

Nordesta Reforestation & Education, Rue de Lyon 12, 1201 Geneva, Switzerland
* Correspondence: leila.perroulaz@nordesta.org
† Passed away.

Simple Summary

Information on bird breeding biology is important, because it enables us to better understand a species, make comparisons with related species, and implement accurate conservation strategies. In this study, our aim was to describe the breeding habits of Pinto's Spinetail (*Synallaxis infuscata*), an endangered Neotropical bird about which little was previously known. Between 1986 and 2018, we observed 33 nests and recorded their measurements, as well as the number and size of the eggs in each nest. Apparent nest success, defined as the proportion of nests where at least one juvenile fledged, was 27.3%. Nests mainly failed due to predation, accounting for 81% of failed nests. The breeding information we found was similar to that found for other Spinetails. Our study provides important information on the breeding of this species, which could help to protect it more efficiently.

Abstract

Information on the breeding of the Pinto's Spinetail (*Synallaxis infuscata*), an endangered Brazilian Furnariid, is scarce. This study aims to complement it, by looking at nest and clutch parameters, breeding period, and nest success. Once nests were found, they were closely monitored from a hide. Between 1986 and 2018, 33 nests were found in the Pedra Talhada Forest near Quebrangulo. Nests were found year-round, except in middle of the dry season. Nests were of the closed/retort type, weighing 552.1 g, and measuring 37.6 × 28.8 cm, with a side arm of 30.6 × 4.9 cm, on average. The clutch size averaged 2.10 eggs, which measured 22.3 × 17.2 mm and weighed 3.2 g. They were white and had an oval to pointed-oval shape. Mean incubation period was 21.5 days and mean nestling period 14.71 days. The apparent nest success was 27.3%, while Mayfield's was 21.8%. Predation was the main cause of nest failure, accounting for 81% of cases. The breeding data we collected on *S. infuscata* falls within the range of observations of a comprehensive analysis on other *Synallaxis* species. This breeding information is important for conservation, as rates of nest loss are a key factor in evaluating population viability.

Keywords: nest success; neotropical bird; avian reproduction; life history

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1. Introduction

Life history studies are important because they help us understand population dynamics and they allow us to make useful comparisons between species [1]. For example, slower life history traits are exhibited by tropical birds than by birds in temperate regions, with

greater investment in survival than reproduction being favoured [2]. In terms of reproduction, longer breeding seasons are experienced by tropical birds [3,4], which are associated with a higher number of clutches and a high re-nesting potential [1,5–7]. Moreover, smaller clutch sizes [8–11], lengthier incubation and nestling periods [1,10,12–16], and extended post-fledging care [17–19] are typical of these species. In terms of species survival, they exhibit reduced mortality [20,21], as well as lower basal and metabolic rates [22–24] and low thermogenic heat production [23]. They also show later sexual maturation [12,18] and delayed senescence [25,26]. Data on the life histories of birds is useful for planning accurate conservation strategies [27–29] and inferring phylogenies [30,31]. However, such data remain scarce for a large number of Neotropical bird species [1].

The *Synallaxis* genus [32] is part of the Furnariidae family and comprises 37 species from the Neotropics [33]. The Pinto's Spinetail *Synallaxis infuscata* (Pinto, 1950) was initially described as a subspecies of *Synallaxis ruficapilla* [34], but Vaurie [35], described it as a distinct species, a classification that has been followed by subsequent authors [36]. Recent morphological and molecular studies indicate that *S. infuscata* is closely related to a group consisting of the species *S. ruficapilla*, *S. whitneyi*, *S. macconnelli*, *S. cabanisi* and *S. moesta* [37–40]. However, the precise position of *S. infuscata* within this group remains to be clarified. Morphological and whole-genome sequencing analyses reveal that *S. infuscata* is more closely related to *S. ruficapilla* and *S. whitneyi* ([38–40], even if Stopiglia [40] consider *S. whitneyi* to be part of *S. ruficapilla*), but a mitochondrial genetic analysis suggests that *S. infuscata* is more closely related to *S. moesta* [37].

Synallaxis species build nests of closed/retort shape (according to Simon & Pacheco [41]), made of plant and animal materials [42]. These nests are located at a low height from the ground [42]. The clutch size varies from two to five eggs [42]. Incubation lasts between 15 and 25 days [43,44], and the nestling period varies lasts between 13 and 22 days [43–45]. Information on the breeding biology of the closely related species is only available for *S. moesta* and *S. ruficapilla* [46–48]. Both species lay clutches of two to three white eggs in nests made of sticks, dry leaves, bark, and snake and lizard skin [46,48]. The incubation and nestling periods are unknown for both species.

S. infuscata is endemic to the north-east of Brazil, in the states of Alagoas, Pernambuco and Paraíba [36,42]. This species is typically found in tropical lowland evergreen forests and thrives in woodland edges, scrubby forest and early second growth, at altitudes of up to 500 m [42]. It is classified as endangered on the IUCN Red List, as well as the Red List of Brazilian Birds, due to its small, fragmented and declining habitat and decreasing population trend [49,50]. Indeed, this species is confined to the Pernambuco Endemism Centre [51], a region that has been significantly impacted by deforestation, with only 12.1% of the initial vegetation remaining [52]. Moreover, it is estimated that the total population comprises fewer than 2500 mature individuals, with no more than 250 individuals in each subpopulation [50]. The populations are severely fragmented, and the number of individuals continues to decline. The main threat to this species is the reduction of its habitat due to the conversion of forests into pastures and sugarcane plantations [50]. *S. infuscata* is an arthropod-consuming species that forages for preys in low-lying vegetation, such as foliage, dead leaves and small branches, at ground level. It forages either alone or in pairs [53]. There is no sexual dimorphism in this species [42].

The available literature on the breeding biology of *S. infuscata* is extremely limited, the only description refers to a personal communication made by the author Anita Studer to the editors of the Handbook of the Birds of the World [42]. This study therefore aims to describe key aspects of the breeding biology of this species, including nest form, clutch and egg size, breeding period, and nest success. The knowledge acquired about this species' natural history will be helpful to elaborate accurate conservation plans [36,50].

2. Materials and Methods

The study was conducted in and around the Pedra Talhada Biological Reserve (09°11′–09°16′ S, 36°22′–36°28′ W, Figure 1), which is located in the states of Alagoas and Pernambuco, Brazil [54]. The area is characterised by significantly higher humidity levels in comparison to the surrounding lowland regions [54]. The mean annual precipitation at the Quebrangulo pluviometric station between 1986 and 2011 was 1586 mm per year (computed from [55]). The rainy season generally extends from April to August, though it can vary from year to year. The area's vegetation is characterised by diverse woodlands on both flatland and slopes, as well as rocky terrain. These woodlands include evergreen and deciduous trees reaching up to 35 metres in height. Open vegetation can be found in a variety of settings, including rocky outcrops, clearings, and marshes [54]. The forest's pristine vegetation has been extensively logged, and today it is surrounded by private cattle ranches (Figure 2).

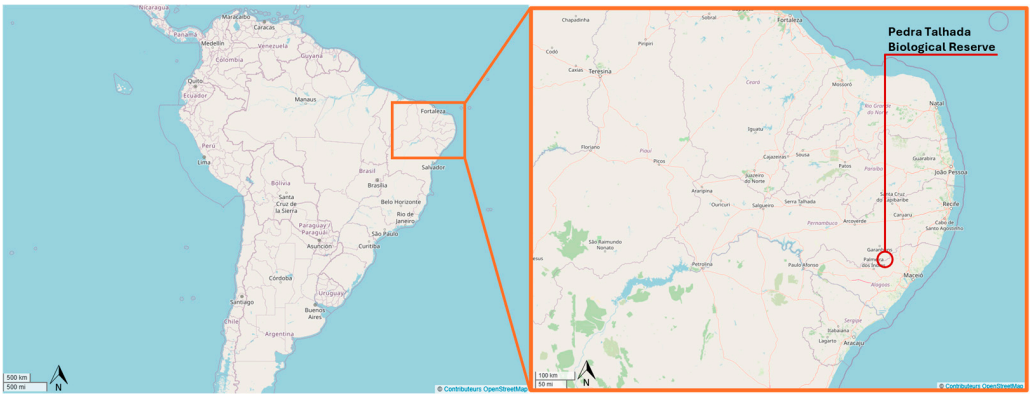


Figure 1. Location of the study area in the Pedra Talhada Biological Reserve over the states of Alagoas and Pernambuco, Brazil. (Map is a screenshot from OpenStreetMap, available under Open Database License at openstreetmap.org/copyright, accessed on 5 January 2026).

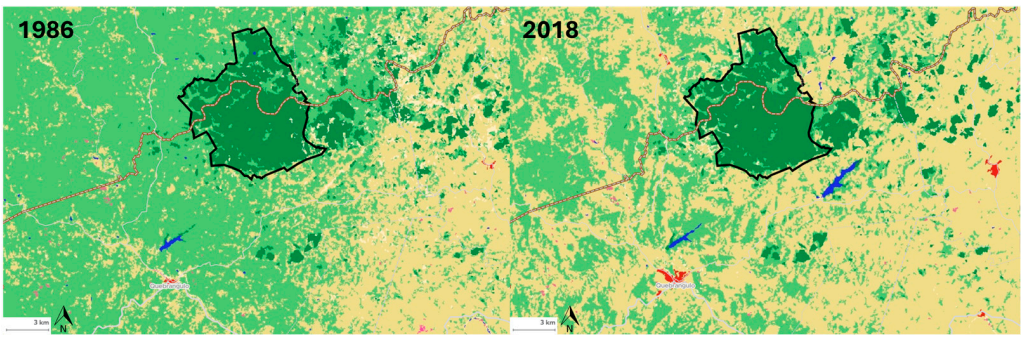


Figure 2. Change in land use around the Pedra Talhada Biological Reserve between 1986 and 2018. The black plain line shows the boundaries of the Pedra Talhada Biological Reserve. The brown striped line shows the border between the states of Alagoas (bottom of the map) and Pernambuco (top of the map). Light green represents savanna, dark green represents forest, beige represents pasture, blue represents rivers and lakes, and red represents urban areas. (Maps are screenshots from MapBiomas Brasil, available under Creative Commons CC-BY license at plataforma.brasil.mapbiomas.org, accessed on 5 January 2026).

The study period ran from 1986 to 2018, but sampling efforts were inconsistent throughout. Indeed, no nests were observed in the years 1987 to 1989, 2003 to 2004 and 2006 to 2016.

Nests were located either by observing adult behaviour or by chance [56]. Once an active nest had been located, it was visited every three to four days, or every other day near hatching or fledging. In instances where the precise date of hatching or fledging could

not be ascertained, it was recorded as the median date of the two most recent visits [57]. Observations were made from a concealed position, situated between six and eight metres away from the nest, using binoculars. Photographic and video recordings were also made each time activity around the nest was observed. Opportunistic behavioural observations were also conducted from the hide. During 100-min observation periods, the presence of an adult at the nest was noted, along with feeding events and preys brought to the nestlings, when identifiable.

The eggs were weighed using a Pesola Spring scale with a 0.1 g accuracy, and their width and length were measured using a calliper with 0.1 mm accuracy. Egg volume was calculated as 0.51 × Egg length × (Egg width)^2 [58] The nest dimensions were measured with a ruler with a precision of 0.5 cm, and the mass was measured with a spring scale with a precision of 0.5 g. The nest was accessed to take these measurements right after the fledglings had left or the nest failed, in order to minimise disturbance. Nests were measured directly on the field and were not dried before taking the measurements. All nest components were collected for weighing, including pieces that fell on the ground during collection. Data on nest measurements were only collected when possible, i.e., when the nest was accessible and without causing too much disturbance. Therefore, not all nests were measured, and not all measurements were possible for those that were. The number of nests for which measurements were taken is indicated in parentheses after each measured value in the results section.

The incubation period was defined as the time between the complete laying of the clutch and the hatching date of the first chick. The nestling period was defined as the time between the hatching of the first egg and the fledging of the last offspring. The breeding season was determined as the period from the earliest date that an active nest was found to the latest date of fledging across all nests found. It was determined that predation was the cause of nest failure when eggs or nestlings disappeared before the expected date of hatching or fledging, respectively. A nest was considered successful if at least one nestling fledged. The Mayfield method was used to calculate nest success [59].

Statistical analysis was performed in R (version 4.5.2) [60] using the RStudio software (version 2025.09.2.418) [61]. To reveal whether a factor had a significant impact on the fate of a nest, Firth logistic-exposure regression models were fitted, using the logistf function from the logistf package (version 1.26.1) [62]. These models reduce bias in small samples and provide accurate estimates in cases of rare events (here, the low number of successful nests) [63,64]. The response variable was the nest fate, coded binomially as 1 = nest success and 0 = nest failure. To avoid overfitting, we coded five different models, one for each predictor (egg volume, month, nest height, nest location and nest environment) [65]. We accounted for unequal monitoring periods by including the logarithm of exposure days as covariate [66,67]. Continuous predictors (egg volume, month and nest height) were standardised (mean-centred and scaled by their standard deviation) prior to analysis [68].

3. Results

Between 1986 and 2018, 33 nests of *Synallaxis infuscata* were found in the Pedra Talhada Forest near Quebrangulo. Nests were found year-round, with the exception of December and January, which correspond to the middle of the dry season. The highest number of nests were recorded in April and October, just before and after the rainy season.

The nests were of the closed/retort type (according to Simon & Pacheco [41]), generally taller than wide, with an average weight of 552.1 g (±205.2, n = 14), height of 37.6 cm (±8.9, n = 15) and width of 28.8 cm (±12.4, n = 17), respectively (Figure 3). A side arm housed a corridor that provided access to the interior of the nest. The average length of this side arm was 30.6 cm (±4.4, n = 7), with an internal diameter of 4.9 cm (±3.4, n = 4). The incubation

chamber itself measured 10.9 cm (±7.6, *n* = 12) and was lined with a cluster of woolly green leaves (Asteraceae) glued together with webs and spider nests, which gave it the appearance of a thick piece of felt. The nests are usually well concealed under tangles of vines and bromeliads, at an average height of 2.16 m (±1.14, *n* = 33) above ground level. Nests were constructed using a variety of materials, including smooth and thorny sticks, dry and green leaves, other vegetation, snake skins and spider webs both internally and externally, with an addition of dry grass, plant fibres and small pieces of wood on the outside (Figure 4). Nests were predominantly located in bushes (*n* = 21), with some also being found in lianas (*n* = 5), piles of leaves/branches (*n* = 2), high grass (*n* = 1) and trees (*n* = 4). The nests were primarily located in forested areas (*n* = 25), but also in semi-open spaces (*n* = 2), such as edges and clearings, and in semi-closed spaces (*n* = 6), such as capoeira and cerrado.

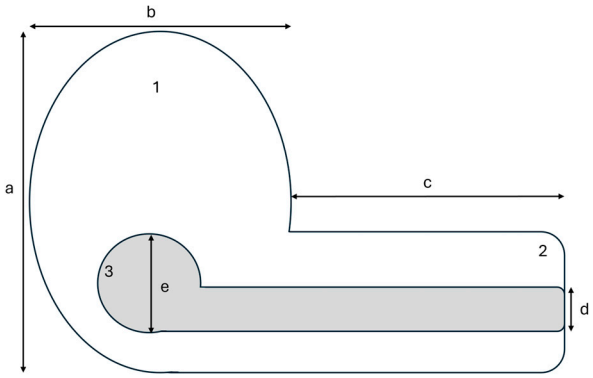


Figure 3. Schematic diagram of a *Synallaxis infuscata* nest. (1) Main part of the nest. (2) Side arm. (3) Incubation chamber. (a) Nest height. (b) Nest width. (c) Side arm length. (d) Internal diameter of the side arm. (e) Height of incubation chamber. See the text for the values. The proportions are maintained from the mean values. White denotes the external part of the nest and grey denotes the internal part. (Scheme created by Leïla Perroulaz).



Figure 4. Nest of *Synallaxis infuscata* (Anita Studer, June 2018).

The clutch size was 2.10 eggs (±0.76, *n* = 30). The eggs had an average length of 22.3 mm (±0.9, *n* = 44) and an average width of 17.2 mm (±0.7, *n* = 44). Their average weight was 3.2 g (±0.4, *n* = 44). Mean egg volume was 3362.4 mm^3 (±327.8, *n* = 44). Eggs are white in colour and have an oval to pointed-oval shape (Figure 5). Hatchlings are characterised by greyish skin on their heads and pink skin on their bodies, as well as yellow colouring on the corners of their beaks, black eyes and brown legs. At 12 days old, it is already possible to see brown plumage on the upper part of the nestlings' bodies and small grey wings, although their bellies remain bare and purplish. At this age, the first change in

the nestlings' beaks become visible, which darken in colour with a white outline. The legs exhibit a pale yellowish-pink colour, with white nails on the toes.



Figure 5. A white egg of *Synallaxis infuscata* in the nest (Anita Studer, May 2017).

Of the 33 nests observed, nine (27.3%) were successful, 21 (63.6%) failed and the fate of three (9.1%) nests is unknown. Predation was the main cause of nest failure, accounting for 81% of cases (Table 1). Nests failed more frequently during the egg stage (66.7%) than during the nestling stage (33.3%, Table 1). The five predictors (egg volume, month, nest height, nest location and nest environment) had no statistically significant effect on whether a nest was successful or failed. The incubation period was 21.5 days (±2.1, n = 2), and the mean nestling period was 14.7 days (±0.8, n = 7). The complete nest cycle length was 36 days (±2.8, n = 2). The daily survival rate during the incubation period was 0.956, whereas during the nestling period it was 0.963. Therefore, the Mayfield survival rate for the mean incubation period of 21.5 days was 0.382, and for the mean nestling period of 14.71 days it was 0.570. The Mayfield nest success rate was thus 21.8%.

Table 1. Causes and periods of nest failure for 21 *Synallaxis infuscata* nests. The percentages represent the proportion of failed nests.

	Predation	**Abandonment**	**Human**	**Total**
Egg	11 (52.4%)	2 (9.5%)	1 (4.8%)	14 (66.7%)
Nestling	6 (28.6%)	0	1 (4.7%)	7 (33.3%)
Total	17 (81%)	2 (9.5%)	2 (9.5%)	21 (100%)

We observed two pairs that took up to 60 days to complete their nests. During the egg incubation and chick feeding phases, *S. infuscata* adults continue to collect leaves that they incorporate into the external structure of the nest, and sometimes also into the internal structure. Pairs commonly renovate and reuse their first nest. Sometimes, they build a second one nearby, often reusing material from the original structure. It is important to note that the pair does not lay a second clutch in locations that are distant from the nest of the first clutch. Both adults were observed feeding the nestlings with dragonflies, beetles, caterpillars, worms and frog tadpoles (Figure 6). In observations of one nest, parents fed 4-day-old nestlings eight times over a 100-min interval, while 7-day-old nestlings from another nest were fed six times during a period of the same length. Both parents were also observed to remove the faecal sacs.



Figure 6. An adult *Synallaxis infuscata* bringing a prey to the nestlings (Anita Studer, March 1992).

4. Discussion

Synallaxis infuscata breeds throughout the year, with the exception of the driest months of December and January. This pattern of year-round breeding has also been observed in other bird species in the Pedra Talhada Biological Reserve, with either a break at the peak of the dry season, or at the peak of the rainy season [69,70].

To contextualise our findings, we will focus our discussion on comparisons with the most closely related species within the genus. As no information was found on life histories of *S. whitneyi*, *S. macconnelli* or *S. cabasini*, only the available information from *S. ruficapilla* and *S. moesta* will be used. Values from other *Synallaxis* species are summarised as genus-level means to provide a broader ecological context while maintaining clarity.

The closed/retort form of the nest of *S. infuscata* is typical of *Synallaxis* nests [43,45–48,71,72]. The only weighted nest of *S. moesta* falls within the range of measured *S. infuscata* nests (Figure 7), but its value is slightly below the mean (Table 2). The weight of the only measured *S. ruficapilla* nest is considerably higher than the values measured for *S. infuscata* (Figure 7, Table 2). Indeed, this nest weighed 4210 g [48], which is 7.6 times higher than the mean value found for *S. infuscata*. Although this may be indicative of interspecific variation, the possibility of an error in the measurement or reporting process cannot be excluded. Consequently, comparisons should therefore be interpreted with caution. The mean value for all measured *Synallaxis* nests is also higher than *S. infuscata* distribution (Figure 7, Table 2). This is probably due to *S. ruficapilla* measurement pulling up the *Synallaxis* species average. *S. infuscata* nests had an average height of 37.6 cm and width of 28.8 cm, which is higher but thinner than the *Synallaxis* mean (Table 2). The nest arm of *S. infuscata* was 30.6 cm long and 4.9 cm wide. The tunnel is thinner than the ones of *S. moesta* and *S. ruficapilla*, but of similar length (Table 2). It is longer and thinner than the mean of *Synallaxis* nests (Table 2). The incubation chamber of *S. infuscata* nests measured 10.9 cm, which is similar to *S. moesta* and *S. ruficapilla* nests, but smaller than the mean of *Synallaxis* nests (Table 2). Nest material of *S. infuscata*, which consists of a mix of plant (sticks, leaves, grass, wood) and animal (snake skin, spider webs) materials, is also similar to what has been found in other *Synallaxis* species (Table A1). *S. albescens* and *S. moesta* also had man-made materials (e. g. pieces of canvas, plastic, candy wrappers) in their nests [45,46]. Nests of *S. infuscata* were mainly found being close to the ground, which is similar to nest of *S. ruficapilla* and the mean of *Synallaxis* species (Table 2).

The clutch size of *S. infuscata* was 2.10. This is similar to clutch size of *S. moesta* and *S. ruficapilla*, but slightly below the mean clutch size for *Synallaxis* species (Table 3). The eggs of *S. infuscata* measured on average 22.3 mm × 17.2 mm. They are similar to eggs of *S. moesta* and *S. ruficapilla*, but they are larger than the average size for *Synallaxis* species (Table 3). The mean weight of *S. ruficapilla* eggs and the only weighted *S. moesta* egg fall within the range of measured *S. infuscata* eggs (Figure 8). The mean value for all measured

Synallaxis eggs falls within the lower part of the *S. infuscata* distribution range (Figure 8, Table 3). Eggs of *S. infuscata* are white with an oval to pointed-oval shape, which is similar to eggs of *S. albilora*, *S. azarae*, *S. moesta* and *S. ruficapilla* [43,46,48,73]. Eggs of *S. candei, however,* vary from turquoise blue to light-green tones [71]. Eggs of *S. albescens* and *S. frontalis* vary from white to greenish-white [45,74–76], Studer *unpub.*, and eggs of *S. erythrothorax* are white to pale blue. Eggs of *S. subpudica* are white with a few brown spots [42].

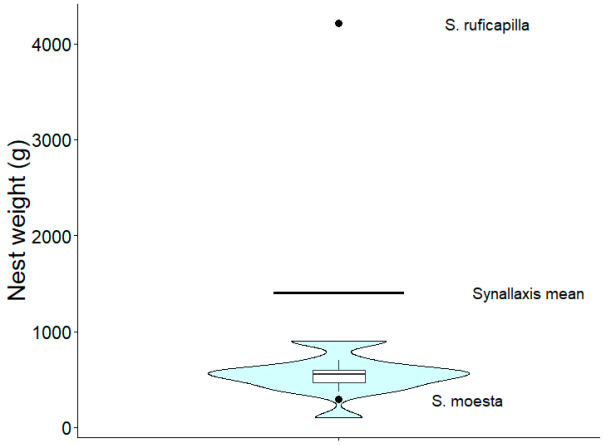


Figure 7. Comparison of nest weight between *S. infuscata*, *S. moesta*, *S. ruficapilla*, and the mean for *Synallaxis* species. The violin and boxplot represent the distribution of values for *S. infuscata*. The bottom point represents the only nest value for *S. moesta*, and the top point represents the only nest value for *S. ruficapilla*. The horizontal line represents the mean for *Synallaxis* species.

Table 2. Comparative table of nest characteristics for *S. infuscata*, *S. moesta*, *S. ruficapilla* and the mean for *Synallaxis* species. See Table A1 for the full *Synallaxis* species data. "–" Indicates that the information was not found within the mentioned reference.

Species	Nest Weight (g)	Nest Height (cm)	Nest Width (cm)	Nest Arm Length (cm)	Nest Arm Diameter (cm)	Height of Incubation Chamber (cm)	Nest Height from Ground (m)
S. infuscata (this study)	552.1 ± 205.2 (n = 14)	37.6 ± 8.9 (n = 15)	28.8 ± 12.4 (n = 17)	30.6 ± 4.4 (n = 7)	4.9 ± 3.4 (n = 4)	10.9 ± 7.6 (n = 12)	2.16 ±1.14 (n = 33)
S. moesta [46]	292 (n = 1)	–	–	30	15	12.5	–
S. ruficapilla [48], *Studer unpub* [1]	4210, (n = 1)	–	–	23–40	14–16	10.5–12	1–3.3
Synallaxis mean (Table A1)	1407.8 (n = 8)	35.86 (n = 21)	34.33 (n = 24)	26.32 (n = 16)	7.13 (n = 11),	15.54 (n = 17)	2.01 (n = 28)

[1] Values for species with multiple estimates were merged for clarity; source-specific data are provided in Table A1.

Nestlings of *S. infuscata* have a pink skin, brown plumage and yellow beak, which turn darker when they get older. Their appearance is similar to nestlings of *S. moesta*, which have pink skin, dark grey plumage and bill in the yellow tones [46], and to *S. candei* nestling, which have orange flesh-coloured skin, greyish plumage and yellow bill [71].

The incubation and nestling periods of *S. infuscata* were 21.5 days and 14.71 days, respectively. The incubation period is longer than what has been observed for most *Synallaxis* species and the general mean (Tables 3 and A2), except for *S. subpudica* (25 days, n = 1, [42]). Nestling period, however, is in the lower range of what has been observed for *Synallaxis* species and is slightly under the general mean (Tables 3 and A2). However, it is important to note that not all authors used the same definition of the length of the two periods. While authors agree that the incubation period should start on the date that the las egg is laid [43–45,74,76], they disagree on when it should end. Some use the

date when the first egg hatches [43,45], whereas others use the date when the last egg hatches [44,74,76]. Similarly, some authors start the nestling periods with the hatching of the first egg [43,45,74], while others start it with the hatching of the last one [44,76]. They all agree, however, that the period ends with the fledging of the last offspring [43–45,74,76]. The differences observed here may merely be due to variations in how the length of both periods was measured in the different studies. Therefore, it could be useful to create a consensus in the way these periods are measured, to facilitate comparisons between studies.

Table 3. Comparative table of breeding parameters for *S. infuscata*, *S. moesta*, *S. ruficapilla* and the mean for *Synallaxis* species. See Table A1 for the full *Synallaxis* species data. "–" Indicates that the information was not found within the mentioned reference.

Species	Clutch Size	Egg Size (mm)	Egg Weight (g)	Egg Colour	Incubation Period (Days)	Nestling Period (Days)
S. infuscata (this study)	2.10 ± 0.76 (n = 30)	22.25 ± 0.9 (n = 63) × 17.18 ± 0.7 (n = 63).	3.17 ± 0.4 (n = 63)	white	21.5 ± 2.12 (n = 2)	14.71 ± 0.76 (n = 7)
S. moesta [46]	2 (n = 1)	24.1 × 16.5 (n = 1)	3.3 (n = 1)	white	–	–
S. ruficapilla [48], *Studer unpub* [1]	2–3 (n = 4)	21.1 × 16.2 (n = 7)	3.1 (n = 2)	white	–	–
Synallaxis mean (Table A1)	2.77 (n = 29)	20.42 × 15.91 (n = 17)	2.63 (n = 15)	-	18.38 (n = 13)	15.74 (n = 14)

[1] Values for species with multiple estimates were merged for clarity; source-specific data are provided in Table A1.

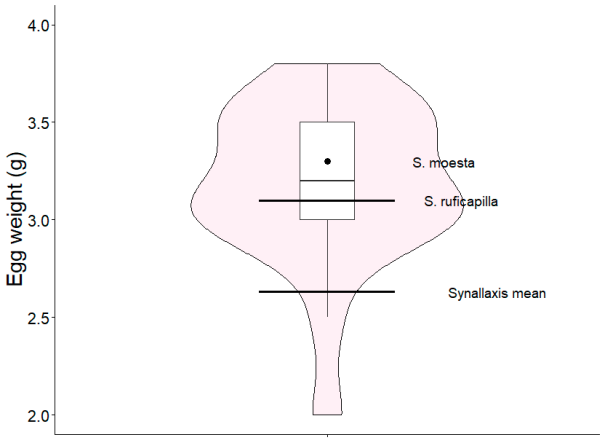


Figure 8. Comparison of egg weight between *S. infuscata*, *S. moesta*, *S. ruficapilla*, and the mean for *Synallaxis* species. The violin and boxplot represent the distribution of values for *S. infuscata*. The top point represents the only egg value for *S. moesta*. The central horizontal line represents the mean for *S. ruficapilla*, and the bottom horizontal line represents the mean for *Synallaxis* species.

The apparent success rate of *S. infuscata* was 27.3%, and the Mayfield's one was 21.8%. This result aligns closely with the 25% success rate documented for *S. albescens* [45]. Predation was the main cause of nest failure (81% of failed nests), as has been found for *S. albescens* (91.7% of failed nests [45]) and for several other tropical bird species [69,70,77–81]. Nests of *S. infuscata* experienced higher failure rates during the egg stage (66.7%) compared to the nestling stage (33.3%), while *S. albescens* demonstrated a different pattern: 45% of eggs were predated during the egg stage, and 55% during the nestling stage [45]. Some authors have hypothesised that predation rates may be higher during the nestling period, due to the presence of parents around the nest and the begging of the offspring, which may attract predators [82–84]. However, the present study did not find such results. The selection of a particular nest site also exerts an influence on the predation rate [83]. Indeed,

when considering nests located in areas easily accessible to predators, the predation rate is higher during the incubation period. Furthermore, as *S. infuscata* reuse their nests, predators may already be aware of the nest's location and be able to predate the eggs more rapidly. Moreover, most vulnerable nests are typically detected by predators during the initial six days of incubation [85]. Parents minimise their investment during this critical period but will invest more intensively in incubation if the eggs survive that period. Our study could not determine whether the egg volume, the breeding month, the nest height from the ground, the nest location or the nest environment affected the fate of a nest. This is mainly because our dataset was small, comprising 33 nests, of which only nine were successful. Further studies compiling a greater number of nests could help to identify the factors involved in nest success.

Overall, the breeding data we collected on *S. infuscata* falls within the range of observations made on other *Synallaxis* species (Tables A1 and A2). The majority of the data is closely similar to those of the two closely related species *S. ruficapilla* and *S. moesta* [46,48], Studer, *unpub*. However, we were unable to find breeding information for the other closely related species *S. whitneyi*, *S. macconnelli* and *S. cabanisi*. Our analysis indicates that the available information on the breeding biology of *Synallaxis* species is still fragmented. There is a lack of information on the breeding biology of several species, and for those for which information is available, it is often incomplete. Further studies are required on the breeding biology of *Synallaxis* species, in order to obtain a comprehensive set of data. This could help to clarify phylogenetic uncertainties, such as those surrounding *S. infuscata*, and contribute to the better protection of these species. Indeed, information on breeding biology and particularly nest success is important for conservation, as rates of nest loss are a key factor in evaluating population viability [28].

Conservation aspects are of particular importance for *S. infuscata*, which is an endangered species [49]. It is endemic to the Atlantic Forest of the Pernambuco Endemism Centre [51], a region that has been heavily degraded [52]. *S. infuscata* has been identified as endangered, primarily due to its exclusive presence within this disturbed geographical area [49,53]. Consequently, priority must be given to the protection and conservation of the remaining Atlantic Forest patches. Anita Studer has followed this initiative by establishing the Pedra Talhada Biological Reserve in 1984 (Presidential Decree n°98.524 of 13 December 1984). This National Reserve, spanning 4469 hectares, is home to a rich biodiversity, supporting over 2100 species, including *S. infuscata* [54]. Initiatives of this kind are essential for ensuring the protection of both this species and others in the Atlantic Forest.

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Institutional Review Board Statement: This observational study involved no capture, restraint, marking or experimental manipulation of individuals. Handling of eggs was limited to brief measurements of egg size, and did not involve removal, damage or alteration of the clutch. Fieldwork was conducted in accordance with the accepted ethical standards for avian field research set out in the Ornithological Council's *Guidelines to the Use of Wild Birds in Research* [86], which provide comprehensive recommendations on minimising disturbance and harm in wild bird studies. Brazil's formal regulatory framework for the ethical use of animals in scientific research was established by Law No 11.794 on 8 October 2008, which created the National Council for the Control of Animal Experimentation (CONCEA) and institutional animal ethics committees (CEUAs) [87]. As much of the present study was conducted prior to the enactment of this legislation and the establishment of

CONCEA/CEUAs, formal institutional ethical approval and research permits were therefore not required at the time of data collection.

Data Availability Statement: The original data presented in the study are openly available in OSF at https://doi.org/10.17605/OSF.IO/D4V72.

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Appendix A

Appendix A.1

Table A1. Nest parameters for different *Synallaxis* species. "–" Indicates that the information was not found within the mentioned reference.

Species	Nest Weight (g)	Nest Height (cm)	Nest Width (cm)	Nest Arm Length (cm)	Nest Arm Diameter (cm)	Height of Incubation Chamber (cm)	Nest Height from Ground (m)	Nest Materials
S. infuscata (this study)	552.1 ± 205.2 (n = 14)	37.6 ± 8.9 (n = 15)	28.8 ± 12.4 (n = 17)	30.6 ± 4.4 (n = 7)	4.9 ± 3.4 (n = 4)	10.9 ± 7.6 (n = 12)	2.16 ±1.14 (n = 33)	Smooth and thorny sticks, dry and green leaves, snake skins and spider webs both internally and externally, with an addition of dry grass, plant fibres and small pieces of wood on the outside
S. albescens [45]	–	16 (n = 7)	17 (n = 6)	11 (n = 7)	–	–	0.3 ± 0.2 (n = 30)	Sticks, inner chamber lined with soft plant material, snake skin, human-made materials (pieces of canvas, plastic tape, candy wrappers)
S. albescens [75]	–	34.5 ± 1.3 (n = 11)	18.3 ± 0.6 (n = 10)	23.6 ± 1.3 (n = 9)	8.5 ± 0.3 (n = 8)	–	1.6–2.4	Thorny sticks, mainly from carob and chañar trees; a base of plant debris on which a cup of soft materials is built.
S. albescens [74]	–	–	–	–	–	–	0.6–9.1	Twigs, egg chamber floored with pad of plant-down, snakeskin in entrance passage
S. albigularis [42]	–	–	40–50	–	–	–	1–2	–
S. albilora [43]	1243 ± 244.6 (n = 5)	29 ± 3.7	11 ± 5.5 (n = 5)	26 ± 4.5	0.8 (n = 5)	24 ± 4.2 (n = 5)	1.5 ± 0.48 (n = 64)	Sticks, bark chips, thorns, green leaves
S. azarae [42]	–	–	–	30–40	–	–	–	Sticks, interior chamber lined with soft plant material, snake skin
S. brachyura [42]	–	20–40	40–50	30–40	–	–	0.5–5	Twigs and sticks, often thorny, reptile skins, floor of chamber lined with pad of soft green or pubescent leaves, spider webs, snake and lizard skin

Table A1. *Cont.*

Species	Nest Weight (g)	Nest Height (cm)	Nest Width (cm)	Nest Arm Length (cm)	Nest Arm Diameter (cm)	Height of Incubation Chamber (cm)	Nest Height from Ground (m)	Nest Materials
S. candei [71]	–	70–75	35–48 (n = 2)	30	5–6	10–13	1.3–2.5 (n = 6)	Dry spinescent or thorny twigs and sticks, bark, green leaves, cactus thorns, shed lizards, snake skin
S. cinerascens [47]	–	–	–	25	–	12.5	On ground	Small sticks
S. cinerascens [88]	3740–3930 (n = 2)	–	28–30 (n = 2)	24–28 (n = 2)	4.5–5 (n = 2)	8–9 (n = 2)	On ground	Dry sticks, bark, wood chips, fresh leaves
S. cinnamomea [42]	–	40	25	15	–	–	3	Thick twigs and dead leaves
S. erythrothorax [72]	–	47.7 (n = 1)	25.4 (n = 1)	–	–	–	1.20 (n = 1)	Twigs
S. erythrothorax [89]	–	48	73	35	–	12	0.76–9.14	Sticks, grass, fine twigs, bark, weed stalks, dry cecropia petioles, broad leaf base of shell-flowers, heliconias, large herbs, Solanum foliage, reptile skin
S. frontalis [76]	–	–	–	–	–	–	0.7–2.5 (n = 46)	Made of sticks and lined with soft plant debris
S. frontalis [Studer, *unpub.*]	350 (n = 1)	25–50 (n = 2)	25 (n = 1)	–	–	17–18 (n = 2)	2.63 ± 2.39 (n = 17)	Internal: smooth sticks, dry and green leaves, feathers, snake skins, spider webs, animal hair and wool External: smooth and thorny sticks, green leaves, snake skins, animal hair and wool, bark
S. gujanensis [42]	–	25	65	–	–	25	1–2	–
S. gujanensis [Studer, *unpub.*]	470 (n = 1)	23 (n = 1)	33 (n = 1)	–	8 (n = 1)	5 (n = 1)	1.3–1.8 (n = 2)	Smooth sticks, dry leaves, bark
S. hypospodia [Studer, *unpub.*]	310 (n = 1)	28 (n = 1)	28 (n = 1)	–	6 (n = 1)	25 (n = 1)	0.65 (n = 1)	Dry and green leaves, spider webs, feathers, snake skins
S. kollari [90]	–	–	20	–	–	10	1.5	Twigs. Incomplete
S. moesta [46]	292	–	–	30	15	12.5	–	Sticks, vine tendrils, dead dicotyledon leaves, palm leaf strips, skeletonized leaves, bark strips, snake skin. Lining made of dried green leaves, plastic, mushroom fragments, orthopteran wings, spider egg sacs and lepidopteran cocoon silk.
S. ruficapilla [48]	4210	–	–	23–40	14–16	10.5–12	1–2.5	Dry leaves and sticks, wood bark, lizard skin. Lining consists of soft leaves, moss, lizard skin.
S. ruficapilla [Studer, *unpub.*]	–	–	–	–	–	–	3.30	–
S. scutata [42]	–	35–60	45–65	20–25	–	10	On ground	Twigs, roots, dead leaves

Table A1. *Cont.*

Species	Nest Weight (g)	Nest Height (cm)	Nest Width (cm)	Nest Arm Length (cm)	Nest Arm Diameter (cm)	Height of Incubation Chamber (cm)	Nest Height from Ground (m)	Nest Materials
S. scutata [Studer, *unpub.*]	–	37 (n = 1)	57 (n = 1)	–	6 (n = 1)	42	–	Internal: dry and green leaves, spider webs External: smooth and thorny sticks, dry leaves
S. spixi [47]	–	20	–	–	–	–	0.6	Small sticks
S. spixi [42]	–	25–30	20–30	25	–	–	1–2	Sticks, usually thorny, snake and lizard skin, occasionally wire, bark, leaves, mosses, hair
S. stictothorax [44]	–	15–40 (mean = 27.2)	24–55 (mean = 35.8)	–	–	5.5–7.5 (mean = 6.6)	2–12 (mean = 5.8)	Spiny sticks, inside lined with feathers and soft seed down
S. subpudica [42]	–	50–60	30–40	–	–	–	2	Sticks, nest-chamber lined with moss and twigs
S. tithys [91]	–	40 (n = 1)	30 (n = 1)	–	–	–	–	–
S. tithys [42]	–	30	30	–	–	–	3–7	Sticks
S. zimmeri [92]	–	–	26	20	4	20	3.5–4.2 (n = 3)	Thorny twigs and sticks, with spines. Inside of chamber lined with old leaf veins
Mean	1407.8	35.86	34.33	26.32	7.13	15.54	2.01	–
N	8	21	24	16	11	17	28	–

Appendix A.2

Table A2. Breeding parameters for different *Synallaxis* species. "–" Indicates that the information was not found within the mentioned reference.

Species	Clutch Size	Egg Size (mm)	Egg Weight (g)	Egg Colour	Incubation Period (Days)	Nestling Period (Days)	Breeding Season
S. infuscata (this study)	2.10 ± 0.76 (n = 30)	22.25 ± 0.9 (n = 63) × 17.18 ± 0.7 (n = 63).	3.17 ± 0.4 (n = 63)	white	21.5 ± 2.12 (n = 2)	14.71 ± 0.76 (n = 7)	Feb.–Nov.
S. albescens [45]	2.6 ± 0.6 (n = 16)	19.7 ± 0.1 × 14.4 ± 0.1 (n = 2)	1.8 ± 0.2 (n = 2)	white	18.1 ± 0.6 (n = 5)	13.6 ± 2.9 (n = 4)	Sep.–Jan.
S. albescens [75]	2.7 ± 0.3 (n = 3)	–	–	white-greenish	–	–	Nov.–Jan.
S. albescens [74]	2–3	20.5 × 15.5 (n = 6)	–	white	18	16	Dec.–Sep.
S. albescens [93]	2.3	–	2.31	–	–	–	–
S. albescens [76]	3.8 ± 0.63	18.83 ± 0.73 × 14.68 ± 0.41 (n = 89)	2.3 ± 0.17 (n = 64)	Greenish-white	16–18	14–18	Oct.–Mar.
S. albigularis [42]	–	–	–	–	–	–	Jun.–Jul.
S. albilora [43]	3.35 ± 0.4 (n = 20)	20.5 × 16.4	2.8 ± 0.2	white	15.3 ± 0.7 (n = 8)	13.6 ± 1.1 (n = 5)	Aug.–Dec.
S. azarae [42]	2–4	–	–	–	–	–	Throughout year in Colombia, Feb.–Apr. in Ecuador, Oct.–Nov. in Argentina.
S. azarae [73]	2 (n = 2)	–	–	white	–	–	Mar.–Apr.
S. brachyura [42]	2–3	–	–	–	18–19	17	Jan.–Feb. and Apr.–Oct. in Costa Rica
S. brachyura [93]	2.5	–	2.90	–	18.5	17.0	–

Table A2. *Cont.*

Species	Clutch Size	Egg Size (mm)	Egg Weight (g)	Egg Colour	Incubation Period (Days)	Nestling Period (Days)	Breeding Season
S. brachyura [94]	–	21.5 × 17.0 (n = 6)	–	–	18 (n = 2)	14–15 (n = 2)	–
S. candei [71]	3–4	20.0 ± 0.7 × 15.9 + 0.5 (n = 7)	2.5 ± 0.1 (n = 7)	turquoise blue to light-green tones	–	–	Oct.–Dec.
S. cinerascens [47]	–	–	–	–	–	–	Sep.
S. cinerascens [90]	–	–	–	–	–	–	Nov.
S. cinnamomea [42]	3	–	–	–	–	–	Mar.–Aug. in Tobago
S. erythorthorax [91]	2–4	21.8–19.8 × 17.5–16.7 (n = 19)	–	White to pale blue	17–18	–	Aug.–Sep.
S. erythrothorax [93]	3.0	–	2.94	–	17.5	16	–
S. erythrothorax [94]	–	21.1 × 16.7 (n = 19)	–	–	17 (n = 4)	14–15 (n = 1)	–
S. frontalis [76]	3.4 ± 0.49 (n = 46)	19.71 ± 0.86 × 15.16 ± 0.52 (n = 58)	2.6 ± 0.23 (n = 49)	Greenish-white	16–18	15–16	Oct.–Mar.
S. frontalis [95], Studer, *unpub.*	2.93 ± 1.33 (n = 17)	19.56 ± 2.04 × 15.46 ± 0.91 (n = 14)	2.05 ± 0.53 (n = 14)	white	–	18–20 (n = 2)	Apr.–May in Alagoas and Sep.–Mar. in Minas Gerais, Brazil
S. frontalis [47]	–	–	–	–	–	–	Nov.
S. gujanensis [42]	2–3	–	–	–	–	–	Jan., Mar., May–Sep. and Dec. in Suriname
S. gujanensis [Studer, *unpub.*]	3 (n = 1)	20.43 ± 0.59 × 17.57 ± 0.25 (n = 3)	2.90 ± 0.1 (n =3)	–	–	–	Dec.
S. gujanensis [96]	2–3	–	–	–	–	–	–
S. hypospodia [95]	2 (n = 1)	20.1–20.5 × 15.3–15.5 (n = 2)	2.3–2.5 (n = 2)	–	–	–	Feb.
S. moesta [46]	2 (n = 1)	24.1 × 16.5 (n = 1)	3.3 (n = 1)	white	–	–	Feb.
S. ruficapilla [48]	2–3 (n = 3)	21.1 × 16.2 (n = 7)	3.1 (n = 2)	white	–	–	Nov.–Jan.
S. ruficapilla [Studer, *unpub.*]	3 (n = 1)	–	–	–	–	–	Oct.
S. ruficapilla [47]	–	–	–	–	–	–	Oct.–Nov.
S. rutilans [42]	3–4	–	–	–	–	–	–
S. scutata [42]	2–3	–	–	–	–	–	Apr. in Brazil, Nov. in Argentina
S. scutata [Studer, *unpub.*]	2–3	20.24 ±1.40 × 15.82 ± 0.53 (n = 5)	2.42 ± 0.34	–	–	14	Nov.–Dec. in Maranhão and Jun.–Jul. in Alagoas, Brazil
S. spixi [47]	–	–	–	–	–	–	Feb.
S. spixi [42]	3–5	–	–	–	–	–	Nov.–Jan. in Argentina
S. stictothorax [44]	3–4 (mean = 3.2)	16.5 × 13.5	–	White with a few brown spots	25	16–22	Feb.–Mar.
S. tithys [42]	–	–	–	–	–	–	Jan.–Apr.
S. zimmeri [92]	2	–	–	–	–	–	May
Mean	2.77	20.42 × 15.91	2.63	–	18.38	15.74	–
N	29	17	15	–	13	14	–

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