Reproduction and nest success of the Scalloped Antbird, *Myrmoderus ruficauda* (Passeriformes: Thamnophilidae), in an Atlantic rainforest of northeastern Brazil

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Introduction

The Scalloped Antbird *Myrmoderus ruficauda* (Wied, 1831) is an uncommon bird endemic to Brazil's lowland Atlantic rainforest (0-600 m, Marini *et al.* 2003) with disjunct populations in Brazil: from Paraíba to Alagoas and others from Bahia to Minas Gerais and Espírito Santo (Ridgely & Tudor 2009). It is considered as an endangered species by the IUCN Red List of threatened species (BirdLife International 2016) as a consequence of its very small and severely fragmented range and population. It is taxonomically separated into two subspecies, the subspecies *M. r. soror* (Pinto, 1940), occurring in the eastern basin and the nominate subspecies *M. r. ruficauda* (Wied, 1831), occurring in the south-eastern basin (Marini *et al.* 2003, Grantsau 2010). Even though it is a rare species, the subspecies *soror* appears to occur at higher densities than the nominate subspecies.

Myrmoderus ruficauda presents sexual dimorphism with males having scalloped underparts, black ear covert patches, rufous brown plumage and broadly tipped blackish wing coverts (Isler *et al.* 2013). The female is similar to the male but with white throat and with a whitish, black scalloped and black spotted breast. It appears to be largely terrestrial and occurs in primary forest or in forests with an advanced state of regeneration, often favouring the understorey, tree-fall gaps and forest borders (Ridgely & Tudor 2009, Silveira 2010, Pereira *et al.* 2014). It forages on the forest floor and sometimes it jumps up to lower perches (Isler *et al.* 2013). Food is obtained from leaf litter or substrates within 1 m of the ground (Isler *et al.* 2013).

Reproductive features of the subspecies *M. r. soror* are poorly studied, and only three nests have been reported in the Atlantic rainforest of Murici (Alagoas) by Buzzetti & Barnett (2003) in September and October 2002. In this study we present new valuable data concerning the reproduction of the subspecies *soror*, including nest characteristics, eggs and nestlings, breeding period and feeding behaviour. With these new findings we aim to contribute to the understanding of the reproduction of this endemic species and to support its conservation.

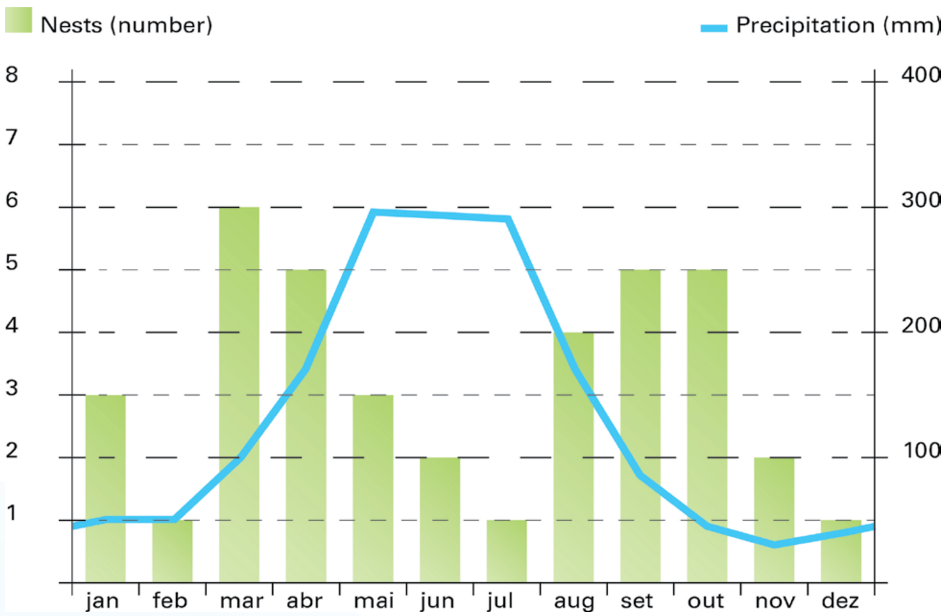

Figure 1. Cumulative number of active nests (green) in every month during the study period. In blue, the average precipitation (mm) in the municipality of Quebrangulo. Source: Agência Nacional de Água (2009).

Material and methods

Study area

The study was conducted in Serra das Guaribas (36°25'W, 09°14'S) between the borders of Alagoas and Pernambuco states in northeastern Brazil. This mountain range is characterised by having several Atlantic rainforest enclaves, with the most important and best preserved being the Pedra Talhada forest. Most of the field work was conducted in this area which comprises about 5,000 ha and reaches 883 m above sea level at its highest point. Most of this forest (4.469 ha) became a Biological Reserve in 1989 (Diário Oficial Brasil 1989, Sousa *et al.* 2015). Pedra Talhada is an Atlantic rainforest biome enclave and is considered to be submontane and montane semi-evergreen seasonal forest (regionally called "brejo de altitude"), far more humid than that of the surrounding lowland areas. These favourable climatic conditions are a consequence of the Borborema Plateau which sweeps the oceanic winds and captures, by condensation, the humidity of the air that returns in the form of rainfall. It is believed that due to its particular climate the relatively high altitude forest enclaves of these northeastern regions can cope with the dry season (Tscharner *et al.* 2015).

The forest grows on a granitic multi-convex relief hill and its vegetation includes rupicolous (rocky) forests, slope forests and plain forests with sempervirent (evergreen) and deciduous trees up to 35 m high as well as open vegetation areas such as rocky outcrops, clearings and marshes (Nusbaumer *et al.* 2015).

Nest search and characterisation

Nest searching was carried out in the southern and eastern parts of the forest between 1990 and 2016. The study area is characterised by having steep slopes, swampy edges, forest clearings, forest in process of regeneration, and preserved primary forest. Data were collected throughout the year, and nests were located either by active inspection or signalled by conspicuous adult behaviour. When an active nest was found, the nest was visited every three days. Under adequate conditions, a leaf--camouflaged blind was installed 10 m away from the nest, providing a good sight of the nest and its surroundings. Observations were made with binoculars, and images were recorded with video cameras.

Figure 2. Left: Nest cup of *M. ruficauda*. Right: Crown of leafs surrounding the nest cup. Photo credit: Anita Studer.

We recorded several nest characteristics such as clutch size, nest and egg dimensions, breeding time and reproductive success. Nests were weighed and their composition described. Egg shape description was determined as suggested by Baicich & Harrison (1997), and nest characterization according to Simon & Pacheco (2005). The incubation period was calculated from egg-laying of the complete clutch to hatching and the nestling period ranged from hatching to flight.

Nest success

Nest success was calculated using the Mayfield (1975) method. This method calculates the daily survival rate during the whole nesting cycle (*S*, equation 1) by means of the daily exposure days factor (*j*) and the survival estimate (*p,* equation 2). The exposure days factor corresponds to the days the nest was exposed during the study period (Mayfield 1975):

1) $S = p^{j}$ 2) $p = 1 - \dfrac{\textit{failed nests}}{\textit{exposure days}}$

Results

Between 1990 and 2016 we found a total of 41 nests of *M. ruficauda* of which 27 failed, 7 succeeded and 7 had an unknown fate

Figures 3-6. 3) Oval shaped eggs of *M. ruficauda*. 4) Young of *M. ruficauda* three days after hatching in a nest placed among the plant stems of *Parodiolyra micrantha.* 5) Chicks of eight days of age. 6) Chicks of 10 days of age, two days before leaving the nest. Photo credit: Anita Studer.

Figures 7-8. 7) Male individual of *M. ruficauda* camouflaged among the leaf litter. 8) Male of *M. ruficauda* in its natural habitat. Photo credit: Anita Studer.

(Appendix I). We found nests in every month of the year, with higher numbers in March/April and September/October, matching respectively the beginning and the end of the rainy season (Figure 1).

The nest belonged to the high cup/base nest category according to Simon & Pacheco (2005), meaning that the external height of the nest exceeded its width. In some cases, the external height of the nest was smaller than its width and therefore nests belonged to the low cup/base nest category. Detailed information on nest dimensions can be seen in Table 1. The nest cup was built with leaves, meticulously compacted together to form a smooth compartment. The content of nests consisted of dry leaves, leaf petioles, fragments of leaves, threads and rootlets (Table 2). Adjacent to the nest, parents built a surrounding crown of dry leaves that were not attached to the nest cup (Figure 2).

Nests were placed directly on the forest floor in the most conserved areas of the upland forests. However, in 2014-2016 we also found its nest in the lowland forests and in secondary forest with an advanced state of regeneration. On one occasion, we observed a nest situated in a slope and a platform of a natural accumulation of dry leaves served as support. On two occasions, nests were also found between plant stems of *Parodiolyra micrantha* (Figure 5) and in these cases the surrounding crown of dry leaves was not present.

Eggs were oval shaped, and we found clutch sizes of two eggs/nestlings in every nest. Eggs were white with a pinkish hue and with brown-pinkish pigments (Figure 3). Thirty eggs were measured and weighed on average 3.3g and had a mean size of 22.96 x 16.31 mm (Table 1).

The Mayfield (1975) method indicated a nest success of 21.94%. The incubation period could be witnessed on four occasions and lasted between 15 and 18 days ($\bar{x}$= 16.75, SE= ±0.63). The nestling period was witnessed on ten occasions and lasted between 10 and 13 days ($\bar{x}$= 11.7, SE= ±0.26). Therefore, we estimated a total breeding period (from egg-laying to fledging) of 28.45 days, SE= ±0.89.

Both parents contributed to incubation and to nestling care. When incubating, the adult remained camouflaged among the surrounding leaves (Figure 7). When hatching, nestlings were altricial, presenting no down feathers on their bright dark-reddish skin (Figure 4). The beak was dark grey with yellow commissures, the throat was orange and the tip of the tongue was black (Figure 4). We observed that the chicks did not present fully developed flight feathers after their nestling period (Figure 6). After leaving the nest, parents continued bringing food to the young and quit this behaviour progressively as the chick became self-sufficient to obtain most of its food.

Parents foraged on the floor among ground leaves (Figure 8). Food consisted mainly of whole arthropods like spiders, centipedes, cockroaches, locusts and others; as well as small frogs. Most of the time, males and females arrived together in silence and approached the nest hopping on the floor or from near branches. The process of feeding the young in the nest was fast, and the faecal sac was either swallowed or carried away by the adults. Adults left the nest quietly in the same way as they arrived. On several occasions when foraging, adults formed intraspecific flocks. Interspecific flocks with *Pyriglena leuconota* (Spix, 1824) were rarely observed.

Discussion

M. ruficauda has been described as a species typical of lowland Atlantic forests (Marini *et al.* 2003). On the contrary, in Pedra Talhada it has been mainly spotted in the upland forest, being found even at the highest altitudes of the forest (883 m).

Even though *M. ruficauda* breeds throughout the year it appears to have a preference for the months before and after the core of the rainy season. The northeastern region is considered a semi-arid ecosystem, where relations between bird reproduction and rainfall seasonality are strongly correlated (Scheuerlein & Gwinner 2002, Cavalcanti *et al.* 2016). This is particularly true in birds, since the availability of high-quality food is strongly dependent on rainfall (Mezquida & Marone 2003). Hence, *M. ruficauda* may find higher densities of food during these two periods and may carry out several breeding attempts during the same season, as Buzzetti & Barnett's (2003) previously suggested.

Buzzetti & Barnett's (2003) nests contained two eggs and the general shape descriptions and nest locations they found match the results reported in this paper. The most interesting nest construction pattern we registered in this study is that the nests, when placed directly on the floor, were surrounded by a crown of dry leafs, apparently to give an extra support and camouflage to the nest cup. When nests were placed among plant stems, the parents did not build this additional layer, and the nest cup was supported by the adjacent plants.

The nestling period of *M. ruficauda* is markedly short and may be one of the shortest found for antbirds (Skutch 1996). It can last a minimum of 10 days (present study) and a maximum of 14 days (Krabbe & Schulenberg 2003). As seen in this study, many ground-nesting altricial birds quit the nest before being able to fly, which means that their fledgling period is longer than the nestling period (Skutch 1945). A short nestling period combined with post-nesting parental care enables *M. ruficauda* to minimize the predation pressure in the forest understorey (Skutch 1945).

Our results show that nest success of the Scalloped Antbird is low, as is the case for many tropical birds (Brawn *et al.* 2011). As nest depredation is the primary cause of nest failure for many bird species (Ricklefs 1969, Martin 1998), we can use the Mayfield (1975) nest success estimator as a reflection of predation pressure. Ground-nesting birds have been traditionally assumed to suffer greater nest predation than non-ground-nesting birds (Martin 1993), In our study area, nest success was only 21.94%, *M. ruficauda* shows a lower nest success than that found in non-ground-nesting birds. This is the case for *Chamaeza campanisona* (Lichtenstein, 1823) and *Taraba major* (Vieillot, 1816), both with nest successes of around 30% (Studer *et al.* in prep.). However, nest success observed for *M. ruficauda* can also be higher than that observed in other non-ground-nesting birds occurring in the same forest, for example, with *Conopophaga melanops* (Vieillot, 1818) and a nest success of <12% (Studer *et al*. in prep.). Therefore, we can state that ground-nesting birds do not suffer the highest predation pressure of all birds, at least in this forest.

Finally, this species has undergone serious population declines resulting from human-driven habitat loss, restricting it to small forest patches (Krabbe & Schulenberg 2003) in primary and well preserved secondary forests. Information regarding its nest success, and predation pressure together with life-history traits can bring to light important conservation and natural history information about the vulnerability of the species and population issues.

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Reference list

Agência Nacional de Água (2009) **Inventário das estações pluviométricas**. Brazil, 495p.

Baicich, P.J. & C.J.O. Harrison (1997) **A guide to the nests, eggs and nestlings of North American birds**. San Diego, California: Academic Press. 347p.

BirdLife International (2016) **Species factsheet: Myrmoderus ruficauda**. Available at: www.birdlife.org. Accessed: 6 March 2017.

Brawn, J.D., G. Angehr, N. Davros, W.D. Robinson, J.N. Styrsky & C.E. Tarwater (2011) Sources of variation in the nesting success of understory tropical birds. **Journal of Avian Biology** 42: 61-68.

Buzzetti, D.R.C. & J.M. Barnett (2003) Description of the nest and eggs of two *Myrmeciza antbirds* endemic to the Atlantic Forest of Brazil. **Cotinga** 20: 89–93.

Cavalcanti L.M.P., L.V. Paiva & L.F. França (2016) Effects of rainfall on bird reproduction in a semi-arid Neotropical region. **Zoologia** 33(6): e20160018.

Diário Oficial Brasil (1989) Decreto 98.524. República Federativa do Brasil.

Grantsau, R.K.H. (2010) **Guia completo para a identificação das aves do Brasil**. São Carlos: Editora Vento Verde. 1249p.

Isler, M.L., G.A. Bravo & R.T. Brumfield (2013) Taxonomic revision of Myrmeciza (Aves: Passeriformes: Thamnophilidae) into 12 genera based on phylogenetic, morphological, behavioural, and ecological data. **Zootaxa** 3717(4): 469–497.

Krabbe, N.K. & T.S. Schulenberg (2003) Family Formicariidae (ground-antbirds), p. 682–731. *In*: del Hoyo, J., A. Elliott & D.A. Christe (eds.). **Handbook of the Birds of the World, Broadbills to Tapaculos**, v. 8. Barcelona, Spain: Lynx Edicions.

Marini, M.A., R. Durães, L.E. Lopes, A.M. Fernandes & C.E. de Alencar Carvalho (2003) Rediscovery of the Scalloped-Antbird (Myrmeciza ruficauda) in Minas Gerais, Brazil. **Cotinga** 19: 59-61.

Martin, T.E. (1993) Nest predation among vegetation layers and habitat types: revising the dogmas. **The American Naturalist** 141 (6): 897–913.

Martin, T.E. (1998) On the advantage of being different: nest predation and the co--existence of bird species. **Proceedings of the National Academy of Sciences of the United States of America** 85: 2196–2199.

Mayfield, H.F. (1975) Suggestions for Calculating Nest Success. **The Wilson Bulletin** 87(4): 456–466.

Mezquida, E.T., L. Marone (2003) Comparison of the reproductive biology of two *Poospiza* Warbling-finches of Argetina in wet and dry years. **Ardea** 91: 251-262.

Nusbaumer, L., M.R.V. Barbosa, W.W. Thomas, M.V. Alves, P.A. Loizeau & R. Spichiger (2015) Flora e Vegetação da Reserva Biológica de Pedra Talhada, p. 59–83. *In:* Studer, A., L. Nusbaumer & R. Spichiger (eds.). **Biodiversidade da Reserva Biológica de Pedra Talhada Alagoas-Pernambuco**. Geneva: Boissiera 68.

Pereira, G.A., S. de M. Dantas, L.F. Silveira, S.A. Roda, C. Albano, F.A. Sonntag, S. Leal, M.C. Periquito, G. Malacco & A.C. Lees (2014) Status of the globally threatened forest birds of northeast Brazil. **Papéis Avulsos de Zoologia** 54(14): 177–194.

Ricklefs, R.E. (1969) An analysis of nesting mortality in birds. **Smithsonian Contributions to Zoology** 9.

Ridgely, R.S. & G. Tudor (2009) **Birds of South America: Passerines**. Texas: University of Texas Press.

Scheuerlein, A. & E. Gwinner (2002) Is food availability a circannual zeitgeber in tropical birds? A field experiment on Stonechats in tropical Africa. **Journal of Biological Rhythms** 17(2): 171-180.

Silveira, L.F. (2010) Myrmeciza ruficauda. p. 607–608. *In*: Machado, A.B.M., G.M. Drummond. & A.P. Paglia (eds.). **Livro Vermelho da Fauna Brasileira Ameaçada de Extinção**. Brasília: MMA; Fundação Biodiversitas.

Simon, E.J. & S. Pacheco (2005) On the standardization of nest descriptions of neotropical birds. **Revista Brasileira de Ornitologia** 13(2): 143–154.

Skutch, A.F. (1945) Incubation and nesting periods of Central American birds. **The Auk** 62 (1): 8–37.

Skutch, A.F. (1996) **Antbirds and ovenbirds: their lives and homes**. Austin: University of Texas Press.

Sousa, M.C., E. Cusimano, N. Vedovotto & A. Studer (2015) Histórico da Reserva Biológica de Pedra. p. 765–778. *In*: Studer, A., L. Nusbaumer & R. Spichiger. (eds.). **Biodiversidade da Reserva Biológica de Pedra Talhada Alagoas--Pernambuco.** Geneva: Boissiera 68.

Studer, A., L. Nusbaumer, R. Spichiger (eds.) (2015) **Biodiversidade da Reserva Biológica de Pedra Talhada Alagoas-Pernambuco.** Geneva: Boissiera 68. 818 pp.

Tscharner, T., G.P. Duda, V.P. Oliveira, C.M.S. Silva, L. Nusbaumer & A.F. Silva--Filho (2015) Parâmetros Abióticos da Reserva Biológica de Pedra Talhada. p. 39–57. *In:* Studer, A., L. Nusbaumer & R. Spichiger (eds.). **Biodiversidade da Reserva Biológica de Pedra Talhada Alagoas-Pernambuco.** Geneva: Boissiera 68.

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Table 1. Measurements of the eggs and nests of *M. ruficauda*.

Nest parameters	n	Limits	Mean ± SE
Greater diameter (cm)	25	9-27	14.16 ±0.79
Smaller diameter (cm)	12	8-16	11.41 ± 0.66
Internal diameter (cm)	26	5-8	6.75 ± 0.15
External height (cm)	26	7-13	9.53 ± 0.32
Internal height (cm)	26	4-7	5.15 ± 0.19
Weight (g)	19	14-45	28.42 ± 2.17
Egg parameters			
Weight (g)	30	2.7-3.9	3.33 ± 0.05
Length (mm)	30	51 -25.6	22.96 ± 0.21
Width (mm)	30	11.2 - 17.8	16.31 ± 0.27

Table 2. Composition of the outer and inner layer of two nests cups of *M. ruficauda*.

OUTER LAYER			INNER LAYER		
Material	*Nest 1*	*Nest 2*	*Material*	*Nest 1*	*Nest 2*
Dry leaves	109	120	*Marasmius* sp. threads	8	15
Leaf petioles	57	60	Leaf petioles	45	60
Leaf fragments	19	20	Leaf fragments	41	40
Rootlets	10	10	-	-	-

Appendix I: Summary table of nests with encounter date, nest stage the day it was found, its fate and final stage the last day it was seen active. "*u*" stands for unknown fate, "x" for failure and "✓" for success.

	Encounter date (ED)	Stage at ED	Hatching date	Fate	Final Stage	Last visit
1	23.04.1990	Incubation	-	*u*	Egg	30.04.1990
2	06.03.1990	Nestling	-	*x*	Egg	14.03.1990
3	27.09.1991	Incubation	10.10.1991	✓	Chick	22.10.1991
4	01.06.1992	Incubation	15.06.1992	*x*	Egg	18.06.1992
5	23.08.1993	Nestling	-	*u*	Chick	03.09.1993
6	14.09.1993	Incubation	-	*x*	Egg	20.09.1993
7	14.10.1993	Incubation	-	*x*	Egg	23.10.1993
8	28.10.1993	Nestling	-	*x*	Egg	01.11.1993
9	21.08.1994	Incubation	-	*x*	Egg	28.08.1994
10	03.05.1996	Incubation	09.05.1996	✓	Chick	21.05.1996
11	24.05.1996	Incubation	-	*x*	Egg	03.06.1996
12	25.11.1996	Incubation	01.12.1996	✓	Chick	11.12.1996
13	15.01.1998	Incubation	01.02.1998	✓	Chick	14.02.1998
14	17.10.1998	Incubation	-	*x*	Egg	29.10.1998
15	16.08.1999	Incubation	-	*x*	Egg	31.08.1999
16	03.09.1999	Nestling	-	*x*	Egg	05.09.1999
17	05.09.1999	Incubation	-	*x*	Egg	12.09.1999
18	14.01.2000	Incubation	20.01.2000	*x*	Egg	25.01.2000
19	15.01.2000	Incubation	27.01.2000	✓	Chick	08.02.2000
20	03.10.2000	Incubation	-	*x*	Egg	11.10.2000
21	06.11.2000	Incubation	18.11.2000	✓	Chick	30.11.2000
22	16.04.2001	Nestling	-	*u*	Chick	28.04.2001
23	02.03.2002	Incubation	09.03.2002	*x*	Chick	18.03.2002
24	24.03.2002	Incubation	02.04.2002	✓	Chick	14.04.2002
25	15.04.2002	Incubation	-	*x*	Egg	30.04.2002
26	17.12.2002	Incubation	23.12.2002	*x*	Chick	03.01.2003
27	31.01.2007	Incubation	-	*x*	Egg	13.02.2007
28	22.03.2007	Incubation	-	*x*	Egg	03.04.2007
29	28.04.2008	Incubation	-	*x*	Egg	09.05.2008
30	26.05.2008	Incubation	-	*x*	Egg	01.06.2008
31	07.06.2008	Incubation	-	*x*	Egg	09.06.2008
32	16.10.2008	Incubation	-	*x*	Egg	01.11.2008
33	22.12.2008	Nestling	-	*x*	Chick	03.01.2009
34	10.02.2009	Incubation	28.10.2009	*x*	Chick	02.03.2009
35	19.03.2009	Incubation	05.04.2009	*u*	Chick	15.04.2009
36	19.03.2009	Nestling	-	*x*	Chick	23.03.2009
37	02.04.2014	Incubation	-	*x*	Egg	10.04.2014
38	18.04.2014	Nestling	-	*x*	Chick	26.04.2014
39	20.09.2015	Nestling	-	*u*	Chick	30.09.2015
40	14.04.2016	Incubation	-	*u*	Egg	26.04.2016
41	18.08.2016	Nestling	-	*u*	Chick	25.08.2016