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OBSERVATIONS ON NESTING BEHAVIOR OF THE RUSTY-WINGED BARBTAIL (*PREMNORNIS GUTTULIGER*)

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Abstract · Little is known of the nesting and parental care behaviors of the Rusty-winged Barbtail (*Premnornis guttuliger*) and its congeners. A single Rusty-winged Barbtail nest with two nestlings located in tropical montane forest was filmed for 230 hours near the Yanayacu Biological Station in Ecuador. Recording began 14 November and continued through 8 December 2009 before nestlings fledged. We report the first observations of incubation and feeding behavior by individual parents. Colored leg bands and molecular sexing of one parent allowed for identification of individuals and the sex of the attending adults. Average visit duration, average number of visits per hour per nestling, and fecal sac removal rate were quantified by video analysis. Adults visited the nest an average of 3.97 ± 0.657 (SE) times per hour per nestling for an average 3.88 ± 0.41 min across the nestling period. Both parents visited the nest with male visits being more frequent but no difference in average visit duration. An average of 1.77 ± 0.120 fecal sacs per hour were removed from the nest by parents. Behavior at the nest was similar to previous studies and did not indicate additional similarity between *Premnornis* and members of the *Margarornis* clade.

Resumen · Observaciones sobre comportamiento de nidificación del Subepalo Alirrojizo (*Premnornis guttuliger*)
Los comportamientos de nidificación y cuidado parental del Subepalo Alirrojizo (*Premnornis guttuliger*) y sus congéneres son poco conocidos. Un nido del Subepalo Alirrojizo con dos pichones fue filmado durante 230 horas en un bosque nublado cerca de la estación biológica Yanayacu en Ecuador. La grabación se realizó entre el 14 de noviembre y el 8 de diciembre de 2009 antes de que los polluelos abandonaran el nido. Estas son las primeras observaciones de incubación y alimentación de los padres marcados de manera individual. Anillamos un individuo que fue sexado en base a análisis genéticos y nos permitió separar la contribución de cada sexo en el cuidado de los polluelos. La duración promedio de las visitas al nido y el número de visitas por hora por polluelo, y la tasa de remoción de sacos fecales fueron cuantificados por análisis de video. Los adultos visitaron el nido una media de 3,97 ± 0.657 (EE) veces por hora/polluelo y cada visita duró un promedio de 3,88 ± 0,41 min. Tanto el macho como la hembra visitaron el nido. No encontramos diferencias significativas entre macho y hembra en la duración de las visitas, pero el macho visitó el nido más frecuentemente. Un promedio de 1,77 ± 0.120 sacos fecales por hora fueron retirados del nido por los padres. El comportamiento de nidificación concuerda con estudios previos y no indica semejanzas adicionales entre *Premnornis* y miembros del grupo *Margarornis*.

Key words: Furnariidae · Nesting · Parental care · *Premnornis* · Rusty-winged Barbtail

INTRODUCTION

The Rusty-winged Barbtail (*Premnornis guttuliger*) is a little studied and uncommon Neotropical montane member of the Furnariidae. Found at elevations between 1600–2750 m a.s.l. from Venezuela to Peru, both sexes have similar brown buff colored plumage and cannot be readily sexed in the field (Fjeldså & Krabbe 1990, Ridgely & Tudor 1994). Primarily insectivorous, it gleans arthropods from the understory by climbing and hopping among mossy branches and twigs (Dobbs et al. 2003, Remsen 2003). In spite of its widespread range and status as a species of least concern (IUCN 2016), little is known of its conservation status, distribution, natural history, breeding biology, and parental care patterns and questions remain concerning its taxonomic placement within the Furnariidae.

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Previous phylogenetic research suggested a close association between *Premnornis* and *Premnoplex* barbtails based on hindlimb musculature and general morphology (Vaurie 1980; Rudge & Raikow 1992a, 1992b) and general placement in the *Margarornis* assemblage, which includes the *Roraimia*, *Premnoplex*, *Premnornis*, and *Margarnornis* genera within the Furnariidae (Rudge & Raikow 1992b). More recent molecular research suggests *Premnornis* forms a separate clade, perhaps with *Pseuodocolaptes*, and is further removed from the *Margarnornis* assemblage than thought (Irestedt et al. 2006, Moyle et al. 2009, Derryberry et al. 2011).

This is supported by reported differences in nest construction of *Premnornis* (Dobbs et al. 2003). *Premnornis* nest structure suggests a closer relationship to *Pseudocolaptes*. *Premnornis* creates cavity nests in tree stumps structurally more similar to those of *Pseudocolatpes*, with both building loose cup nests using tree fern scales to make a cup-shaped nest inside of pre-existing cavities (Skutch 1969, Areta 2007, Solano-Ugalde & Arcos-Torres 2007, Greeney & Gelis 2011*).* However, only two nest sites of the genus *Pseudocolaptes* have been described with little information on nest behavior (Strewe 2001, Solano-Ugalde & Arcos-Torres 2007).

Current data on breeding biology and behavior have only been published from the study of one *Premnornis* nest (Dobbs et al. 2003). Recent work has provided insights into the feeding and parental care roles of *Premnoplex* barbtails (Muñoz & Martin 2014, Port & Greeney 2015) and allows for comparisons of parental care and feeding behaviors with *Premnornis*. With several authors suggesting divergence between *Premnornis, Premnoplex,* and the *Margarornis* assemblage (Dobbs et al. 2003, Areta 2007), further work on the breeding biology of this species is needed to provide a deeper understanding of the phylogenetic relationships within this group of little studied tropical montane ovenbirds.

METHODS

We videotaped the feeding activity of banded adults at a single *Premnornis guttuliger* nest between 14 Nov to 8 Dec 2009 near the Yanayacu Biological Station, in Napo Province, Ecuador (00°36'S, 77°54'W) with tripod-mounted cameras 3–5 m from the nest that we operated continuously during daylight hours (ca. 06:00–18:00 Ecuador Time [ECT]). On 19 and 25 November, recordings ended before noon, and no data were recorded on 16 November, or 1 and 4 December. Nest activity was recorded beginning in late incubation through shortly before fledging. The nest was about 2 m above the ground in the cavity of a dead *Cyathea* (Cyatheaceae) tree-fern stump surrounded by canopy up to 25 m tall and located in humid, montane forest at an elevation of about 2050 m a.s.l.. Food items brought by parents were not readily distinguishable due to resolution and camera angle. Quantification of parental care and nestling behavior patterns was done through video analysis completed using VLC software for playback (VideoLAN Organization 2013). All statistical analyses were performed using SPSS (SPSS 2012). Results of two-tailed tests were considered significant at the 0.05 level and means presented ± standard error (SE).

We analyzed a total of 230 filmed hours across 21 days of the nesting period. Both parents were captured using mist nets, banded and marked with colored legs bands, making it possible to distinguish between individuals visiting the nest in most cases. Due to camera angle, lighting, and camera resolution, individuals could not be identified for all visits. A blood sample taken from one of the adults was analyzed using methods described in Port & Greeney (2012) to identify the sex of one member of the pair.

Data recorded included visit duration and frequency, nest activity patterns, and fecal sac removal by adults. Brooding behavior (heat transfer to nestlings) and feeding of young were not distinguishable because parental activity was not visible inside the nest cavity. While brooding activities could not be separated from other visit activities such as feeding, nest visit duration provided insights into parental behaviors and investment at the nest. Visit duration was measured as the time when a parent entered the nest to its exit time. Frequency of visits is reported as the number of visits per nestling per hour.

RESULTS

Nest structure. The nest was located near the top of a *Cyathea* tree-fern stump approximately 2 m in height and tapering toward the top. Nest was lined primarily with *Cyathea* scales. Nest materials were not removed for further analysis in hope the location would be re-used at a future date.

Eggs and nestlings. Two eggs were found in the nest on 12 November and hatched on 21 November. Eggs were immaculate white, sub elliptical and similar to those described for many Furnariidae. Eggs and young were measured five times throughout the nestling period numbered one and two arbitrarily each time (Table 1). Egg weight and dimensions, and nestling weight (g) and tarsus length (mm) were recorded. By day nine, secondary wing coverts had broken from sheaths (Figure 1). Nestlings spent 18 days in the nest and likely fledged early on 9 December.

Incubation behavior. Parents were recorded incubating eggs 14–20 November. Both parents spent time incubating and the individuals did not differ significantly in the number of visits, length of visits, or timing of visits. The incubating adult typically switched at the nest with one adult exiting the nest cavity once the other arrived outside the nest entrance. Occasionally, one adult would enter the cavity when the

Table 1. Weight and length measurements for eggs and nestlings in a single Rusty-winged Barbtail (*Premnornis guttuliger*) nest observed near Cosanga, Ecuador between 14 November to 8 December 2009. The two eggs and young were not individually marked for measurements (labelled arbitrarily #1 and #2 in table).

Date	Weight (g)		Tarsus length (mm)		Egg dimensions (mm)	
	#1	#2			#1	#2
9 days prior to hatch	2.70	2.60	N/A	N/A	19.5x11.5	19.5x11.2
Day 1 (hatch)	2.48	2.36	7.3	7.0		
Day 4	11.1	9.8	13.6	13.7		
Day 9	14.7	14.7	17.8	17.3		
Day 15	18.8	20.1	20.7	22.0		

other adult was already inside, then one would exit. During incubation, individual bouts averaged 32.38 ± 12.36 min (range 0.45–94.32 min, N = 68) on the nest. The female averaged 42.03 ± 18.32 min (N = 23) while the male averaged 39.76 ± 6.95 min (N = 22). The difference was not significant (t = 0. 83, df = 41, *P* = 0.41). Incubation was relatively consistent throughout the day and did not vary in pattern over the time observed, with breaks in incubation averaging 49.73 ± 3.72 min (range 0.13–147.57 min, N = 70). Male and female patterns were similar (87 ± 18.15 min (N = 10) and 83.78 ± 0.17 min (N = 11), respectively) with average visits per hour similar (male = 0.44 ± 0.13, female = 0.53 ± 0.14; *t* = 0.68, df = 22, *P* = 0.50).

Nest attendance. Visits to the nest averaged 63.9 ± 9.25 (N = 1405) per day (12 h). Visit duration was 3.78 ± 0.42 min (N = 1402) and overall visitation patterns during the nestling period were clumped (Index of Dispersion, Fowler et al. 1998) with more visits occurring later in the nesting cycle. For 10 out of 15 days within the nestling cycle, the distribution of visits during the day was clumped with more visits occurring between 07:00 h and 15:00 h, on the remaining days it was regular with visits interspersed throughout the day (Index of Dispersion; Fowler *et al*. 1998) (Figure 2).

Feeding visits. Our observations on individually marked adults confirm that both male and female *Premnornis* provisioned young. We did not observe any other individuals feeding young or visiting the nest outside of the marked individuals. Adult visits averaged 3.88 ± 0.42 min (range 0.03–41 min, N = 1337) throughout the nestling period. Due to the lack of visibility inside the nest, it was not possible to separate brooding time from feeding visits, although a decrease in average visit length was noticeable as the nestlings developed (Figure 3a). Beginning when nestlings reached 7 days of age, the frequency of visits per nestling per hour increased (Figure 3b; days 1–6, mean =2.57 ± 0.10; N = 1046, older than 7 days, mean = 4.78 ± 0.27, N = 291; *t* = -6.3, df = 12, *P* < 0.001) and visit length decreased significantly when compared to the first 6 days post hatch (Figure 3a; days 1–6, mean = 7:55 ± 0:42 min, older than 7 days, mean = 0:36 ± 0:09 min, N = 1046; t = 10.1, df = 98, *P* < 0.001).

Overall provisioning rates averaged 3.94 ± 0.650 per nestling/h. Provisioning rates and time spent at the nest varied between the male and female. The female made an average of 45.7% of the daily feeding visits (range 21.4–58.3%, N = 12 days, 420 feeds). The male's proportion of daily feeding visits averaged 54.2% (range 41.7–78.6%, N = 464 feeds; *t* = -2.14, df = 22, *P* = 0.02). The female did not show significantly faster provisioning rates, averaging 1.63 ± 0.16 visits/nestling/h (range 0.63–2.91, N = 420 feeds). The male averaged 1.77 ± 0.16 visits/nestling/h (range 1.12–2.79, N = 464 feeds; *t* = -0.72, df = 21, *P* = 0.48).

Nestling behavior and material removal. Nestlings were not visible inside the nest during the recorded observations. Vocalizations could be heard regularly and were associated with feeding visits but due to the depth of the cavity and the camera angle, it was not possible to directly observe nestling behavior or feeding behavior. Nestlings produced fecal sacs, with the first observed removal by an adult occurring the day after hatch and continuing through the end of the observations on 8 December. The average number of fecal sacs removed per hour was 1.77 ± 0.12 with frequency increasing with nestling age (Figure 3c). Fecal sac removal or nest material removal occasionally coincided with feeding visits; 24.6% of all post-hatch visits (N = 1339) resulted in a parent removing a fecal sac. Nearly all (99.4%) fecal sacs were carried out of sight by parents (total N = 331) and two were dropped by parents immediately after exiting the nest cavity. On average the male removed slightly more fecal sacs over the duration of the nesting cycle (10.00 ± 2.11 per day, N = 110) compared to the female (9.36 ± 2.33 per day, N = 103). Eleven instances of nest maintenance behaviors by adults including removing nesting material such as stems and twigs after visits were observed.

DISCUSSION

Premnornis guttuliger nest activity recorded by us was consistent with observations made by Dobbs

Figure 1. Development of a Rusty-winged Barbtail (*Premnornis guttuliger)* nestling from a single nest between 21 November and 5 December 2009. Nestling age is indicated below each image.

et al. (2003). Nest structure appeared identical to that reported by other authors (Skutch 1969, Dobbs et al. 2003, Areta 2007). Adults constructed the nest in a tree-fern cavity, using tree-fern scales to line the nest. While *Premnornis* and *Premnoplex* both nest in globular cavities, nest structure is fundamentally different, with *Premnornis* constructing inside tree cavities and using tree-fern scales to line the nest, something that might be a synapomorphy uniting *Premnornis* and *Pseudocolaptes* (Dobbs et al. 2003). In contrast, *Premnoplex* nests are more similar to *Margarornis*, constructed of ferns and moss and built over a period of several weeks or months and reused many times over (Greeney 2008, Greeney & Gelis 2011).

Activity patterns at the nest during incubation and the nestling period were similar to those reported by Dobbs et al. (2003). We can confirm male contributions during incubation and post-hatch, with males contributing significantly in the form of incubation time (46.0% of total) and feeding visits (54.2% of total). Both male and female removed fecal sacs from the nest. While parental fecal sac removal has been commonly reported for many songbird species, this differs from the sanitation behavior reported for *Premnoplex*. *Premnoplex*, along with apparently *Margarornis*, lack parental removal of fecal sacs produced by the young (Areta 2007, Greeney 2008b, Port & Greeney 2014). Areta (2007) noted this defecation behavior would not be possible in the tree cavity nest of *Premnornis*.

In this study, observed incubation breaks ranged from 8 seconds to 2 hours and 27 minutes (mean = 49.7 ± 3.7 min). This observation is similar to those reported for other cloudforest passerines in the area (e.g., *Grallaricula peruviana* mean = 66 ± 61 min; *Grallaria quitensis* mean = 12 ± 21 min; *Hellmayrea gularis* mean = 17.3 ± 12.9 min; *Mionectes striaticollis*

Figure 2. Average hourly activity of adults as measured by the number of visits to the nest throughout the observation period, with standard error. Observations between 14 November to 8 December 2009 from a single Rusty-winged Barbtail (*Premnornis guttuliger*) nest near Cosanga, Ecuador.

mean = 17 ± 25 min; Greeney 2009) and in contrast to the unusual pattern reported for *Premnoplex* (mean = 6.4 ± 1.9 h, Greeney 2009). Total incubation length for this *Premnornis* nest could not be estimated and incubation periods are not well known, but incubation periods in *Premnoplex* are reported to be longest among any Furnariidae (Greeney 2009). In addition, nestling periods in *Premnornis* are significantly shorter (18–19 days this nest, estimated 19–20 days Dobbs et al. 2003) compared to the 27–31 days reported for *Premnoplex* (Greeney 2009, Port & Greeney 2014), resulting from 3–6 hour bouts of parental absence from the nest (Muñoz & Martin 2014). While the factors influencing the unusual pattern in incubation in *Premnoplex* are not fully understood, the difference in parental behavior may suggest an evolutionary divergence.

The age at which *Premnornis* nestlings start thermoregulating is unknown, but secondary feathers broke sheaths on day eight and primaries likely emerged at nine days post-hatch. In addition, the change in parental feeding and brooding behaviors at seven days of age suggests nestlings were beginning to thermoregulate. In the Spotted Barbtail (*Premnoplex brunnescens*), thermoregulative ability of young was presumed at nine days post-hatch when adults ceased brooding on day 10 (Port et al. 2014).

Observations of *Premnornis* behavior and ecology have led to the suggestion that the phylogenetic relationships of *Premnornis* should be reconsidered (Dobbs et al. 2003, Areta 2007). DNA data (Irestedt et al. 2006) confirm these suggestions, and differences in nest structure and parental behavior from this and other studies of *Premnornis* and *Premnoplex* further support this suggestion. Though the extent of this study was limited to filmed observations of parental care behavior of eggs and nestlings, this study supported the doubts raised about placement of *Premnornis* within the *Margarornis* clade (Dobbs et al. 2003). Further research on this species will expand our understanding of parental roles during the nesting period and help elucidate taxonomic relationships. In addition, further study on the breeding biology in other closely related members of Furnariidae would also be useful to understand the phylogenetic relationships within the family and the *Margarornis* clade in particular.

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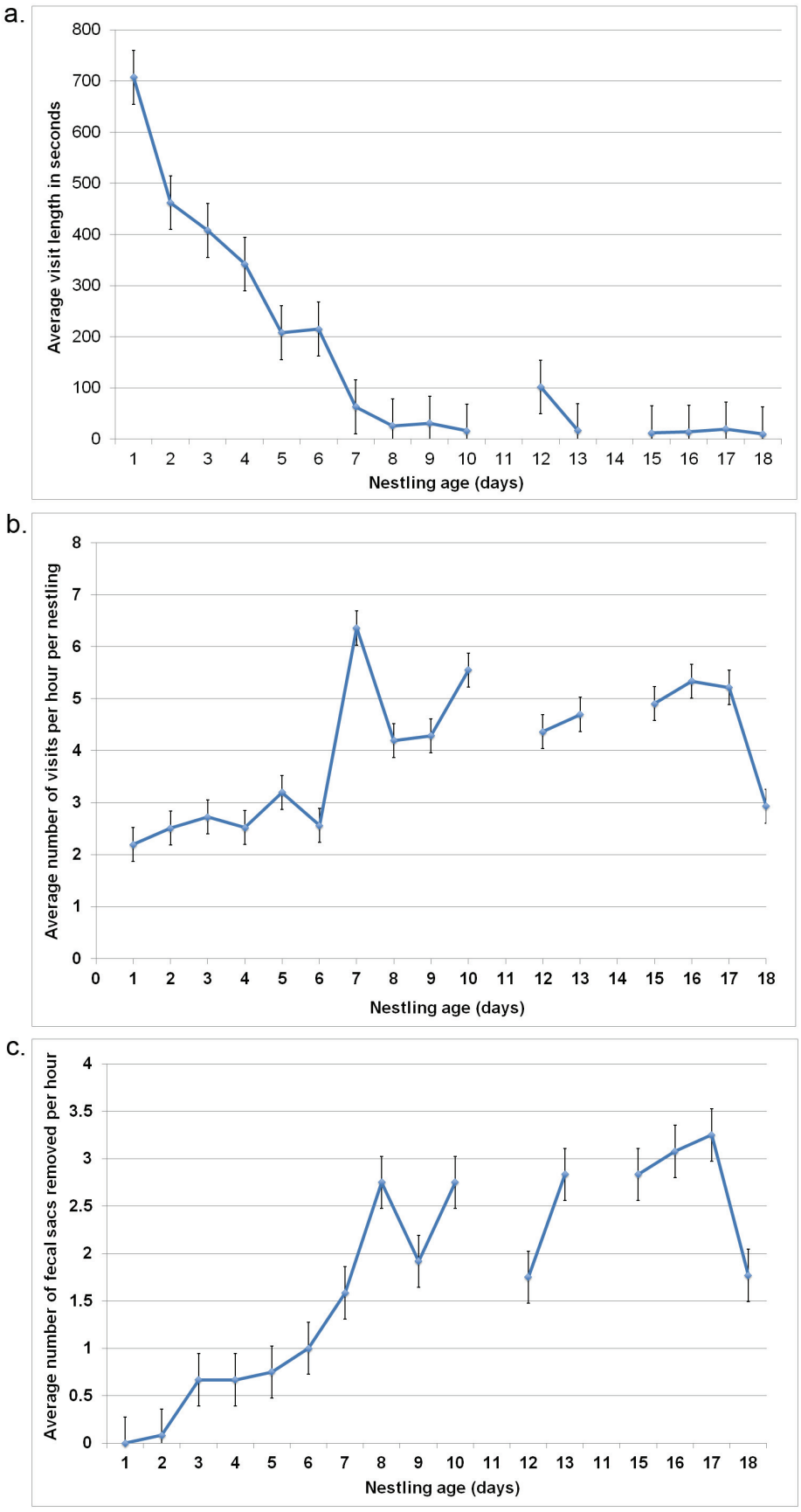

Figure 3. (a) Average visit time (in seconds) by parents after nestlings hatched, (b) average number of provisioning visits to the nest per hour per nestling, and (c) average number of fecal sacs per hour by nestling age removed by parents, each with standard error bars. Data was not recorded on day 11 or 14. Observations between 14 November to 8 December 2009 from a single Rusty-winged Barbtail (*Premnornis guttuliger*) nest near Cosanga, Ecuador.

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