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THE SPOTTED BARBTAIL (*PREMNOPLEX BRUNNESCENS*): OBSERVATIONS ON THE PARENTAL CARE BEHAVIOR OF A MONTANE NEOTROPICAL FURNARIID

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Resumen. – Observaciones sobre comportamiento parental del Subepalo Moteado (*Premnoplex brunnescens*). – Documentamos el período de crianza de los polluelos del Subepalo Moteado (*Premnoplex brunnescens*), incluyendo la tasa de alimentación y el tipo de alimento traído al nido. Analizamos 230 horas grabadas en vídeo, desde la eclosión de los huevos hasta volantones, donde confirmamos que los dos adultos del Subepalo Moteado alimentan principalmente a los polluelos con artrópodos (89.7%), y también documentamos la primera alimentación con ranas para *Premnoplex*. A su vez, observamos un periodo de pichones en el nido de 22 días. La tasa de aprovisionamiento aumentó considerablemente cuando los polluelos alcanzaron 10 días de edad (desde 2.29 ± 0.38 a 5.25 ± 0.76 alimentación/polluelo/h), en comparación con los primeros días del periodo de empollamiento (media 2.29 ± 0.38 alimentación/polluelo/h). Además, documentamos la expulsión no asistida de los sacos fecales por los polluelos a los 10 días de edad.

Abstract. – We document the nestling care of the Spotted Barbtail (*Premnoplex brunnescens*) including provisioning rates and items brought to the nest. Based on 230 hours of video spanning from hatch to fledging at a single nest, we confirm that both sexes of the Spotted Barbtail primarily provision nestlings with arthropods (89.7%) but also document the first feeding of frogs in the genus *Premnoplex*. Concurrent with a sudden drop in daily brooding time, provisioning rates increased significantly when nestlings reached 10 days of age (from 2.29 ± 0.38 to 5.25 ± 0.76 feeds/nestling/h). We also document unassisted fecal sac ejection by nestlings beginning by 10 days of age. Our observed length of the nestling period was 22 days. *Accepted 11 July 2014.*

Keywords. Spotted Barbtail, *Premnoplex*, Furnariidae, nestling: parental care.

INTRODUCTION

The Spotted Barbtail (*Premnoplex brunnescens*) is a small, inconspicuous member of the ovenbird (Furnariidae) family occupying humid, montane, Neotropical forests at elevations of 600–3000 m a.s.l. from Costa Rica southward to central Bolivia, and currently includes five recognized subspecies (Fjeldså & Krabbe 1990, Remsen 2003, Greeney 2011). Traveling singly or in mixed flocks, Spotted Barbtails forage in the understory to midstory, creeping along horizontal and vertical branches, only occasionally using their barbed tails as support. Adults glean and probe for a variety of arthropods on branches, bark crevices, epiphytes, dead leaves, and tree trunks, often hanging upside down (Wetmore 1972, Remsen 2003, Areta 2007). While the phylogenetic placement of *Premnoplex* barbtails has

been debated, recent molecular data suggest they form a monophyletic clade with *Margarornis* (Derryberry *et al.* 2011) and *Pygarrhichas* (Irestedt *et al.* 2006).

Although the nest of Spotted Barbtail was first described almost half a century ago (Skutch 1967), only recently have the details of reproductive ecology been elucidated (Greeney 2011 and included references). Spotted Barbtails build globular, mossy, ball-shaped nests with a downward facing tubular entrance (Skutch 1967, Marín & Carrión 1994, Areta 2007, Greeney 2008a). Nests are built in a wide variety of situations ranging from earthen or wooden cavities to suspended clumps of moss, almost exclusively directly over streams (Greeney 2009a). Two white eggs are incubated for 27–31 days (Greeney 2009b).

Almost nothing has been described of Spotted Barbtail nestling care. Greeney (2008c) describes a nestling period of 19–22 days and Areta (2007) and Greeney (2008b) provide the only published information on behavior, noting only that older nestlings defecate through the nest entrance in the absence of adults, the fecal sacs presumably removed by the running water below. Other than these basic aspects of nesting biology, little is known of parental care, nestling behaviors, or nestling diet. Here we describe parental care behaviors including provisioning rates, prey items, and brooding patterns along with nestling defecation behaviors and fledging of Spotted Barbtails in northeastern Ecuador.

METHODS

We made all observations at the Yanayacu Biological Station and Center for Creative Studies (0°36'S, 77°53'W) located adjacent to the Cabañas San Isidro reserve, 5 km west of Cosanga, Napo Province, Ecuador; for more complete descriptions of the area see Greeney *et al.* (2006) and Guayasamin *et al.* (2006). We carried out all observations at one focal nest. This nest was situated at a height of approximately 0.5 m attached to a horizontal log directly above a fast flowing mountain stream at an elevation of 2050 m a.s.l.. We videotaped the nest from 2 October to 24 October 2007, placing the camera on a tripod 3–5 m away from the nest. We recorded between sunrise and sunset, approximately 06:00–18:00 h, beginning with the day prior to hatch (2 October) and ending with fledging of the young on 24 October. Only 16 October, the day both adults were captured and color banded, was not recorded resulting in 230 total hours of video over 22 days. Quantification of visitation rates and identification of prey items were done through video analysis using VLC software (VideoLan 2013) for playback.

RESULTS

Nestling provisioning. The nestlings hatched between 2 October, 15:30 h and 3 October, 12:30 h, after which both adults began to provision the two nestlings. Adults typically landed on the lip of the nest entrance, remaining there momentarily before entering into the nest cavity. As the nestlings grew larger, adults remained on the lip of the nest while feeding. Adults always carried food in their bills when approaching the nest and prey items were delivered one at a time. An adult arriving to find its mate already inside the nest would wait just outside the nest entrance for its mate to leave before entering to feed or brood. On three occasions, the adults left with the food item without feeding and on one occasion appeared to return with the same item to feed the nestlings at later point in time. On two occasions, food was dropped into the water below without feeding successfully.

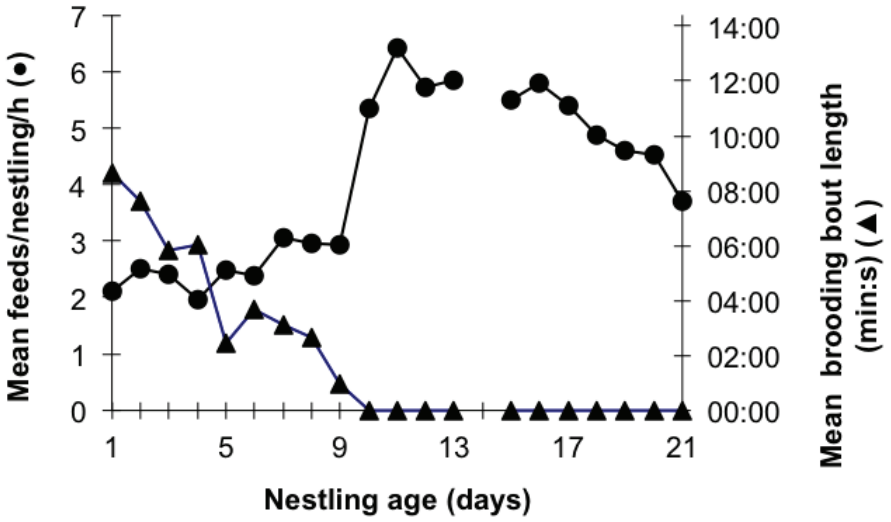

FIG. 1: Means feeds per hour (circles; n = 1788 visits) and brooding bout length (triangles; n = 358) during the nestling period for a single nest of Spotted Barbtail (*Premnoplex brunnescens*) containing two nestlings near Cosanga, Ecuador.

The adults fed the nestlings at an overall rate of 4.03 ± 1.51 (mean ± SD) feeds/nestling/h. This represents the number of visits made by both parents to the nest. Feeding rate remained relatively constant (mean = 2.29 ± 0.38 feeds/nestling/h, range = 1.96–3.09 feeds/nestling/h) through nine days of age. Beginning when nestlings were 10 days old, feeding rate increased significantly (mean = 5.25, SD = 0.76 feeds/nestling/h, range = 3.70–6.41 feeds/nestling/h) ($t = -6.7$, $df = 5$, $P < 0.000$; Fig. 1). The day of fledging (nestlings aged 22 days), was omitted from these calculations, as adult behavior on this day was distinctive (see below).

Beginning when the nestlings were 10 days old, in addition to an increase in the average number of visits per hour, the amount of time spent at the nest each visit changed significantly ($t = 5.86$, $df = 8$, $P < 0.000$). Visits averaged 0:03 ± 0:02 min (mean ± SD; n = 1301) compared to 5:05 ± 2:34 min (n = 483) for the first nine days of the nestling period. Provisioning rates peaked at 12.5 feeds/nestling/h when nestlings were 11 days old (range 2.5–12.5 feeds/nestling/h). Provisioning rates by individuals were also rapid with a single individual recorded feeding 33 times over a three hour span with as little as 52 s between feeding visits. The shortest recorded period of time between visits by a single individual was 10 s indicating that, at least occasionally, adults may forage very close to the nest.

For 3 of 15 days for which complete 12 h observations were available, the distribution of visits during the day was clumped, and on remaining days it was random (Index of Dispersion; Fowler *et al.* 1998). Visits per hour ranged from as few as 1 to a high of 23. Visits per hour declined significantly throughout the day across the nesting period (ANOVA, $F = 14.01$, $P = 0.004$) (Fig. 2).

Adults fed a variety of insects and invertebrates to the nestlings, but their diet could not be fully analyzed, due to the very

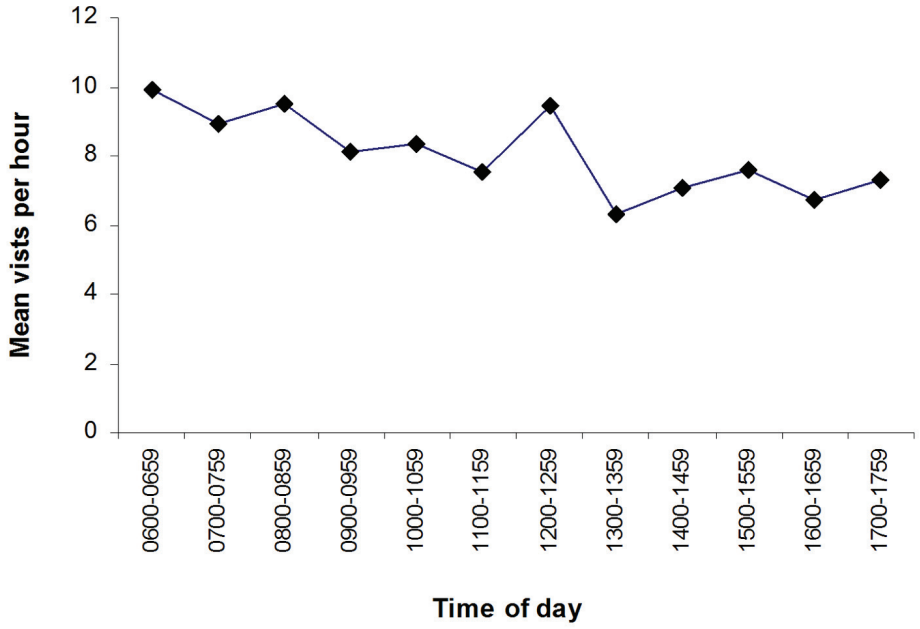

FIG. 2: Mean hourly pattern of feeding visits for a single nest of Spotted Barbtail (*Premnoplex brunnescens*) containing two nestlings near Cosanga, Ecuador. Only days for which complete (12 h, n = 15) observations were available were used in this figure.

small size of food items and video resolution. A total of 1788 feeding visits were recorded. We were able to identify 409 food items (22.9%). Nearly all of the identified items were insects (89.7 %, n = 367), primarily Orthoptera and Lepidoptera and represented nine insect orders, with additional prey from two orders of arthropods, annelids, and vertebrates (Table 1). Orthoptera represented the largest proportion of the identified prey items (50.1%, n = 205) with prey from the Tettigoniidae, Gryllidae, and Acrididae recorded. Additional invertebrates included Annelida, Arachnida, and Diplopoda and collectively comprised 9.3% of the items identified. On two occasions adults brought items encased in silk which we interpret to be either spider egg cases or lepidopteran pupae. These items were classified as unknown in Table 1. Vertebrates were also represented in the prey items brought to the nest to provision the young. Three frogs were fed to the nestlings including one identified as *Pristimantis eriphus* (Strabomantidae).

Brooding behavior. The nestlings were brooded 20.5 % of the total daylight observation time (358 bouts, range = 1–46.7 min) during the first nine days post-hatch. Beginning with day 10, adults were never recorded entering the nest to brood during daylight hours. Prior to day five, all visits to the nest included some time inside the nest (n = 195 bouts). By day five, adults began to make some visits solely for the purpose of provisioning with no entry into the nest for brooding. By day nine only 27.1% of visits (10 of 37 visits) included brooding during the morning hours and no brooding occurring during the afternoon (0 of 17 visits). In total, 80.4% of visits during the brooding period (through day 9) included time inside the nest (n = 445 total visits).

TABLE 1. Composition of prey items brought to nest containing two nestlings by Spotted Barbtail (*Premnoplex brunnescens*; n = 409). 22.9% of all items brought to the nest were identified. Items listed as unknown were noted for their similarity to arachnid egg cases or Lepidoptera pupal cases but could not be positively identified.

Prey type	Number of items	Percent of total prey items
Insecta	367	89.73
Orthoptera	205	50.12
Lepidoptera	107	26.16
adult	65	15.89
larva	42	10.27
Phasmidae	34	8.31
Odonata	11	2.69
adult	6	1.47
larva	5	1.22
Diptera (Tipulidae)	3	0.73
Trichoptera	3	0.73
Neuroptera	2	0.49
Coleoptera	1	0.24
Blattodea	1	0.24
Arachnida	3	0.73
Diplopoda	1	0.24
Annelida	32	7.82
Vertebrates		
Anura	3	0.73
Fish	1	0.24
Unknown	2	0.49

During the first nine days of the nestling period, the average brooding session lasted 4.34 ± 2.35 min (mean ± SD; n = 358 bouts). Brooding rates appeared to be independent of time of day but highly associated with nestling age during the course of the study (Fig. 1).

The amount of time adults spent at the nest (either brooding or feeding) decreased steadily throughout the first nine days of the nesting period. During the brooding period, adults on average spent 38.4% (n = 95 h observed) of daylight hours at the nest (combined brooding and feeding). Once brooding ceased, even though provisioning visits nearly doubled, the amount of time spent at the nest declined (0.93%, n = 124.5 h).

Time between visits did not change significantly during the nesting cycle. During the brooding period, adults often exchanged positions at the nest and time between visits was limited. However, while visit time was substantially longer during the first nine days (Fig. 1), average time between visits was similar to the post-brooding period (mean = 6:42 min, SD = 8:48 min, n = 458). For the post-brooding period (days 10–21), mean time between visits was 5:51 min ± 21:10 min, n = 1258 (t = 1.16, df = 1688, $P = 0.24$).

Defecation by nestlings. Nestlings were observed defecating directly out of the nest by 10 days of age. By this age nestlings typically positioned themselves with their heads near the nest entrance. To defecate, nestlings rotated

180°, positioning their cloaca over the edge of the nest, and forcibly expelled waste out of the nest and into the water below. Direct observations at numerous barbtail nests (HFG unpubl.) revealed that this behavior did not result in any visible soiling of the nest rim or entrance tunnel. Furthermore, feces collected from the water below the nest, even by older nestlings, were still encased in a fecal sac. Across the entire nestling period, adults were never observed removing fecal sacs in their bills and no fecal matter accumulated within the nest, indicating that waste produced by young nestlings is either ejected or consumed by adults. It is possible that fecal ejection began prior to day 10, but the small size of fecal sacs during this stage was too small to be recorded by the video. The camera angle precluded reliable detection and quantification of these subtle behaviors, particularly during the early nestling period when young (and their droppings) were too small to be observed.

Fledging. Fledging occurred during the morning of 24 Oct, when nestlings were 22 days old. Only a single adult was observed at the nest during the fledging period. Three feeding visits were made including one that occurred after the nestlings had left the nest. The adult flew off with the food item and was not seen at the nest again. Prior to fledging and after feeding, the adult appeared to encourage the nestlings to exit the nest by repeatedly leaning in and then falling backwards while still clinging to the nest. No vocalizations were recorded by the camera due to the noise of the stream but we suspect that adult vocalizations were involved, as adults are known to make soft calls and chirps while feeding (HFG unpubl.). On one occasion, the adult tugged on a nestling's wing after it climbed onto the lip if the nest. Seconds later, the nestling followed the adult from the nest.

DISCUSSION

The number of feeds per hour described for Spotted Barbtail increased with nestling age in an abrupt fashion, nearly doubling when the nestlings were 10 days of age. Greeney (2008c) reported that nestlings had contour and flight feathers emerging from sheaths by this age, suggesting an increased ability to thermoregulate as well increased energetic demands due to rapid growth. The increase in feeding rate coincided with a complete cessation of brooding bouts. While some authors report no relationship between nestling age and visitation rates in the Furnariidae (Dias *et al.* 2009, Cockle & Bodrati 2013), increases in feeding rate late in the nesting cycle are reported for Rufous Hornero (*Furnarius rufus*, Massoni *et al.* 2012), Thorn-tailed Rayadito (*Aphrastura spinicauda*, Moreno *et al.* 2007), Scalloped Woodcreeper (*Lepidocolaptes falcinellus*, Bodrati & Cockle 2011), and Olivaceous Woodcreeper (*Sittasomus griseicapillus*, Bodrati *et al.* 2012).

While the overall average number of feeding visits per hour (4.03 visits/nestling/h) reported here is in line with those reported for other ovenbirds (e.g., Auer *et al.* 2007, Moreno *et al.* 2007, Dias *et al.* 2009) adequate comparisons are limited by the lack of standardized methods among studies. Dias *et al.* (2009) reported a feeding rate of 12.8 feeds/h for the Bay-Capped Wren-Spinetail *Spartonoica maluroides* (4.3 visits/nestling/h when corrected for the number of nestlings) while Dobbs *et al.* (2003) reported an overall feeding rate for the Rusty-winged Barbtail (*Premnornis guttuligera*) of 4.7 visits/nestling/h. Individual feeding rates documented here are among the highest reported for Furnariidae with one individual making separate visits with food items at a rate of 18 visits per hour and as few as 10 s between visits.

Our observed length of the nestling period (22 days) is comparable to that

reported elsewhere (Greeney 2008b, 2008c) and that reported for members of the sister clade *Margarornis* and other ovenbirds (Skutch 1996, Remsen 2003).

Our direct observations of prey brought to nestlings supports prior assertions that Spotted Barbtails are generalist insectivores (Wetmore 1972, Areta 2007, Greeney 2008c). We did record the provisioning of small vertebrates including *Pristimantis eriphus,* a frog species currently listed as vulnerable by the IUCN. In addition, we observed what appeared to be a fish fed to nestlings. The possible inclusion of fish in the diet of an ovenbird would, to our knowledge, be the first for this species, and deserves confirmation. Salvador & Bodrati (2013) report instances of fish consumption in Furnariidae including Scaly-throated Earthcreeper (*Upucerthia dumetaria*) and Yellow-chinned Spinetail (*Certhiaxis cinnamomeus*) but among the *Premnoplex-Margarornis* clade, no other species have been reported feeding on vertebrates. More broadly, within the ovenbird-woodcreepers the Narrow-billed Woodcreeper has been reported feeding on vertebrates along with a number of other furnariids, which are known to feed their nestlings vertebrates including frogs, lizards, bird eggs, and nestlings (Skutch 1969, Willis 1972, Hayes & Escobar Argaña 1990, Bodrati 2003, Cockle & Bodrati 2009, Kirwan 2009, Salvador & Bodrati 2013).

We also confirm Areta's (2007) statement that older nestlings defecated out the nest entrance in the absence of adults. While detailed quantitative descriptions from early in the nesting cycle were not possible due to the small size of the fecal droppings and the limitations of the video, older nestlings (> 10 days) were clearly recorded defecating out of the nest when adults were not present. Greeney (2008b) reported that younger nestlings (up to 4 days of age) remained positioned with their heads opposite the nest entrance, presumably to facilitate adult removal of fecal matter until they were old enough to position themselves to drop feces out of the nest entrance. Adults were not documented removing fecal sacs during the early nestling stages and presumably consumed any waste matter produced by young before the young were capable of eliminating directly out of the nest. Mennill & Doucet (2005) noted similar behaviors in *Margarornis rubiginosus*, and Greeney & Gelis (2011) reported the apparent lack of fecal sac removal by parents in the Pearled Treerunner (*M. squamiger*). The nestling defecation behavior described here may reduce the amount of time adults spend at the nest waiting to consume or carry fecal sacs. As adult activity at the nest is known to increase predation rates (Ibáñez-Alamo *et al.* 2013), the defecation of nestlings in the absence of adults may have selective advantages. Soiling of the nesting area with fecal matter has potential to detrimentally effect nestling survival due to the olfactory and visual attraction of predators (Petit *et al.* 1989, Lang *et al.* 2002). The strong fidelity to nesting directly over water by Spotted Barbtails (Greeney 2008a) provides a natural sewage system whereby fecal matter is removed or obscured by water below the nest, a trait that may have allowed the evolution of such behavior.

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