ORNITOLOGIA NEOTROPICAL 25: 421–431, 2014

NESTING OF THE SHORT-TAILED ANTTHRUSH (*CHAMAEZA CAMPANISONA)* IN THE ATLANTIC FOREST OF ARGENTINA

Alejandro Bodrati[1], Kristina L. Cockle[1,2,3], & Facundo G. Di Sallo[1]

[1]Proyecto Selva de Pino Paraná, Vélez Sarsfield y San Jurjo S/N, San Pedro, Misiones, 3352, Argentina. *E-mail:* alebodrati@yahoo.com.ar

[2]School of Renewable Natural Resources, LSU AgCenter, Baton Rouge, LA 70803, USA.

[3]Centre for Applied Conservation Research, Department of Forest and Conservation Sciences, Univ. of British Columbia, 2424 Main Mall, Vancouver, BC V6T 1Z4, Canada.

Resumen. – Nidificación de la Tovaca Común (*Chamaeza campanisona tshororo*) en la selva Atlántica de Argentina. – Las tovacas (familia Formicariidae) son poco conocidas en cuanto a su historia natural y reproducción. Aquí presentamos nueva información sobre la biología reproductiva de la Tovaca Común (*Chamaeza campanisona*) en la provincia de Misiones, Argentina. Encontramos 13 nidos de septiembre a diciembre en selva Atlántica primaria, en cavidades de árboles, originadas por degradación de la madera (no excavadas por pájaros carpinteros). Las cavidades estaban a 5,4 ± 0,8 m (promedio ± error estándard) sobre el suelo (rango = 1,7–9,6 m); sus entradas medían por lo menos 4 cm en diámetro; y tenían una profundidad vertical de 111 ± 27 cm (rango = 32–312 cm). Antes de la puesta, los dos adultos tapizaron el fondo de la cavidad con hojas, o formaron una repisa del mismo material en el medio de la cavidad. Los 2–3 huevos blancos fueron incubados por los dos adultos, con turnos de 119 ± 11 min (rango = 82–145 min). En base a observaciones en dos nidos, estimamos el período de incubación en 18 días. Los adultos traían hojas cuando llegaban al nido para incubar, y formaron una muralla de hojas verdes alrededor de los huevos. Los pichones estaban cubiertos de plumón gris con tinte violáceo cuando nacieron, tenían los ojos abiertos el día 10, y los canutos estaban abriendo en el cuerpo y en las alas el día 16. Los dos adultos alimentaron a los pichones con artrópodos (51% larvas de Lepidoptera), llevando en promedio 2,6 ± 0,2 presas por visita (rango = 1–7). En cuanto progresó el desarrollo de los pichones, los adultos visitaron el nido con menos frecuencia, pero llevaban más presas en cada visita. Removieron sacos fecales desde el día 8. Cada adulto usaba un diferente sector de la selva y tenía su ruta establecida de arribo al nido. Los pichones abandonaron el nido luego de 22–23 días, haciendo un corto vuelo cuando un adulto arribó a la cavidad. Volantones tenían apariencia de adultos pero con cola corta, pico más claro y corto, y un vestigio de la comisura amarilla. Varios aspectos de la nidificación fueron similares a la Tovaca Cara Negra (*Formicarius analis*), pero sería necesario realizar más estudios para saber si los patrones encontrados se pueden generalizar a la familia.

Abstract. – Little is known of the natural history and reproduction of the antthrushes (family Formicariidae). Here we provide new information on the breeding biology of the Short-tailed Antthrush (*Chamaeza campanisona*) in Misiones province, Argentina. We found 13 nests from September to December in primary Atlantic forest, in tree cavities produced by wood decay (not excavated by woodpeckers). The cavities were 5.4 ± 0.8 m (mean ± SE) above the ground (range = 1.7–9.6 m); their entrances were at least 4 cm in diameter; and their vertical depth was 111 ± 27 cm (range = 32–312 cm). Before eggs were laid, both adults used leaves to cover the cavity floor or construct a platform mid-cavity. The 2–3 white eggs were incubated by both adults, with bouts lasting 119 ± 11 min (range = 82–145 min). From observations at two nests, we estimate the incubation period at 18 days. Adults brought leaves when they arrived to incubate, forming a wall of green leaves around their eggs. Nestlings were covered in violet-tinted grey

down when they hatched, they had open eyes on day 10, and pin feathers were opening on their bodies and wings on day 16. Both adults fed the nestlings arthropods (51% caterpillars), taking on average 2.6 ± 0.2 prey items at a time (range = 1–7). As the nestling period progressed, the adults visited the nest less frequently but brought more prey items per visit. They removed fecal sacs beginning on day 8. Each adult used a different sector of the forest and had its own established route to arrive at the nest. Nestlings fledged after 22–23 days, making a short flight when an adult arrived at the cavity. The fledglings looked like adults but had shorter tails; shorter, lighter-colored bill; and a remnant of the yellow gape flanges. Several aspects of nesting were similar to the Black-faced Antthrush (*Formicarius analis*), but more studies are needed to determine whether these patterns can be generalized to the rest of the family. *Accepted 18 December 2014.*

Key words: Short-tailed Antthrush, *Chamaeza campanisona*, Argentina, diet, fledging, incubation, nest, parental care.

INTRODUCTION

The antthrushes (Formicariidae) are a family of feeble-winged insectivorous birds, inhabiting Neotropical forests and including the genera *Chamaeza* and *Formicarius* (Irestedt *et al.* 2002, Remsen *et al.* 2014). These ground-dwelling birds walk on roots, logs, and the forest floor, pecking invertebrates from leaf litter and low plants (Skutch 1945, Willis 1992, Sick 1993). They nest in tree cavities or hollows (Bertoni 1901, Cherrie 1916; Skutch 1945, 1969; Schäfer 1969, Sick 1993, Cadena 2000, Krabbe & Schulenberg 2003, Maders & Matuchaka 2011, Franz 2013).

Arguably the best-known species of Chamaeza is the Short-tailed Antthrush (*Chamaeza campanisona*), which inhabits a large but disjunct circum-Amazonian range (Greeney 2013). The Short-tailed Antthrush is divided into twelve subspecies, but these divisions are uncertain (Krabbe & Schulenberg 2003). The subspecies *tshororo* of the interior Atlantic forest (eastern Paraguay through Misiones, Argentina, to Río Grande do Sul, Brazil) may not be distinct from the nominate *campanisona* of the coastal Brazilian Atlantic forest, and these two subspecies together may comprise a separate species from the northern subspecies (Krabbe & Schulenberg 2003). Despite its large distribution, little is known about the natural history of the Short-tailed Antthrush, including diet and reproductive biology (Greeney 2013).

Limited information has been published on nesting of the Short-tailed Antthrush. Schäfer (1969) did not report specific data but stated that nests are placed in holes at the edges of gullies or 1–2 m above the ground in a rotten stump, and both parents feed the two nestlings. All nests that have been described in detail had smooth white eggs, placed on a bed of leaves in a tree cavity (Bertoni 1901, Maders & Matuchaka 2011, Franz 2013; Table 1). Eggs measured 25.7–32 x 21.4–24 mm and weigh 0.33–0.42 g (Ihering 1900, Schönwetter 1967, Fraga & Narosky 1985, Maders & Matuchaka 2011). Nestlings had pink skin and blackish grey down when < 6 days old, and pin feathers at 9–12 days old (Maders & Matuchaka 2011, Franz 2013). Franz (2013) estimated the nestling period to be 16–19 days. Two nestlings were also found at a nest at Sumaco-Napo Galeras National Park in Ecuador, but no other details are given (Greeney & Gelis 2007). Nest trees have been found in well-preserved Atlantic forest near a swampy area (Maders & Matuchaka 2011) and at the edge of an 80-ha patch of low Atlantic forest within an agricultural landscape (Franz 2013). Little is known about other aspects of the reproductive biology of the Short-tailed Antthrush or any other *Chamaeza*.

TABLE 1. Characteristics of nests of Short-tailed Antthrush (*Chamaeza campanisona tshororo*) from the Atlantic forest, including 13 newly reported nests from Argentina ([1]Bertoni 1901, [2]Maders & Matuchaka 2011, [3]Franz 2013, [4]this study). Entrance diameter is given as vertical x horizontal measurement, with measurements for second and third (higher) entrances in parentheses. Stage found is given as "laying" if the nest was found before the last egg was laid, "incubation" if the clutch was complete when the nest was found, and "eggs" if the nest contained eggs but we do not know if the clutch was complete. Clutch size is only given for clutches known to be complete.

Locality	Tree		Cavity			Nest				
	Species	DBH (cm)	Height (m)	Entrance diameter (cm)	Depth (cm)	ID	Date found	Stage found	Clutch size	Fate
Paraguay[1]	-	-	1	-	100	-	late Sep	-	-	fledged 18 Oct
Parque Provincial (PP) Moconá, Misiones, Argentina[2]	Myrtaceae	-	3	30 x 6	21	-	Sep 2002	eggs	3	unknown
Sapiranga, Rio Grande do Sul, Brazil[3]	*Allophylus edulis*	17	1.5	12 x 10	87	-	12 Nov 2011	incubation	3	unknown
PP Cruce Caballero[4]	*Alchornea triplinervia*	61	5.5 (6.5)	7 x 9 (39 x 19)	312	1	20 Oct 2010	incubation	3	unknown
Same cavity as nest 1						2	24 Sep 2011	construction	3	unknown
Same tree as nest 1			1.7	28 x 10	138	3	8 Nov 2014	construction	-	depredated
Same cavity as nest 3						4	21 Nov 2014	construction	-	abandoned
PP Cruce Caballero[4]	*Prunus myrtiflorus*	30	3.8	50 x 4	34	5	28 Sep 2012	eggs	-	depredated
PP Cruce Caballero[4]	*Allophylus edulis*	40	9.6	9 x 9	89	6	18 Nov 2012	eggs	-	depredated
PP Cruce Caballero[4]	*Allophylus edulis*	29	4.0 (4.7)	13 x 5 (118 x 3)	135	7	13 Oct 2013	construction	2	fledged 1–2 Dec
Same cavity as nest 7						8	22 Sep 2014	incubation	2	depredated
Same cavity as nest 7						9	2 Nov 2014	incubation	2	depredated
PP Cruce Caballero[4]	*Tetrochoridium rubrivenium*	35	7.3 (8.5)	17 x 7 (45 x 15)	64	10	25 Nov 2013	laying	2	depredated
PP Cruce Caballero[4]	unknown	35	6.7	12 x 9	145	11	26 Sep 2014	eggs	-	depredated
PP Cruce Caballero[4]	*Ruprechtia laxiflora*	29	3.0 (3.2, 3.4)	29 x 6 (10 x 4, 18 x 5)	54	12	13 Oct 2014	construction	3	depredated
PP Cruce Caballero[4]	*Trichilia claussenii*	27	7	25 x 10	32	13	19 Oct 2014	eggs	-	depredated

Here, we report on 13 nesting attempts of the *tshororo* subspecies of the Short-tailed Antthrush in the Atlantic forest of Misiones province, Argentina, and provide new information about nest construction, incubation and nestling periods, parental care, nestling diet, and fledging.

METHODS

Nests were found as part of a long-term study on the ecology of cavity-nesting birds (2006–2014; Cockle *et al.* 2010, 2012). Each spring (Sep–Dec, the main breeding season for passerines in the study area), we searched for nests in primary forest, selectively logged forest, regenerating forest, and isolated trees on farms from San Pedro (26º38'S, 54º07'W) to Tobuna (26º27'S, 53º54'W), Misiones, Argentina. The study area is a mosaic landscape of small (2–100 ha) farms, nature parks, and tree plantations, varying in elevation from 550–650 m a.s.l.. Natural forest remains in large blocks (~1000 ha), fragments (0.5–50 ha), and corridors, and conforms to Cabrera's (1976) "mixed forest with laurel (*Nectandra* spp. and *Ocotea* spp.), guatambú (*Balfourodendron riedelianum*) and Paraná pine (*Araucaria angustifolia*)." To find nests, we 1) walked along preestablished trails and roads, a grid of transects (total 27 km), and off-trail; 2) followed adult birds; 3) looked for birds entering or emerging from cavities; 4) listened for nestlings begging; and 5) monitored cavities that were used in previous years.

Contents of cavities were monitored using a small color video camera mounted on a 15 m telescoping pole or carried up to the cavity using single-rope climbing. We checked cavities every 1–3 weeks when they had no evidence of nesting, every 1–14 days when they contained eggs or nestlings, and every 1–2 days during laying and around the expected hatch date. A nest was presumed to be depredated if all eggs were missing from the cavity or nestlings were missing before they were fully feathered on the head, back, and wings. We took the following measurements when the birds finished nesting: tree diameter at breast height (DBH), cavity height (from lower lip of entrance to ground), vertical and horizontal diameter of each entrance to the cavity, and cavity depth (from lower lip of lowest entrance to floor of cavity).

We also watched nests from the ground using binoculars or a telescope for a total of 1 h 30 min during the nest-building and laying period, 25 h 25 min during incubation, and 50 h 25 min during the nestling period, to study adult behavior.

RESULTS

We recorded 13 nesting attempts of the Short-tailed Antthrush in nine cavities, all in primary forest at Parque Provincial Cruce Caballero (Table 1). The closest simultaneously active nests were 85 and 90 m apart (nests 8 and 11; nests 3 and 12). Only one nest could be followed through to fledging. Nine were depredated (six with eggs and three with nestlings) and one was abandoned with only one egg. Two nests were not monitored frequently enough to determine fate.

Timing of reproduction. Laying occurred before 22 September at the earliest nest (nest 8) and on 24 or 25 November at the latest nest (nest 10).

Nest site and construction. All nests were made of leaves, in cavities produced by decay (not excavated), 1.7–9.6 m high (Table 1). Seven cavities were in trees in advanced stages of decay (nests 1–5, 7–11, 13), and two were in live healthy trees (nests 6 and 12). All nests appeared to be placed directly on the cavity floor, except nest 2. The cavity in the *Alchornea triplinervia* experienced some deterioration between nests 1 and 2. When we checked it

on 11 September 2011, the cavity bottom had fallen out, and the cavity extended down the tree and out the trunk. When we returned on 24 September, the birds were using the cavity and had built a cup or platform nest of leaves to fill in the gaps between natural ledges in the cavity interior. In 2014, the upper and lower cavities remained separated by a platform of detritus, and the birds used the lower cavity, which now extended nearly to the ground inside the tree (nests 3 and 4; Table 1).

Nest construction was observed at nests 3, 4, 7, and 12. We first saw a few green and brown leaves in these cavities 1–4 days before laying. The first egg was laid on a bed of brown and green leaves. By day 10 of incubation, a wall of green leaves surrounded the eggs. Adults brought most of the leaves to the cavity during the incubation period, when they entered the cavity to incubate the eggs (nests 7 and 12); however, they continued to add leaves occasionally until day 17 of the nestling period (nest 7). They brought several leaves at once. For example, on one of its visits on day 12 of incubation, an adult brought dead *Nectandra megapotamica* leaves and green *Plinia trunciflora* and *Eugenia uniflora* leaves (nest 7).

Eggs. Complete clutches had 2–3 eggs (mean ± SE = 2.4 ± 0.2, n = 7; Table 1). Eggs were white, but at nest 7 they became soiled by nest material by day 9.

Incubation. At nest 7, the last of the two eggs was laid between 15:46 h on 20 October and 10:25 h on 21 October, and the two nestlings hatched between 10:32 h on 7 November and 15:37 h on 9 November, giving an incubation period of 17–19 days. Nest 12 contained no eggs at 18:08 h on 15 October, two eggs at 16:40 h on 18 October, and three eggs at 16:30 h on 22 October, suggesting that the eggs were laid on 16, 18, and 20 October (assuming they are laid every second day). Two eggs hatched between 17:30 h on 4 November and 10:33 h on 6 November, and the third egg did not hatch. The incubation period was 18 days if incubation began with the second egg, and 16 days if incubation began with the third egg. Considering the evidence from both nests, the incubation period is likely 18 days.

Both adults contributed to incubation (nests 1, 7, 12). One or both adults were in the cavity 87% of the time during incubation (n = 11 observations at nests 1, 7, and 12), and complete incubation bouts averaged 119 ± 11 min (range: 82–145 min; n = 5; nests 7 and 12). The adults that incubated overnight entered the nest 1 h 23 min before sunset on day 3 of incubation (17:34 h on 24 October 2013, a cloudy day) and 59 min before sunset on day 10 (18:03 h on 31 October 2013, with clear skies; nest 7).

Hatching and nestling development. Nestling development was observed at nests 7, 9, and 12. On hatching (days 0–3), nestlings appeared as dark violet-grey pompoms, with pink skin visible in a few spots (including belly), closed eyes and a light-colored bill. They lay together and their long puffy down made it very difficult to see body parts or determine how many nestlings were present. We saw no eggshells in the nest. Nestlings still looked like pompoms on day 5, but their heads could be better distinguished from their bodies and they showed large yellow gape flanges and pink mouth-linings. By day 7, one chick was larger than the other. By day 10, eyes were open, and down was lighter grey, shorter, and less dense. By day 16, pin feathers were beginning to open and the bill was darker. On day 18, the nestlings were feathered, with short brown feathers on the back and wings. The iris and tip of the bill were black. They raised their heads and moved in the nest. On day 20, they looked generally like adults, but with tail feathers about one third of adults' length. The

tip of the bill was black but the base was pale, with yellow gape flanges still visible. Flanks were streaked as in adults. On day 21, they had white eyebrows and malar line and were like adults except for their short tails and wings. We could hear the nestlings vocalizing when the adults landed on perches near the nest beginning on day 8, but we did not observe them climbing to the nest entrance to be fed until day 22.

Nestling diet and parental care. Nestlings were fed a diet of arthropods, and half of all identified food items were caterpillars (Lepidoptera; nests 1 and 7; Table 2). The adults always arrived at the nest through areas of tree ferns (*Alsophila procera*) with open understory (nests 1, 7, 8, and 12). At nests 7 and 8 (same cavity), this meant they avoided an area of dense *Chusquea tenella* bamboo. They often spent several minutes walking around the base of the nest tree, observing their surroundings, before ascending to the nest (nests 1, 7, and 8). Nests 1, 7, and 8 had two entrances, but the adults always entered via the lower entrance (they exited via the higher entrance at nest 1, but usually via the lower entrance at nests 7 and 8). Although the adults were not individually marked, the following observations suggest that each member of the pair at nest 7 used a different area of the forest for foraging, and a different route to ascend to the nest cavity. The adults approached either from the south or from the west. When the adult approached from the south it always walked up a fallen diagonal trunk to a height of 45 cm, and then hopped to a swinging horizontal branch of *Sorocea bonplandii* at a height of 2.3 m. There it stopped, looking all around for about 30 s, before making a short (4.2 m) flight to the lower cavity entrance. When it exited the cavity, it flew back to the south. When the adult approached from the west, it walked up a different fallen trunk, hopped to a horizontal branch of another *Sorocea bonplandii* (2.2 m high), paused, and made a short (4 m) flight to the lower cavity entrance. When it exited the cavity, it flew back to the west. Thus each adult returned to the sector of the forest from which it had come, and where it could later be heard vocalizing. We could always predict (based on the direction from which they came) which route they would use to access the cavity, and in which direction they would leave. The same routes were used the following year to access and leave the cavity, except that the *Sorocea* branches had become covered with bamboo (*Merostachys claussenii*), and the antthrushes now flew directly from the fallen trunks to the lower cavity entrance (nests 8 and 9). Both adults seemed to spend less time observing their surroundings from the *Sorocea* branches as the nestling period progressed. When they exited the cavity, they spent a few seconds standing in the entrance, looking around, and then flew downward to land 8–15 m from the nest (nests 1, 7, 8, and 12). The adults sang (full song) often, but always 40–100 m from the nest. They occasionally emitted alarm calls near the nest.

Parents began feeding the nestlings 21 ± 5 min after sunrise (mean ± SE; n = 6 observations at nests 1 and 7). Nestlings were fed at an overall rate of 2.1 ± 0.2 visits/h (n = 20 observation-days at nests 1, 7 and 8). At nest 7, feeding rate (parental visits/h) was low on the first two days after hatching, but high on day 3, after which it showed a slight decline until the end of the nesting period (Fig. 1). Parents usually carried more than one prey item to the nest at a time (mean ± SE: 2.6 ± 0.2 items, range = 1–7 items, n = 90 parental visits), but the mean number of prey items increased over the nestling period (except for the last two days when only one chick remained in the nest; Fig. 1). Adults often had mud on their beaks and faces, suggesting that they had been digging for food. We did not observe parents removing fecal sacs until day

TABLE 2. Prey items brought to nests of the Short-tailed Antthrush (*Chamaeza campanisona tshororo*) in the Atlantic forest of Argentina, based on 50 h 25 min of observations during the nestling period.

Class	Order	Life stage	n items	Details
Insecta	Lepidoptera	adult	14	includes 2 Pieridae, 1 Hytomidae, and 1 *Morpho aega* (Nymphalidae, Morphinae)
		pupa	2	
		larva	103	
	Orthoptera	adult	21	
	Coleoptera	adult	1	
		larva	8	all *Dilobodera* spp. (Scarabaeidae, Dynastinae)
	Hymenoptera	adult	5	
	Diptera	adult	5	includes 2 Tipulidae
	Hemiptera	adult	4	
	Odonata	adult	4	
	Blattaria	adult	2	
	Mantodea	adult	3	
	Dermaptera	adult	4	
	Isoptera	adult	1	
Arachnida	Araneae	adult	12	
	Opiliones	adult	5	
Chilopoda		adult	4	
Diplopoda		adult	4	
Total			202	

8. Thereafter, at nest 7 the adult from the west removed fecal sacs on 21 of 41 visits (51%), and the adult from the south on 5 of 17 visits (21%). We also observed an adult removing a scorpion (Arachnida: Scorpiones) from the cavity (nest 7, day 17). The adult from the south roosted in the cavity on nestling days 3, 8, and 14; both adults on day 5; and neither adult on days 15 and 17 (nest 7). The following year, both adults roosted in the cavity when the nestlings were about 2 days old (nest 8).

Fledging. The first nestling at nest 7 fledged 17 min after sunrise on day 22 (05:58 h on 1 December 2013), just when the adult from the west arrived with the first food of the day. It made a short clumsy flight, and fell onto a fallen trunk 7 m from the nest tree. It looked like an adult but with a shorter tail, a shorter and lighter bill, and yellow gape flanges. The adult approached the nestling, vocalizing softly, but did not feed it. After 22 min, the fledgling made another short flight (6 m) and was lost from sight.

After the first chick fledged, we only observed the adult from the west feeding the nestling that remained in the nest (n = 6 visits). The second nestling fledged 1 h 30 min before sunset on day 23 (17:56 h on 2 December 2013), again just as the adult from the west arrived at the cavity with food. The fledgling came out of the cavity, startling the adult, and perched on nearby branches of the nest tree. Just then the second adult arrived on the tree trunk with food, and the fledgling flew downward to land about 15 m away.

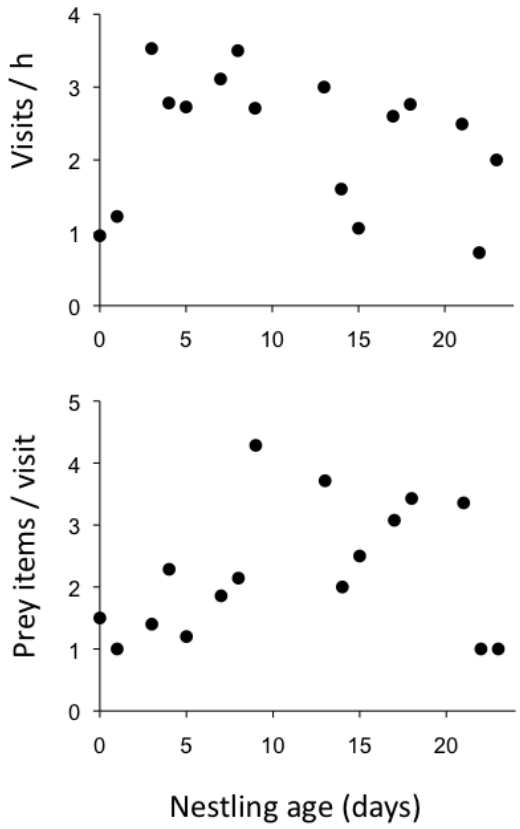

FIG. 1. Feeding rate (visits per hour) and mean number of prey items brought per visit, over the nestling period, at a nest (# 7, this study) of the Short-tailed Antthrush (*Chamaeza campanisona tshororo*) in the Atlantic forest of Argentina.

We watched the nest cavity again the following morning. Adults brought food to the tree and occasionally looked in the cavity, but they did not leave food there. Presumably the fledglings were hidden nearby. There were a few fecal sacs on the bottom and walls of the cavity, and detritus, including pieces of insects. The cup-shaped nest of leaves had completely come apart, and the bottom of the cavity was filled with dead leaves.

Nest predation, anti-predator behavior, and defense. One nest predation was witnessed by Carlos Ferreyra. A White-throated Woodcreeper (*Xiphocolaptes albicollis*) landed on the nest tree and an adult antthrush flew out of the cavity (nest 11). The woodcreeper entered the cavity and then exited with an egg.

The adult antthrushes did not approach their nest while a troop of Black Capuchin Monkeys (*Sapajus nigritus*) was above the nest tree (nestling day 17, nest 7). When the monkeys moved about 50 m away, an antthrush came to the nest but was extremely cautious while ascending to the cavity, the nestlings did not vocalize, and the adult flew much farther than usual (30–40 m) when exiting the nest. We sometimes had difficulty flushing adults

to observe nest contents. On these occasions, one or both adults inside the cavity would sometimes wag their tails slowly, and gave an impression of snakes or opossums rather than birds.

Cavity reuse. We observed Short-tailed Antthrushes reusing two of their cavities within the same breeding season after the first nest failed. Eight days after the eggs disappeared from nest 3, laying began at nest 4 in the same cavity. At nest 9, eggs were observed <17 days after the nestlings disappeared from nest 8. Additionally, two cavities were reused in a subsequent year (Table 1). The adults used the same routes to access the cavity in both years, and rarely flushed when we approached in the second year, suggesting they were the same individuals and had become accustomed to our visits (nests 7, 8, and 9). Two of the cavities were also used for nesting by White-throated Woodcreepers (nests 10 and 12), and one by Black-billed Scythebill (*Campylorhamphus falcularius*; nest 5). One cavity later contained a roosting White-eared Opossum (*Didelphis albiventris*; nest 5).

DISCUSSION

The 13 nests we found were all in primary forest at Parque Provincial Cruce Caballero, where the Short-tailed Antthrush is abundant (Bodrati *et al.* 2010). The species is present, but less common, in nearby logged forest (Krauczuk & Baldo 2004), where there are few available cavities (Cockle *et al.* 2010).

The nests we found were similar in many ways to previously studied nests of *Chamaeza* and *Formicarius* antthrushes (Bertoni 1901; Skutch 1945, 1969; Maders & Matuchaka 2011, Franz 2013). We found nests as high as 9.6 m above ground, much higher than we normally find adult birds, which walk or run on the ground even when escaping observers (pers. observ.). The cup-shaped nest of leaves we observed during incubation was very similar to the Short-tailed Antthrush nest photographed by Franz (2013). The walls of this cup were not yet constructed when the eggs were laid, and deteriorated to a bed of leaves during the nestling period, which may explain why other observers have described a bed of leaves rather than a cup (e.g., Bertoni 1901, Maders & Matuchaka 2011). In contrast, in a cavity from which a Striated Antthrush (*Chamaeza nobilis*) had recently fledged, Cadena *et al.* (2000) found only a few feathers and no vegetative material. We calculated an incubation period of 18 days for Short-tailed Antthrush, similar to Black-faced Antthrush (*Formicarius analis*; 18–20 days; Skutch 1969). Nestlings initially had pink skin covered in dense grey or violet-grey down, similar to other newly-hatched Short-tailed Antthrushes (Maders & Matuchaka 2011, Franz 2013) and Black-faced Antthrushes (Skutch 1945).

Among the Formicariidae, parental care has only been described in detail for the Black-faced Antthrush (Skutch 1945, 1969). We found that both sexes of the Short-tailed Antthrush contributed to incubation and nestling-rearing, as in the Black-faced Antthrush (Skutch 1945, 1969). The incubation bouts we recorded for Short-tailed Antthrushes (mean = 119 min) were slightly shorter than those recorded for the Black-faced Antthrush (rarely less than 2 h, sometimes up to 5 h; Skutch 1969). Eggshells were not observed in the nest after hatching in either Short-tailed or Black-faced Antthrushes (Skutch 1969, this study). Adults of both Short-tailed and Black-faced Antthrushes arrived with their bills full of (sometimes mangled) food items, walked around on the ground extensively before ascending to the nest cavity, and were usually silent around the nest (Skutch 1969, this study). The feeding rate of 2.1 visits/h was roughly similar to that of Black-faced Antthrushes, 1.9 ± 0.3 visits/h (calculated from Skutch 1969: 283, n = 4

observations). Whereas Short-tailed Antthrushes removed fecal sacs beginning on day 8, Black-faced Antthrush parents were not seen to remove fecal sacs and were assumed to swallow them until nestlings could be fed at the cavity entrance (Skutch 1969).

We found a slight decline in feeding rate as the nestling period progressed, compensated by an increase in the quantity of prey at each feeding. As nestlings age, they may be able to take larger portions, allowing parents to visit less frequently and avoid drawing the attention of predators. Nestling passerines usually experience increased energy demands as they age, and adults often respond by increasing the size of food loads while also increasing or maintaining visitation rate (e.g., Haggerty 1992, Goodbred & Holmes 1996). Our preliminary result that increased food load was accompanied by a decline in visitation rate as nestlings aged, suggests an interesting avenue for future research on life-history trade-offs in antthrushes.

We calculated a nestling period of 22–23 days for the Short-tailed Antthrush, whereas Franz (2013) estimated 16–19 days at a nest in Rio Grande do Sul, roughly corresponding with Skutch's (1969) calculation of 18 days for the Black-faced Antthrush. However, Franz (2013) did not observe fledging and we suggest that the nestlings may have been depredated. We observed one Short-tailed Antthrush fledging in early morning and another, at the same nest, in the evening, in both cases just as a parent arrived at the nest; Black-faced Antthrushes were only observed fledging in early morning, before sunrise, when a parent arrived (Skutch 1969). We encourage researchers to report the nests of other antthrushes, and to study their parental care, diet, and incubation and nestling periods, to determine whether the patterns observed for Short-tailed and Black-faced Antthrushes are generally representative of the Formicariidae.

ACKNOWLEDGMENTS

We thank the field assistants and volunteers who helped us study these nests: Bianca Bonaparte, Carlos Ferreyra, Cecilia Cuatianquiz Lima, Marcos Cenizo, Kirsten Wilcox, José Segovia, Julieta Benitez, Analía Fernández, Juan Klavins, and Emilse Mérida. Daryl Cockle created and modified the video cameras according to our needs. Sergio Salvador and Harold Greeney provided bibliography. We thank Niels Krabbe and Paul Smith for their thoughtful reviews that improved the manuscript. For access to field sites we thank the Ministerio de Ecología y Recursos Naturales Renovables (Provincia de Misiones), provincial park rangers, and private landowners. CREOI, Columbus Zoo and Aquarium, NSERC, CONICET, and Ornithological Council provided funding. AMIRBY loaned equipment.

REFERENCES

Bertoni, A. de W. 1901. Aves nuevas del Paraguay. Catálogo de las aves del Paraguay. Anal. Cient. Parag. 1: 1–216.

Bodrati, A., K. Cockle, J. M. Segovia, I. Roesler, J. I. Areta, & E. Jordan. 2010. La avifauna del Parque Provincial Cruce Caballero, provincia de Misiones, Argentina. Cotinga 32: 41–64.

Cadena, C. D., G. A. Londoño, & J. L. Parra. 2000. Nesting records of five antbird species from the Colombian Amazon. Wilson Bull. 112: 313–317.

Cherrie, G. K. 1916. A contribution to the ornithology of the Orinoco region. Brooklyn Inst. Arts Sci. Mus. Bull. 2: 133–374.

Cockle, K. L., K. Martin, & M. C. Drever. 2010. Supply of tree-holes limits nest density of cavity nesting birds in primary and logged subtropical Atlantic forest. Biol. Conserv. 143: 2851–2857.

Cockle, K. L., K. Martin, & G. Robledo. 2012. Linking fungi, trees, and hole-using birds in a Neotropical tree-cavity network: Pathways of cavity production and implications for conservation. For. Ecol. Manag. 264: 210–219.

Fraga, R., & S. Narosky. 1985. Nidificación de las aves argentinas (Formicariidae a Cinclidae). Asociación Ornitológica del Plata, Buenos Aires, Argentina.

Franz, I. 2013. On the nest, eggs and nestlings of the Short-tailed Antthrush (*Chamaeza campanisona*). Rev. Bras. Ornitol. 21: 101–104.

Goodbred, C. O., & R. T. Holmes. 1996. Factors affecting food provisioning of nestling Black-throated Blue Warblers. Wilson Bull. 108: 467–479.

Greeney, H. F. 2013. Short-tailed Antthrush (*Chamaeza campanisona*). *In* Schulenberg, T. S. (ed.). Neotropical Birds Online. Cornell Lab of Ornithology, Ithaca, New York, USA. Downloaded on 20 September 2014 from http://neotropical.birds.cornell.edu.

Greeney, H. F., & R. A. Gelis. 2007. Breeding records from the north-east Andean foothills of Ecuador. Bull. Br. Ornithol. Club 127: 236–241.

Ihering, H. von. 1900. Catalogo crítico-comparativo dos ninhos e ovos das aves do Brasil. Rev. Mus. Paul. 4: 191–300.

Irestedt, M., J. Fjeldså, U. S. Johansson, & P. G. P. Ericson. 2002. Systematic relationships and biogeography of the tracheophone suboscines (Aves: Passeriformes). Mol. Phylogenet. Evol. 23: 499–512.

Haggerty, T. M. 1992. Effects of nestling age and brood size on nestling care in the Bachman's Sparrow (*Aimophila aestivalis*). Am. Midl. Nat. 128: 115–125.

Krabbe, N. K., & T. S. Schulenberg. 2003. Family Formicariidae (ground-antbirds). Pp. 682–731 *in* del Hoyo, J., A. Elliott, & D. A. Christie (eds). Handbook of the birds of the world. Volume 8: Broadbills to tapaculos. Lynx Edicions, Barcelona, Spain.

Krauczuk, E. R., & J. D. Baldo. 2004. Contribuição para o conhecimento da avifauna de um fragmento de floresta com araucária em Misiones, Argentina. Atual. Ornitól. 119: 6.

Maders, C. J., & V. Matuchaka. 2011. Descripción del nido, huevos, y pichones de la tovaca común (*Chamaeza campanisona tshororo*). Nuestras Aves 56: 10–11.

Remsen, J. V., Jr., C. D. Cadena, A. Jaramillo, M. Nores, J. F. Pacheco, J. Pérez-Emán, M. B. Robbins, F. G. Stiles, D. F. Stotz, & K. J. Zimmer. 2014. A classification of the bird species of South America. American Ornithologists' Union. Version [26 May 2014]. Downloaded on 20 September 2014 from http://www.museum.lsu.edu/~Remsen/SACCBaseline.html.

Schäfer, E. 1969. Über Lebensweise und Ökologie der im Nationalpark von Rancho Grande (Nord-Venezuela) nachgewiesenen Ameisenvogelarten (Formicariidae). Bonn. Zool. Beitr. 20: 99–109.

Schönwetter, M. 1967. Handbuch der Oologie. 14. Lieferung. Akademie-Verlag, Berlin, Germany.

Sick, H. 1993. Birds in Brazil: a natural history. Princeton Univ. Press, Princeton, New Jersey, USA.

Skutch, A. F. 1945. On the habits and nest of the ant-thrush *Formicarius analis*. Wilson Bull. 57: 122–128.

Skutch, A. F. 1969. Life histories of Central American birds. III. Families Cotingidae, Pipridae, Formicariidae, Furnariidae, Dendrocolaptidae, and Picidae. Pac. Coast Avifauna 35: 1–580.

Willis, E. O. 1992. Three *Chamaeza* antthrushes in Brazil (Formicariidae). Condor 94: 110–116.