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NESTING OF THE PLANALTO WOODCREEPER (*DENDROCOLAPTES PLATYROSTRIS*)

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ABSTRACT.—We provide the first description of the nest, eggs, and nestlings of the Planalto Woodcreeper (*Dendrocolaptes platyrostris*), a secondary cavity-nester, based on three nests in natural cavities and 14 in nest boxes. Nests were found from October to January in 1997, 2006, and 2007 in the humid Chaco and Atlantic Forest of Argentina. Planalto Woodcreepers used natural cavities and nest boxes 40–60 cm deep with entrance diameters of 5–12 cm. They selected the deepest nest boxes available. Three or four white eggs were laid on a bed of bark flakes and incubated for 14–16 days. Newly hatched nestlings had pink skin with gray down, yellow mouth linings, and large whitish gape flanges. They opened their eyes when 6–7 days of age and fledged at 16–18 days. Nearly all nestlings were infested with botflies (*Philornis* sp.). Both adults contributed to nest building, incubation, nestling-rearing, and nest sanitation. *Received 25 August 2008. Accepted 3 April 2009.*

The woodcreepers are a group of cavity-nesting neotropical birds now recognized by many authors as members of the Furnariidae (Irestedt et al. 2002, 2006; Fjeldså et al. 2005). They are mostly scansorial with specialized retrices that allow them to climb tree-trunks where they glean, probe, or sally for arthropods (Fjeldså et al. 2005) and vertebrates (Hayes and Escobar Argaña 1990, Sick 1993). Woodcreepers are obligate secondary cavity-nesters, relying on existing cavities for nesting (Skutch 1969, Marantz et al. 2003) although they may enlarge cavity entrances (Skutch 1981). Most woodcreepers appear to be monogamous, except *Dendrocincla* and perhaps a few other species (Skutch 1981, Marantz et al. 2003). Most information on nesting woodcreepers is the result of careful observational studies of a few species in Costa Rica and Brazil (Skutch 1969, 1996; Oniki and Willis 1982, 1983; Willis 1992). Little is known about the breeding ecology of most woodcreepers in the humid forest of South America (Marantz et al. 2003).

The Planalto Woodcreeper (*Dendrocolaptes platyrostris*) is a relatively large woodcreeper found primarily in humid forest from northeastern Brazil to northern Argentina and eastern Paraguay (Marantz et al. 2003). Two nests are mentioned in the literature, both in tree holes 6–8 m high (Saibene 1995, Willis and Oniki 2001). One adult was observed taking pieces of bark to one of the nests (Saibene 1995) and two adults were observed carrying food to the other (Willis and Oniki 2001). There are no published descriptions of the nest interior, clutch size, eggs or nestlings of the Planalto Woodcreeper (Marantz et al. 2003).

We report on the nest, eggs, nestlings, and breeding behavior of the Planalto Woodcreeper (subspecies *platyrostris*) based on three nests in natural cavities and 14 in nest boxes in subtropical forest in northeastern Argentina.

METHODS

Study Area.—We studied nests in the Atlantic Forest (Misiones Province) and the southern humid Chaco (Chaco Province) in Argentina. The Planalto Woodcreeper is common in both areas. The study area in the Atlantic Forest included mature, selectively logged, and secondary forest at 550–600 m elevation in Parque Provincial de la Araucaria (26° 38′ S, 54° 07′ W), Parque Provincial Cruce Caballero (26° 31′ S, 53° 58′ W), and Tobuna (26° 28′ S, 53° 53′ W), in the Department of San Pedro. This area is part of a mosaic landscape of small farms, remnant forest, and tree plantations. The vegetation type is mixed forest with laurel (*Nectandra* and *Ocotea* spp.), guatambú (*Balfourodendron riedelianum*) and parana pine (*Araucaria angustifolia*) (Cabrera 1976). Annual rainfall is 1,200 to 2,400 mm distributed evenly throughout the year. The study area in the humid Chaco was Parque Nacional Chaco (26° 30′ S, 59° 30′ W, 70 m elevation), in the Departments of Sargento Cabral and Presidencia de la Plaza. The park is within the subregion of esteros, cañadas, and

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gallery forest (Cabrera 1976). Mean annual rainfall is 1,350 mm with nearly all occurring in the austral spring and summer from September to March.

Field Methods.—We found nests by following adult woodcreepers and systematically checking natural cavities and nest boxes using a pole-mounted, pinhole video camera. We placed 26 traditional wooden nest boxes on trees at a height of 5–6 m in Parque Provincial de la Araucaria in 2006 to learn whether Planalto Woodcreepers selected nest boxes based on their dimensions (depth and entrance diameter). These boxes ranged in entrance diameter from 8 to 14 cm, and in depth from 22 to 60 cm. We used Wilcoxon rank sum tests in R Version 2.5.1 (R Development Core Team 2007) to compare used and unused boxes in 2006. Non-parametric tests were used because the data were not normally distributed.

We added 64 more nest boxes in 2007, all 10 × 12 cm in entrance diameter, 60 cm deep, and placed 9 m high on trees. Thirty of these nest boxes were placed in Parque Provincial Cruce Caballero and 34 at Tobuna. We placed 5 cm of sawdust in all boxes.

All nests were found during the laying or incubation periods, except nest # 17, which was found during the nestling period. We inspected nests daily with the pole-mounted video camera during the laying period and near the expected hatch date whenever possible.

We measured eggs and nestlings using dial calipers and wing-rulers, and took weights to the nearest gram using 50- or 100-g spring scales. We report mean ± standard deviation for all measurements. Eggs found during laying were individually marked with non-toxic permanent marker. Nestlings were individually marked with white nail polish on their toenails and color-banded around Day 4.

We observed two nests for a total of 641 min during laying and incubation periods, and four nests for a total of 427 min during the nestling period. The female Planalto Woodcreeper is more robust than the male, and has ''sleek'' head plumage where the male has ''rough'' head plumage (Willis and Oniki 2001). We trapped and color-banded both members of the pair at nest # 14. One individual was sleek-headed and weighed 65 g. The other was rough-headed and weighed 60 g. We could reliably identify the sleek-headed and rough-headed individuals when they arrived at the nest tree, based on their head plumage and body size, later confirming their identity when they moved along the trunk and exhibited their color bands. We climbed to natural nest cavities (except nest # 17) and measured height, entrance diameter, and depth using a measuring tape after the nestlings fledged.

RESULTS

Timing of Reproduction.—Clutch initiation in the Chaco was estimated to start ~23 September for nest # 17 (Table 1). This timing coincides with the onset of the rainy season in the humid Chaco. The earliest clutch initiation date in the Atlantic Forest was estimated as 4 October (nest # 1). The latest nest (nest # 5) contained two eggs on 8 January 2007, but the eggs disappeared the following day. This timing coincides with the major reproductive period for most birds in our study areas.

Nest Description.—The nest at Parque Nacional Chaco was near the Río Negro in mature gallery forest dominated by myrtles, especially guabiyú (*Myrcianthes pungens*). Nests at Parque Provincial Cruce Caballero were in mature forest, at Parque Provincial de la Araucaria in logged forest and second growth adjacent to the town of San Pedro, and at Tobuna in logged forest remnants. Three were in natural cavities and 11 in nest boxes.

Natural cavities used by Planalto Woodcreepers were 3–7 m high, 45–46 cm deep, with entrance diameters of 5–7 cm (Table 1). Nest boxes used were 6–9 m high, 40–60 cm deep with entrance diameters of 9–12 cm. The shallowest nest boxes (<40 cm deep) were not occupied. Nest boxes used by Planalto Woodcreepers in Parque Provincial de la Araucaria were deeper ($\bar{x}$ = 42.8 cm) than unused boxes ($\bar{x}$ = 32.2 cm; Wilcoxon rank sum test with continuity correction, W = 109.5, P = 0.003; n = 26) but did not differ in entrance diameter (W = 53, P = 0.68; n = 26). All used cavities (natural and nest boxes) were lined with stiff pieces of bark from the nest tree or nearby trees, including *Araucaria angustifolia*, *Holocalyx balansae*, *Syagrus romanzoffiana*, *Trichilia catigua*, *Apuleia leiocarpa*, *Matayba eleagnoides*, *Diatenopteryx sorbifolia*, *Patagonula americana*, and *Pinus* spp.

Flakes of bark were ripped from live trees and taken to the nest cavity by both males and females as they arrived during the laying and incubation periods; the amount of bark in nests increased considerably over the laying and incubation periods. There was no bark in one nest box (# 14) when the first egg was found, shortly after

TABLE 1. Characteristics of 17 nests of the Planalto Woodcreeper in three natural cavities and 11 nest boxes, in 1997, 2006, and 2007. Values in parentheses are estimates.

Nest #	Cavity origin	Entrance diameter (cm)		Vertical depth (cm)	Hatch date
		Horizontal	Vertical		
Parque Provincial de la Araucaria					
1	Nest box	12	12	43	(25 Oct 2006)
2		Same nest box as above			1 Nov 2007
3	Nest box	9	9	40	(26 Oct 2006)
4	Nest box	10	10	42	(3 Nov 2006)
5		Same nest box as above			Eggs predated 9 Jan 2007
6		Same nest box as above			12 Nov 2007
7	Nest box	10	10	42	(11 Nov 2006)
8	Nest box	10	10	45	Eggs predated 9 Dec 2006
9	Nest box	10	10	45	(23 Dec 2006)
Parque Provincial Cruce Caballero					
10	Nest box	10	12	60	22 Nov 2007
11	Nest box	10	12	60	(25 Oct 2007)
Tobuna					
12	Decay	5	20	46	29 Oct 2007
13	Woodpecker	7	7	45	29 Oct 2007
14	Nest box	10	12	60	21 Dec 2007
15	Nest box	10	12	60	3 Nov 2007
16	Nest box	10	12	60	15 Nov 2007
Parque Nacional Chaco					
17	Decay	(5)	(5)	?	(8 Oct 1997)

dawn on 4 December 2007. Three pieces of bark were placed under the egg between 0759 and 1100 hrs. Two days later at 1000 hrs, there were two eggs and more than 20 pieces of bark.

Laying and Incubation.—Complete clutches had 3–4 eggs (mode = 3, $\bar{x} \pm SD = 3.4 \pm 0.50$, $n = 14$). Eggs were laid on alternate days. The third and final egg at nest # 14 was laid between 0520 and 0857 hrs. Both males and females were flushed from nests during the laying period. When nest # 14 contained only one egg, one or both adults were in the nest box for 58% of a 116 min watch.

Although adults spent time in the nest cavity during the laying period, relatively synchronous hatching of nestlings suggests that incubation began only when the last egg was laid. Both members of the pair at nest # 13 had brood patches, and both males and females were observed incubating at several nests. The female was in the cavity, presumably on the eggs, 71% of the time during the incubation period, the male 18% of the time, an unknown adult 4% of the time, and no adult 7% of the time. We did not observe any complete incubation bout, but at nest # 14, on the day the last egg was laid, the female incubated from before 0916 to 1138 hrs, was off the nest for 28 min, and returned at 1206 hrs. Eight days later at the same nest, the male incubated from before 0755 to 0935 hrs, and the female from 0935 to after 1307 hrs. That night, the female incubated overnight, and the male relieved her at 0617 hrs the following morning, well after dawn.

Eggs.—The eggs were opaque white, 31.4 ± 1.1 mm $\times$ 23.5 ± 0.57 mm ($n = 39$) and weighed 9 ± 1 g ($n = 32$). Two to four eggs hatched per nest (mode = 3, $\bar{x} \pm SD = 3.0 \pm 0.67$, $n = 14$ nests that survived to hatching).

Hatching.—The first nestlings hatched 15 ± 1 days ($\bar{x} \pm SD$) after the last egg was laid ($n = 3$ nests). We measured nestlings on hatch day in five nests. All nestlings hatched on hatch day in one of these nests. In the other four nests, one to three nestlings hatched on hatch day and the others hatched overnight or early the next morning. The first-laid egg in nest # 14 had a 1-mm hole and the nestling inside made weak ''peeping'' sounds at 0915 hrs on 21 December 2007, 14 days after the last egg was laid. The second-laid egg had a small crack. The first egg had hatched by 1845 hrs and the second egg had a hole in the side. The second egg hatched either

overnight or the following day. The third egg did not hatch and remained in the nest until the afternoon of 24 December, but was gone by 1000 hrs the following morning.

Nestlings.—Newly hatched nestlings (day 0, $n = 14$ nestlings at 5 nests) weighed 8.3 ± 0.83 g ($\bar{x}$ ± SD). They had pink skin with gray down only on the head, back, and legs. Their gape flanges were large and white, and their mouth linings were bright yellow-orange. Pin feathers projected from the skin by day 4 and the nestlings opened their eyes by day 6 or 7. They attained adult weight around day 10 and fledged on day 16, 17, or 18. The bills of nearly-fledged nestlings were still considerably shorter than those of adults (culmen length: $\bar{x}$ ± SD for 15 day-old nestlings at nest # 2 = 24.1 ± 0.99 mm, $n = 3$; adult males at Museo Argentino de Ciencias Naturales (MACN): 33.1 ± 2.4 mm, $n = 7$; adult females at MACN: 34.1 ± 1.8 mm, $n = 9$).

Parental Care of Nestlings.—Both males and females fed the nestlings and removed fecal sacs. Egg shells were not found in or around the nest, even on hatch day.

Two observations suggest that males brooded nestlings overnight. First, the male was captured in nest # 13 at 0450 hrs, well before dawn on 4 November 2007 when the nestlings were 6 and 7 days old. Second, the male at nest # 14 entered the nest box at 1943 hrs, well after dusk on 22 December 2007, when the two nestlings were 0 and 1 days of age. The bright moonlight allowed us to observe the nest box until 2005 hrs and the male did not leave.

Nestlings were fed arthropods and one vertebrate. Prey items that could be identified were: lepidopteran larvae ($n = 3$), unidentified larvae ($n = 2$), pupae ($n = 3$), spiders or insects with legs ($n = 4$), and a small snake ($n = 1$). Parents visited nests 33 times in 308 min of observation in the early morning and late evening ($\bar{x}$ ± SD = 6.4 ± 1.5 visits/hr) when the nestlings were 0–3 days of age (nest #s 13, 14, and 16), seven times in 29 min (14.5 visits/hr) in the early morning when nestlings were 5 days of age (nest # 13), and 18 times in 90 min (12 visits/hr) at mid-morning when the nestlings were beginning to fledge (nest # 17). The nestlings at nest # 17 came to the entrance to be fed; one nestling clung to the tree trunk outside the cavity, but entered the cavity when the parents arrived.

Nest Success.—Five nests were found during egg-laying. The eggs disappeared during incubation at one nest, one nestling disappeared and the other was found dead in another nest, presumably killed by a severe botfly (*Philornis* sp.) infestation, and the nestlings were presumed to fledge (nestlings at least 12 days of age were observed) in the other three nests. Eggs hatched in 14 nests, and nestlings survived to fledging in 11 of these. Successful nests ($n = 11$) produced 2–4 fledglings each (mean = 3.1). Twenty-nine of 35 nestlings that could be inspected ($n = 15$ nests) were infested with subcutaneous botflies (*Philornis* sp.). Most nestlings fledged despite their apparently severe botfly infestations.

DISCUSSION

Planalto Woodcreepers selected nest boxes based on depth but not entrance diameter. They used only the deepest nest boxes and avoided boxes <40 cm deep. Nesting in a deeper cavity may reduce risk of nest predation. Cavity volume was the best predictor of predation at the egg stage in Northern Flickers (*Colaptes auratus*): nests in larger cavities more often survived to hatching (Wiebe and Swift 2001). Deeper cavities were also selected preferentially by vertebrate fauna in Australia (Gibbons et al. 2002), and were more often reused by secondary cavity nesting birds in British Columbia (Aitken et al. 2002).

Planalto Woodcreepers may be limited by nest-site availability, particularly in logged forests, if they require particularly deep cavities for nesting. Cavities seem abundant at our field sites, but sufficiently deep cavities may be rare. Cockle et al. (2008) estimated a density of 4.6 cavities/ha below 15 m in Atlantic Forest within our study area in Misiones; however, the density of cavities >40 cm deep, below 15 m, is only 0.25/ha. Available cavities are shared with numerous other species of secondary cavity nesters, especially parakeets, toucans, possums, and feral bees; thus, there may be considerable competition for the deepest cavities.

We found no striking differences in breeding biology between nests in natural cavities ($n = 3$) and those in nest boxes ($n = 14$). However, in many species, reproductive parameters including clutch size, parasite loads, and nest success differ between natural cavities and nest boxes (Nilsson 1984, Wesołowski and Stańska 2001, Evans et al. 2002).

The breeding ecology of the Planalto Woodcreeper is similar to that of other woodcreepers for which information is available. The white eggs were placed in a relatively low cavity (Beebe and

Beebe 1910; Skutch 1969, 1996; Willis 1972, 1992; Oniki and Willis 1982; Bodrati 2003; Vega Rivera et al. 2003). Planalto Woodcreepers lined their cavity with hard pieces of bark, as reported for the Streak-headed Woodcreeper (*Lepidocolaptes souleyetii*), Spot-crowned Woodcreeper (*L. affinis*), Cocoa Woodcreeper (*Xiphorhynchus susurrans*) (Skutch 1969, 1996), and Lesser Woodcreeper (*X. fuscus*) (Marini et al. 2002). In contrast, other species of woodcreepers line their nests with dead leaves and fungal rhizomorphs (Plain-brown Woodcreeper [*Dendrocincla fuliginosa*], Willis 1972), or rootlets and fibers (Wedge-billed Woodcreeper [*Glyphorynchus spirurus*]; Beebe and Beebe 1910, Skutch 1969, Oniki and Willis 1983, and Tawny-winged Woodcreeper [*Dendrocincla anabatina*] Skutch 1969).

Clutch size (3–4 eggs) was relatively large compared to most woodcreepers (1–2 eggs) (Skutch 1969, Marantz et al. 2003) but similar to that of woodcreepers at similar latitudes in Argentina: 2–3 eggs for the Great Rufous Woodcreeper (*Xiphocolaptes major*) (Narosky et al. 1983, Bodrati 2003, De la Peña 2005, Di Giacomo 2005) and the Scimitar-billed Woodcreeper (*Drymornis bridgesii*) (Narosky et al. 1983, Mezquida 2001, De la Peña 2005), and 3–4 eggs for the Narrow-billed Woodcreeper (*Lepidocolaptes angustirostris*) (Narosky et al. 1983, De la Peña 2005, Di Giacomo 2005). Planalto Woodcreepers laid eggs on alternate days, like the Wedge-billed Woodcreeper (Oniki and Willis 1983).

The incubation period of the Planalto Woodcreeper was 14–16 days, and the nestling period 16–18 days, similar to other species of woodcreepers where both parents contribute (Skutch 1969, Marantz et al. 2003). Both males and females contributed to nest-building and incubation, as suspected for the Amazonian Barred Woodcreeper (*Dendrocolaptes certhia*) (Willis 1992) and the closely related *Xiphocolaptes* (Marantz et al. 2003), and reported for the Streak-headed Woodcreeper, Spot-crowned Woodcreeper, and Wedge-billed Woodcreeper (Skutch 1969). In contrast, only females seem to contribute in the *Dendrocincla* (Willis 1972, Skutch 1969, Marantz et al. 2003) and at least three species of *Xiphorhynchus* (Skutch 1981, 1996; Marini et al. 2002; Vega Rivera et al. 2003).

The incubation bouts we describe for the Planalto Woodcreeper at nest # 14 (more than 2–3 hrs for the female) are similar to those described by Skutch (1981,1996) for the Cocoa Woodcreeper (usually 1.5–3 hrs for the female) but considerably longer than those of the Streak-headed Woodcreeper (7 to >72 min for the female), Wedge-billed Woodcreeper (18–90 min for both males and females), and Spot-crowned Woodcreeper (6–47 min for both males and females) (Skutch 1969). Nest attentiveness of the Planalto Woodcreeper was high during incubation (93% during the day in this study). In comparison, nest attentiveness was 61% for the Tawny-winged Woodcreeper, 69% for the Streak-headed Woodcreeper, 80% for the Cocoa Woodcreeper, 83% for the Spot-crowned Woodcreeper, and 100% for the Wedge-billed Woodcreeper (Skutch 1969, 1981, 1996). High nest attentiveness and long incubation bouts could reduce exposure of nests to predators and nest site competitors.

There are few published descriptions of woodcreeper nestlings. Nestlings of the Planalto Woodcreeper closely resembled Skutch's (1969) descriptions for those of the Spot-crowned, Cocoa, and Wedge-billed woodcreepers. Like other woodcreeper nestlings (Willis 1972, Marantz et al. 2003), fledgling Planalto Woodcreepers had shorter bills than their parents.

Both parents helped rear nestlings as reported by Willis and Oniki (2001). They fed nestlings mostly arthropods, as do other woodcreepers (Skutch 1969, 1981; Marini et al. 2002; Marantz et al. 2003). They also provided a vertebrate on at least one occasion. Similarly, a passerine nestling and a snake were fed to nestling Great Rufous Woodcreepers (Bodrati 2003), and lizards were fed to nestling Tawny-winged Woodcreepers (Skutch 1969), Plain-brown Woodcreepers (Willis 1972), Cocoa Woodcreepers (Skutch 1981), and Northern Barred Woodcreepers (*Dendrocolaptes sanctithomae*) (Marantz et al. 2003).

Much remains to be learned about the breeding ecology of woodcreepers and other cavity-nesting passerines in the Neotropics. Information about nest type, clutch size, chick development, and breeding behavior are still lacking for many species. This basic information is essential for comparative studies of the life history, population biology, and evolution of these birds (Cornelius et al. 2008).

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