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NEST PREDATION BY ARBOREAL SNAKES ON CAVITY-NESTING BIRDS IN DRY CHACO WOODLANDS

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Depredación por serpientes arborícolas en aves nidificantes de cavidades en los bosques del Chaco Seco.

Key words: Blue-fronted Parrot, *Amazona aestiva,* Blue crowned Parakeet, *Aratinga acuticaudata,* Narrow-billed Woodcreeper, *Lepidocolaptes angustifrons*, Crested Hornero, *Furnarius cristatus*, arboreal snakes, cavity nesting, nest predation.

INTRODUCTION

Ornithologists have extensively studied nest predation because predators are responsible for most nest failures (Ricklefs 1969, Martin 1995, Newton 1998). Factors correlated with variation in the occurrence of predation on Neotropical birds have been intensively studied and documented, but identity of predators has largely remained unknown (Larivière 1999, Lahti 2009). Knowledge of the identity of predators is often necessary to accurately focus conservation efforts for threatened species as well as to interpret results of research on factors affecting nest success and to understand the dynamics of predator-prey relationships (Benson *et al.* 2010).

When predators have been documented, snakes were identified as the most important group, accounting for up to 90% of all nest predation (Weatherhead & Blouin-Demers 2004, Robinson *et al.* 2005, Weatherhead *et al.* 2010). Cavity nesting birds exhibit some characteristics that could make them susceptible to predation by arboreal snakes (Martin 1993, Christman & Dhondt 1997, Brightsmith 2005). Accumulation of nestling feces inside the cavity produces a strong odor which could contribute to nest detection because snakes have a well-developed vomeronasal (Jacobson's) organ for detecting odor molecules (Conover 2007).

Neotropical arboreal snakes have been reported as common nest predators on open-cup nests (Matheus *et al.* 1996, Robinson *et al.* 2005). Predation is also the main cause of nest failure for Neotropical cavity nesters (Auer *et al.* 2007). However, predators identities have rarely been reported (Auer *et al.* 2007, Berkunsky & Reboreda 2009, Renton & Brightsmith 2009, Berkunsky 2010) and, until this work, only a few studies have confirmed cases of nest predation on Neotropical cavity nesters by snakes (Koenig *et al.* 2007).

The Dry Chaco region is one of the largest extensive forests of native dry forest in South America (Gasparri & Grau 2009), where more than 36 species of cavity-nesting birds occur (Cornelius *et al.* 2008). Arboreal snakes are common in these woodlands, with at least four reported species (Kacoliris *et al.* 2006, Berkunsky & Kacoliris 2008). While several bird studies in the Chaco woodlands have reported the occurrence of nest predation, none of these studies revealed the identity of the nest predators (Erikson *et al.* 2001).

Here we report field observations recorded between 2002 and 2007 in Chaco Province, Argentina, on nest predation events performed by three snake species.

METHODS

Field observations were gathered at Loro Hablador Provincial Park and neighboring areas (25º48'00"S, 61º70'00"W, 170 m a.s.l.), in the Chaco province, Argentina. The area is a continuous dry forest dominated by White Quebracho *Aspidosperma quebracho-blanco* and Red Quebracho *Schinopsis lorentzii*. The climate is dry subtropical, with a marked seasonality (75% of the 590 mm average annual rainfall occurs from November–March) and a long dry season (April–October, Gonzalez & Flores 2010).

Observations were collected from early October to late February in five consecutive breeding seasons (2002–2007) as part of a parrot reproductive ecology monitoring program. In each breeding season, we regularly monitored tree cavities that were used by Blue-fronted Parrot (*Amazona aestiva*) and Blue-crowned Parakeet (*Aratinga acuticaudata*). We reached the entrance hole using climbing equipment. Active nests and empty cavities were monitored regularly (on average every 3 days and every 15 days respectively).

We identified cavity nester species and we recorded nest entrance height above ground (m), nest age (days), and snake presence (with digital photographs and/or digital video). We identified snakes based on photographic references (Cei 1993) and used age-specific markings and size to determine if individuals were adults or juveniles.

RESULTS

We observed nine predation events performed by three snake species: Argentine Green Snake (*Phylodrias baroni*, Colubridae; 5 cases, Fig. 1), Constrictor Boa (*Boa constrictor occidentalis*, Boidae; 2 cases), and Argentine Rainbow Boa (*Epichrates cenchria alvarezii*, Boidae; 2 cases). Snakes performing predations were adults in all cases although we found a 0.65 m long juvenile Argentine Rainbow Boa dead inside of an active Blue fronted Parrot (*Amazona aestiva*) nest on one occasion. The snake had injuries and we think it was attacked by one of the adult parrots.

In most cases (eight of nine), we found the snake inside of the cavity. In the ninth case, because the nestling was equipped with a radio-collar, we were able to find it in the stomach of a 1.7 m Constrictor Boa in an underground burrow 50 m from the nest (IB and SIKF pers. observ.). In four of nine

FIG. 1. Blue-crowned Parakeet nest, with nestlings killed by an Argentine Green Snake (*Phylodrias baroni*) on 8 January 2005, Loro Hablador Provincial Park, Chaco, Argentine (photograph: J. Carrera).

opportunities, we observed the snakes attacking and/or swallowing nestlings.

Cavity nesting bird species affected by these predators were Blue-fronted Parrot (four cases), Blue-crowned Parakeet (*Aratinga acuticaudata*, three cases), and Narrow-billed Woodcreeper (*Lepidocolaptes angustifrons*, one case). Additionally, we documented another predation event in an enclosed-nester, the Crested Hornero (*Furnarius cristatus*, one case). All predation events occurred in White Quebracho (*Aspidosperma quebracho-blanco*), and nest entrances were on average 5.9 ± 0.24 m above ground. Successful attacks occurred mainly during December (2 cases) and January (5 cases) and all them were performed during the nestling stage (Fig. 2).

Additional remarks. As a part of a parrot monitoring program, we visited empty tree cavities every two weeks and often found individuals of Argentine Rainbow Boa, Constrictor Boa, and Flame snake (*Oxyrhopus rhombifer inaequifasciatus*) inside those cavities.

We also found Constrictor boas prowling near active Blue-fronted Parrot nests on four occasions, all of which were at the nestling stage. Snakes remained on the ground, near the main trunk (three cases) or on the nearest tree (one case).

DISCUSSION

All successful predation events occurred during nestling stage. This could be due to at least

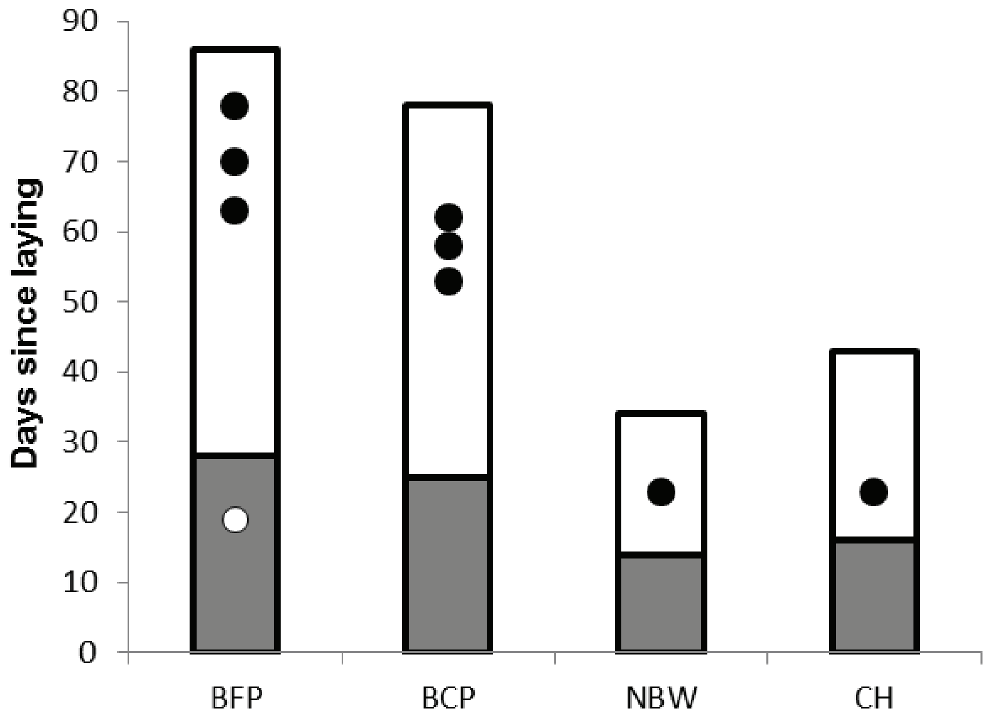

FIG. 2. Scores for the timing of successful (black dots) and unsuccessful (white dot) predation events. The duration of incubation (grey bars) and nestling (white bars) periods were obtained from previous works (Fraga 1980, Mezquida 2001, Berkunsky 2010). BFP: Blue-fronted Parrot, BCP: Blue-crowned Parakeet, NBW: Narrow-billed Woodcreeper, and CH: Crested Hornero.

three factors. First, the nest could be easier to find during the nestling stage than the incubation stage because of the strong odor produced by accumulating nestling feces inside the cavity. It is known that olfaction and vomerolfaction are among the most important senses used by snakes to detect prey (Zug *et al.* 2001). Also, parents enter and exit the nest more frequently during nestling stage for nestling food provisioning. Second, nestlings in a late growing phase provide more energy than eggs and hatchlings. Third, in depredating nests at the nestling stage, snakes would avoid encounters with adults. During nestling period, parents spend less time inside the cavity than during incubation, when one of the parents, usually the female, spends most of the time inside the nest. The only unsuccessful recorded predation attempt was during incubation resulting in a dead snake.

Three arboreal snakes species (i.e., Argentine Green Snake, Constrictor Boa, and Argentine Rainbow Boa) were identified as predators of three cavity nesters (i.e., Blue-fronted Parrot, Blue-crowned Parakeet, and Narrow-billed Woodcreeper) and of one tree enclosed-nester (i.e., Crested Hornero). Predation is responsible of 50% of nest losses in Blue fronted parrots (Berkunsky 2010). Besides the snakes reported here, only one bird, the Spot-winged Falconet (*Spiziapteryx circumcinctus*), was positively identified as predator of Blue-fronted parrot nestlings (Berkunsky 2010).

Random observations, such as those reported in this paper, provide clues about the predatory species but, however, do not allow a more detailed analysis since in most cases of predation the identity of the predator was not determined. To achieve a better understanding of the community of predators that affects the cavity nesters of Chaco, studies involving continuous nest monitoring would be needed.

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