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Short communication

Nest predation on birds that nest in rock cavities in a tropical limestone forest of southern China

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HIGHLIGHTS

- The rate of predation of nests in rocky holes in limestone forests is unknown.
- An artificial nest experiment showed high predation in May, but lower in March.
- Results suggest large ectotherms like snakes may be important nest predators.

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ABSTRACT

High nest predation is often found in tropical birds, though data from tropical limestone regions are lacking. In a limestone karst rainforest of south China, two species of babblers breed in rock cavities in different seasonal periods: the endangered Nonggang Babbler (*Stachyris nonggangensis*) breeds in May, like most birds, and the common Streaked Wren Babbler (*Napothera brevicaudata*) breeds in March. We tested the hypothesis that nest predation varied by nesting period using an artificial nest experiment. We used natural rock cavities that varied in their distance to the forest edge, checked nests at different intervals and measured characteristics of cavity location. We found nest predation to be much higher in May (65 of 99 nests) than March (14 of 83); predation tended to be higher when nests were visited only once, but no other factor significantly influenced the result. The higher predation rate during warmer weather, and the fact that eggs disappeared mostly at once, yet predators were not detected on infrared nest cameras, suggests that snakes could be important predators; further research is needed to confirm this hypothesis. We conclude that the aberrant nesting period of the Streaked Wren Babbler may be a strategy to escape nest predation.

1. Introduction

High nest predation is an important life history trait of tropical birds, especially those that nest on the ground and in the understory (Söderström, 1999; Brawn et al., 2011). Indeed, high nest predation is thought to be an important factor influencing tropical birds' clutch size, breeding period, extra-pair mating, and other aspects of life history and breeding behavior (Stutchbury and Morton, 2001). However, it is difficult to assess the levels and patterns of nest predation in the tropics because of how few nests can be found, especially in the case of threatened species. Experiments using artificial nests (the monitoring of eggs placed by the investigators) have useful advantages, since both the number of nests and the characteristics of the nest sites can be controlled (Major and Kendal, 1996; Seibold et al., 2013; Vetter et al., 2013). It must

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be remembered that artificial nests differ significantly from natural ones, primarily in that there is no adult incubating in the artificial nest, nor any begging nestlings (Major and Kendal, 1996; Ibáñez-Álamo et al., 2015). Despite these differences, artificial nest experiments can be useful to gain baseline information about what common predators are present, and how nest predator pressure differs spatially and temporally, and they have been widely applied in tropical forests to look at major issues in nest predation, such as how it is influenced by fragmentation (Vetter et al., 2013).

Limestone areas are interesting ecosystems in which to explore tropical nest predation. These karst ecosystems, mostly distributed in southern China and Southeast Asia, are a special kind of topography formed by limestone deposition at the bottom of ancient seas, followed by upheaval, and then by a process of erosion over millions of years (Clements et al., 2006). Historically understudied, these landscapes have been the site of recent ornithological advances; for example, several new bird species have been described in the last decade in the limestone area of China and Southeast Asia (e.g., Zhou and Jiang, 2008). Limestone areas are famous for their caves, and there are also many smaller holes in rocks that can be used as breeding sites or habitats for some endemic animals, such as swiftlets and some babblers (Clements et al., 2006; Jiang et al., 2013a). For example, in southern China near Vietnam, both the endangered Nonggang Babbler (*Stachyris nonggangensis*) and the common Streaked Wren Babbler (*Napothera brevicaudata*) build nests in holes in rocky outcrops (Jiang et al., 2013a). Such nests have a unique combination of properties that make it unclear whether they receive high levels of nest predation or not: they are on the ground, and may therefore be susceptible to ground-living small mammals and snakes, yet they also are a type of cavity, and species that live in cavities in trees generally have low nest predation (Martin and Li, 1992).

We here present the results of an artificial nest experiment designed to investigate nest predation on these two species of limestone hole-nesting babblers. We concentrated on the effect of seasonality because the species differ in their nesting period: Streaked Wren Babbler starts its breeding from late February, whereas Nonggang Babbler and most other birds lay their first eggs starting in April (Jiang et al., 2013a). The reported nest predation rates for the two species also differ: observations of natural nests of Streaked Wren Babbler reported predation in 2 of 10 nests (Jiang et al., 2013b), but observations of predation for Nonggang Babbler were higher (3 of 4 nests; Jiang et al., 2013a). We hypothesized that the difference in nest predation rates between the two species was related to the difference in the nesting period, and therefore in this study examined predation rates on artificial nests both in March and May. Because nest predation is affected by landscape level factors (e.g., distance to the forest edge, Vetter et al., 2013), and the frequency of checking by the observers (Ibáñez-Álamo et al., 2012), we systematically varied these factors. As the nest microhabitat is also influential in shaping nest predation (Seibold et al., 2013), we also took detailed measurements of the location of the hole and nearby vegetation.

2. Methods

2.1. Studied area

This study was conducted in Nonggang National Nature Reserve (22°22.7′N, 106°57.9′E, ASL 80–280 m), southwestern Guangxi Province, southern China. Nonggang is located in the northern margin of tropical Asia with a mean annual temperature ranging from 20.8–22.4 °C and a mean annual rainfall ranging from 1150–1550 mm, as measured at the Longzhou meteorological station, about 20 km from the study site, and experiences a dry season (Nov.-Apr.) and a rainy season each year (May–Oct.; Nong, 1988). The nature reserve, of 5400 ha in extent, is categorized as limestone hill seasonal rainforest, dominated by *Burretiodendron hsienmu* and *Cephalomappa sinensis* (Shu et al, 1988). The forest is bordered by farmland, primarily used for sugarcane plantation.

2.2. Artificial nests experiment

We conducted two surveys in March and May of 2014, representing the different breeding periods for the Streaked Wren Babbler and the Nonggang Babbler. We placed four eggs of domestic Japanese Quails (*Coturnix coturnix*) in natural holes to test nest predation. The size of Japanese Quail eggs is slightly larger than those of the babblers: 28.0 by 21.0 mm, versus 25.0 by 18.9 mm for Nonggang Babbler (Jiang et al., 2013a) and 24.0 by 17.1 mm for Streaked Wren Babbler (AJ, unpublished data). Nevertheless, these were the smallest eggs that we could reliably obtain in both seasons. Quail eggs have also been used in many artificial egg studies, although they have shown to be impossible for small-gaped mammals such as small squirrels to predate (Haskell, 1995; Seibold et al., 2013), even though such predators will still be attracted to quail eggs (Purger et al., 2012). Holes in large boulders were randomly selected, ranging in distance to the forest edge between 0 and 430 m. Nest holes were selected to be similar in dimensions to natural nests for these two species and averaged 13.0 (±5.3 SD) cm in height, by 15.3 (±6.3) cm in width, by 16.7 (±7.5) cm in depth (Jiang et al., 2013a, b). Holes used in March were reused in May ($n = 79$), except for four holes near areas that were impassable in the wetter later month, and twenty new holes used in May (hence the total number of nests used in the whole study was 103). To avoid predators potentially finding reused nests more easily, all the eggs were cleaned from the holes after the first experiment in March before they had any noticeable odor.

To evaluate the vegetation near the nest, we measured canopy openness, tree (defined as a stem above 5 cm in DBH) density and canopy height, and shrub density, in the 10 × 10 m plot centered around the hole. We also took a measurement of the visibility of the nest from below (as holes were in boulders above ground level) and from above. To do this we placed