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AN EXPERIMENTAL TEST OF SNAKE SKIN USE TO DETER NEST PREDATION

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Abstract. Some bird species utilize snake skins as nesting material, possibly to decrease predation. We constructed 60 artificial nests simulating the nests of Great Crested Flycatchers (*Myiarchus crinitus*) in nest boxes to test the prediction that snake skins deter nest predators. Twenty of the boxes lacked rat snake (*Elaphe obsoleta*) skins (control), 20 had a single skin in the nest, and 20 had a skin in the nest and another displayed outside the box. Five of the control boxes were depredated (20%), while none of the experimental boxes were depredated. Our results supported our prediction that use of snake skins would deter mammalian predators, particularly the southern flying squirrel (*Glaucomys volans*). Although our results suggest a potential adaptive explanation for this behavior, our design did not allow us to address the degree of olfactory or visual detection by the squirrels, and left other potential explanations untested.

Key words: artificial nest, Glaucomys volans, *Great Crested Flycatcher,* Myiarchus crinitus, *nest predation, snake skin use, southern flying squirrel.*

Una Prueba Experimental del Uso de Pieles de Serpientes para Ahuyentar a los Depredadores de Nidos

Resumen. Algunas especies de aves utilizan pieles de serpientes como material en la construcción de sus nidos, posiblemente para reducir la depredación. Construimos 60 nidos artificiales en cajas que simulaban los nidos de *Myiarchus crinitus* para poner a prueba la hipótesis de que las pieles de serpientes se utilizan para ahuyentar a los depredadores de nidos. Viente de los nidos artificiales carecían de pieles de la serpiente *Elaphe obsoleta*, 20 tenían solamente una piel en el nido y 20 tenían una piel en el nido y tambien una piel dispuesta en la parte externa de la caja que contenía al nido. Cinco de las cajas de control (20%) fueron depredadas, mientras que ninguna de las cajas con pieles de serpientes fue depredada. Nuestros resultados apoyan la predicción de que el uso de pieles de serpientes ahuyentaría a los mamíferos depredadores, especialmente a la ardilla voladora *Glaucomys volans*. Aunque nuestros resultados sugieren una explicación adaptativa potencial de esta conducta, nuestro diseño experimental no nos permite conocer el grado de detección visual u olfatoria por parte de las ardillas, y deja abiertas otras posibles explicaciones que no han sidos evaluadas.

Birds have evolved strategies to reduce nest predation, such as the camouflaged nests of Mallards (*Anas platyrhynchos*; Albrecht and Klvana 2004) and broken wing displays of Black-winged Stilts (*Himantopus himantopus*; Wijesinghe and Dayawansa 1998). Several bird species include snake skin or pieces of snake skin as nesting material, for example the Tufted Titmouse (*Baeolophus bicolor*) and Blue Grosbeak (*Passerina caerulea*; Strecker 1926). Cavity-nesting Great Crested Flycatchers (*Myiarchus crinitus*) often use a whole coiled snake skin in the nest and sometimes also display a skin conspicuously outside the nesting cavity (Cornell Laboratory of Ornithology 1999). Skins both inside and outside the cavity are visibly present from incubation through fledging (Bolles 1890, Suthard 1927, Taylor and Kershner 1991). Some have thought that flycatchers use snake skins to deter predators (Bolles 1890, Strecker 1926), whereas others have proposed that it is a result of attraction to shiny objects (Suthard 1927).

Great Crested Flycatchers have many predators including rat snakes (*Elaphe obsoleta*) and southern flying squirrels (*Glaucomys volans*; Miller 2002). The southern flying squirrel, which commonly preys on eggs of cavity-nesting birds (Dolan and Carter 1977, Stabb et al. 1989), has a geographic distribution strikingly similar to that of the Great Crested Flycatcher (compare range maps in Dolan and Carter [1977] and Sibley [2003]). The rat snake is known to prey on mammals as well as birds and their eggs (Stickel et al. 1980, Weatherhead et al. 2003), and black rat snakes (*E. o. obsoleta*) have been noted as a primary predator of the southern flying squirrel (Fokidis and Risch 2005). The opportunity for frequent interaction among these three species is clear, particularly since all have been observed to use cavities (Fokidis and Risch 2005).

The use of snake skins in bird nests is widely cited in species descriptions and field guides and was noted in the scientific literature as early as the late 19th century (Bolles 1890). However, the adaptive nature of this behavior has not been addressed with field investigations. Early accounts are merely anecdotal

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and speculative (Bolles 1890, Strecker 1926, Suthard 1927), and to date no experimental studies have addressed the presumed antipredation benefits of this behavior.

Our aim was to test the hypothesis that use of snake skins in nests is a response to predation. Using quail eggs in artificial Great Crested Flycatcher nests in nest boxes we attempted to simulate the tree cavities that bring Great Crested Flycatchers, southern flying squirrels, and rat snakes into close proximity. We predicted that: 1) the frequency of predation would be lower for nests containing one snake skin than nests without a snake skin, and 2) the frequency of predation would be lower for nests with two snake skins, one inside and one outside the artificial cavity, than nests with only one skin.

METHODS

We conducted our study in a rural residential area approximately 16 km north of Jonesboro in Craighead County, Arkansas. The study area contained a mix of prairie, fallow fields, and hardwood forest; all experimental nests were placed in hardwood forest. Nest boxes were placed in two sites approximately 4 km apart, since neither property alone was large enough for our desired sample size of 60 boxes. Site one contained 19 nest boxes and site two held 41 nest boxes.

Eastern Bluebird (*Sialia sialis*) nest boxes (Grantham 1999) were installed in a grid-like manner with all boxes at least 40 m apart. Nest boxes are an excellent model for Great Crested Flycatcher nests, since Great Crested Flycatchers are known to use these boxes in addition to natural cavities (Miller 2002). Boxes were installed in mid-March, 10 weeks before the study began, to allow resident southern flying squirrels to become accustomed to using the boxes. To attract southern flying squirrels, boxes were attached to tree trunks at a height of 4.5 m (Risch and Brady 1996).

Artificial nests were made with local materials. Nests were assembled to approximate a natural Great Crested Flycatcher nest, with a bowl of grasses and pine needles lined with moss. Once a nest was placed in a box, it was completed with three Japanese Quail (*Coturnix japonica*) eggs and one clay egg. Japanese Quail eggs were selected for the experiment because they are easily acquired and often used in artificial nest studies. Clay eggs were made from modeling clay (EZ-Shape, Polyform Products Company, Elk Grove Village, Illinois) to resemble the size and shape of a quail egg, and captured bite marks left by predators, allowing us to identify predator species.

Nests were assigned to one of three treatments at random: 1) no snake skin (control); 2) one skin, which contained a snake skin coiled around the outside of the bowl of the nest; or 3) two skins, which contained a snake skin coiled around the bowl of the nest and a skin hung from the door of the box.

Snake skins were acquired from a captive population of black rat snakes. Because scent may be a factor in predator deterrence, all snake skins were placed in a pillow case with a live black rat snake for 5 hr the day before use. After artificial nests were placed inside nest boxes, they were monitored daily for 14 days in concordance with the natural length of incubation for flycatcher eggs (Taylor and Kershner 1991). Boxes were checked for broken or missing eggs, teeth or bill marks in clay eggs, and for the deterioration or loss of snake skins. Deteriorating or missing snake skins were not replaced.

Nests were set out on four different dates during the Great Crested Flycatcher breeding season of early May to early June (James and Neal 1986): all nineteen nests at site one were placed in boxes on 16 May 2004, sixteen nests at site two were positioned on 25 May 2004, twenty nests at site two were put out on 29 May 2004, and the last five nests at site two were set out on 30 May 2004. Our experiment concluded on 12 June 2004.

Due to a lack of predation on all nests containing snake skins, both treatments were pooled for statistical analysis. A Fisher exact test was used to determine statistical significance of predation events.

RESULTS

Five artificial nests were depredated, four most likely by southern flying squirrels, as evidenced by the manner in which the quail egg was eaten (opened at the apex and hollowed out) in combination with teeth marks in the clay eggs. The fifth nest was also likely depredated by a mammal, as the eggs were crushed, but we were unable to confirm the species. All five depredated nests were in the control group ($n = 60$, df = 1, $P = 0.009$). Depredated boxes were spatially separated by at least 120 m. Most snake skins had shown considerable deterioration by the end of seven days. Depredation of eggs occurred at an average of 8.2 days (range = 4–14 days) after nests were placed.

DISCUSSION

There is strong evidence that the presence of a snake skin in a nest box reduces the likelihood of predation, thus flycatchers and other species may have evolved the behavior of including snake skins as nesting material to deter predation. Our results suggest that one snake skin is sufficient to deter nest predation, thus our hypothesis that two skins would be superior in deterring predators was not supported.

Interestingly, most snake skins had deteriorated almost completely by day 14 of the study. The gradual deterioration of the snake skins was caused by scavenging ants. We speculate that nesting flycatchers maintain their nests free of ants to protect their progeny, allowing persistence of snake skins through fledging.

Criticisms of artificial nest experiments include that the artificial nest is a poor approximation of the natural nest (Villard and Pärt 2004). Our study used nests made from natural, locally obtained materials placed inside nest boxes, which are often used by Great Crested Flycatchers. In addition, predators may develop a search image for nest boxes, thereby increasing predation pressure (Miller 2002), however in our case this merely increased our chances of comparing nest features experimentally. The use of Japanese Quail eggs has also been criticized because the eggs are larger than those of most songbirds

(Haskell 1995, DeGraaf and Maier 1996), however our results indicate that quail eggs are sufficient to capture predation events by squirrels.

Future studies should address the effectiveness of snake skins at deterring predation beyond incubation, since snake skins are typically present through fledging. In addition, we suggest studying a species that is more variable in its use of snake skins as a nesting material, such as the Tufted Titmouse. Although our study did not address whether olfaction is the method by which mammalian predators detect skins, several lines of evidence suggests that this is the case. Experiments have demonstrated that captive southern flying squirrels using nest boxes are repelled by snake scent (Borgo et al. 2006) and that snake skins repel free-ranging southern flying squirrels from nest boxes in Florida (K. E. Miller, Florida Fish and Wildlife Conservation Commission, unpubl. data). This further supports the hypothesis that birds use snake skins to deter mammalian predation.

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