Nest building behavior of the Resplendent Quetzal (*Pharomachrus mocinno*: Trogonidae)

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**ABSTRACT**

Resplendent Quetzals (*Pharomachrus mocinno*: Trogonidae) form monogamous pairs during the breeding season (Johnsgard 2000). Both the male and female invest in nest building and the parental duties of egg incubation and chick rearing (Skutch 1944). I looked at the nest building behavior of two pairs of quetzals in Monteverde, Puntarenas, Costa Rica. This study quantitatively examined differences between the amount of time each sex spent excavating the nest as well as qualitatively described the behavior of the pair as they worked. The female of one of the pairs spent a significantly longer time working in the nest than the male (p < 0.05). The other pair did not show significant time differences. I describe in detail the tail flapping and soft calling behavior that is only briefly mentioned in other papers. Conservation of the quetzal depends on having accurate descriptions of their behavior so changing trends can be monitored over time.

**RESUMEN**

Quetzales (*Pharomachrus mocinno*: Trogonidae) forman los pares monógamos durante la temporada que cría (Johnsgard 2000). Ambos el masculino y femenino invierte en la construcción del nido y los deberes paternales de la incubación del hueveo y criar de polluelo (Skutch 1944). Miré la conducta de la construcción del nido de dos pares de Quetzales en Monteverde, Puntarenas, Costa Rica. Este estudio las diferencias cuantitativamente examinadas entre la cantidad de tiempo cada sexo excavado gastado el nido así como también describió cualitativamente la conducta del par como ellos trabajaron. La hembra de uno de los pares gastaron un tiempo significativamente más largo que trabaja en el pares en el nido que el masculino (p < 0.05). El otro par no mostró las diferencias significativas de tiempo. Describo con todo detalle la cola que bate y la conducta suave del llamamiento que es solo brevemente mencionada en otros papeles. La conservación del quetzal depende de tener las descripciones exactas de su conducta las tendencias tan cambiantes se pueden controlar con el tiempo.

**INTRODUCTION**

The Resplendent Quetzal, *Pharomachrus mocinno* (Trogonidae) is a large, endangered trogon with iridescent green feathers (Johnsgard 2000). Its range is restricted to cloud forests of southern Mexico to northern Nicaragua (the northern race, *Pharomachrus mocinno mocinno*) and Costa Rica to western Panama (the southern race, *Pharomachrus mocinno costaricensis*; Johnsgard 2000). The species is sexually dimorphic, with the male frequently referred to as one of the most beautiful birds in the New World (Skutch 1944; Fogden and Fogden 1996; Johnsgard 2000). Though beautiful, the quetzal can be elusive due to its habit of staying largely in the forest canopy (LaBastille et al 1972). When surveying their surroundings, quetzals sit facing away from intruders, thus hiding their bright red ventral feathers (Bowes and Allen 1969). They are frugivorous and feed primarily on fruits of the family Lauraceae (Wheelwright 1983;
Wheelwright and Haber 1984; Avila et al. 1986). Indeed, the life cycle of the quetzal seems heavily dependent on this plant family (Wheelwright 1983). Wheelwright (1983) noted that the quetzals seasonally migrate from their breeding grounds to follow the ripe fruits. They are also known to eat fruits of nine (Avila et al. 1996) to 16 (Wheelwright 1983) other plant families. Quetzals have a large gape size that allows them to swallow these fruits whole (Wheelwright 1983). After digesting the pericarp, they regurgitate the seeds whole and thus act as important dispersers for some plant species (Avila et al. 1996).

During its breeding season, which lasts from March to approximately June, the quetzal is found in monogamous pairs within a defended territory (Skutch 1944; Bowes 1969). Quetzals nest in decaying tree stumps that are often rotten enough that natural events like wind storms will topple them over (Skutch 1944; Bowes and Allen 1969). The trees commonly chosen for nest sites include species from Moraceae, Pinaceae (Bowes and Allen 1969), and Lauraceae (Wheelwright 1983). The nests are located anywhere from three to 20 m up the trunk (Fogden and Fogden 1996) and are about 30 cm deep with a 10 cm diameter entrance (Bowes and Allen 1969). The pair will use a nest several years in a row, though often they will excavate a new nest lower than the previous because trees rot from the top down (Fogden and Fogden 1996). It is not known if the same pair stays together year after year. Quetzals lay two sky-blue eggs per clutch and have two clutches per year, the second set being laid soon after the first nestlings have either fledged or died (Skutch 1944; Wheelwright 1983). Both the male and female take turns excavating the nest, incubating the eggs, and looking for food to give the growing chicks (Skutch 1944).

For this study I collected data on the nest excavating behavior of the quetzal. I specifically looked for how much time each sex spent working on the nest. Nest building is a little-studied but important aspect of quetzal breeding behavior. This early time of the breeding season is important for establishing pair bonds (Wheelwright 1983) and may play an important part in regulating their reproductive cycles (Bowes and Allen 1969). Due to the tendency for females to invest more heavily in their offspring, I predicted that the female would spend more time excavating the nest per visit than the male.

**MATERIALS AND METHODS**

I made observations of two pairs of quetzals on 15 days between 13 April and 04 May 2002. The birds were located in and around the Monteverde Cloud Forest Preserve (MVCFP) in Puntarenas, Costa Rica. The MVCFP contains 10,500 hectares of forest lying largely within the lower montane wet forest life zone (Haber et al. 2000), elevation 1550-1850 m (Haber 2000).

I observed the first pair in the MVCFP working in two artificial nest boxes and one natural nest in an area between, the reserve's entrance and lower laboratory (1520 m). One of these boxes contained a QuetzalCam camera. The camera, located above the nest in the box, took a photo labeled with the time and date once every 20 seconds. Most observations outside the nest were made approximately 20 m away from the nests. This pair, distinguished from others by the male's short tail coverts, went on to lay their eggs and hatch out two chicks in the box with the camera. I recorded some later observations using only the QuetzalCam data.

The second pair of quetzals was working on a nest located 840 m west from the MVCFP entrance, just off the north side of the road from the reserve. They were excavating a hole in a half-rotten but still living *Pouteria exfoliates.* (Sapotaceae) tree. Observations were made from six to seven m from the nest. I monitored this pair from 20 April to 04 May 2002.

I was in the field an average of three hours and 43 minutes each of the 15 days. I made notes on where the birds perched, what they were doing while perching and (when possible) in the
nest and at what time the quetzals entered and exited the nest. In this way, I treated each minute as a separate data set, writing down each minute that a behavioral event took place (and disregarding the second). I totaled up the number of minutes each quetzal was in the nest for each visit.

RESULTS

Behavioral Observations

I found the easiest way to locate the quetzals was to listen to the male's two-note whining whistle as the pair approached the nest area. This habit of whistling on approach seemed to gradually cease at the P. exfoliata tree as time went on, and I had to rely instead on seeing their bright green feathers or flight amidst the trees. Once they were in the area, the pair would usually remain in a nearby tree for several minutes, possibly giving a preliminary predator check of the area. The trees and perch heights chosen varied. Next they would move to the nest, and again perch in surrounding trees for several minutes. Occasionally one would fly directly to the nest.

As soon as one was perched on the outside of the nest, tail bracing against the tree or box in the manner of a woodpecker, its mate would usually move to a favorite perch and start calling softly. This call sounded like a softer, distant, one-note version of the male's whistle, and was given every few seconds for the entire time the other was in the nest, sometimes starting before the other actually went in the nest. Before entering the nest, the quetzals perched at the nest entrance and went through a "bowing-in" routine as described by LaBastille et al (1972). The bird would look around for one to three minutes, and then make several attempts to enter the nest without actually doing so. Finally it would make a controlled dive into the nest, its tail going almost straight up before descending completely into the nest. The male working on the P. exfoliata nest had long tail coverts, and 20-30 cm of these feathers always stuck out of the nest when he was inside. Occasionally the excavating bird would stick the end of its tail out of the nest and rapidly flap its tail up and down or side to side. I could not see what the rest of the bird was doing, but this action was always accompanied by a shower of wood chips sprinkling down the box or tree. Both males and females engaged in tail flapping.

The bird waiting outside the nest typically stayed on its perch. Sometimes it would go to a different one of its two to four favorite perch, or would sally to a nearby branch so it could turn around and face away from the near-constant crowd of birdwatchers. During this time it surveyed the area, slowly turning its head from side to side, and preened, which included stretching its wings and tail, grooming feathers with its beak, and scratching itself with a foot, which necessitated moving a wing aside. It kept up the soft calling the entire time.

I began to wonder what the purpose of this calling was. I heard guides from the RBBN explain that the outside bird was calling for its mate to come out so it could take a turn in the nest. Skutch (1944) observed that while incubating, the male and female quetzal would give "nasal or whining notes" when it came to relieve the other of nest duty, which seems to support this explanation. However, I developed my own hypothesis for this behavior as I spent more time with the birds. There were several reasons I did not think the bird was calling its mate out. First of all, the outside bird had usually just come from the nest. Second, it would often start calling before its mate even went inside the nest. The last reason came from two interactions I watched. On one occasion at a box near the QuetzalCam nest, the male was calling while the female was inside. Suddenly, he flew off in the direction of another male calling from somewhere beyond the nest. He did not vocalize at all as he left. Less than a minute after the male left, the female stuck her head out of the box and looked around. She flew up to her favorite perch and called.
softly to her mate, who returned within two minutes. I began to think that maybe the absence of soft calling is a warning to the bird inside that all is not well. Support for this theory came six days later as I was watching the P. exfoliata pair. The male was in the nest, tail flapping, and the female was on the usual perch. They had only been at the nest for 18 minutes when a large dog showed up and laid down less than three m from the female's tree. She immediately stopped calling, and less than a minute later the male stuck his head out of the nest. He flew over to his mate, perching briefly in the same tree, and then they both left the area. Evidence against my theory occurred on later occasions at this same nest. Once in a while the male would be outside, calling softly, and then he would stop calling for a couple minutes after a sound was heard in the woods or a tourist would make a sudden movement. Meanwhile, the female would stay inside; not even sticking her head out to see what was going on.

Differences in Nest Building Investment

I observed a total of 74 visits. A complete visit was recorded when I watched the bird go into the nest, remain inside for any length of time, and then come back out. The longest single visit by a bird was 48 minutes, the shortest was one minute. When analyzing the data, I kept the numbers of visits (Table 1) and recorded minutes (Table 2) for the two pairs separate. For the QuetzalCam pair, the male was in the nest an average of 3.00 ± 2.27 minutes (N = 8) per visit and the female an average of 4.59 ± 3.05 minutes (N = 22) (Fig. 1). There was no significant difference between the amounts of time each sex spent in the nest (t = -1.34, p > 0.05). For the P. exfoliata pair, the male was in an average of 16.52 ± 4.30 minutes (N = 21) and the female 21.61 ± 9.09 minutes (N = 23) (Fig. 2). The female spent a significantly longer time in the nest than the male (t = -2.33, p = 0.025). Figures 3 (QuetzalCam pair) and 4 (P. exfoliata pair) show the percent of time each sex spent in the nest during observation.

DISCUSSION

None of the important papers on Resplendent Quetzal breeding behavior has really quantified the nest building behavior of these birds. Seeing how nest building is a potentially vital part of quetzal breeding (Bowes and Allen 1969), it may be useful to explore this behavior in more detail. The results of my study generally provided support for my hypothesis that the female quetzal would spend more time excavating the nest per visit. The QuetzalCam pair did not show a significant difference between visit lengths of the male and female. This may be attributed to the somewhat inconsistent data from the first few days recorded by the QuetzalCam. For the P. exfoliata pair, the female did spend a significantly longer time per visit than the male. These results from only two pairs can hardly be generalized to all Resplendent Quetzals. However, it is noteworthy as a first step to understanding the quantitative trends in nest building behavior of these birds.

Previous literature that mentioned nest building noted that the male and female quetzal took turns excavating the nest (Wheelwright 1983; Fogden and Fogden 1996; Johnsgard 2000), which is what I observed. Wheelwright (1983) wrote about one pair that excavated at least five nests in one month before laying eggs in yet another one. The pair at the preserve worked on at least three nests. Skutch (1944) noted in his paper that as he watched a female enlarge the entrance of an old woodpecker hole, he heard "soft, full notes," but couldn't be sure if they were coming from her or her mate perched nearby. Wheelwright (1983) also noted this behavior of a pair working on the outside of a rotting snag. The birds worked on the nest "for shifts of about
five minutes while its mate called softly from a nearby branch” (Wheelwright 1983). Neither of these authors speculated in their papers about the purpose of this calling. From my observations, I think it may be a call to tell the excavating mate, who cannot watch for predators while digging in the nest, that everything is okay. The outside bird is the more vulnerable of the two, but if it leaves or stops calling, the inside bird is left vulnerable and unable to tell what is going on. To minimize vulnerability while outside the nest, the quetzal will usually face away from intruders (Bowes and Allen 1969) such as tourists. I believe the soft call is also designed for this purpose. The quetzal appears to make it without opening its beak. It even calls while vigorously grooming itself with its beak, though this often garbles the call. The whistle is very soft and difficult to hear from more than 10 m away, which makes it sound distant. If there is any hint of potential predator activity, such as quick motions or rustling in the leaf litter below, the calling bird simply falls silent. In this way, it both warns its mate of danger and stops giving out audible clues to its location.

I did not record any data on incubation and nestling care of these quetzals. The pair in the QuetzalCam box laid eggs while I was doing the study, but the incubation alone would have continued a week or two after my study ended, giving me incomplete data for only one nest. The *P. exfoliata* pair were excavating until at least 02 May. On my last day of observation, 04 May, the behavior of the birds changed. They remained in the area of the nest for several hours, but did not call or work on the nest at all. The male briefly entered the nest, but the female was not nearby. I took this as a sign that they either had laid an egg, but were not yet incubating it, or the female was very close to laying an egg and they were just unusually sensitive to the people and vehicle traffic that typically took place outside their nest.

Nest building is an important part of quetzal behavior, but it has not been studied as closely as incubation and nestling investment. Previous data collected on incubation found that both sexes share incubation duty, trading off sitting on the nest for long hours at a time (Skutch 1944; LaBastille et al 1972; Wheelwright 1983). The female sits on the nest through the night (Skutch 1944; Heller 2001). Once the eggs hatch 17-19 days later, the parents share the duty of bringing food to the chicks (Skutch 1944; Wheelwright 1983). The chicks are given insects, fruit, and small lizards and frogs (Fogden and Fogden 1996). They fledge 25 (Heller 2001) to 31 (Skutch 1944) days after hatching.

The trends in nest building behavior could be further explored by monitoring more quetzal nests early in the breeding season. It would be interesting to try and determine the reason for the soft calling, but doing this without causing artificial disturbance to the birds would require many hours of patient and diligent bird watching. LaBastille et al. (1972) found that a lack of suitable nesting trees is probably the main limiting factor of quetzal populations. More recently, the clearing and fragmenting of forest habitats they depend on is having important effects on their populations (Powell and Bjork 1996).

The conservation of the Resplendent Quetzal is dependent on gathering information on all of their ecology, including migration routes, breeding behavior, and important limiting factors of their population (LaBastille et al 1969; Powell and Bjork 1996). Additional information on nest building and parental investment increases our understanding of their life cycle and the importance of both sexes in the survival of the chicks. Once a good database of their breeding behavior is established, changing trends in their behavior can be monitored and conclusions drawn about factors important to the stable and continuing of the existence of this magnificent bird.
ACKNOWLEDGMENTS

I owe a big thank you to the guides and staff of the Monteverde Cloud Forest Preserve for letting me birdwatch in their beautiful park and use the QuetzalCam data. Everyone was helpful and friendly, and I enjoyed being the Quetzal Girl for a while. Thank you Alan Masters for helping me focus my project, Karen Masters for teaching me to make graphs, Mauricio Garcia for listening when I needed to rant, Andrew Rodstrom for not throwing rocks at my birds, Wilt Wieder for showing me the nest by the road in the first place, and Bill Haber and Willow Zuchowski for identifying the tree for me.

LITERATURE CITED

Table 1. Number of complete visits by the male and female of each pair.

<table>
<thead>
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<th>No. of Visits Observed</th>
<th>QuetzalCam pair</th>
<th>P. exfoliata pair</th>
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<tr>
<td>Male</td>
<td>8</td>
<td>21</td>
</tr>
<tr>
<td>Female</td>
<td>22</td>
<td>23</td>
</tr>
<tr>
<td>Total</td>
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<td>44</td>
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Table 2. Number of total minutes the male and female of each pair were working on the nest.

<table>
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<tr>
<th>Minutes in Nest</th>
<th>Quetzal Cam pair</th>
<th>P. exfoliata pair</th>
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</thead>
<tbody>
<tr>
<td>Male</td>
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<td>347</td>
</tr>
<tr>
<td>Female</td>
<td>101</td>
<td>497</td>
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<tr>
<td>Total</td>
<td>125</td>
<td>844</td>
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Figure 1. The mean length of time the male and female quetzal spent in the QuetzalCam nest per visit, with standard deviation bars.
Figure 2. The mean length of time the male and female quetzal spent in the *P. exfoliata* nest per visit, with standard deviation bars.

Figure 3. The percent of time each QuetzalCam male and female spent in the nest during observation.
Figure 4. The percent of time each *P. exfoliate* male and female spent in the nest during observation.