Nesting behaviors of the Amazonian Motmot (*Momotus momota*) and Fulvous-chinned Nunlet (*Nonnula sclateri*)

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Abstract

The genera *Momotus* and *Nonnula* contain a combined 13 species of neotropical, cavity-nesting birds. Nests of the Amazonian Motmot (*Momotus momota*) and Fulvous-chinned Nunlet (*Nonnula sclateri*) were studied between September and October at Finca Las Piedras research station, in Madre de Dios, Peru. 322 nestling feeding instances of *M. momota* were recorded, and identified food items demonstrated a diet composed largely of arthropods, supplemented by fruits and occasional vertebrates. Although formerly speculated to nest in subterranean burrows, *N. sclateri* constructs a nest cavity above ground, by creating a frame of interwoven twigs which is covered by leaf litter and dirt, rendering the structure largely indistinguishable from a burrow. Pure white eggs were susceptible to predation by ground-dwelling lizards.

Introduction

The families Momotidae and Bucconidae comprise 51 species of neotropical burrow-nesting birds found in forest and woodland from northwest Mexico to northern Argentina. The genus *Momotus* is the largest of the family Momotidae, and has experienced significant taxonomic revision and uncertainty that was not thoroughly resolved until the six-way split of the "Blue-crowned Motmot" complex was finalized in 2016 (Stiles, 2009; Chesser et al., 2016). Due to the recent split, information regarding many *Momotus* species, in particular their nesting biology, is limited. The Amazonian Motmot (*Momotus momota*) has the largest range of all *Momotus*, present throughout the entirety of the Amazon basin. It has been observed nesting on several occasions, in July and from October–April (O'Neill, 1974; Pesquero et al., 2014; Orzechowski and Schulenburg, 2020), though information on nesting is scarce, and the feeding of nestlings has been observed only once. Pesquero et al. (2014) noted a nestling diet primarily composed of arthropods, though it was supplemented by lizards, frogs, and fruit. Adults are known to consume a range of arthropods and fruits (Remsen et al., 1993), and have been documented predating unidentified rodents, reptiles, birds, and frogs (Schubart, 1965; Willard, 1991).

The genus *Nonnula* contains six species of inconspicuous bucconid, almost entirely unknown in regards to their breeding biology and behavior in general. The Rufous-capped Nunlet (*N. ruficapilla*), Gray-cheeked Nunlet (*N. frontalis*), and Chestnut-headed Nunlet (*N. amaurocephala*) lack published data on their nesting biology altogether, with the latter species rediscovered only in 1992 (Whittaker et al., 1995). Nests of the Brown Nunlet (*Nonnula brunnea*) have been observed on two occasions, with one described as a shallow tunnel concealed by leaf litter, containing a white egg and young nestling (Dauphiné et al., 2007). The other was discovered by Greeney and Port (2010), described as a pile of leaves gathered above a natural scrape in the ground, into which the birds excavated to form an interior chamber that was subsequently strengthened by the addition of small sticks. The only species with detailed information regarding the nest and its construction is the Rusty-breasted Nunlet (*N. rubecula*); Cockle et al. (2020) studied 17 nests and demonstrated a typical nest construction process commencing with the excavation of a small cup into the ground. Over this, birds

constructed a frame of sticks, which they further covered in a layer of leaves and other debris. The final structure appeared largely like a burrow, inside of which an average of four white eggs were laid. The authors suggested that a similar nest and construction process is used by all nunlet species. The final *Nonnula* species is the Fulvous-chinned Nunlet (*N. sclateri*). Though the species is almost entirely unknown, O'Neill (1974) described the belief of local people that it nests in cavities at the end of subterranean burrows. He further noted an observation of *N. sclateri* perched directly above a large mound of leaves which had been collected from a small circle surrounding the structure. The pile was suggested to be part of a courtship display. Besides these accounts, little to no information has been published regarding the life history of the species.

Both *Momotus momota* and *Nonnula sclateri* lack comprehensive information regarding large portions of their natural history and biology. The aim of this report is thus to fill some of the gaps in knowledge surrounding both species. In doing so, I will describe their feeding habits and defensive behavior, further providing a description of the eggs, nest, predation, and construction process of *N. sclateri*.

Methods

Nests and the behavior of attending adults were studied from 25 September 2024 to 20 November 2024, in mature terra firme and adjacent secondary forest, at Finca Las Piedras research station in southeastern Peru (12°13′34″S, 69°6′32″W). Nest observation was conducted both in person and using camera traps, which were assembled 1–2 m from nests. Nests were observed for eight days after completion or predation, and following this period the nests of *Nonnula sclateri* were disassembled to take measurements. Data analysis was conducted using R 4.4.1 (R Core Team 2024).

Results

Amazonian Motmot (*Momotus momota*)

Nest structure

The nest was a large burrow dug into the bank of a sunken section of ground, discovered on 7 October. The bank was shielded by the stilt-roots of a large cecropia (*Cecropia sciadophylla*), and was situated near a brazil nut (*Bertholletia excelsa*). The burrow extended 0.85 m, opening up into a large cavity in which the rearing process occurred. The floor of the interior was covered in leaves, and no dead nestlings were observed within the nest, influencing the presumption herein that only one offspring was present during the study period.

Fledging

Fledging of one individual occurred in the early morning of 22 October. Remaining briefly near the nest hole, it hopped out of view of the camera and was not recorded again. It had black eyes, differing from the red iris of an adult, as well as significantly reduced primary and tail feathers. The fledgling's bill was approximately 30% smaller than an adult's.

Nestling feeding

Provisioning of the nestling was recorded by camera traps, resulting in the documentation of 322 food items. 216 were identified to the highest degree, while the remainder (33%) could not be identified with certainty (Table 1). Arthropods comprised 55% of the prey, with major groups including katydids (37%), cockroaches (8%), grasshoppers (3%), centipedes (2%), and Lepidoptera caterpillars (2%). Fruits comprised 8% of the total diet. Vertebrate prey included five frogs (2%), none of which could be conclusively identified, a *Bachia* lizard, three *Anolis* lizards, one *Plica umbra*, two *Amphisbaena fuliginosa*, and a small colubrid snake. Food was brought to the nest by both adults where it was delivered to the nestling within the burrow. An average of 2.51 food items were brought to the nestling per active hour, with a total average of 29.3 per day. Feeding instances were most prevalent between 0500 h and 0730 h.

Food item	*n*	% of total
Frog	**5**	**1.5**
Lizard	**7**	**2.2**
Bachia	1	0.3
Amphisbaena fuliginosa	2	0.6
Anolis	3	0.9
Plica umbra	1	0.3
Snake	**1**	**0.3**
Colubridae	1	0.3
Arthropod	**177**	**55.0**
Scorpiones	2	0.6
Araneomorphae	3	0.9
Scolopendromorpha	7	2.2
Chilognatha	4	1.2
Tettigoniidae	119	37.0
Acridoidea	8	2.5
Euphasmotodea	1	0.3
Blattoidea	24	7.5
Cicadidae	1	0.3
Scarabaeidae	1	0.3
Lepidoptera	7	2.2
Fruit	**26**	**8.1**
Unidentified	**106**	**32.9**
Total	**322**	**100**

Table 1. Prey fed to a nestling Amazonian Motmot (*Momotus momota*) between 7 and 21 October, 2024.

Defensive behavior

Several instances of defensive behavior were observed, differing in their intensities. In the presence of large animals, humans in particular, the motmots would not attempt to protect the nest physically, but would wag their tails in a disturbed fashion. When a green acouchi (*Myoprocta pratti*) approached the nest, an attending motmot dashed quickly between nearby roots and branches, fanning its wings and tail in an aggressive manner. The acouchi retreated temporarily, but returned shortly thereafter, wherein the same defensive behavior was observed with the addition of a scolding call. This was effective in deterring the mammal, which did not return. The motmots did not react to the presence of smaller species, such as a *Marmosa* opossum, near the nest.

Fulvous-chinned Nunlet (*Nonnula sclateri*)

Plumage differences

Adults from the second nest could be differentiated by their size and plumage. The female was noticeably larger and had a distinctive browner overall coloration. Flanks were buffy, resulting in

contrast with the white vent. Gray coloration behind the eye was limited to a small region and was surrounded by coffee-brown. Conversely, the male was smaller, and significantly grayer overall. Flanks were largely gray, resulting in less contrast with the vent. The gray patch on the face was larger and was not noticeably contained, blending smoothly with the gray-brown back of the head.

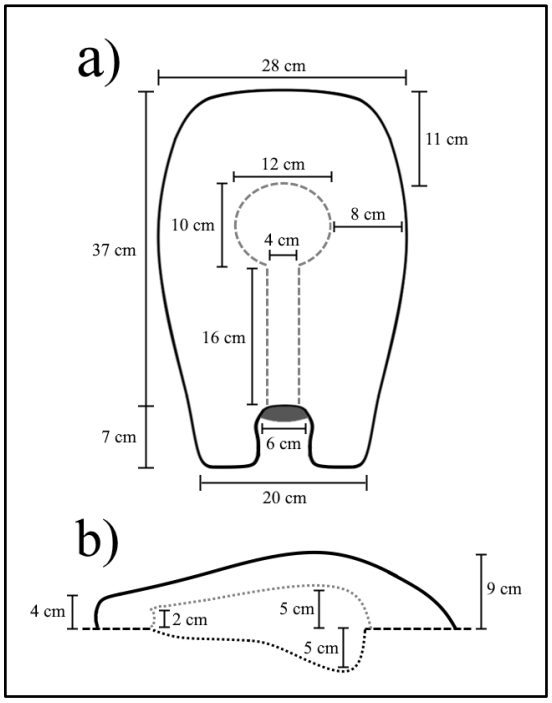

Figure 1. The dimensions of the interior and exterior structure of the nest of Fulvous-chinned Nunlet (*Nonnula sclateri*), with a top-down view (a) and side-view (b).

Nests

Two nests were discovered, the first in mature forest on 15 October, and the second in secondary forest on 26 October. Completed nests were composed of a small excavated depression in the ground, filled with leaves. Above this was a roof and entrance tunnel constructed of small sticks, averaging 10 cm in height. In the completed second nest, the main nest structure was 37 x 28 cm, with a 7 cm tunnel (Fig.1). This structure was covered in debris, becoming difficult to distinguish from the surrounding ground (Fig. 2). Nests were built with their backs against a large object, either the trunks of fallen trees or clusters of woody stems. Otherwise, the surrounding regions were relatively open.

Figure 2. A completed nest of Fulvous-chinned Nunlet (*Nonnula sclateri*), covered in leaves such that only the entrance is visible.

Nest construction

Nest construction took an approximate ten days, though minor modifications continued until at least the time of egg-laying. During construction, birds alternated between tossing leaves away from the nest area, and arranging sticks and twigs. Leaf-tossing resulted in a cleared region surrounding the front of the nest. These processes occurred until the completion of the nest structure, at which point leaves were returned to the nest area. The birds operated with distinct roles during construction, with one acting as a worker and the other perched as a guard directly above. They swapped roles frequently, with shifts lasting 9.5 minutes on average (range = 2–26 min), although they would often work in tandem during the interim of role-swaps. Average shift length was longer for the male than the female. Guards would often use this time to preen and hunt, though they were otherwise vigilant. The birds did not vocalize while constructing save for rare, soft, one-note calls.

Eggs

Upon finishing construction, the pair left the nest site for two periods of three days, returning only briefly in between periods to make small alterations to the nest. One pure-white egg was laid in the second nest on 9 November. Both adults incubated the egg until the mid-morning, and it was again

incubated for a two-hour period in the early morning of 10 November. Shortly after, the egg was predated, and the birds did not return to the nest for two days. Despite this, the adults laid another egg on 12 November, again in the early morning. This too was incubated briefly by both adults until mid-morning, and was predated shortly thereafter. Eggs were not measured.

Defensive behavior and predation

The first nest was entered several times on 15 October by a large tegu (*Tupinambis cuzcoensis*), causing its abandonment, although this was prior to the nest's completion. The second nest was predated on 10 November by a giant ameiva (*Ameiva ameiva*), which consumed the first egg and returned several times to the nest region over the next few days. On 12 November, a second egg was laid and quickly predated by the same ameiva. The female nunlet was present during the second predation attempt, during which she entered the nest to defend the egg, but was quickly deterred by the lizard.

Hunting and feeding

Adults hunted in short dashes from their perch, grabbing prey from branches and leaves. At times, prey was captured from the ground, and on one occasion mid-flight. Larger prey was killed by several shakes of the head. Thirteen prey items were identified, comprising nine grasshoppers (including one Proscopiidae sp.), two small katydids, one small cicada, and a caterpillar.

Discussion

The nesting behavior of many neotropical species remains largely understudied. As such, the behavior of the Amazonian Motmot (*Momotus momota*) and Fulvous-chinned Nunlet (*Nonnula sclateri*) were studied using a mixture of in-person and camera trap observations. Although information regarding parts of the life history of *M. momota* has been documented, several aspects including nestling feeding have not been comprehensively researched. Camera traps were installed at the site of a nest, where they recorded 322 nestling feedings, although an approximate third of food items could not be

identified. This was in large part due to the resolution of the camera traps, not allowing for the differentiation of smaller prey. Furthermore, motmots employ a "beat-and-kill" style of hunting (Stiles, 2009), often resulting in the disfigurement of their prey. This became an issue during the identification process of food items, as prey were often mangled beyond recognition. The large majority of identified prey were arthropods. This included several groups capable of potentially deadly envenomation, namely several scorpions and a number of large centipedes (Scolopendromorpha sp.). Fruits comprised 12% of the identified food items, largely in alignment with the frequency observed by Remsen et al. (1993). Five frogs were fed to the motmots; four of which were unidentifiable as a result of the aforementioned concerns, though two of these were likely tree frogs (Hylidae). The fifth frog appeared to be a gold-striped frog (*Lithodytes lineatus*), though it may have been one of a number of similar poison frogs. Master (1999) observed the Rufous Motmot (*Baryphthengus martii*) predating poison frogs (*Dendrobates auratus*) in Costa Rica, suffering no effects from the toxin, and *Momotus* have been observed consuming captive dart frogs (Master, 1999), though the captive frogs lack the typical toxicity. It is unlikely that *M. momota* would be able to distinguish between the Batesian coloration of *L. lineatus* and that of legitimate poison frogs. It therefore seems reasonable that *M. momota* in the region also consume the similarly-patterned poisonous frogs of *Allobates* and *Ameerega*.

All genera in the family Bucconidae, commonly known as puffbirds, nest in cavities in the ground or in termitaria (Rasmussen and Collar, 2018), with the exception of the genus *Nonnula*. Until the work of Cockle et al. (2020), *Nonnula* too was presumed to be a burrow-nesting genus, as other observations of nests were largely inconclusive. In *N. rubecula*, Cockle et al. noted the use of shallow excavation and construction using sticks and leaf litter to produce nests, in effect creating a surface-level burrow. The nest structure observed in *N. sclateri* aligned almost exactly with those of *N. rubecula*, with an excavated cup in the ground enclosed completely by a frame of sticks and debris. As in *N. rubecula*, nests included a small, camouflaged entrance tunnel, becoming largely indistinguishable from a subterranean burrow. O'Neill (1974) observed an adult *N. sclateri* perched above a curious, neatly organized pile of leaves, while the ground surrounding this pile had been entirely cleared of leaf litter. Having been told by locals that the species nested in burrows, he

assumed the structure to serve a purpose in courtship. Given the striking similarity between O'Neill's observations (i.e., apparent pile of leaf litter, cleared surroundings, adult perched directly above) and the information contained in this report, it is almost certain that the structure he observed was a nest. The nests observed of *N. brunnea* may similarly have been misdescribed. Dauphiné et al. (2007) noted a shallow, horizontal tunnel leading to a larger cavity, with the entrance lined by leaf litter. Images included in the paper also show an entrance tunnel framed by sticks. They made an additional note of a nest cup within the interior cavity, approximately 7 cm deep. Though the description is relatively vague as the nest was not deconstructed, it maintains consistency with the nests of *N. rubecula* and *N. sclateri*. The nest observed by Greeney and Port (2010) appears nearly identical to those of the two aforementioned species, with the description differing only in the nest's presumed method of construction and interior structure. Regardless, these combined reports suggest a constant nest structure between the three species. It is therefore likely that this method is used by the three other *Nonnula* species still lacking documentation regarding their nesting practices, consistent with the suggestion of Cockle et al. (2020). The eggs of Fulvous-chinned Nunlet (*N. sclateri*) were pure white, consistent with both *N. rubecula* and *N. brunnea*, as well as all of those described in Bucconidae (Rasmussen and Collar, 2018). The ground-level nests of *N. sclateri*, despite their strong camouflage, are apparently highly susceptible to predation by lizards. Even prior to egg-laying, nests were visited frequently by lizards that were likely attracted by the scent of the adult birds. Otherwise, having the appearance of a burrow presumably serves a purpose in reducing the frequency of predation from other potential predators, perhaps larger mammals. Cockle et al. (2020) observed the feeding of *N. rubecula* nestlings with primarily Orthoptera, with Odonata and Lepidoptera also represented in the diet. Observations of *N. sclateri* revealed a diet of almost entirely Orthoptera, supplemented by a Lepidoptera caterpillar, as well as one cicada. Further research on this species is still necessary for large portions of its biology, including the incubation and nestling periods, and would be a valuable addition to the understanding of the divergence of the genus from other members of Bucconidae.

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