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SHORT NOTE

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INSIGHTS INTO THE HABITS OF THE ELUSIVE NOCTURNAL CURASSOW (*NOTHOCRAX URUMUTUM*)

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Abstract · Nocturnal Curassows (*Nothocrax urumutum*) are enigmatic birds from South American rainforests. Their elusive habits and nocturnal vocal behavior have led to the generalized assumption that they are primarily nocturnal. Here, we compiled camera trap data from long-term projects in the Amazon rainforest and the Andes foothills to describe the temporal activity of Nocturnal Curassows. Based on an overall sampling effort of 68,838 camera-days (operated for 24-hour periods), we obtained 274 independent records of their activity. Results of this study showed that Nocturnal Curassows have diurnal habits and that their activity pattern resembles those of other cracids more than previously assumed. This study highlights the use of field technologies and collaborative research towards a better understanding of the natural history, ecology, and behavior of animals with cryptic behaviors, such as the Nocturnal Curassow.

Resumen · Notas sobre los hábitos del huidizo paujil nocturno (*Nothocrax urumutum*)
El paujil nocturno (*Nothocrax urumutum*) es una de las aves más enigmáticas de los bosques tropicales de Suramérica. Su comportamiento esquivo y sus vocalizaciones estrictamente nocturnas han generado la suposición de que esta especie es principalmente nocturna. En este estudio, compilamos datos de cámaras trampa en múltiples proyectos en la Amazonia y el piedemonte de la cordillera de los Andes con el fin de describir el patrón temporal de actividad del paujil nocturno. A partir de un esfuerzo de muestreo de 68.838 días-cámara (operadas por períodos de 24 horas), obtuvimos 274 registros independientes de su actividad. Los resultados de este estudio muestran que el paujil nocturno tiene hábitos diurnos y que sus patrones de actividad se asemejan más a otras especies de crácidos que lo que se había asumido previamente. Este estudio resalta el valor del uso de nuevas tecnologías y de la colaboración entre grupos de investigación para ayudar a proveer un mejor entendimiento de la historia natural, la ecología y el comportamiento de especies crípticas como el paujil nocturno.

Key words: Activity patterns · Amazonia · Cracidae · Crepuscular · Cryptic behavior

INTRODUCTION

Curassows (Cracidae) are some of the most emblematic birds of the South American lowland forests due to their large body size, terrestrial habits, and low-frequency vocalizations (Rodríguez-Mahecha et al. 2005). Cracids are most often found in pairs, with their offspring or alone, but they also occur in larger groups (Parra et al. 2001, Rodriguez-Mahecha et al. 2005). Curassows, except the Nocturnal Curassow (*Nothocrax urumutum*), have diurnal activity patterns (Srbek-Araujo et al. 2012, Pérez-

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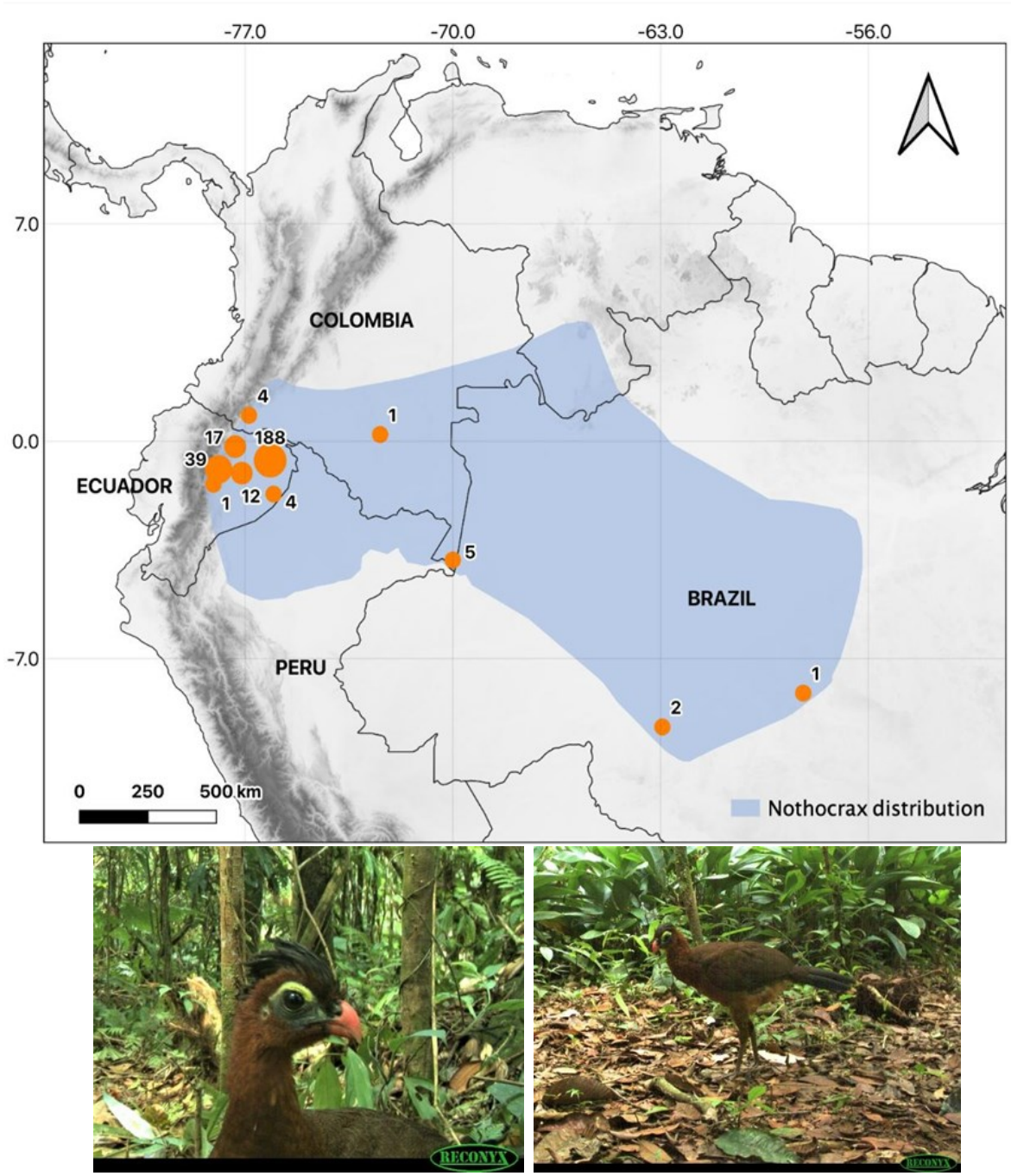

Figure 1. IUCN Red List map of the distribution of the Nocturnal Curassow (*Nothocrax urumutum)* showing localities and number of camera trap records included in this study (see Supplementary Table 1). Below, Nocturnal Curassow. Photos by Pablo Medrano-Vizcaíno (left) and John Blake (right).

Ineo & Santos-Moreno 2021). During the reproductive season, they emit low-frequency vocalizations that may carry for several kilometers and vocalize during both day and night (Parker III 2002, Rodríguez-Mahecha et al. 2005). Curassows typically sleep or rest in the mid-canopy, where they often vocalize from (Rodríguez-Mahecha et al. 2005).

In the only description of the natural history of the elusive and enigmatic Nocturnal Curassow, Theodore Parker III noted that "the Nocturnal Curassow (*Nothocrax urumutum*) is probably the most difficult to observe of all South American birds" (Parker III 2002, 154). Written in the late 1980s and published posthumously more than a decade later, this brief account of their behavior, habitat and status remains as the most comprehensive contribution towards the understanding of one of the least known cracids in the world (Parker III 2002). Parker´s (2002) description of the Nocturnal Curassow's behavior was mainly based on three anecdotal observations in the wild, as well as commentaries from local hunters and indigenous groups, based on their traditional knowledge about them.

Nocturnal Curassows have a broad geographical distribution within the Amazon basin, including the Andean-Amazon foothills in Colombia, Ecuador, and Peru (Parker III 2002). Although most records come from lowland forests between 400 – 900 m a.s.l. (Ridgely & Greenfield 2006), recent studies have recorded Nocturnal Curassows at higher elevations (Medrano-Vizcaíno & Rueda 2018).

Even though Nocturnal Curassows are relatively large (approx. 1.7 kg) and their vocalizations can carry for several kilometers in dense Amazonian forests, our current knowl-

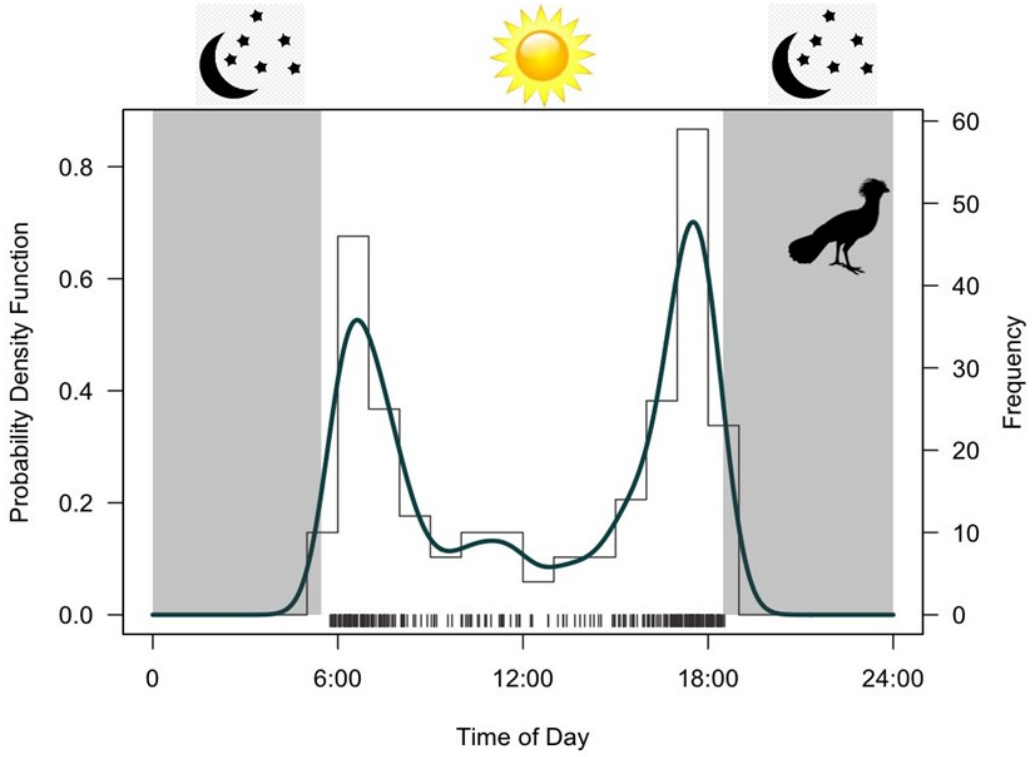

Figure 2. Activity pattern of the Nocturnal Curassow (*Nothocrax urumutum*) from 274 independent records of camera traps across its geographic range. The fitted line represents the probability density function and bars indicate the number of records throughout the day.

edge of their ecology, behavior, and biology remains remarkably anecdotal. Since the seminal description of curassow diversity and behavior by Delacour & Amadon (1973), Nocturnal Curassows have been considered relatively distinct within cracids due to their unusual nocturnal habits (Rodríguez-Mahecha et al. 2005). In fact, part of the poor understanding of their biology has been largely attributed to their presumed nocturnality and secretive behavior. The general agreement amongst local Peruvian hunters was that Nocturnal Curassows were extremely elusive, but also noted that occasionally they may be active during the daytime (first and last hours of sunlight), when they were observed feeding on fruits on the forest floor (Parker III 2002).

Several recent studies have already noted the diurnal activity of Nocturnal Curassows. A camera trap study by Medrano-Vizcaíno & Rueda (2018) found that Nocturnal Curassows were active during the day. Griffiths et al. (2020) reported for the first time Nocturnal Curassows visiting mineral licks in the northeastern Peruvian Amazon, and found that they were active during the day. Similarly, Austad (2021) detected activity of curassows in early and mid-morning in Brazil.

The use of camera traps has become increasingly useful for studying wildlife (O'Connell et al. 2011). They are used as a noninvasive monitoring tool that may record an animal's presence without the prevalent biases and limitations of observational studies (Tobler et al. 2008). They are often used in biological inventories as they are able to detect rare and cryptic species (Carbone et al. 2001). Here, we compiled records of Nocturnal Curassows from several camera trap studies conducted in Amazon rainforests and the foothills of the eastern slope of the Andes and describe its activity pattern to contribute to the knowledge of one of the least known Amazonian forest birds.

METHODS

Data were extracted from camera trap studies conducted in the Amazon basin and the eastern slope of the Andes from 2004 through 2020 (Figure 1, Supplementary Table 1). In total, we gathered information from 16 localities (range: 200 – 1,481 m a.s.l.), for a total sampling effort of 68,838 camera-days (Supplementary Table 1). At all locations, cameras were active throughout the 24-h cycle and placed 30-60 cm above ground level (Supplementary Table 1). Date and time were recorded for each photograph containing at least one Nocturnal Curassow. All photos of Nocturnal Curassows that were obtained by a given camera within < 30 min were considered a single record (Sollmann 2018).

The activity pattern of Nocturnal Curassows was estimated using the entire dataset of independent records (Supplementary Table 1), applying non-parametric Kernel density estimation (Oliveira-Santos et al., 2013), and generating a distribution probability of our records across the 24 hours of the day using camtrapR v2.03 (Niedballa, J. & et al. 2020) and the software R 1.2.5033 (R Core Team, 2019). We used the *Circular* package (Agostinelli & Lund 2017) and used a Watson test of uniformity to evaluate if diel activity data of Nocturnal Curassows were distributed uniformly across the day.

RESULTS

Overall, we obtained 274 independent records of Nocturnal Curassows. All records were obtained between dawn and dusk, when there was sufficient light to allow diurnal animals

to move in dense rainforests (Figure 2). The earliest record was at 05:45 h and the latest at 18:32 h. Activity was highest during the early morning (05:30 h - 08:30 h) and late afternoon (15:00 h - 18:30 h) (> 80% of records), while activity around midday (08:30 h - 15:00 h) was lower (< 20% of records). Thus, the activity of Nocturnal Curassows was not uniform (Watson test = 3.11, $p < 0.01$, critical value = 0.184).

DISCUSSION

Data compiled in this study provides additional and compelling evidence of the diurnal activity of Nocturnal Curassows taking place while individuals were foraging and moving on the forest floor. In fact, there were no records of Nocturnal Curassows during the night, further indicating that during this time the birds were perched in trees. Overall, the activity pattern of Nocturnal Curassows seemed to resemble those of most other curassows by being mostly active during the day and vocalizing during the night from their roosting sites.

Data on the activity pattern of Nocturnal Curassows compiled in this study showed that they have a bi-modal activity cycle, with peak activities taking place around sunrise and sunset. Their activity on the forest floor decreased during midday, and their activity pattern resembles those of Red-billed Curassows (*Crax blumembachii*) by being strictly diurnal, with activity throughout the entire day (05:23 h – 18:12 h) and peak activity early in the morning and late in the afternoon (Srbek-Araujo et al. 2012). A similar pattern has also been found for Great Curassows (*Crax rubra*) in southern Mexico (Perez-Irineo & Moreno-Santos 2021). In contrast, Griffths et al. (2020) showed that Nocturnal Curassows tended to visit mineral licks in the Peruvian Amazon around midday. Many other curassows and guans (Griffiths et al. 2020), as well as diurnal mammals, tend to concentrate their visits to mineral licks near mid-day (Link et al. 2011). Thus, our study highlights the importance of collaborative studies, as larger datasets minimizes limitations of small sample sizes; for example, the study on the activity pattern of Nocturnal Curassows by Medrano-Vizcaíno & Rueda (2018), suggesting a more uniform activity pattern throughout the day, was based on few independent records (N = 14).

Direct records of Nocturnal Curassows in the wild have been mostly anecdotal, as clearly described by Parker III (2002) when he highlighted Delacour & Amadon's (1973) annotation: "so far as we know, no naturalist has ever seen *Nothocrax* in the wild by day." In his notes, Parker III (2002) mentioned that local hunters considered Nocturnal Curassows to be relatively rare, and did not include them as preferred game partly because of their elusive and cryptic behavior. Thus, low encounter rates by hunters of Nocturnal Curassows compared to those of other cracids may be partially explained by their response to human presence. While most curassows when alarmed tend to give conspicuous alarm calls and fly into the mid-canopy, the Nocturnal Curassow tends to escape by quietly running away from predators, including humans (see details in Parker III 2002).

Overall, slow understanding of the most basic aspects of the Nocturnal Curassow's behavioral biology (e.g., its activity patterns) might have been influenced by its cryptic behavior during foraging and its evasive escape behavior from humans. Finally, the compilation of data from several long-term projects presented here provides confirmation that the daily activity period of "Nocturnal" Curassows is more similar to that of other curassows than previously expected. The study also highlights the relevance of collaborative studies to build on our current knowledge of relatively unknown species.

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All authors have contributed equally to the study by providing unpublished data and revising all versions of the document. All studies comply with the legal requirements of Colombia, Ecuador, and Brazil. The authors declare no conflict of interest.

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