ORNITOLOGÍA NEOTROPICAL
(2021) 32: 75–77

SHORT NOTE

Sociedad de Ornitología Neotropical

VOCAL ACTIVITY OF THE GREAT POTOO (*NYCTIBIUS GRANDIS*) IN RELATION TO MOONLIGHT IN A TROPICAL FOREST OF COSTA RICA

Valentín Zárate[1*] · Agostina S. Juncosa-Polzella[2]

[1]Instituto de Biología Subtropical (CONICET-UNaM), Bertoni 85, Puerto Iguazú (CP 3370), Misiones, Argentina.
[2]Centro de Zoología Aplicada, Facultad de Ciencias Exactas Físicas y Naturales, Universidad Nacional de Córdoba (UNC), Argentina.
E-mail: Valentín Zárate · valentinzarateee@gmail.com

Abstract · Variations in moonlight can affect the vocal activity of many nocturnal birds, including the Great Potoo (*Nyctibius grandis*), a rarely seen bird usually detected through its characteristic vocalizations. We evaluated the vocal activity of the Great Potoo in relation to moonlight in a tropical forest of Costa Rica. We surveyed potoos using four replicated 13-minute counts, covering a single moon cycle, at 31 points in La Selva Biological Station during March and April 2020. We detected seven individuals on nights with 76–100% moonlight, seven with 51–75%, and we did not detect any with 0–25%, or 26–50%. Great Potoos were mostly detected during moonlit nights, which is consistent with other studies about other nocturnal birds, and suggests that future studies modeling occupancy or habitat use of Great Potoos should consider moonlight as a covariate of detectability.

Resumen · **Actividad vocal del urutaú grande (*Nyctibius grandis*) con respecto a la luz de la luna en un bosque tropical de Costa Rica**
Las variaciones en la luz lunar pueden afectar la actividad vocal de muchas aves nocturnas. El urutaú grande (*Nyctibius grandis*) es un ave difícil de observar, pero es regularmente detectada por su característico canto. Evaluamos la actividad vocal del urutaú grande en relación con la luz lunar en un bosque tropical de Costa Rica. Realizamos muestreos nocturnos de 13 minutos, cubriendo un ciclo lunar, en 31 puntos de registro en la Estación Biológica La Selva durante marzo y abril de 2020. Detectamos siete individuos en noches con 76–100 % de luz de luna, siete con 51–75% y no detectamos ninguno con 0–25% ni con 26–50%. Los individuos del urutaú grande fueron principalmente detectados en noches con alta iluminación lunar, en concordancia con otros estudios de aves nocturnas. Esto sugiere que futuros estudios de ocupación y uso de hábitat del urutaú grande deben considerar la luz lunar como covariable de detectabilidad.

Key words: Caprimulgiformes · Moon cycle · Nocturnal birds · Nyctibiidae · Vocalizations

INTRODUCTION

Moonlight is an important factor for nocturnal birds because it could affect their foraging, vocal, and movement patterns (Enríquez-Rocha & Rangel-Salazar 2001, Woods & Brigham 2008, Penteriani et al. 2010, 2014, Bodrati & Cockle 2012). Specifically, potoos (Nyctibiidae) apparently vary their activity rates with moon phases (Adams 2020). They are rarely seen, and thus variations in their vocal activity with the moon cycle and light levels could be important for studying their ecology. However, few studies have shown how potoos respond to moonlight (Peréz-Granados & Schuchmann 2020).

The Great Potoo (*Nyctibius grandis*) is an insectivorous nocturnal bird that inhabits tropical forests from southern Mexico to southeastern Brazil and central Bolivia (Adams 2020). Despite its large size, the Great Potoo is seldom observed, probably because of its cryptic plumage and lethargic diurnal behavior (Perry 1979, Adams 2020). However, this species is regularly detected through its characteristic guttural vocalizations (Perry 1979, Slud 1979). A recent study indicated that the Great Potoo is more vocal during brighter nights in the Pantanal, a savanna-forest mosaic in Southern Brazil (Peréz-Granados & Schuchmann 2020). This study provides the only published indication of moon-driven vocal behaviors in the Great Potoo. However, information from other parts of its distribution is needed. First, the Great Potoo may comprise multiple cryptic species throughout its distribution range, because of large genetic variations among populations and geographic disjunction (Brumfield et al. 1997, Cohn-Haft 1999). Thus, it could be important to assess if moon-driven vocal behaviors stand throughout the Great Potoo's wide geographic distribution (Podos & Warren 2007).

In addition, variations in vegetation (e.g., canopy cover) can influence the penetrability of moonlight into the Great Potoo's habitat (Gilmore 2016). Consequently, the effect of moon illumination on this species' behavior could vary among vegetation types (e.g., tall, dense, continuous old-growth forest vs. savanna-forest mosaic). Here, we report Great Potoo auditory detections and their relation to moonlight in a tall, closed-canopy, old-growth tropical forest in northern Costa Rica.

Submitted 26 July 2020 · First decision 17 November 2020 · Acceptance 01 December 2020 · Online publication 04 August 2021
Communicated by Carlos Bosque

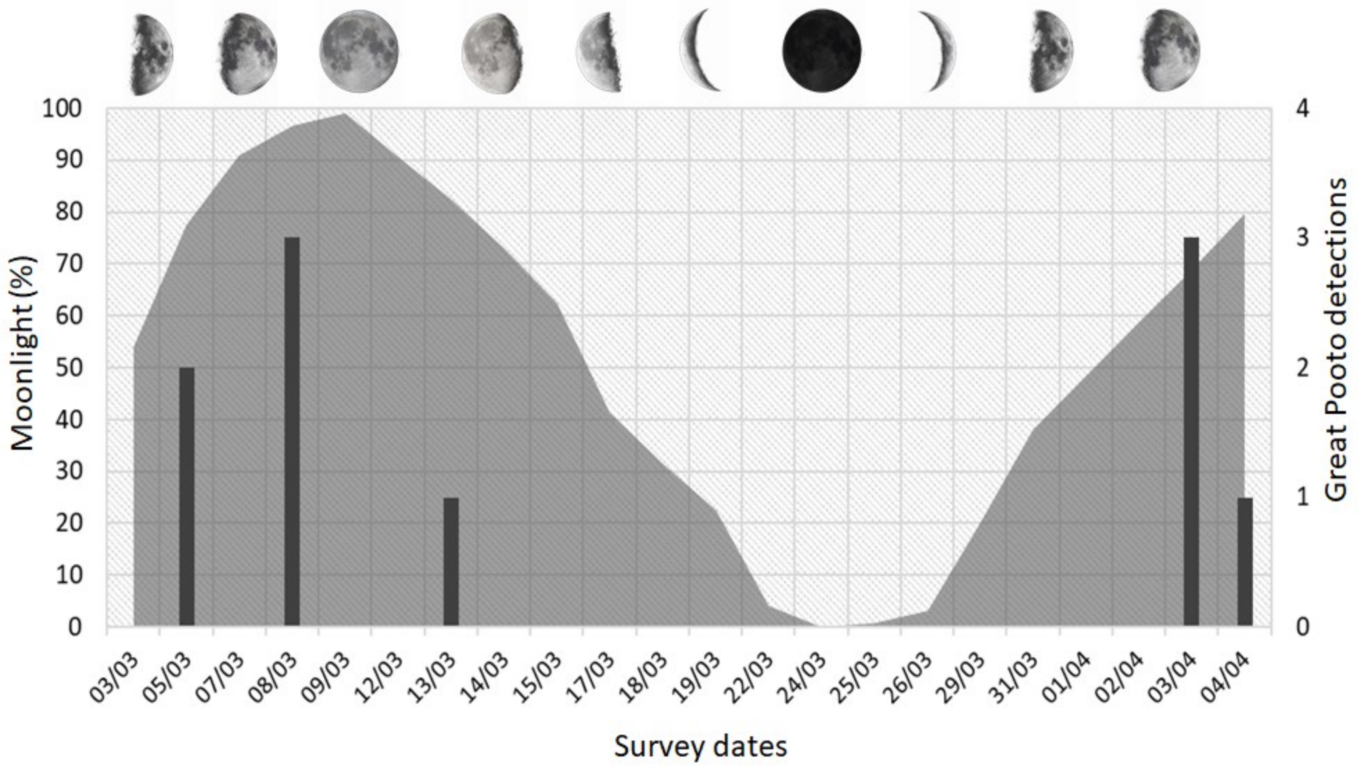

Figure 1. Detections of the Great Potoo (*Nyctibius grandis*) during an entire moon cycle at La Selva Biological Station, Costa Rica, in March-April 2020. Great Potoo detections (N=10) are indicated with grey bars. Mean percentage of the moon illuminated during each survey night (moonlight %) is represented by the grey area.

METHODS

Study area. This study was conducted at La Selva Biological Station (LSBS), Costa Rica, during the dry season in March and April 2020. Although the breeding biology of the Great Potoo is virtually unknown for Central America, this period is probably included within its breeding season, according to reports from northern South America (Adams 2020). LSBS covers an extension of 1600 ha of Tropical Rainforest located in the lowlands of the north Caribbean slope (10°25'22" N, 84°01'19" W, < 100 m a.s.l.). The area around LSBS is a mosaic of farms with cattle and agriculture, mainly pineapple plantations, whereas its southern border is adjacent to Braulio Carrillo National Park. Mean monthly temperature varies between 24.7°C and 27.1°C and mean yearly rainfall is 3,962 mm (McDade & Hartshorn 1994). Our survey points were located in old-growth and secondary forests (> 42 years old), where forest canopy height was 30-40 m, and canopy cover was highly closed (>80%).

Great Potoo surveys. We conducted nocturnal surveys (19:00–01:00 h) to detect Great Potoo individuals. We surveyed 31 counting points of 100 m radius, separated by 200 m intervals. At each point, we counted every individual heard within a 13-min period (Reino et al. 2015). We did not use playback of Great Potoo vocalizations during the surveys. To assess the effect of moonlight on Great Potoos' vocal activity, we visited each counting point four times (repetitions were approximately one week apart) to include an entire moon cycle. During each visit, we recorded two variables: percent of the moon illuminated and moon elevation angle (Digby et al. 2014). Considering the moon as a circular disk, the ratio of the area illuminated by direct sunlight to its total area is the fraction of the moon's surface illuminated (Hoffman 2020), which multiplied by 100 represents the percent of the moon illuminated (Penteriani et al. 2010). We considered the percent of the moon illuminated each night as the average percentage of the moon illuminated in each of the 6 hours of the survey. This variable was divided into four categories: 0–25%, 26–50%, 51–75%, and 76–100%. To account for changes in moonlight due to moon position in the sky, we registered the elevation angle of the moon at the moment of Great Potoo detections. The elevation angle is defined as the angle between the center of the moon and the horizon (Hoffman 2020). The elevation angle was 0° when the moon was below the horizon and 90° (maximum value) when the moon was at zenith position. Only four nights the moon rose late (after 1:00 h), during which time the elevation angle was 0° for the entire survey. However, the percent of the moon illuminated during these nights was within 0–25%, suggesting that moonlight would not have varied significantly.

To prevent double-counting of individuals in the same survey, location of each auditory detection was determined by compass triangulation. We avoided six windy and rainy nights (out of 32) to improve the detection of Great Potoo vocalizations (O'Donnell 2004). Also, we avoided cloudy nights (cloud cover > 20% for at least 1 h in a row during the survey, 4 nights out of 32) because it can reduce moonlight incidence (Cadbury 1981). We surveyed a total of 22 nights. Given the low number of detections, we did not conduct statistical analyses.

RESULTS AND DISCUSSION

We detected 10 Great Potoos at nine survey points. Seven were detected on nights with 76–100% of moon illuminated, seven on nights with 51–75%, and none were detected on nights with 0–25% nor with 26–50% (Figure 1). All Great Potoo detections occurred when the moon elevation angle was higher than 60° and under clear sky conditions (cloud cover < 5%), and when the moon was not covered by clouds. Individuals were separated at least by 600 m. Only two Great Potoos were detected at the same counting point and were easily differentiated as they vocalized simultaneously. Despite the low number of detections, our results suggest that Great Potoos at LSBS were more vocal during moonlit nights.

Moon-driven behaviors were reported in many potoos and nightjars since moonlight can affect both their vocal activity, their feeding and laying dates (Perrins & Crick 1996, Bodrati & Cockle 2012, Reino et al. 2015, Adams 2020, Perez-Granados & Schuchmann 2020). Different hypotheses have been proposed to account for moonlight-related vocal behaviors, although none of them have been strictly tested. For example, it has been proposed that some species could take advantage of moonlight to exhibit visual sexual features (e.g., the white shoulder patch of *Nyctibius leucopterus*) simultaneously with reproductive vocalizations (Cohn-Haft 1993). The Great Potoo does not present visual sexual features easily detected by the human eye, but we should not rule out the possibility of this bird having visual cues not yet detected. Also, it has been proposed that nocturnal birds increase their general activity, such as foraging and exploratory movements, during well-lit nights, which leads to greater numbers of inter and intra-specific vocal interactions (Jetz et al. 2003, Penteriani et al. 2014). However, explanations for these moon-driven vocal behaviors are still under discussion.

Our observations in a tropical rainforest of Costa Rica, a tall, dense, continuous old-growth forest, were concordant with those reported by Peréz-Granados & Schuchmann (2020) in the Pantanal, a savanna-forest mosaic. This concordance suggests that moon-driven vocal behaviors are widespread in Great Potoos, regardless of the vegetation type. Similar studies in other areas of its distribution could contribute to supporting this hypothesis.

Detecting individuals is probably one of the most critical limitations when studying cryptic birds like the Great Potoo. Therefore, knowledge related to Great Potoo vocal activity variations could be crucial for maximizing records. Our observations and those of Peréz-Granados & Schuchmann (2020) suggest that moonlight should be included as a covariate of detectability when modeling occupancy or habitat use of the species.

ACKNOWLEDGMENTS

We are deeply grateful to the Organization for Tropical Studies for allowing us to conduct fieldwork at La Selva. We thank Sofia Rodriguez, Fernando Soley, and Beth Braker for their support while conducting this study. Suggestions and comments from Kristina L. Cockle, Alejandro Bodrati, Alejandro Pietrek, and Facundo Di Sallo greatly enhanced earlier versions of this manuscript.

REFERENCES

Adams, K (2020) Great Potoo (*Nyctibius grandis*). *In* TS Schulenberg (ed.) Version 1.0. *Birds of the World*. Cornell Lab of Ornithology, Ithaca, New York, USA. Available at https://doi.org/10.2173/bow.grepot1.01 [Accessed 31 May 2020]

Bodrati, A & KL Cockle (2012) El Atajacaminos Coludo *Macropsalis forcipata* en Argentina: ¿una especie amenazada o en expansión? *Cotinga* 34: 46–54.

Brumfield, RT, DL Swofford & MJ Braun (1997) Evolutionary relationships among the potoos (Nyctibiidae) based on isozymes. *Ornithological Monographs* 48: 129–145.

Cadbury, CJ (1981) Nightjar census methods. *Bird Study* 28: 1–4.

Cohn-Haft, M (1993) Rediscovery of the White-winged Potoo (*Nyctibius leucopterus*). *The Auk* 110: 391–394.

Cohn-Haft, M (1999) Family Nyctibiidae (Potoos). Pp. 288–300 *in* del Hoyo, J, A Elliott & J Sargatal (eds). *Handbook of the birds of the world. Volume 5: Barn-owls to hummingbirds*. Lynx Edicions, Barcelona, Spain.

Digby, A, M Towsey, BD Bell & PD Teal (2014) Temporal and environmental influences on the vocal behaviour of a nocturnal bird. *Journal of Avian Biology* 45: 591–599.

Enríquez-Rocha, PL & JL Rangel-Salazar (2001) Owl occurrence and calling behavior in a tropical rain forest. *Journal of Raptor Research* 35: 107–114.

Gilmore, SER (2016) The influence of illumination and moon phase on activity levels of nocturnal mammalian pests in New Zealand. Ph.D. diss., Univ. of Lincoln, Lincoln, New Zealand.

Hoffman, T (2020) *MoonCalc.* Available at http://www.mooncalc.org/ [Accessed 25 August 2020].

Jetz, W, J Steffen & KE Linsenmair (2003) Effects of light and prey availability on nocturnal, lunar and seasonal activity of tropical nightjars. *Oikos* 103: 627–639.

McDade, LA & GS Hartshorn (1994) La Selva biological station. Pp. 6–14 *in* McDade, LA, KS Bawa, HA Hespenheide & GS Hartshorn (eds). *La Selva: Ecology and natural history of a neotropical rainforest*. University Chicago Univ. Press, Chicago, USA.

O'Donnell, RP (2004) Effects of environmental conditions on owl responses to broadcast calls. *Transactions of the Western Section on the Wildlife Society* 40: 101–106.

Penteriani, V, M del Mar Delgado, L Campioni & R Lourenco (2010) Moonlight makes owls more chatty. *PloS one* 5: e8696.

Penteriani, V, M del Mar Delgado, A Kuparinen, P Saurola, J Valkama, E Salo, J Taviola, A Aebischer & R Arlettaz (2014) Bright moonlight triggers natal dispersal departures. *Behavioral ecology and sociobiology* 68: 743–747.

Pérez-Granados, C & KL Schuchmann (2020) Monitoring the annual vocal activity of two enigmatic nocturnal Neotropical birds: The Common Potoo (*Nyctibius griseus*) and the Great Potoo (*Nyctibius grandis*). *Journal of Ornithology* 161: 1–13.

Perrins, CM & HQP Crick (1996) Influence of Lunar Cycle on Laying Dates of European Nightjars (*Caprimulgus europaeus*). *The Auk* 113: 705–708.

Perry, DR (1979) The Great Potoo in Costa Rica. *The Condor* 81: 320–321.

Podos, J & PS Warren (2007) The Evolution of geographic variation in birdsong. *Advances in the Study of Behavior* 37: 403–458.

Reino L, M Porto, J Santana & TS Osiejuk (2015) Influence of moonlight on nightjars' vocal activity: a guideline for nightjar surveys in Europe. *Biologia* 70: 968–973.

Slud, P (1979) Calls of the Great Potoo. *The Condor* 81: 322.

Woods, CP & RM Brigham (2008) Common poorwill activity and calling behavior in relation to moonlight and predation. *The Wilson Journal of Ornithology* 120: 505–512.