Tecnociencia, Vol. 25, N°2: 66-83
Julio-Diciembre 2023
ISSN L 2415-0940

BEHAVIOURAL NOTES OF *Zentrygon goldmani oreas* (NELSON, 1912) AND OTHER WILD DOVES AT THE CHUCANTÍ PRIVATE NATURAL RESERVE (CPNR), DARIEN, PANAMA

Pedro G. Méndez-Carvajal
Universidad de Panamá. Panamá. mendez55.pm@gmail.com
https://orcid.org/0000-0003-1306-5869

Karol M. Gutiérrez-Pineda
Universidad de Panamá. Panamá. gutierrezpinedakm@gmail.com
https://orcid.org/0000-0001-9129-7716

Guido Berguido
Adopta Bosque Panamá S.A. Panamá. gcberguido@hotmail.com
https://orcid.org/0000-0002-5952-3901

DOI https://doi.org/10.48204/j.tecno.v25n2.a4065

Fecha de recepción: 30 de octubre de 2022
Fecha de aceptación: 16 de marzo de 2023

ABSTRACT

The province of Darien in eastern Panama is well known for its endemic doves. Most of them are poorly studied and threatened. The aim of this study was to recognize the wild dove's diversity from CPNR and describe an ethological baseline. We compiled 38,592-day hours, with information on circadian activity and behavioral data from camera traps from December 2012 to May 2014 in a cloud forest. We detected four species of wild doves and obtained information on circadian activity for the most frequent species detected. An ethogram was built for *Zentrygon goldmani* and *Leptotila cassinii* in five categories: transversal walking, foraging, courtship, copulation and walking together. Courtship occurred during December, February, July and September, in both the dry and rainy seasons. We also detected *Geotrygon montana* and *Zentrygon lawrencii* for the Pacific slope of Panama and for the Chucanti Private Natural Reserve. The diversity found regarding wild doves represents a unique opportunity to study this endemic species at CPNR, and another important reason for its conservation.

KEYWORDS

Birds, Cloud Forest, Columbiformes, Pigeons

NOTAS DE COMPORTAMIENTO DE Zentrygon goldmani oreas (NELSON, 1912) Y OTRAS PALOMAS SILVESTRES EN LA RESERVA NATURAL PRIVADA CHUCANTÍ (CPNR), DARIEN, PANAMÁ

RESUMEN

El lado este de Panamá es bien conocido por sus palomas endémicas, la mayoría de ellas poco estudiadas y amenazadas en la provincia de Darién, Panamá. El objetivo de este estudio fue reconocer la diversidad de palomas silvestres en la RNPC y describir una línea base de su comportamiento. Compilamos 38,592 horas día, con información sobre la actividad circadiana y datos de comportamiento de las cámaras trampa desde diciembre de 2012 hasta mayo de 2014 en un bosque nuboso. Detectamos cuatro especies de palomas silvestres y obtuvimos información de actividad circadiana para las especies más frecuentes detectadas. Se construyó una etograma para *Zentrygon goldmani* y *Leptotila cassinii* en cinco categorías: caminata transversal, búsqueda de alimento, cortejo, cópula y caminata en pareja. El cortejo se produjo durante diciembre, febrero, julio y septiembre, incluidas las estaciones secas y lluviosas. También detectamos *Geotrygon montaña* y *Zentrygon lawrencii* para la vertiente del Pacífico de Panamá y para la Reserva Natural Privada Chucantí. La diversidad encontrada con respecto a las palomas silvestres representa una oportunidad única para estudiar estas especies en la RNPC y otro motivo importante para su conservación.

PALABRAS CLAVES

Aves, Bosque nuboso, Columbiformes, Palomas

INTRODUCTION

Columbidae is one of the most diverse families of birds, with high endemism in Darien and other highlands in Mesoamerica (Angehr & Dean, 2010). Ground-dwelling birds are poorly studied but may be important for understanding biogeography due to their high dispersal capabilities and colonization between regions and continents (Johnson & Weckstein, 2011, Lapiedra *et al*., 2013). Darien is a unique habitat for species like *Z. goldmani* (Nelson, 1912), which has been reported only in a few peaks within the region, and an endemic species like *Odontophorus dialeucos* (Tacarcuna wood quail), which has adapted to

high-altitude habitats in the Darien mountain chains (Ridgely & Gwynne, 1989, Angehr *et al*., 2004). These adaptations are clearly illustrated by unique behaviour and habitat use observed in Chucanti Private Natural Reserve (CPNR). While *L. cassinii* has adapted to live in mixed open habitat, the other reported pigeon-doves have adapted to cloud forests and have developed strict arboreal habits compared with *Zentrygon* and *Geotrygon* species (Lawrence, 1867; Sanfilippo & Werther, 2001). It is known that the range of food resources used by these species provides more ecological opportunities to survive and disperse. Some species exploit a wide variety of food resources within habitats, some are selective of fruits, and others are seed and grain specialists (Lapiedra *et al*., 2013). Snails and insects are another protein source for wild doves like *Geotrygon* and *Zentrygon* species (Baptista *et al*., 2009). The foraging, reproductive and vocalization patterns of these species have only changed in adaptations for crypsis and brooding (Tubaro & Mahler 1998; Brooks, 2012). There is a direct correlation between body mass and advertising calls, based on innate and stereotyped patterns described by Lade & Thorpe (1964).

From studies related to vocalizations in *Z. lawrencii* 858 kilohertz (kHz) and *Z. goldmani* (586 kHz), *Z. goldmani* may have greater nutritional requirements, given a body mass average of 258 gram (g) (Salvin 1874; Tubaro & Mahler, 1998). The energy requirements of the eye coordination and bobbing head movements needed for clear and effective foraging activity, plus the vigilance these birds invest, being at the ground for courtship, imply specialization for particular habitats, food, and temperatures for successful colonization (Mac-Arthur, 1972; Diamond, 1975). One of the most poorly studied and elusive wild doves in the country is the Russet-Crowned Quail-Dove, *Zentrygon goldmani* (Columbiformes: Columbidae), discovered by Edward A. Goldman on March 5, 1912. The type specimen (No. 232545) is located at the United States National Museum (Nelson, 1912). It was found at Limón river, Pirre mountain, Darien at 1,524 meters average sea level (masl). The physical description of this species includes a rufous chestnut between the eyes, reddish chestnut by the crown and nape, olivaceous and dark gray on the upper side of the neck, vinaceous color on the back and tail, brownish wings, and pinkish buff on the ear bordered with black lines from the bill to the lower side of both cheeks. Body measurements are 144 millimeter (mm) extended wings, 87 mm tail, sixteen mm culmen,

and 44 mm tarsus (Nelson, 1912). Other measurements reported body size 280 mm (Angehr & Dean, 2010). This species is predominantly found in forested mountain habitat (Nelson, 1912). Common names include Goldman's Wood Dove (Nelson, 1912), "perdiz de frente dorada", "perdiz cabezicanela" in Colombia, and "perdiz cabecicastaña" in Panama (Méndez, 1979, Angehr *et al*., 2004, Angehr & Dean, 2010). Historically, *Z. goldmani* has been classified by the following names: *Geotrygon goldmani goldmani*, *Oreopeleia goldmani goldmani*, and *Zentrygon goldmani goldmani*, the latter proposed by Banks *et al*. (2013) and listed for the Birds of the World and Birdlife (Birdlife International, 2016). *Zentrygon goldmani oreas* was designated as a rare subspecies from Panama (Hilty & Brown, 1986; Ridgely & Gwynne, 1989; Baptista *et al*., 1997, 2020). *Zentrygon goldmani oreas* has been poorly studied and is distributed from lowlands (~700 m) up to 1,600 m in Panama.

There are 28 columbids reported for Panamá (Angehr & Dean, 2010; MiAmbiente, 2016). Columbids are regular targets for rural hunting in different parts of Panama, and others are pressured by natural predators (Méndez, 1979). Determining the distributions, population densities, basic behaviours, and their predators, helps to determine their conservation statuses and threats. Most of the pigeon species present in Panama lack this information, making it difficult to evaluate their conservation category. In Panama, some species have restricted habitats and small distribution ranges due to endemism, habitat requirements, and activity patterns (Miller *et al*., 2011). For these species, behavioral data is in need. A few studies have focused on *Z. goldmani*, including inventories at Tacarcuna, Pirre, Altos de Quia, Nique, Jurado, and other highlands in Darien and at the Colombian border, which contain nearly untouched mountain forest ecosystems (Renjifo *et al*., 2017). Studies with the genus *Zentrygon* and *Geotrygon* have examined behaviour (vocalization, courtship) (Tubaro & Mahaler, 1998; Johnson and Weckstein 2011; Donegan and Salaman, 2012; Renjifo *et al*., 2017; Baptista *et al*., 2020), genetic and evolutionary adaptations (Brooks, 2012; Lapiedra *et al*., 2013). The aims for this study were to build preliminary list of wild-dove species and obtain behavioural information that can help as baseline for monitoring and conserve the wild-doves from Darien.

MATERIALS AND METHODS

Study area

Chucanti Private Natural Reserve (CPNR) is located in Darien Province, Republic of Panama, (08°47′ N 078°27′ W). Chucanti mountain is the highest elevation of the Maje Mountain Chain, at 1,400 masl (Laurance, 2008). Annual temperatures are between 24-27.2 Celsius (ºC), and the annual mean precipitation is 1,940.5 mm (Navas *et al*., 2001). Habitats include montane and submontane forest with characteristics of cloud forest with many epiphytes and bryophytes (Aizprúa unpubl. data). It has 1,200 species of vascular plants, the most abundant families being Rosaceae, Magnoliaceae, Gentianaceae, and Fabaceae (Ortíz *et al*., 2016; Flores *et al*., 2017; Mijango-Ramos *et al*., 2020). The CPNR has been recognized by several studies for its endemism of plants, amphibians, mammals, and birds (Batista *et al*., 2020; Bezark *et al*., 2013; Bermúdez *et al*., 2012; Méndez-Carvajal, 2014; 2015; Gutiérrez-Pineda *et al*., 2021).

Data collection

The baseline camera trap monitoring system at the reserve was comprised of three camera traps along the main trail, a six-kilometer loop that connects the mountain valley to Chucanti peak. One camera Cuddeback model 1347, and two Bushnell Trophy Cam model 11-9736 Bushnell model were placed only along the first three km. The cameras were located at different elevations as follows: station 1 “tronco” (800 masl; 08º47’ North, 78º27’ West'), station 2 “filo 1” (1,350 masl; 08º47’ North, 78º27’West), and station 3 “filo 2” (1,375 masl; 08º48’ North, 78º27’ West). Cameras were separated starting from 800 masl at station 1 “tronco” (1 km from biological station), station 2 “filo 1” (2.5 km from camera 1), and station 3 “filo 2” (3.5 km from camera 2) (Fig. 1). This project follows the Panamanian ethical approval and was conducted under scientific permit No. SE/A-70-14 from the Panamanian Environmental Ministry (Mi Ambiente).

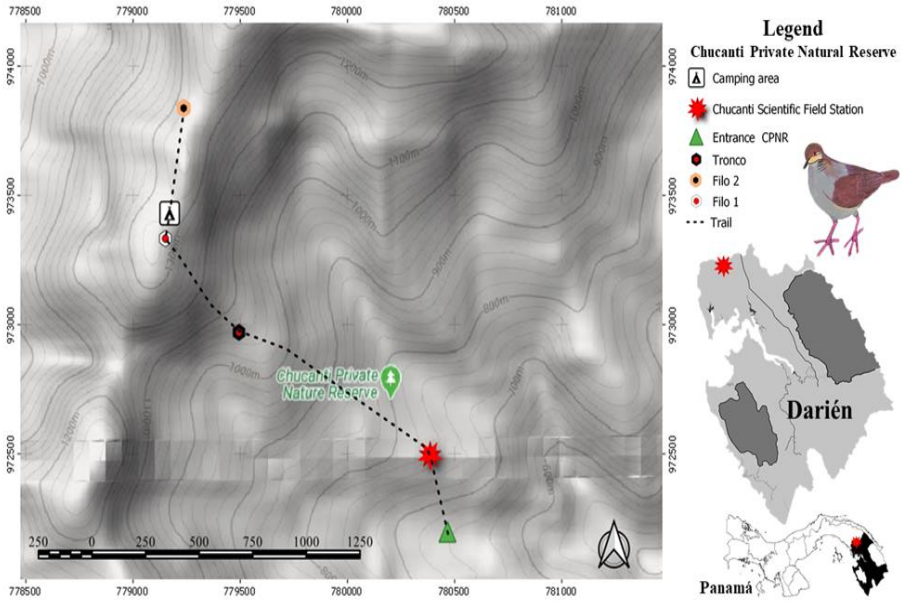

Fig 1. Study area, Chucanti Private Natural Reserve, Darien, Panama

Data analysis

PAleontological STatists Software (PAST 4.02) was used to calculate the detection graph of the number of doves's species per month and their frequency of detection. Graphs of circadian activity were also created for species with more than eleven photographic events at intervals of more than 30 minutes per photograph, if it was of the same species following Mosquera-Muñoz (2014). An ethogram was built based on Steadman (2001) and Brooks (2012), adding any other relevant behaviour observed in the photographs during the two years of data. As behaviours were repetitive, we calculated percentage of occurrence from the total of all appearances of the animals in the camera.

RESULTS

Behaviour

Data for behaviour analysis obtained from pictures is presented as an ethogram in Table 1 for *Z. goldmani* and *L.cassinii,* comparing courtship display and other behaviours, the patterns of movements for approach, touch of beaks, "front dance," copulation, separation and a distant walking circle resembling a typical Panamanian dance called "El punto" (Fig. 2). Doves expended between 1-2 minutes, walking around, and crossing in front of the cameras, and 1% of the time recorded they stopped for a short rest. Foraging for grain was the second most common activity. There is a variation of transversal walking (77%) with "circular walking" (2%), where doves walked in circles from right to left, pecking while walking. We detected the characteristic bobbing behaviour as "head bobbing and tail is raised", which was included as part of the courtship we describe here (Table 1). In general, the same pattern was reported only twice during our study. It is notable that these events occurred on April 12 and 28, 2013 and match with the same season reported for the *Zentrygon* genus (Steadman, 2001; Brooks, 2012). For *Z. goldmani*, we found: 1) bobbing movement to be about one second, and 2) tail and head lowered and raised quickly. *Zentrygon goldmani* did not fan the tail. *Zentrygon goldmani* appears to call the partner from a distance, alone from the ground, with the head up/down, and moving in circles twice. The partner lands, both less than half a meter from each other, approaches with eye contact, then they put their chest in contact while joining their beaks. Moving slowly, each turns its body, switching sides and slowly moving forward in different directions (Fig. 2). *Leptotila cassinii* exhibited more socialization behaviour, described in five categories: transversal walking (47.5%), foraging (15%), courtship (15%), copulation (2.5%) and walking together (2.55%). Courtship occurred in different months during the two years of the study (December, February, July, and September), including dry and rainy seasons.

Table 1. Ethogram of *Zentrygon goldmani* and *Leptotila cassinii* at CPNR, Darien province, Panama.

Ethogram	*Zentrygon goldmani*	*Leptotila cassinii*
Courtship Display		
Stationary head down and tail up	x	x
Pumping head down with tail up	x	x
Approaching breasts and peaks	x	x
Frontal dancing together with touching beaks	x	x
Walking side by side	x	x
Male fluttering and jump over female/female receptive	-	x
Separation	x	x
Spoil	x	x
Walking together	x	x
Other behaviour		
Foraging	x	x
Walking transversal	x	x
Walking on circles	x	x
Grooming	x	x
Ground sitting	x	-

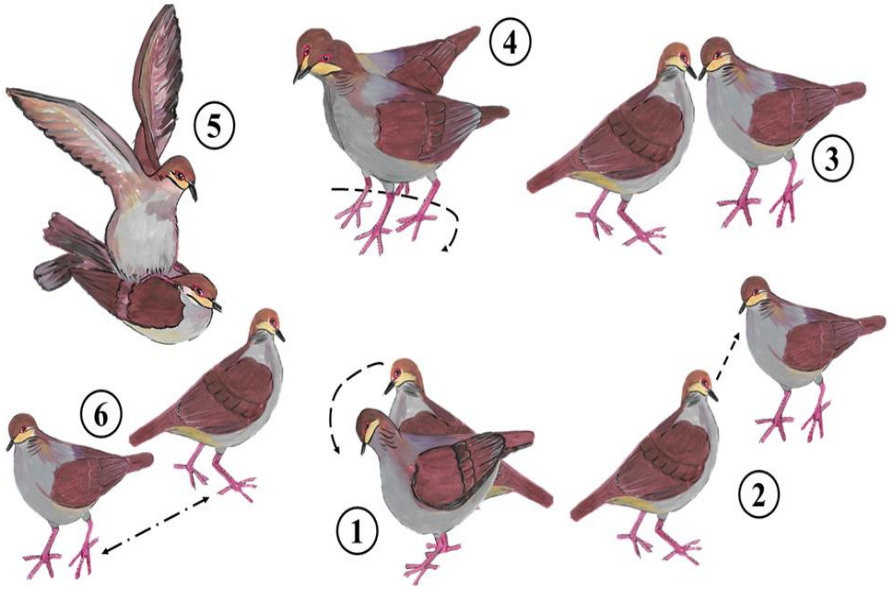

Fig. 2. Courtship behaviour of *Zentrygon goldmani oreas*

Diversity and Circadian activity

We detected four species of wild doves: *Geotrygon montana, Zentrygon goldmani, Z. lawrencii,* and *Leptotila cassinii*. The months from January to April obtained more detectability (Fig. 3). The species with the highest occurrence frequency during sampling was *Z. goldmani* (Fig. 3, Fig. 4). *Zentrygon goldmani* was frequently detected from July 2013 to May 2014 (Fig.3. Circadian activity shows the wild doves were mainly diurnal starting activities at 06:00 and finishing activities between 17:00 to 18:00 (Fig.4). The graphics were only examined for species with more than eleven photographic events; thus, we list only *Z. goldmani*, and *L. cassinii* (Fig. 3). *Zentrygon goldmani* showed a greater range of activity between 08:00 to 09:00 hours (hrs), with a decrease at 13:00 hrs, and peak activity in the afternoon between 15:00 to 16:00 hrs (Fig. 4). *Leptotila cassinii* had three well-marked activity peaks, at 10:00, 12:00, and 15:00 hrs (Fig.4).

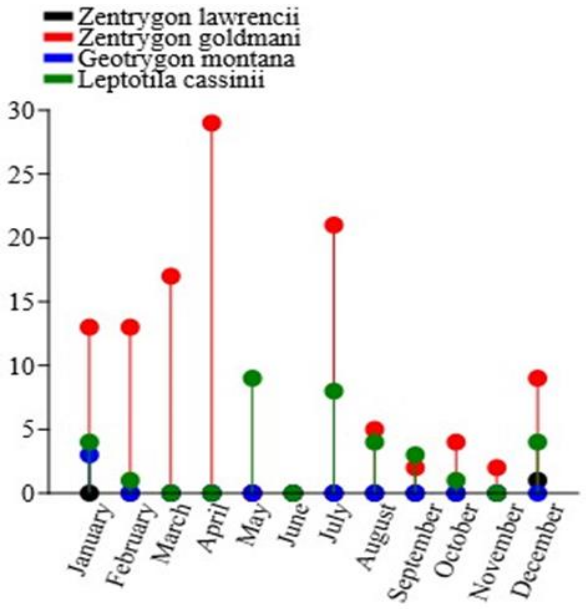

Fig. 3. Frequency of occurrence for wild doves at Chucantí Private Natural Reserve, Darien, Panama. Note: This graph included only data for 2013.

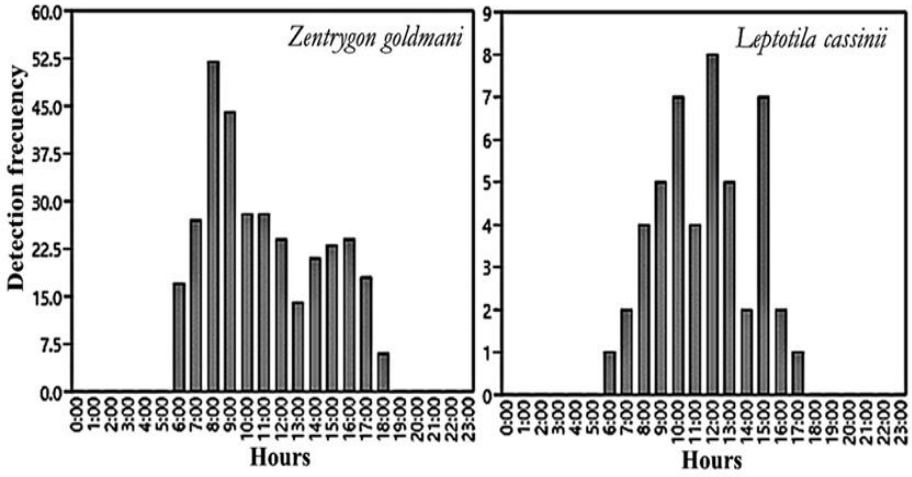

Fig. 4. Circadian activity of wild doves at Chucantí Private Natural Reserve, Darien, Panama.

DISCUSSION

Behavioral patterns were detected for *L. cassinii* and *Z. goldmani*. The preferred habitats of both species were well-defined and non-overlapping, with *Z. goldmani* exhibiting exploration (end of December 2012) and colonization at the edge "filo 1" and *L. cassinii* at "tronco". Reproductive behaviour for Geotrygon/Zentrygon has been controversial. Steadman (2001) described the courtship display as occurring either on the ground or perching on a branch, while Brooks (2012) reports only *Z. chiriquensis* displaying courtship at ground level. The latter study compared *Z. chiriquensis* with seven species of quail-doves in Panama, including species other than those found in this study, and noted the lack of information related to this behaviour. The current study at CPNR may support the results of Steadman (2001), as we recorded *Z. goldmani* and *L. cassinii* displaying courtship behaviour strictly at ground level. Ethograms showed the most common activity on trails for these birds was "transversal walking" that took place away from clear areas of the trail, potentially to avoid predators (Martin, 1988). *Zentrygon goldmani* and *L.cassinii* are similar in conducting courtship on the ground, differing from *Z. chiriquensis* which performs courtship on a perch (Brooks, 2012). *Zentrygon goldmani* did not fan the tail as this seems unique to the courtship display of Z. *chiriquensis* (Brooks, 2012). Those patterns were always observed several days before courtship events (1%) and were in some ways like the movements reported for *Z. chiriquensis* in phylogeny studies (Brooks, 2012). More observations are needed to describe a clear pattern for this courtship behaviour and if captivity results in changes to behavioral patterns.

Copulation was photographed in June 2014, and the nesting season has been reported to occur around May in the lowland Panama Canal Watershed (Pérez & Tejera, 2018). *Leptotila cassinii* was found sharing habitat in the lower parts of CPNR "tronco" with *G. montana,* both with characteristic alar modifications for fast flight to avoid predators over short periods (Ocampo *et al*., 2019). *Leptotila cassinii* and *G. montana* showed preferred conditions and dominance in semi-open areas at 800 masl, as did *Z. goldmani* and a new species for Chucanti detected in this study, for CPNR, *Z. lawrencii,* at 1,350-1,400 masl. *Zentrygon lawrencii* is reported as rare for the Pacific and Central Panama and is distributed mostly along the Caribbean coast (Angehr & Dean 2010). However,

Z.goldmani was one of the more photographed between nine species of understory birds presents at CPNR according to Gutiérrez-Pineda *et al*. (2021). Patterns of circadian activity were very well represented for *Z. goldmani,* with eleven active daytime hours, and *L. cassinii*, with ten active daytime hours. Most *Z. goldmani* activity detected on cameras occurred between April-May (around the breeding period), with main activity occurring around 08:00-09:00 hrs and a small peak between 15:00-16:00 hrs, probably related to temperature and food availability. However, main activities for *L. cassinii* occurred between 10:00 and 15:00 hrs. In this study, we report preliminary data for four species of wild doves, including the first report of *Z. lawrencii* within CPNR and records of circadian activity and baseline behaviour for *Z. goldmani*, *L. cassinii*, and *Geotrygon montana.* We remark upon their capability to adapt and diversify in response to ecological opportunities, a feature that is common at CPNR as stated by Wege (1996), who first described it in Darien province in Panama. The presence of these wild doves represents a unique opportunity to study this endemic species at CPNR, and another important reason for its conservation (Fig. 5).

Fig. 5. *Zentrygon goldmani oreas* at Chucantí Private Natural Reserve, Darien, Panama.

CONCLUSIONS

There is a well-represented individuals of wild doves at CPNR, with a marked preference of *Z. goldmani* for the cloud level of the forest (between 700 to 1,400 masl). The *Z. goldmani* showed a greater range of activity between 08:00 to 09:00 hours (hrs), with a decrease at 13:00 hrs, and peak activity in the afternoon between 15:00 to 16:00 hrs, which could be predictable. This study described for the first time an ethogram for this endemic and rare species, which is relevant to understand habitat use, preference, ethogram, and interactions with other species at same habitat. More studies related to population should be conducted at the CPNR to monitor its conservation.

Author's contributions

PGMC. Principal researcher, participated in the field working with the camera traps, prepared, and reviewed different versions of the article´s main text and figures.

KMGP. Assisted in the field, writing process, prepared the study map, illustrations, and statistics.

GB. Helped with the ID of the species, facilitated the field station and participated in the writing process.

ACKNOWLEDGEMENTS

We are grateful to Fundación Pro-Conservación de los Primates Panameños (FCPP), Panamá, Panamá for their support. Milvia Sánches, Yayson Péres, Arcadio Castillo, Elena Méndez, who helped in the field at the Chucanti Private Natural Reserve research station. We deeply appreciate the support of Idea Wild, Mohamed bin-Zayed Species Conservation Fund (projects # 1025476 and 12055182), and II Rufford Small Grant (project #16021-2). Our special appreciation to Ricardo Moreno from Yaguará Panamá, and the Virginia Commonwealth University (VCU), for their generous camera trap donation, to Cathy Viverette, Edward Crawfort, and especially to Gabrielle LaTora and Ramón Da Pena for kindly reviewed the English of the manuscript. We

appreciate the editorial comments from Tecnociencia to improve earlier versions of this manuscript.

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