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Nocturnal activity and behaviour of the elusive bushy-tailed opossum (*Glironia Venusta)*

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Abstract

The bushy-tailed opossum (*Glironia venusta*) is a small arboreal marsupial found in the Amazon basin. *G. venusta* is rarely seen and has few published sightings throughout its range. Videos (N = 79) were obtained from arboreal camera traps located in the Las Piedras Amazon Center near the Las Piedras River (SE Peru) from April 2017 until November 2017. Our new records, the first for the Las Piedras River, demonstrate that the species is nocturnal with activity peaks at 3:00 h and 20:00 h in the hours of complete darkness. The abundance of camera trap footage of such a rarely observed species further demonstrates the effectiveness of arboreal camera trapping to conduct species assessments.

Introduction

The bushy-tailed opossum (*Glironia venusta*) belongs to the family *Didelphidae* and the genus *Glironia* (Solari & Martin 2016). *G. venusta* inhabits the lowland rainforests and dry forests of Bolivia, Brazil, Colombia, Ecuador, and Peru (Solari & Martin 2016). Due to the elusive nature of *G. venusta*, its populations and population trends are currently unknown and it is listed as least concern by the IUCN red list.

Since being described by Michael Rogers Oldfield Thomas (1912), researchers have only recorded 23 sightings of *G. venusta* (Sant & Catzeflis 2018, Arévalo et al. 2021, Arguero et al. 2017, da Silveira et al. 2013). The only record of *G. venusta* in southeastern Peru is from the Cocha Cashu Biological Station along the Madre de Dios River (Ardente et al. 2013, Solari et al. 2006), approximately 210 km from our study site.

Little is known about the ecology and behaviour of *G. venusta* in the wild, as previous studies are primarily based on opportunistic sightings, individuals in captivity, and from descriptions of morphology of *G. venusta* (Díaz & Willig 2004, Ardente et al. 2013, Nogueira et al. 1999, Rossi et al. 2010, da Silveira et al. 2013, Vieira et al. 2015). The species is primarily arboreal but occasionally descends to the ground, as researchers have captured them in pitfall traps (Bernarde & Rocha 2003). *G. venusta* is agile and can easily climb and navigate the canopy (da Silveira et al. 2013). *G. venusta* is omnivorous, with records of the species eating seeds, fruits, eggs, insects, and gum (Nowak 1999, Auricchio & Rodrigues 1994, Emmons & Feer 1997, Fonseca et al. 1996, da Silveira et al. 2013). Researchers previously considered *G. venusta* nocturnal; however recently, it has been described as crepuscular (Emmons & Feer 1997, da Silveira et al. 2013).

The use of arboreal camera traps is rapidly increasing the knowledge of many cryptic and arboreal species, many of which are understudied with little known about their ecology. Information such as the activity and behaviour of these lesser-known species is important for researchers as it allows for a better understanding of these species, which in turn allows for better conservation or land use planning strategies in the future. Understanding species' circadian rhythms can also be used to understand how relationships with other species influence behaviours and thus their function within the ecosystem (Gracanin & Mikac 2022).

Two of the four camera sites at the Las Piedras Amazon Centre (LPAC) recorded a total of 79 videos of *G. venusta.*

Materials and Methods

Four Browning Strike Force HD 850 cameras were placed in emergent trees (a tree that is taller than the surrounding canopy height) on the land surrounding the LPAC Research Center (19 L 446284, 8665695). Locations were recorded using UTM 19S. Cameras 1, 2, 3, and 4 were set up in the dry season, between April 2017 and November 2017, for a total of 195, 53, 72, and 122 nights, respectively (442 nights in total). Emergent trees were chosen by their accessibility (i.e. avoiding crossing large streams while carrying equipment, no visible wasp nests nearby, and branch distribution for the climbing gear). The camera trap locations were also chosen in trees with branches that were suitable for climbing equipment to be used safely. We used tree climbing equipment to access the canopy and place the camera traps. The cameras

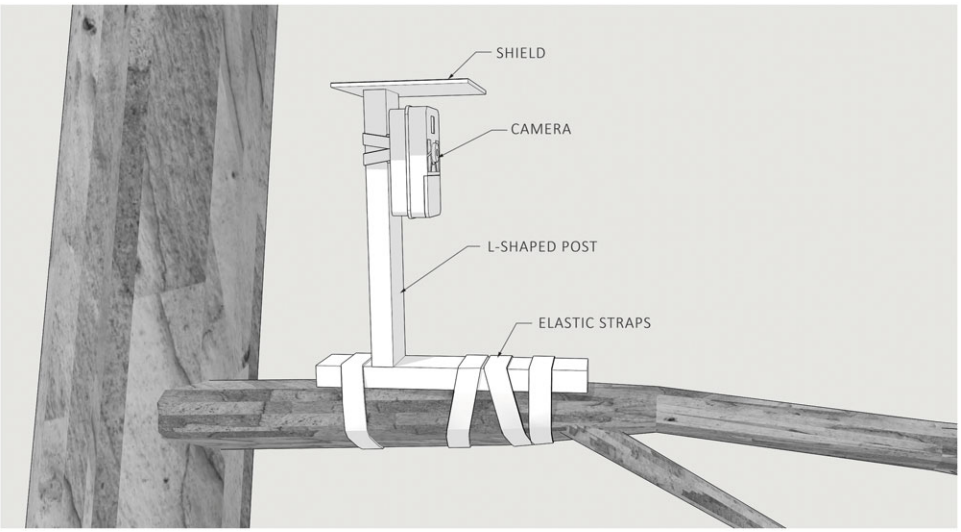

Figure 1. A model of the arboreal camera trap setup (By Ali Karlen)

were attached to the tree using an L-shaped wooden post, and we used elastic straps to hold the L-post to the tree, see Figure 1. After the initial setup, cameras were checked approximately once a month for the study duration.

Camera 1 was installed on 27 April 2017. It was placed 22 m from the ground, located on the edge of the Las Piedras Amazon Centre's research facilities (19 L 446268, 8665705). Camera 2 was installed on 18 September 2017. It was placed at a height of 26 m from the ground and approximately 305 m from the research facility (19 L 446158, 8665953). Camera 3 was placed at a height of approximately 21 m (19L 445943 8666130). Camera 4 was placed at the height of 22 m (19 L 446465 8665851). The closest cameras to each other were 1 and 4 at a distance of 244 m, while the furthest cameras were 3 and 4 at a distance of 595 m. A summary of these data can be found in Appendix 1.

Throughout the duration of this study, sunrise occurred between 5:15 h and 5:40 h, and sunset occurred between 17:30 h and 17:40 h, in the Madre de Dios region. The deployed cameras were set to record 30-second videos during the day and night. Videos were deemed independent if they were 30 minutes apart, and the delay between each video was 30 seconds. Only independent videos were used in the analysis. Analysis of overlap in the activity records was carried out in R (R Core Team 2021) using the package 'Activity' (Ridout & Linkie 2009). This was carried out to see if there was a significant difference in activity times recorded by each camera.

Results

The four cameras recorded 272 videos of 13 identified arboreal mammal species, summarized in appendix 1, between April 2017 and November 2017. Of the four cameras, only cameras 1 and 2 captured images of *G. venusta*. A total of 79 independent videos were of *G. venusta*. The overlap coefficient of activity registered between cameras 1 & 2 was 0.64 (64%); however, both cameras found that there was no activity in the crepuscular periods 30 minutes on either side of sunrise and sunset.

All videos showed *G. venusta* travelling towards or away from the cameras with no other notable behaviours recorded. Camera 1 captured 71 videos of *G. venusta,* and camera 2 captured eight. Individual recognition is not possible for the species; however, this study captured at least two individuals on camera 1. One individual had a truncated tail, as seen in appendix 2, while another's tail was intact. The individual with the truncated tail was recorded once on camera 1 and never detected on camera 2. Apart from this unique individual, it is unclear how many individuals were recorded by cameras 1 and 2.

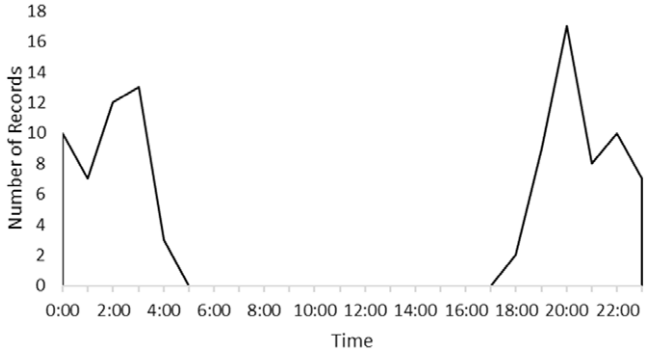

Figure 2. Activity records of G. venusta as recorded by cameras 1 and 2

No video of *G. venusta* was captured between 5:00 and 18:00, suggesting that their behaviour is most likely nocturnal. Figure 2 shows the highest activity registers were at 3:00 h and 20:00 h.

Discussion

This was the first study to document arboreal mammals using camera traps along the Las Piedras River. The most frequent records of *G. venusta* from this study occurred during nocturnal periods at 3:00 h, and 20:00 h respectively. These results support the theory that this species is primarily nocturnal as previous records have shown (Emmons & Feer 1997) and does not support the hypothesis by da Silveira et al. (2013) that this species is crepuscular.

Although the overlap in similarity for activity patterns for cameras 1 & 2 was only 64%, there was an imbalance in the records for each camera; therefore, our conclusions are based on both cameras' records combined. We also investigated the difference in activity for each month; however, due to an insufficient amount of data this provided no significant results.

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Although camera trapping is a common way to study terrestrial wildlife, arboreal camera trapping is a relatively new method. Globally, researchers have used arboreal camera trapping to study cryptic species with varying levels of success (Gracanin & Mikac 2022, Suzuki & Ando 2019, Laughlin et al. 2020, Séguigne et al. 2022). In Peru, in the Manu Biosphere Reserve, Whitworth et al. (2016) found arboreal camera trapping beneficial for determining arboreal species' presence. Their study also concluded that arboreal camera trapping is very effective for studying cryptic, rare, and elusive nocturnal species that terrestrial transect surveys would fail to register. With very little known about many small arboreal mammals, arboreal camera trapping could allow for a greater knowledge of these species' ecology, distributions, and behaviours, which currently are unknown. However, one consideration for this type of research is that it requires more expensive equipment and specialist training to climb the trees where camera traps are placed. Furthermore, this method of camera trapping includes the complexity of vertical space as well as sampling space (Moore et al. 2021). This brings in unique challenges to avoid bias as some branches will favour certain species, and certain heights of camera placement will also affect the data collected. Therefore, study design for arboreal camera trapping must be carefully considered when designing a study in order to minimize the impacts of study bias (Moore et al. 2021).

An increase in arboreal camera trapping will undoubtedly increase the global scientific knowledge of many arboreal mammals' behaviours including that of *G. venusta*. Targeted research for *G. venusta* using arboreal camera traps would require researchers to establish a larger camera trap grid and include a greater variety of tree types than those included in this research. Since little is known about the habitat preferences of *G. venusta,* a variety of habitat types would need to be selected. A report by da Silveira et al. (2013) stated that an adult female and cubs were seen foraging along the vegetation's edge where more lianas occur. A second reported sighting by da Silveira et al. (2013) stated that when the adult climbed up a tree that was not directly linked to other trees, she was forced to descend from the canopy and climb up another tree. In our study, the two trees where *G. venusta* was recorded anecdotally had more foliage and lianas. As it seems that lianas play a role in *G. venusta*'s navigation of the canopy, it is suggested that future studies focus on trees with more lianas and foliage. Furthermore, in our findings, we found that only 2 of the 4 cameras detected *G. venusta*. As it has not been recorded in many other studies, this suggests that their habitats might be niche and restricted even to individual trees or tree clusters.

Additionally, the forest surrounding LPAC is primarily a floodplain riverine successional forest. The area surrounding LPAC is a mix of privately protected forest concessions and Brazil nut concessions. Rapidly growing agricultural and logging communities encroach upon the primary and secondary forests of the region and the closest large anthropogenic disturbance, the community of Lucerna is only 4 km from the study area. As suggested by da Silveira et al. (2013), *G. venusta* may be tolerant to anthropogenic disturbance; the proximity of our records to LPAC and the growing anthropogenic disturbances in the region reinforce this possibility, but further investigation is needed.

This study, along with others (Gracanin & Mikac 2022, Suzuki & Ando 2019, Laughlin et al. 2020, Séguigne et al. 2022), has shown the benefits of studying small arboreal mammals with camera trapping techniques. Continuing arboreal research will likely increase the scientific knowledge of these lesser-known, rare, and cryptic species that have been understudied. In order to determine the full species range, population, behaviour and ecology of *G. venusta*, studies using telemetry or capture mark-recapture would be needed to gain a better understanding of this lesser-known species.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/S0266467423000032

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Competing interests. We have no conflict of interest to declare.

References

Ardente NC, Gettinger D, Fonseca R and de Godoy Bergallo H (2013) Mammalia, Didelphimorphia, Didelphidae, *Glironia venusta* Thomas, 1912 and *Chironectes minimus* (Zimmermann, 1780): distribution extension for eastern Amazonia. *Check List* **9**, 1104–1107.

Arévalo HFL, Morales-Martínez DM, Mora-Beltrán C, Calderón-Capote MC, Cárdenas-González C, Atuesta-Dimian N, Melo MJ and Ramírez W (2021) Mamíferos (Mammalia) de San José del Guaviare, Colombia. *Biota colombiana* **22**, 127–146.

Arguero A, Albuja L and Brito1 J (2017) Nuevos registros de Glironia venusta Thomas, 1912 (Mammalia, Didelphidae) en el suroriente de Ecuador. *Mastozoología Neotropical* **24**, 219–225.

Auricchio P and Rodrigues ASM (1994) *Marsupiais do Brasil. Série Zoologica-Zoo III, Mamíferos do Brasil*. São Paulo: Coleção Terra Brasilis.

Bernarde PS and Rocha VJ (2003) New record of *Glironia venusta* (bushy-tailed opossum) (Mammalia, Glironiidae) for the state of Rondonia, Brazil. *Biociencias* **11**, 183–184.

Díaz MM and Willig MR (2004) Nuevos Registros De *Glironia Venusta* y *Didelphis Albiventris* (Didelphimorphia) Para Perú. *Mastozoología Neotropical* **11**, 185–192.

Emmons LH and Feer F (1997) *Bushy-Tailed Opossum. Neotropical Rainforest Mammals: a Field Guide*, 2nd ed. Chicago: University of Chicago Press, pp. 14.

Fonseca GAB, Herrmann YLR, Leite RA, Mittermeier AB, Rylands AB and Patton JL (1996) Lista anotada dos mamíferos do Brasil. *Occas Papers Conserv Biology* **4**, 1–38.

Gracanin A and Mikac KM (2022) Camera traps reveal overlap and seasonal variation in the diel activity of arboreal and semi-arboreal mammals. *Mammalian Biology* **102**, 341–355.

Laughlin MM, Martin JG and Olson ER (2020) Arboreal camera trapping reveals seasonal behaviors of peromyscus spp. in Pinus strobus canopies. *The American Midland Naturalist* **183**, 210–222.

Moore JF, Soanes K, Balbuena D, Beirne C, Bowler M, Carrasco-Rueda F, Cheyne SM, Coutant O, Forget PM, Haysom JK, Houlihan PR, Olson ER, Lindshield S, Martin J, Tobler M, Whitworth A and Gregory T (2021) The potential and practice of arboreal camera trapping. *Methods in Ecology and Evolution* **12**, 1768–1779.

Nogueira JC, Da Silva MNF and Camara BGO (1999) Morphology of the male genital system of the bushy-tailed opossum *Glironia venusta* Thomas, 1912 (*Didelphimorphia, Didelphidae*). *Mammalia* **63**, 231–236.

Nowak RM (1999) *Walker's Mammals of the World*, 6th ed. V.1 e 2. Baltimore: The John Hopkins University Press, pp. 836.

Oldfield Thomas MR (1912) A new Genus of Opossums and a new Tuco-tuco. *The Annals and Magazine of Natural History* **9**, 239–241.

R Core Team (2021) R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/ (accessed September 2022).

Ridout MS and Linkie M (2009) Estimating overlap of daily activity patterns from camera trap data. *Journal of Agricultural Biological and Environmental Statistics* **14**, 322–337.

Sant S and Catzeflis F (2018) Première mention de Glironia venusta Thomas, 1912 (Mammalia: Didelphidae), pour la Guyane française. *Cahier Scientifique Du Parc Amazonien Guyane* **4**, 119–121.

Séguigne M, Coutant O, Bouton B, Picart L, Guilbert E and Forget PM (2022) Arboreal camera trap reveals the frequent occurrence of a frugivore-carnivore in neotropical nutmeg trees. *Scientific Reports* **12**, 7513.

Solari S and Martin GM (2016) Glironia venusta. The IUCN Red List of Threatened Species 2016:e.T9245A22179598. https://doi.org/10.2305/IUCN.UK.2016-1.RLTS.T9245A22179598.en (accessed 18 February 2021).

Solari S, Pacheco V, Luna L, Velazco PM and Patterson BD (2006) Mammals of the manu biosphere reserve. *Fieldiana Zoology* **110**, 13–22.

da Silveira TB, de Melo FR and Lima JEP (2013) New field data on reproduction, diet, and activity of Glironia venusta Thomas, 1912 (Didelphimorphia, Didelphidae) in northern Brazil. *Mammalia* **78**, 217–222.

Suzuki KK and Ando M (2019) Early and efficient detection of an endangered flying squirrel by arboreal camera trapping. *Mammalia* **83**, 372–378.

Rossi RV, Miranda CL, Santos TS and Semedo TBF (2010) New records and geographic distribution of the rare *Glironia venusta* (*Didelphimorphia, Didelphidae*). *Mammalia* **74**, 445–447.

Vieira BS, Schuingues CO, de Lima MG, Martins DS and Costa GM (2015) Morphology of salivary glands of the Glironia venusta Thomas, 1912 (Didelphimorphia). *Pesquisa Veterinaria Brasileira* **35**, 199–207.

Whitworth A, Braunholtz LD, Huarcaya RP, MacLeod R and Beirne C (2016) Out on a limb: arboreal camera traps as an emerging methodology for inventorying elusive rainforest mammals. *Tropical Conservation Science* **9**, 675–698.

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