



Moving far from water: unusual dispersal movement of the water opossum (*Chironectes minimus*: Didelphimorphia, Didelphidae) in central Brazil

André Faria Mendonça^{1*}  & Emerson Monteiro Vieira¹ 

¹Universidade de Brasília, Instituto de Ciências Biológicas, Departamento de Ecologia, Laboratório de Ecologia de Vertebrados, Campus Darcy Ribeiro, 70919-970, CP 04457, Brasília, DF, Brasil.

*Corresponding author: mendonca.af@gmail.com

MENDONÇA A.F., VIEIRA, E.M. Moving far from water: unusual dispersal movement of the water opossum (*Chironectes minimus*: Didelphimorphia, Didelphidae) in central Brazil. *Biota Neotropica* 22(1): e20211301. <https://doi.org/10.1590/1676-0611-BN-2021-1301>

Abstract: Unusual movements of an animal can potentially represent a dispersal event. A higher frequency of young males dispersing is a pattern observed for most part of polygynous or promiscuous mammals with these dispersion events occurring, mainly, before or at the beginning of the breeding season. The water opossum (*Chironectes minimus*), the only marsupial adapted for semi-aquatic life, occurs from Mexico to Argentina and it has been mostly described as a sensitive species to river and riparian vegetation degradation, occurring exclusively near water courses. Here we describe the first record of long-distance movement of a water opossum not associated with riverine vegetation through dry land. We captured a healthy adult male of *C. minimus* in July 2012 beside of a highway (DF-001) located 1,100 m from nearest gallery forest in the Federal District. The region is characterized by urban and suburban residential, small fragments of typical savanna and degraded gallery forests. Our unique record could be an event of dispersion through degraded dry lands as observed for other semi-aquatic mammals and also suggests that this species is more resistant to anthropogenic disturbances than previously described. Also, information about dispersal patterns of water opossum is scarce and may contribute to a deeper understanding of ecological requirements of this species.

Keywords: Yapok; Cerrado; neotropical savanna; dryland movement; small mammals.

Afastando-se da água: movimento de dispersão incomum da cuica d'água (*Chironectes minimus*: Didelphimorphia, Didelphidae) no Brasil central

Resumo: Deslocamentos incomuns realizados por um animal podem representar potencialmente um evento de dispersão. Grande parte dos mamíferos poligínicos ou promíscuos, apresentam uma maior frequência de machos jovens dispersando, e esses eventos ocorrem, principalmente, antes ou no início da estação reprodutiva. A cuica d'água (*Chironectes minimus*), único marsupial adaptado à vida semiaquática, ocorre do México à Argentina. Tem sido descrito principalmente como uma espécie sensível à degradação de cursos d'água e matas ciliares, ocorrendo exclusivamente próximo aos cursos d'água. Desta forma, descrevemos aqui o primeiro registro do deslocamento de longa distância de uma cuica d'água não associado à vegetação ribeirinha através de um ambiente seco. Capturamos um macho adulto saudável de *C. minimus* em julho de 2012 à margem de uma rodovia (DF-001) localizada a 1.100 m da mata de galeria mais próxima no Distrito Federal. A região é caracterizada por residências urbanas e suburbanas, pequenos fragmentos de cerrado sentido restrito e matas de galeria degradadas. Nosso registro singular pode ser um evento de dispersão através de ambientes secos antropizados, conforme observado para outros mamíferos semiaquáticos, o que, também, sugere que esta espécie é mais resistente a distúrbios antropogênicos do que descrito anteriormente. Além disso, as informações sobre os padrões de dispersão da cuica d'água são escassas e podem contribuir para um entendimento mais profundo dos requisitos ecológicos desta espécie.

Palavras-chave: Yapok; Cerrado; deslocamento em ambientes secos; pequenos mamíferos.

Introduction

Dispersal events, which may be defined as the movement and subsequent breeding of individuals from one area to another, play a crucial role on the population dynamics (Ramakrishnan 2008). The understanding of dispersal patterns, especially related to long-distance dispersal, is crucial for species conservation specially with the current global scenario of land use change (Trakhtenbrot et al. 2005). Adequate information about dispersal of elusive species however, is not easily obtained. This is the case of the water opossum or yapok (*Chironectes minimus*, Zimmerman 1790) (Didelphimorphia, Didelphidae), an uncommon nocturnal small mammal (Galliez et al. 2009), which is the only known marsupial, fossil or living, adapted for semi-aquatic life (Brandão et al. 2015, Damasceno & Astúa 2016).

Like other semi-aquatic mammals, *C. minimus* displays numerous adaptations associated to this lifestyle as streamlined body shape, slightly flattened tail, large webbed hind feet, enlarged pisiform in the manus, dense and water-resistant pelage, and a well-developed pouch in both sexes. The water opossum feeds on fishes, crustaceans, insects, and occasionally on frogs and bats (Santori et al. 2006, Breviglieri & Pedro 2010). It is nocturnal and solitary (Galliez et al. 2009), with the breeding season beginning in June and extending to February (Fernandez et al. 2015).

The distribution of this marsupial ranges from southern Mexico to northeastern Argentina (Marshall 1978). In South America, recent records in southern Amazonia and central Brazil suggest that this species is distributed continuously from Amazonia through riparian forests in the Cerrado (Brazilian savanna) to the southern portion of Atlantic forest (Brandão et al. 2015). Most knowledge on about spatial patterns and population dynamics of water opossums, however, comes from studies conducted in southeastern Atlantic Forest, encompassing only a small part of this species' geographic range.

Although *C. minimus* is classified as a Least Concern (LC) species according to IUCN, some populations may be threatened by the intense degradation of freshwater ecosystems (Torremorell et al. 2021) and by climate change that could lead to a 22% reduction in the area of potential distribution of the water opossum (Freitas-Oliveira et al. 2021). At local spatial scale, the water opossum is potentially threatened by deforestation of riverine vegetation, contamination and deterioration of freshwater ecosystems (Pérez-Hernandez et al. 2016). In Atlantic Forest, *C. minimus* has been described as highly sensitive to the degradation of riparian forest and riverine vegetation, preferring well preserved habitats such as streams and rivers with stony substrate, clear and fast-running water associated with a highly preserved riparian forest (Handley 1976, Galliez et al. 2009, Palmeirim et al. 2014, Leite et al. 2016). However, the water opossum also seems to be able to occur in degraded habitats, with few studies showing that this marsupial is found in degraded riverine forests. Brandão et al. (2015) captured an individual in a narrow gallery forest surrounded by monoculture in central Brazil, Prist *et al.* (2020) registered the water opossum in culverts under a highway near a degraded riverine forest in Atlantic Forest biome, and Arias-Alzate *et al.* (2021) described the activity patterns of the water opossum in peri-urban areas in Colombia. A rapid decline in the potential distribution of the water opossum, however, has been observed, mainly caused by habitat loss and fragmentation (Prieto-Torres & Pinilla-Buitrago 2017).

Herein, we describe the first record of long-distance movement of a water opossum not associated with riverine forest through dry lands in central Brazil, in the core region of the Cerrado, a neotropical savanna. We also discuss potential implications of this record for the understanding of use of space and ecological requirements of the water opossum in the Cerrado.

Material and Methods

We hand-caught a water opossum in a fortuitous event at 11:30 PM on July 6th, 2012, alongside a highway (DF-001 or *Estrada Parque Contorno*) at the kilometer 22, near the entrance of a suburban residential (*Estância Quintas da Alvorada*) localized 10 km east of Brasília city, Federal District, Brazil (15°49'21.10" S 47°47'40.48" W), at an elevation of 1,120 m a.s.l, between Antas stream (Paranoá river sub-basin, upper Paraná river basin) located 1,100 m from the capture site and Taboquinha stream (São Bartolomeu river sub-basin, upper Paraná river basin) located 1,250 m from the capture site (Figure 1). The region is characterized by urban and suburban residential areas; small fragments (up to 38 ha) of typical savanna (cerrado *sensu stricto*); and degraded gallery forests. The nearest gallery forest, which occurred along the Antas stream was located inside of the Copaibas District Park (*Parque Distrital das Copaibas*) (Figure 1). The climate of the region is tropical and highly seasonal (Köppen 1948), with only 10% of the annual rainfall occurring between April and September (Miranda et al. 1993). The average annual rainfall recorded over 25 years (from 1980 to 2004) is 1440 mm, with an average temperature of 22.1 °C (data obtained from the meteorological station RECOR/IBGE).

Results and Discussion

The captured individual was an adult but non-reproductive male, apparently in good body condition, with 640g of body mass; 281mm of head and body length; 345 mm of tail length; 30 mm of ear length; 63mm hind foot length; and complete dentition (i 5/4, c 1/1, p 3/3, m 4/4) (Figure 2). It was deposited (skin and skull) in the Mammal Collection of the University of Brasília with number CMUnB 3736.

Our observation is unique for water opossums and raises some scientific questions and hypotheses about use of space and environmental requirements of this marsupial. One of these is why was this individual caught so far from the nearest riverine vegetation (i.e., gallery forests). Stoddart (1970) defined long-distance movements as dispersal movements in which the individual moves away from the original area occupied by the local population. In this context, the capture of the non-reproductive male water opossum outside of riverine forests in July (dry season), in the beginning of the breeding season (Fernandez et al. 2015), possibly was an event of dispersion through dry lands. This kind of event has been observed for other semi-aquatic mammals, such as otters (Jancke & Giere 2011) and water voles (Stoddart 1970). Moreover, the month of the capture is in agreement with the indication that dispersal events of mammals usually occur before or at the beginning of the breeding season (Wolff 1994).

Our assumption that the male water opossum was captured during a long-distance dispersal event is supported by some pieces of evidence. The dispersal of polygynous or promiscuous small mammals (as is the case of *C. minimus*) is sex-biased, with the predominance of young males (Li & Kokko 2019, Wolff 1994, Quaglietta et al. 2013, Liberg & von Schantz 1985). Specifically for the water opossum, unlike most mammals, a male-biased sex ratio has been described (Mondolfi & Padilha 1958, Galliez et al. 2009). Thus, a particularly high competition among males (both for resources and for females) would cause an even higher dispersal of water opossum young males in comparison to other mammals.

Other relevant point that must be evaluated is the real sensitivity of the water opossum to the process of degradation and isolation of

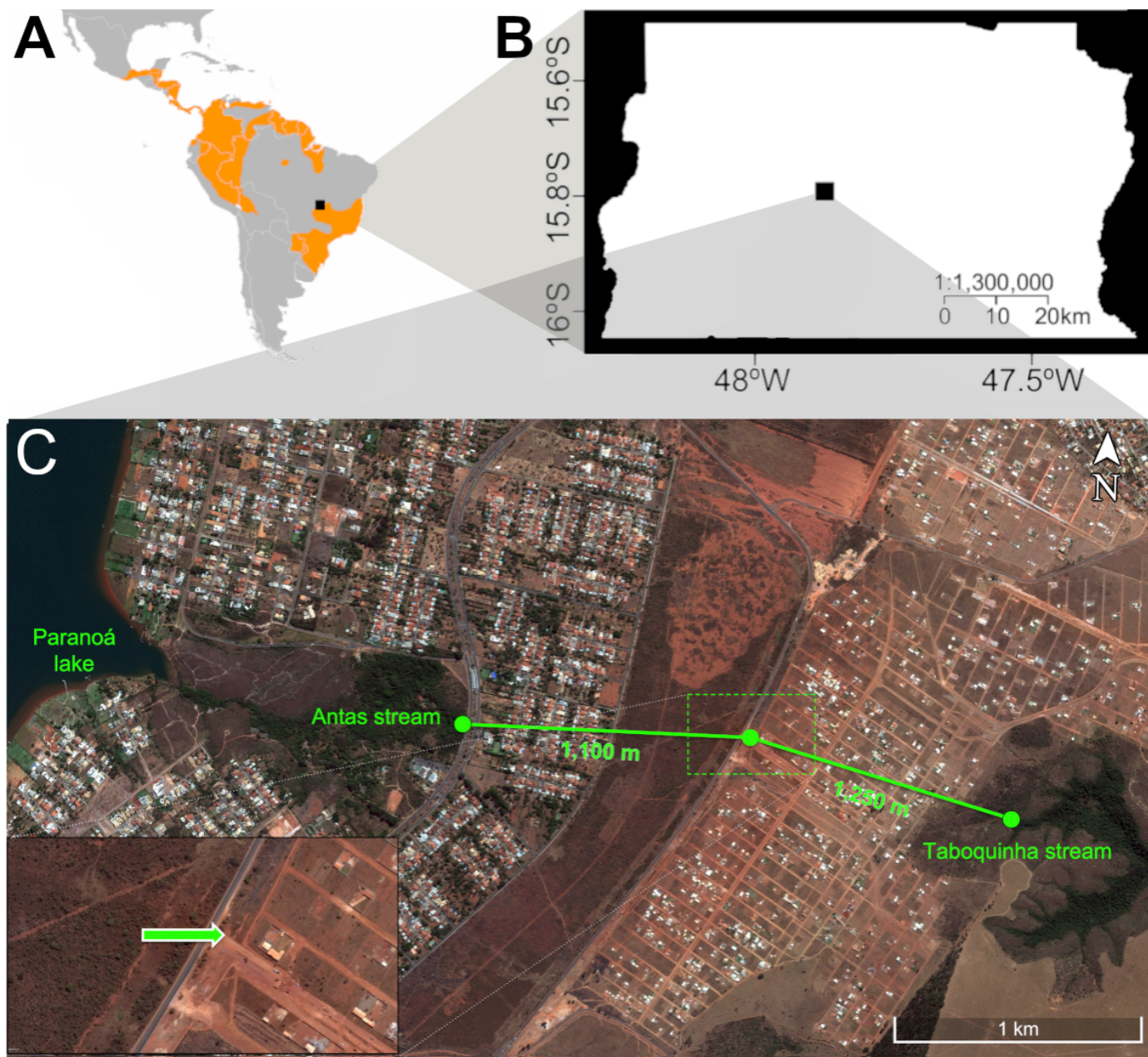


Figure 1. Capture location of *Chironectes minimus* in Federal District in central Brazil; (A) geographic distribution of *C. minimus*; (B) capture location in Federal District, Brazil; (C) the linear distance to nearest gallery forests from capture site; and green arrow indicate capture site.

riparian forests inserted in an anthropized matrix. Historically, the water opossum is described as a very sensitive species to the degradation of watercourses and riparian vegetation, occurring mainly in well-preserved streams with stony substrate and clear, fast-flowing water (Galliez et al. 2009, Prieto-Torres & Pinilla-Buitrago 2017, Handley 1976). Thus, Galliez et al. (2009) suggest that degradation of riparian areas may prevent dispersal to adjacent sub-basin. Furthermore, even the very few studies that registered water opossums in degraded habitats indicated that they were still associated with riverine vegetation (Arias-Alzate et al. 2021, Prist et al. 2020, Brandão et al. 2015). Our record indicates, however, that there are exceptions to this strong association. However, this sensitivity of *C. minimus* to degradation and isolation of riparian forests may vary between biomes. In open biomes such as

tropical savannas, gallery forests have a restricted distribution along rivers and streams, inserted in a savanna matrix (Oliveira-Filho & Ratter 2002), making the ability to move through dry land an potential factor in the maintenance of water opossum populations. Freitas-Oliveira et al. (2021) estimated that climate change will potentially lead to a 22% reduction in the geographic distribution of this marsupial, with most of this loss occurring in central Brazil due loss of riverine forests.

If the observed long-distance movement of the water opossum through dry lands was indeed a dispersal event, studies aiming to model the potential occurrence of this species should consider the scenarios in which this species may occur in anthropized environments. In addition, these studies should also consider the possible dispersal of this species between river basins, including the potential threats to the

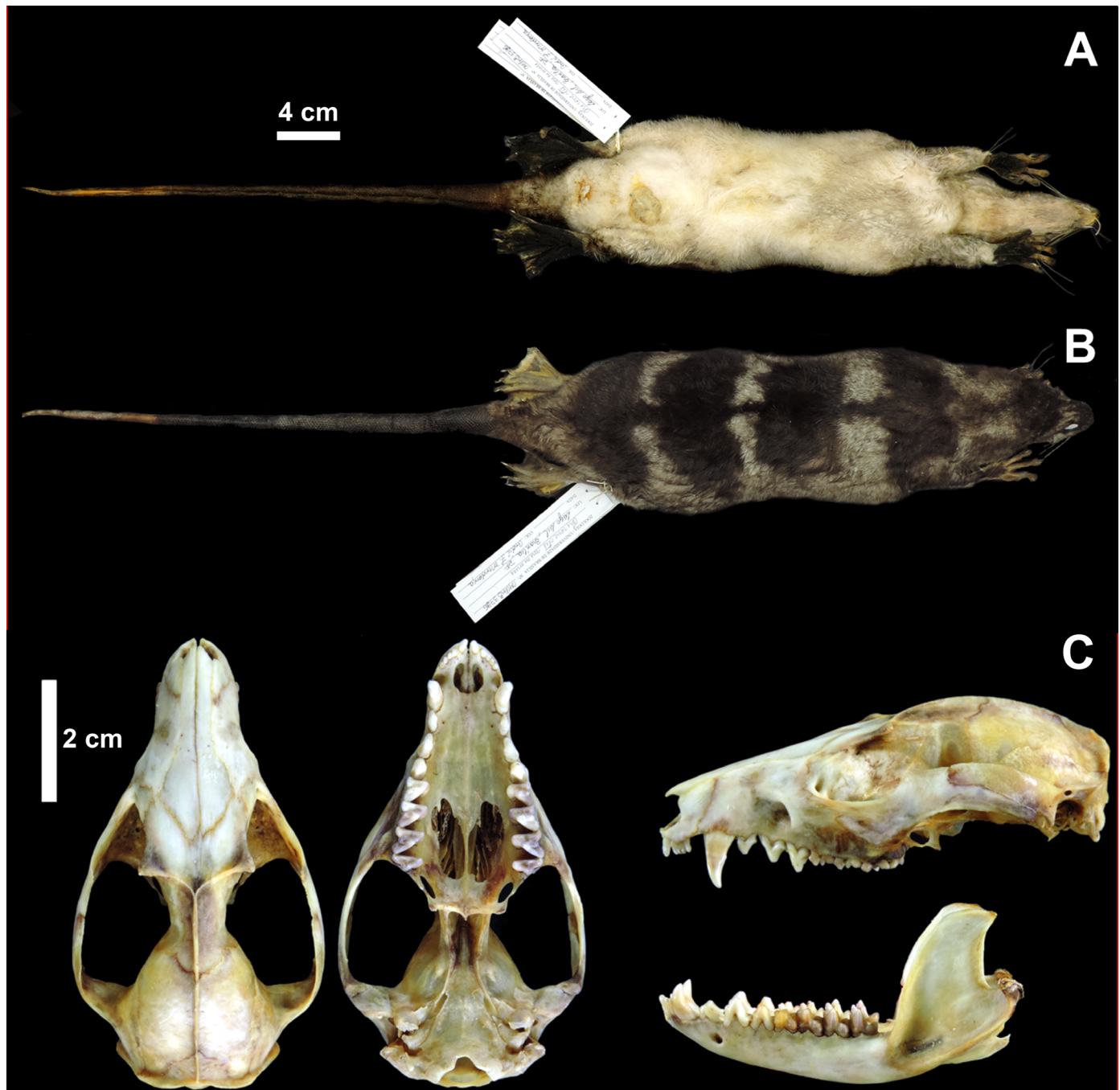


Figure 2. Ventral and dorsal views of skin (A and B, respectively); and dorsal, ventral, and lateral views of skull and lateral view of mandible (C) of *Chironectes minimus* (adult male, CMUnB 3736). External measurements (head-body length: 281mm; length of tail: 345 mm; height of ear: 30 mm; hindfoot length with claws: 63 mm; weight: 640 g; and tooth formula [i 5/4, c 1/1, p 3/3, m 4/4]).

individuals while dispersing (e.g., road crossing, lack of suitable paths). This possible dispersal event that we detected was not associated to a possible flooding and increase of suitable paths for the species, since the individual was captured in July, in the middle of the Cerrado dry season. Our assumption of long-distance dispersal event needs to be supported, however, by long-term studies focused on the evaluation of movements and space use by the water opossum mainly just before and in the beginning of the breeding season. Despite that, we believe that the evidence reported here will contribute to a deeper understanding of the use of space, long-distance dispersal, and ecological requirements

of the water opossum in the Cerrado, the largest and most threatened tropical savannah in the world (Klink & Machado 2005). We expect that our previously unknown record will encourage further studies on the species, with potential for improving actions and policies for the conservation of this unique mammal.

Acknowledgments

We thank the Coordination of Improvement of Higher-Level Personnel (*Coordenação de Aperfeiçoamento de Pessoal de Nível*

Superior – CAPES) for the postdoctorate scholarship, the University of Brasília (*Universidade de Brasília*) for a research grant Edital DPI - UnB N°04/2019 (AFM), and the Brazilian National Council for Scientific and Technological Development (*Conselho Nacional de Desenvolvimento Científico e Tecnológico* – CNPq) for the Research Productivity Grant (EMV, N°311988/2017-2). We are also grateful to N.F. de Camargo and P.L. Zangrandi for comments on previous version this paper and L.F. Machado for assistance with photos.

Associate Editor

Diego Astúa

Author Contributions

André Faria Mendonça: Substantial contribution in the concept and design of the study; Contribution to data collection; Contribution to data analysis and interpretation; Contribution to manuscript preparation.

Emerson Monteiro Vieira: Contribution to manuscript preparation; Contribution to critical revision, adding intellectual content.

Conflicts of Interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

Ethics

The individual was captured with permission from the Chico Mendes Institute for the Conservation of Biodiversity (ICMBio) (permanent licence n° 15424-1 granted to EMV).

References

- ARIAS-ALZATE, A., OBANDO, J.M., MORA, J.J., BOTERO-CORREA, C., ARIAS-GIL, J.J. & DELGADO-V, C.A. 2021. Patrón de actividad de *Chironectes minimus* (Didelphimorphia: Didelphidae) en ecosistemas periurbanos (Valle de Aburrá-Colombia), con anotaciones sobre su distribución altitudinal. *Mammal. Notes* 7(1):184.
- BRANDÃO, M.V., GARBINO, G.S.T., GODOY, L.P., DA SILVA, L.A. & PASCOAL, W. 2015. New records of *Chironectes minimus* (Zimmermann, 1870) (Didelphimorphia, Didelphidae) from central Brazil, with comments on its distribution pattern. *Mammalia* 79(3):363–368.
- BREVIGLIERI, C.P.B. & PEDRO, W.A. 2010. Predação de morcegos (Phyllostomidae) pela cuíca d'água *Chironectes minimus* (Zimmermann, 1780) (Didelphimorphia, Didelphidae) e uma breve revisão de predação em Chiroptera. *Chiropt. Neotrop.* 16(2):732–739.
- DAMASCENO, E.M. & ASTÚA, D. 2016. Geographic variation in cranial morphology of the water opossum *Chironectes minimus* (Didelphimorphia, Didelphidae). *Mamm. Biol.* 81(4):380–392.
- FERNANDEZ, F.A.S., GALLIEZ, M., LEITE, M. de S., QUEIROZ, T.L. & PALMERIM, A.F. 2015. Natural history of the water opossum *Chironectes minimus*: a review. *Oecologia Aust.* 19(01):47–62.
- FREITAS-OLIVEIRA, R., HANNIBAL, W., LIMA-RIBEIRO, M.S. & TERRIBLE, L.C. 2021. Implications of climate change for the distribution of the water opossum (*Chironectes minimus*): habitat loss and conservation opportunities. *Mamm. Biol.* 101(5):729–737.
- GALLIEZ, M., LEITE, M.D.S., QUEIROZ, T.L. & FERNANDEZ, F.A.S. 2009. Ecology of the water opossum *Chironectes minimus* in Atlantic Forest streams of southeastern Brazil. *J. Mammal.* 90(1):93–103.
- HANDLEY, C.O.J. 1976. Mammals of the Smithsonian Venezuelan Project. Brigham Young Univ. Sci. Bull. 20(5):1–89.
- JANCKE, S. & GIÈRE, P. 2011. Patterns of otter road mortality in a landscape abundant in lakes. *Eur. J. Wildl. Res.* 57(2):373–381.
- KLINK, C.A. & MACHADO, R.B. 2005. Conservation of the Brazilian Cerrado. *Conserv. Biol.* 19(3):707–713.
- KÖPPEN, W. 1948. Climatología: con un estudio de los climas de la Tierra. Fondo Cultura Económica, Mexico City, Mexico.
- LEITE, M. de S., GALLIEZ, M., QUEIROZ, T.L. & FERNANDEZ, F.A.S. 2016. Spatial ecology of the water opossum *Chironectes minimus* in Atlantic Forest streams. *Mamm. Biol.* 81(5):480–487.
- LI, X.Y. & KOKKO, H. 2019. Sex-biased dispersal: a review of the theory. *Biol. Rev.* 94(2):721–736.
- LIBERG, O. & VON SCHANTZ, T. 1985. Sex-biased philopatry and dispersal in birds and mammals: the Oedipus hypothesis. *Am. Nat.* 126(1):129–135.
- MARSHALL, L.G. 1978. *Chironectes minimus*. *Mamm. Species* 1091–6.
- MIRANDA, A.C., MIRANDA, H.S., DIAS, I. de F.O. & DIAS, B.F. de S. 1993. Soil and air temperatures during prescribed cerrado fires in central Brazil. *J. Trop. Ecol.* 9(3):313–320.
- MONDOLFI, E. & PADILHA, G.M. 1958. Contribución al conocimiento del “perrito de agua” (*Chironectes minimus* Zimmermann). *Mem. la Soc. Ciencias Nat. La Salle* (17):141–155.
- OLIVEIRA-FILHO, A.T. & RATTER, J.A. 2002. Vegetation physiognomies and woody flora of the Cerrado biome. In *The Cerrados of Brazil. Ecology and Natural History of a Neotropical Savanna* (P. S. Oliveira & R. J. Marquis, eds) Columbia University Press, New York, NY, p.91–120.
- PALMEIRIM, A.F., LEITE, M.D.S., SANTOS-REIS, M. & FERNANDEZ, F.A.S. 2014. Habitat selection for resting sites by the water opossum (*Chironectes minimus*) in the Brazilian Atlantic Forest. *Stud. Neotrop. Fauna Environ.* 49(3):231–238.
- PÉREZ-HERNANDEZ, R., BRITO, D., TARIFA, T., CÁCERES, N., LEW, D. & SOLARI, S. 2016. *Chironectes minimus*. IUCN Red List Threat. Species e.T4671A22173467.
- PRIETO-TORRES, D.A. & PINILLA-BUITRAGO, G. 2017. Estimating the potential distribution and conservation priorities of *Chironectes minimus* (Zimmermann, 1780) (Didelphimorphia: Didelphidae). *Therya* 8(2):131–144.
- PRIST, P.R., GARBINO, G.S.T., ABRA, F.D., PAGOTTO, T. & GIACON, O.O. 2020. Use of highway culverts by the water opossum (*Chironectes minimus*) in southeastern Brazil. *Biota Neotrop.* 20(4):95–97.
- QUAGLIETTA, L., FONSECA, V.C., HÁJKOVÁ, P., MIRA, A. & BOITANI, L. 2013. Fine-scale population genetic structure and short-range sex-biased dispersal in a solitary carnivore, *Lutra lutra*. *J. Mammal.* 94(3):561–571.
- RAMAKRISHNAN, A.P. 2008. Dispersion-Migration. In *Encyclopedia of Ecology* (S. E. Jørgensen & B. D. Fath, eds) Academic Press, Oxford, UK, p.930–938.
- SANTORI, R.T., LESSA, L.G. & ASTÚA DE MORAES, D. 2006. Alimentação, nutrição e adaptações alimentares de marsupiais brasileiros. In *Os Marsupiais do Brasil* (N. C. Cáceres, ed.) Editora UFMS, Campo Grande, MS, p.364–406.
- STODDART, D.M. 1970. Individual range, dispersion and dispersal in a population of water voles (*Arvicola terrestris* (L.)). *J. Anim. Ecol.* 39(2):403.
- TORREMORELL, A. et al. 2021. Current and future threats for ecological quality management of South American freshwater ecosystems. *Inl. Waters* 11(2):125–140.
- TRAKHTENBROT, A., NATHAN, R., PERRY, G. & RICHARDSON, D.M. 2005. The importance of long-distance dispersal in biodiversity conservation. *Divers. Distrib.* 11(2):173–181.
- WOLFF, J.O. 1994. More on juvenile dispersal in mammals. *Oikos* 71(2):349–352.

Received: 03/11/2021

Accepted: 27/01/2022

Published online: 21/02/2022