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Activity of the white-eared opossum *Didelphis albiventris* Lund, 1840, and its interaction with the yellow-crowned night heron *Nyctanassa violacea* (Linnaeus, 1758) in an urban mangrove in northeastern Brazil

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ABSTRACT
This paper shows, in time duration and frequency of records, the activity of the white-eared opossum *Didelphis albiventris* Lund, 1840, in a mangrove and its interaction with the yellow-crowned night heron *Nyctanassa violacea* (Linnaeus, 1758). We used six camera traps for ten months. Results from 596 recorded events showed a nocturnal circadian activity pattern. Events recorded show that the opossum feeds on remains from the bird's predatory activity. The work discusses the behavior of taking advantage of resources involuntarily provided by other animals. It emphasizes the generalist and opportunistic characteristics of the opossum and its ability to adapt to different ecosystems.

Keywords: behavior, biologic rhythm, marsupial, tide

RESUMO - Atividade do timbu *Didelphis albiventris* Lund, 1840, e sua interação com o savacu-de-coroa *Nyctanassa violacea* (Linnaeus, 1758) em manguezal urbano no nordeste do Brasil. Apresentamos, em tempo de duração e frequência de registros, a atividade do *Didelphis albiventris* Lund, 1840 em um mangue e sua interação com o savacu-de-coroa, *Nyctanassa violácea* (Linnaeus, 1758). Utilizamos seis armadilhas fotográficas durante dez meses. O marsupial apresentou um padrão de atividade circadiano noturno. Registrou-se alimentação de restos provenientes da atividade predatória da ave. O trabalho discute a estratégia de aproveitar recursos providos por outros animais e ressalta a característica generalista e oportunista do timbu e sua capacidade de se adaptar aos diferentes ecossistemas.

Palavras chave: comportamento, maré, marsupial, ritmo biológico

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White-eared opossums *Didelphis albiventris* (Didelphidae, Didelphimorphia) are common in urban environments. They are widely distributed in Northeastern Brazil, not in the Atlantic Forest of Southeastern Brazil or the Amazon Forest (Dias & Perini 2018; Marsh et al. 2022). Despite their broad distribution, most of the available information on the biology of this species in Brazil comes from studies conducted in patches of forests in the southern part of the country (Cáceres 2000, 2003), and few in the northeastern region of Brazil (Aléssio et al. 2005; Calazans & Bocchiglieri 2020). White-eared opossums are broadly distributed and can be found in different environments, such as in Caatinga, Cerrado, edges of the Atlantic Forest, and northeastern mangrove, as well as in highly human-modified environments, being considered synanthropic animals in urban areas (Bezerra-Santos et al. 2021). That broad distribution is supported by a generalist feeding habit, including various food items consumed opportunistically (Eisenberg & Redford 1989; Santori et al. 1995; Leite et al. 1996; Carvalho et al. 1999; Cáceres & Monteiro-Filho 2001; Cáceres 2002; Lessa et al. 2023).

The occurrence of marsupials in mangroves was reported in some papers (Fernandes et al. 2006; Graipel & Filho 2006; Prevedello et al. 2009). They are part of a mangrove-associated fauna and transit between the mangrove and the dry land. Still, there are few studies on the ecology and behavior of marsupials in those environments.

In this study, we investigated the pattern of activity of white-eared opossums in an urban mangrove. We showed for the first time that they may directly benefit from the yellow-crowned night heron *Nyctanassa violacea* (Linnaeus, 1758) (Ardeidae, Pelecaniformes) by opportunistically feeding on its regurgitated pellets. The study was conducted at Chico Science mangrove in the Espaço Ciência Museum (latitude -8.03389; longitude -34.86917), Olinda-Pernambuco, Brazil. The size of the mangrove area is approximately two hectares. The climate is predominantly tropical, with a drier season during the summer (Nascimento et al. 2020). The vegetation mainly comprises *Rhizophora mangle*, *Laguncularia racemosa*, and *Avicennia schaueriana* (Periquito et al. 2008).

Six camera traps (Suntekcam mini600) were installed every 50 meters on the banks of the mangrove and monitored over approximately ten continuous months between February and December 2022. The sampling effort was calculated by multiplying the number of camera traps by the number of sampling days. To avoid counting the same behavior more than once, we used media for at least 10 minutes apart, not including those within shorter intervals (Yasuda 2004; Srbek-Araujo & Chiarello 2013; Sollmann 2018). The cameras were programmed to take a photograph followed by a short 10-second video. The software Timelapse 2.3.0.6 (by Saul Greenberg, University of Calgary-CA) was used for data analysis. A spreadsheet was generated with the records and information about the date, time, moon phase, and temperature. Tide data was obtained from the Brazilian Navy information service. The frequency of pictures with *D. albiventris* was separated into two groups according to high and low tide phases. A chi-square test was used to compare groups. The movies were used to calculate the hourly duration of the activity and the cosinor method (Cornelissen 2014) for test rhythmicity.

The sampling effort accumulated during the ten months of study (1830 camera days) resulted in 8213 independent pictures and the same number of films, with 596 (7.25%) recording the presence of white-eared opossums. Data show nocturnal behavior (Fig. 1a), and the cosinor method indicated circadian rhythmicity, with acrophase at 21h (Zero-amplitude test; F= 459.24; p< 0.00001) (Fig. 1b). The frequency of records with the presence of *D. albiventris* is higher at low tide and lower at high tide (*X*2= 7.386; GL= 1; n= 8213; p= 0.0065) (Fig. 2). Behavioral analysis indicates that *D. albiventris* used the mangrove mainly for foraging (57.6%), but some records show walking (32.4%), eating (8.7%), agonistic behavior (0.7%), collecting leaves (0.3%), grooming (0.2%), and defecating (0.2%). Identifying the food items consumed by *D. albiventris* was possible in only 15.4% of the records, which included 7.7% crabs, 7.7% coconut remains, and 1.9% regurgitated pellets from *N. violacea*. Records show that individuals of *D. albiventris* sometimes (14.8%) forage after *N. violacea* feeds in some place. *Didelphis* individuals use the leftovers in two ways: the bird breaks the big crabs into small pieces, and the marsupial feeds on the remaining legs, claws, or small parts; the bird regurgitates pellets of undigested food, and the marsupial eats them (Fig. 3).

The more extensive time spent by opossums to explore the mangrove at low tide can be related to the organic matter brought by the tide and the activity of crabs at the border of burrows. The predominantly nocturnal-circadian activity of opossums is well known (Ferreira & Vieira 2014; Marques & Fabián 2018; Santiago et al. 2019). We did not find a correlation between tide and opossum activity, and the data may indicate opportunistic behavior.

Didelphis albiventris has a frugivorous-omnivorous diet, consisting mainly of fruits (Silva et al. 2014). Still, few studies report the consumption of crabs by *Didelphis* in mangrove environments (Cáceres 2003; Pereira Junior et al. 2019). Cáceres (2003) reported the consumption of crabs by *D. aurita* in a stream in a fragment of *Araucaria* Forest in Curitiba city. It seems that, during the reproductive period, females prioritized foraging close to streams. Pereira Junior (2019) reported that *D. albiventris* opportunistically feeds on captive guaiamum crabs (*Cardisoma guanhumi*) in Northeast Brazil. This paper shows that crabs can be a high source of protein used by *D. albiventris* that inhabit areas bordering mangroves.

Our findings showed a circadian behavior with activity peak at 21h. During the frequent incursions of *D. albiventris* into the mangrove, they consumed pellets regurgitated by *N. violacea* and crab remains captured by this bird. Although other behaviors have been recorded, *D. albiventris* explores mangroves mainly in search of food, reinforcing what we know about the opportunistic nature of its behavior in these environments.

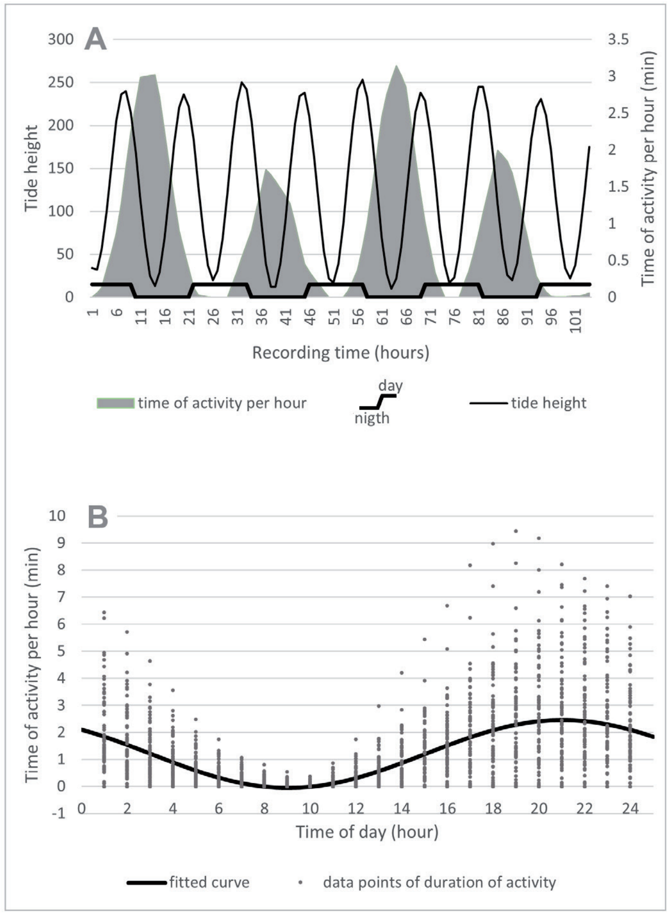

Figure 1. Representation of rhythmicity in the activity of *D. albiventris*. A) Average time duration per hour, of the activity of *D. albiventris* showing day/night cycles, and tide height. Duration in minutes per hour, tide height in centimeters; B) Cosinor fitted curve showing the duration of events of activity of *D. albiventris* (acrophase= 21h; bathyphase= 9h; zero-amplitude test: n= 1897; F= 459.24; p< 0.00001).

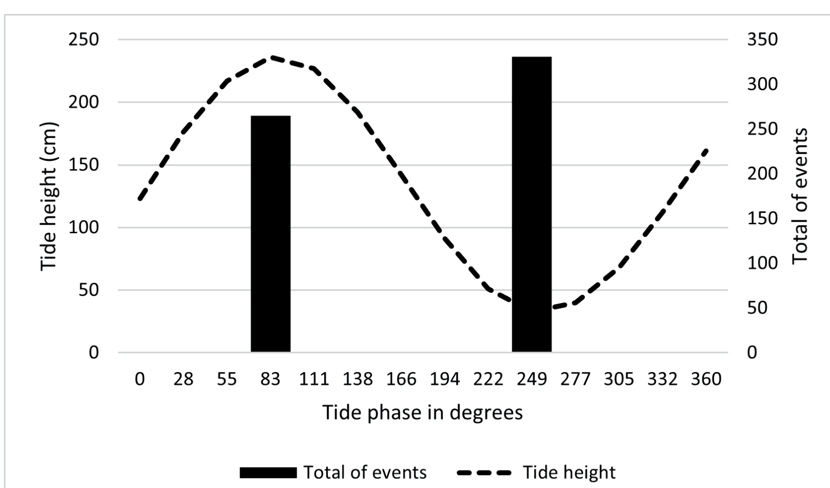

Figure 2. Cumulative total of events recorded with the presence of *D. albiventris* and their relationship with tidal phases. A significantly higher number of events were recorded during low tide (*X*2= 7.386; GL= 1; n= 8213; p= 0.0065).

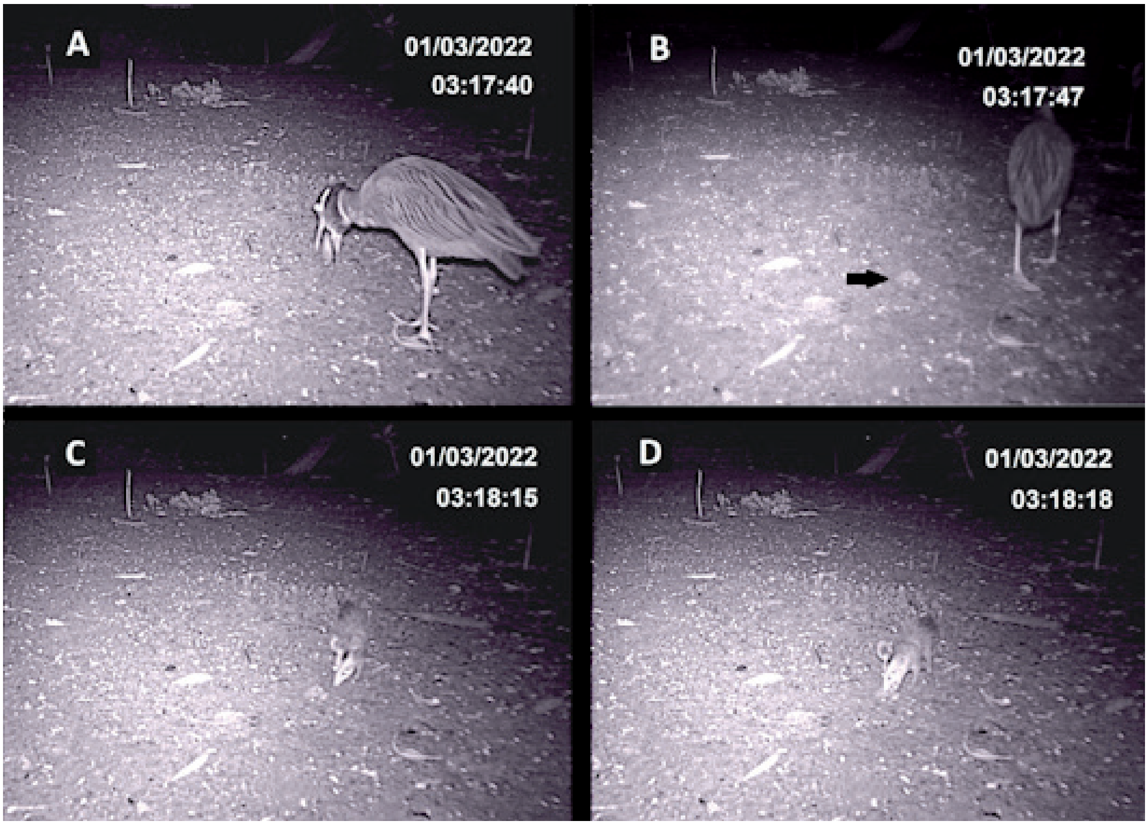

Figure 3. Sequence of consumption events by *D. albiventris* of the pellet regurgitated by *N. violacea*. A) Pellet regurgitation; B) *N. violacea* moves away and leaves the pellet (arrow) on the ground; C) arrival of *D. albiventris* 28 seconds later; D) pellet consumption by *D. albiventris*.

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