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RESEARCH ARTICLE

Silent predator: Dietary patterns of *Tyto furcata* (Strigiformes: Tytonidae) at the Taiamã Ecological Station, Pantanal, Brazil

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ABSTRACT. The Pantanal, the largest tropical wetland globally, faces growing threats from habitat destruction, agribusiness growth, and wildfires The barn owl, *Tyto furcata* (Temminck, 1827), is an opportunistic predator that helps structure small vertebrate communities, primarily by preying on non-volant mammals. We investigated the diet of *T. furcata* at the Taiamã Ecological Station, in the northern Pantanal, by analyzing 167 owl pellets (95 intact and 72 partially disintegrated) collected in August 2017, September 2019, and March 2020. Cranial and dental remains were examined to estimate the minimum number of individuals represented in the diet of the barn owl. A total of 255 prey items were identified, dominated by *Holochilus chacarius* Thomas, 1906 (88.2%) and *Cryptonanus chacoensis* (Tate, 1931) (7.8%), followed by birds (3.5%) and bats (0.4%). Some species previously recorded through live trapping, such as *Philander opossum* (Linnaeus, 1758) and *Oecomys mamorae* (Thomas, 1906), were absent from the pellets, suggesting that prey selection is influenced by abundance, behavior, and accessibility. These results underscore the value of owl pellet analysis to detect cryptic or underrepresented species and to complement traditional survey methods. As anthropogenic pressures intensify, understanding the dynamics of populations of small mammals becomes increasingly urgent, highlighting the need for complementary tools to support ecological research and conservation.

KEYWORDS. Barn owl, biodiversity monitoring, diet analysis, foraging behavior, small mammal predation.

INTRODUCTION

The Pantanal, the world's largest tropical wetland, is characterized by a complex network of ecosystems that harbor an impressive biological diversity. With approximately 2,000 plant species (Pott et al. 2011), this biodiversity-rich biome includes 174 mammal species (Alho et al. 2011) and 580 bird species (Nunes 2011), ranking it among the richest Brazilian ecosystems in terms of vertebrates (Alho et al. 2019). Nevertheless, the growing transformation of natural spaces into agricultural and livestock operations, along with the increase in intense wildfires in recent years, has resulted in habitat fragmentation and a decline in biodiversity (IBGE 2020). These environmental changes pose a significant threat to many species, potentially leading to population declines and even local extinctions of little-known or yet undescribed organisms (Moura and Jetz 2021). Considering this scenario, surveying and monitoring different faunistic groups become essential for biodiversity conservation and management, especially in threatened regions that harbor many species, such as the Pantanal wetlands.

Sampling small mammals (i.e., bats, rodents and marsupials weighing less than 1 kg), a group essential for maintaining ecological balance through seed dispersal and insect population control (Lacher et al. 2019), requires efficient and complementary methodologies. Traditionally, live traps have been the most employed technique for studying these organisms. Nevertheless, it has constraints concerning

sampling effort, expenses, and capture bias (Silveira et al. 2021). In this context, the analysis of regurgitated pellets from predator birds, such as owls, has emerged as a complementary tool for the inventory of small mammals, allowing the identification of prey species from bone remains and regurgitated fur (Bonvicino and Bezerra 2003).

The barn owl, *Tyto furcata* (Temminck, 1827) (Tytonidae), is a widely distributed species across the American continent. It plays a significant ecological role as an apex predator. The diet of barn owls mainly consists of small mammals, especially rodents and marsupials, positioning them as vital partners in research on local species diversity (Motta-Junior and Alho 2000, Stutz et al. 2020, Almeida et al. 2022, Pontes et al. 2023). Pellet analyses have revealed new distributions of little-known species. For instance, in a study conducted in the Jurubatiba Restinga, Rio de Janeiro state, at least six new occurrences of small mammals were recorded (Lemos et al. 2015).

Estimates have shown that at least 40 species of non-volant small mammals occur in the Pantanal wetlands (Schaller 1983, Alho et al. 2011). Nevertheless, the absence of extensive sampling limits a deeper insight into the makeup and distribution of these mammalian species, along with their ecological relationships. In this context, utilizing owl pellets as a research tool can enhance our understanding of the local wildlife, while also offering insights into predation behaviors and potential seasonal changes in prey availability. We intended to assess the diet of *T. furcata* at the Taiamã Ecological Station in northern Pantanal by examining pellets to gain insights into predation patterns and the usefulness of owl pellet analysis as a supplementary method for surveying small mammals.

MATERIAL AND METHODS

Study area

We analyzed barn owl pellets collected in August 2017, September 2019, and March 2020 near the Taiamã Ecological Station (TES) headquarters (16°50'35.7"S; 57°35'07.2"W). Located in the municipality of Cáceres, state of Mato Grosso, Brazil, the TES is a fully protected area located in the northern region of the Pantanal biome, within the Upper Paraguay Basin. TES comprises a fluvial island covering 11,555 ha, bordered by the Paraguay and Bracinho rivers. In this region, the landscape is primarily characterized by floodable grasslands, which play a fundamental role in the hydrological and ecological dynamics of the northern Pantanal biome (Fig. 1).

According to Köppen-Geiger climatic classification, the region falls under the Aw type, characterized by a hot and humid tropical climate (Pell et al. 2007). The Pantanal hydrological regime exhibits four distinct periods throughout the year: drought, flooding, full flood and ebb. The predominant vegetation at the TES largely consists of semi-deciduous seasonal forests, which are adapted to the seasonal variations during the inundation season. The average annual precipitation ranges between 1,235 and 1,255 mm, while the average annual temperature is 26.3 °C.

Collection of owl pellets and diet analysis

The owl pellets analyzed were collected by staff members of the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio). All samples were gathered from the floor of a building used for equipment storage near the station headquarters, where a resident pair of *T. furcata* were frequently observed by the local staff. For each sampling period (August 2017, September 2019, and March 2020), a single sampling was conducted, and all pellets accumulated inside the building up to that time were collected for analysis.

Initially, we moistened the pellets with water to facilitate the separation of bone materials. Subsequently, we manually disaggregated this mixture using a histological tweezer, allowing for the extraction and isolation of bone fragments. We conducted the taxonomic identification of the prey items based on the analysis of skulls and teeth, aiming to achieve the lowest possible taxonomic level.

In order to identify species through bones, we utilized specialized literature sources (Voss et al. 2005, Gardner 2008, Patton et al. 2015) and comparisons with specimens from the mammal collection at the Mastozoology Laboratory of the Pantanal Center for Limnology, Biodiversity, and Ethnobiology (CELBE) of the Mato Grosso State University. Comparative material included skulls of *Holochilus chacarius* Thomas, 1906 and *Cryptonanus chacoensis* (Tate, 1931). The samples analyzed in this study were properly catalogued and deposited at this aforementioned institution. To estimate the minimum number of individuals (MNI) present in the owl pellets, we tabulated the bones according to their typology and laterality, ensuring a more accurate count of the preyed specimens.

RESULTS

We analyzed a total of 167 owl pellets (95 intact and 72 partially disintegrated), resulting in the identification of 856 cranial bone fragments, predominantly belonging to two species of non-volant small mammals: *H. chacarius* and *C.*

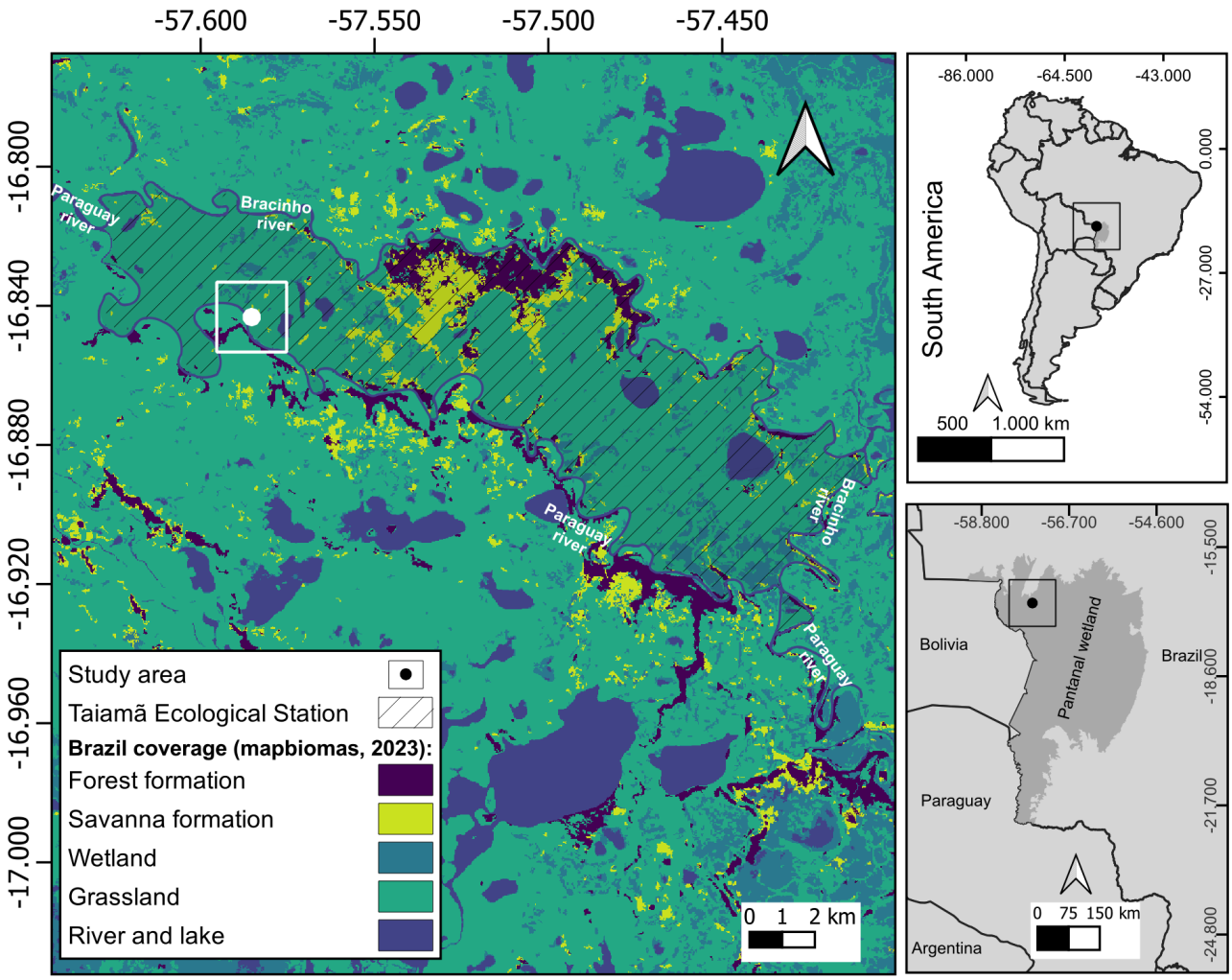

Figure 1. Location of the data collection site at the Taiamã Ecological Station in the Northern Pantanal of Mato Grosso.

chacoensis (Table 1). The most commonly found fragments originated from the mandible and maxilla, which were essential for the taxonomic identification of the prey and for determining the minimum number of individuals (MNI).

According to the MNI approach, we identified 255 individuals, of which 88.2% belonged to the rodent *H. chacarius* and 7.9% to the marsupial *C. chacoensis* (Table 1). In addition to these small mammals, the diet of *T. furcata* also included birds (3.5%), bats (0.4%), and arthropods, as well as fragments of eggshells. However, the latter two were not considered in the volume analysis. Of the nine bird species identified in the diet, seven were present in the owl pellets collected during the rainy season.

The fragility of the bone remains influenced the taxonomic identification of *C. chacoensis*, allowing only for the recognition of fragments of the maxilla and mandible, which limited identification to dental and palate morphology. In contrast, *H. chacarius* was frequently represented by complete skulls, along with a skin fragment (Fig. 2). Similarly, the skulls of birds and bats exhibited a low degree of deterioration, enabling their identification down to the order and family levels, respectively (Table 1).

DISCUSSION

Tyto furcata is well recognized for its dietary choice of non-volant small mammals, but it demonstrates opportunistic behavior by modifying its diet based on the availability of prey. For example, bats were rarely found in our samples, suggesting they are sporadically consumed by *T. furcata* (e.g.,

Figure 2. Items found in the barn owl pellets at the Taiamã Ecological Station in the Northern Pantanal of Mato Grosso. Skull, mandible, and skin fragment of *Holochilus chacarius* (A, B, C, D); mandible and maxilla of *Cryptonanus chacoensis* (E, F); skull and mandibles of Chiroptera (G, H, I, J); bird skulls (K, L). Scale bar: 1.0 mm.

Table 1. Minimum number of individuals (MNI) identified in the pellets from the Taiamã Ecological Station, with the corresponding percentage relative to the total prey.

Taxon	MNI	Individuals (%)
Rodentia		
Cricetidae		
Holochilus chacarius	225	88.2
Didelphimorphia		
Didelphidae		
Cryptonanus chacoensis	20	7.9
Chiroptera		
Phyllostomidae	1	0.4
Aves		
Passeriformes	9	3.5
Total	255	100.0

Escarlate-Tavares and Pessôa 2005). Similarly, birds are less frequently preyed upon by this species (Motta-Junior 2006), and although they ranked as the third most found item in our samples, they accounted for only 3.5% of the total identified (Table 1).

Conversely, in a cave in northeastern Brazil, a study showed a distinct dietary pattern, with bats comprising 70.2% of the vertebrates consumed by barn owl, followed by birds (18%) and non-volant small mammals (5.3%; Jesus and Oliveira 2017). These findings contrast with our results, reinforcing the influence of the environment on the hunting behaviour of *T. furcata*, and highlighting its opportunistic behavior and dependence on prey availability (Motta-Junior and Alho 2000).

In our data, 95.8% of the owl pellets were collected during the dry season, whereas the few samples from the rainy season (4.2%) contained seven of the nine bird species identified. This suggests that flooding may influence the availability of small mammals and increase the frequency of birds in the diet of the barn owl. A more comprehensive seasonal study and behavioral predation analyses would be necessary to better understand these dynamics and potential changes in prey composition throughout the year.

Previous surveys of small mammals at the Taiamã Ecological Station using trapping methods indicated a low species richness in the area, with only four species recorded (LP Costa unpublished data). Such low diversity is consistent with patterns observed in seasonally flooded forests, where prolonged inundation and the consequent shift towards arboreal or semi-aquatic taxa reduce the pool of terrestrial small mammal species (Pereira-Ramos et al 2013). At the TES, *Oecomys mamorae* (Thomas, 1906) and

Philander opossum (Linnaeus, 1758) were the most frequently recorded species in trapping surveys. *Holochilus chacarius* and *Cryptonanus chacoensis* were either rarely captured or not recorded. However, the analysis of owl pellets revealed a predominance of *H. chacarius* and *C. chacoensis*, indicating that species less frequently detected through trapping were the most abundant in the diet of *T. furcata*.

The predominance of *H. chacarius* and *C. chacoensis* in the barn owl's diet can be attributed to their adaptation to open and seasonally inundated regions (Hershkovitz 1955, Voss et al. 2005), where they forage and consequently become more exposed to predation by *T. furcata*, which shows a preference for this type of habitat (Bonvicino and Bezerra 2003). The taxonomic identification of *C. chacoensis* still presents challenges due to its recent separation from the genus *Gracilinanus* (Voss et al. 2005) and the scarcity of records in the literature. With the increase in studies and the incorporation of pitfall traps, its distribution has expanded, encompassing environments from open areas to forests (Rossi et al. 2012, Carmignotto et al. 2022). *Holochilus* spp. and *Cryptonanus* spp. are frequently recorded in the diet of *T. furcata* (Lemos et al. 2015, Brandão 2021, Almeida et al. 2022), and studies employing barn owl pellet analysis have already resulted in at least three new records of *C. chacoensis* in Brazil (Rocha et al. 2011, Martinelli et al. 2011, Gardner 2008). For instance, *C. chacoensis* was detected exclusively through owl pellets (Rocha et al. 2011), underscoring the importance of this method for expanding our knowledge of small mammals.

Despite the important contribution of barn owl pellet analysis, this methodology has limitations. The diet of *T. furcata* does not encompass all small mammal species present within its hunting range, as it is influenced by prey abundance, behavior, and size (Bonvicino and Bezerra 2003). Moreover, the barn owl's preference for open environments may lead to an underestimation of the local species richness (Hershkovitz 1955, Voss et al. 2005). Nonetheless, it remains an important complementary method in the taxonomic studies of small mammals. In our study, for example, *P. opossum* and *O. mamorae*, species frequently captured by traps in the region, were not recorded in the pellets, which may be related to the size of these species or their lower availability in the environment. *Philander opossum*, despite being common in camera trap surveys in the study area (unpublished data), may represent prey that is less accessible to *T. furcata* due to its large size in comparison to other small mammals. On the other hand, the barn owl specialization can be advantageous, enabling the sampling of species that, due to their behavior, are often found in owl pellets but rarely captured by conventional trapping methods (Silveira et al. 2021). Thus, employing different sampling approaches in faunal surveys is essential, and owl pellet analysis stands out as a crucial complementary tool, particularly in open environments where under-sampled species may be detected more efficiently.

Our results show that, while previous surveys suggested that *H. chacarius* was a relatively uncommon species at the TES, the analysis of barn owl pellets revealed the opposite, demonstrating that a predator's diet reflects prey availability in the environment. This information is particularly relevant considering that it pertains to a protected area, where detailed knowledge of the fauna is crucial for developing effective management and conservation strategies. The use of barn owl pellets can be a valuable tool for understanding the fauna in biomes such as the Cerrado and the Pantanal, where monitoring studies remain scarce. Given the intensifying anthropogenic pressures, understanding the dynamics of small mammal populations become increasingly urgent, reinforcing the importance of complementary methods for obtaining complementary ecological data.

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Competing Interests
The authors have declared that no competing interests exist.

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Datasets related to this article will be available upon request to the corresponding author.

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