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NOTES ON GEOGRAPHIC DISTRIBUTION

First record of *Histiotus diaphanopterus* Feijó, Rocha & Althoff, 2015 (Chiroptera, Vespertilionidae) in the state of Tocantins, Brazil

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Abstract. We report the first record of *Histiotus diaphanopterus* Feijó, Rocha & Althoff, 2015 in the state of Tocantins, Brazil and the third record of the species in the Cerrado biome, reinforcing its association with seasonally dry environments of the South American diagonal of open formations. Morphological traits confirm specimen identity, with transparent wings as the most distinctive diagnostic character. Our findings highlight the species' ecological specificity and exposure to anthropogenic threats, including habitat loss and climate change, underscoring the need for further studies and integrated conservation strategies.

Key words. Cerrado biome, global biodiversity hotspots, Neotropical Savanna, range extension, South America, transparent wings

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Introduction

The family Vespertilionidae currently comprises 545 species arranged into 62 genera and four subfamilies: Vespertilioninae, Kerivoulinae, Murininae, and Myotinae (Simmons and Cirranello 2025). Nine vespertilionid genera occur in the Neotropics: *Bauerus* Van Gelder, 1959, *Corynorhinus* H. Allen, 1865, *Eptesicus* Rafinesque, 1820, *Histiotus* Gervais, 1856, *Lasiurus* Gray, 1831, *Myotis* Kaup, 1829, *Neoeptesicus* Cláudio et al., 2023, *Perimyotis* Menu, 1984, and *Rhogeessa* H. Allen, 1866 (Wilson and Reeder 2005; Gardner 2007; Cláudio et al. 2023).

Histiotus is currently represented by 11 species (Simmons and Cirranello 2025), all endemic to South America and broadly distributed across the continent, from northern Venezuela to the southern regions of Chile and Argentina. Its range extends from western Venezuela and Colombia southward through Ecuador, Peru, and Bolivia to Paraguay and northwestern Argentina (Wilson and Reeder 2005; Gardner 2007; Cláudio et al. 2023).

Five species are known to occur in Brazil (Garbino et al. 2024): *Histiotus alienus* Thomas, 1916, *H. diaphanopterus* Feijó, Rocha & Althoff, 2015, *H. laephotis* Thomas, 1916, *H. montanus* (Philippi & Landbeck, 1861), and *H. velatus* (I. Geoffroy, 1824). These species are broadly distributed except for the Amazon, with records from the Northeastern, across the Central-Western, to the Southeastern and Southern regions, reaching as far as the state of Rio Grande do Sul (Gardner 2007; Cláudio et al. 2023).

Species of this genus are medium-sized to large bats characterized by a distinctive combination of morphological traits, including long ears connected by a band of skin with variable development; skull is delicate, narrow, and long; sagittal and lambdoidal crests weakly developed; postorbital process of the jugal well developed; and usually long dorsal fur (Reis et al. 2017; Cláudio et al. 2023).

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Histiotus species are rarely captured in the field and are poorly represented in scientific collections. For instance, in the Mammal Collection of the Museu Nacional at Universidade Federal do Rio de Janeiro, Brazil, there are only 32 specimens of the genus, of which 28 are cataloged, including a single specimen of *H. diaphanopterus* documented in the present study. Consequently, *Histiotus* remains one of the least-known genera of Neotropical bats, although recent studies have revealed the existence of new species within the genus (Feijó et al. 2015; Rodríguez-Posada et al. 2021; Velazco et al. 2021).

Histiotus diaphanopterus was described by Feijó et al. (2015), with the type locality in Boqueirão da Onça, municipality of Sento Sé, state of Bahia, within the Brazilian Caatinga. In the same study, the species was also reported from four additional localities, three in the Caatinga and Cerrado biomes of Brazil, including the states of Paraíba (São José dos Cordeiros), Ceará (Fortaleza), and Maranhão (Tasso Fragoso); and one in the Chaco ecoregion of Bolivia, department of Santa Cruz (Pampagrande). The distribution of the species was later expanded with new records in the Cerrado biome from the state of Mato Grosso (Cuiabá) and with additional records in the Chaco ecoregion of Santa Cruz, Bolivia (Valle Grande; Semedo and Feijó 2016). Recently, the species was reported from the state of Pernambuco, with records from two municipalities, Buíque and Tupanatinga, within the Caatinga biome (Bernard et al. 2023).

Here, we report a range extension of *H. diaphanopterus* to Tocantins, representing the third record of the species in the Cerrado biome of Brazil. We also provide an updated distribution map and a table summarizing external and cranial measurements for all known specimens.

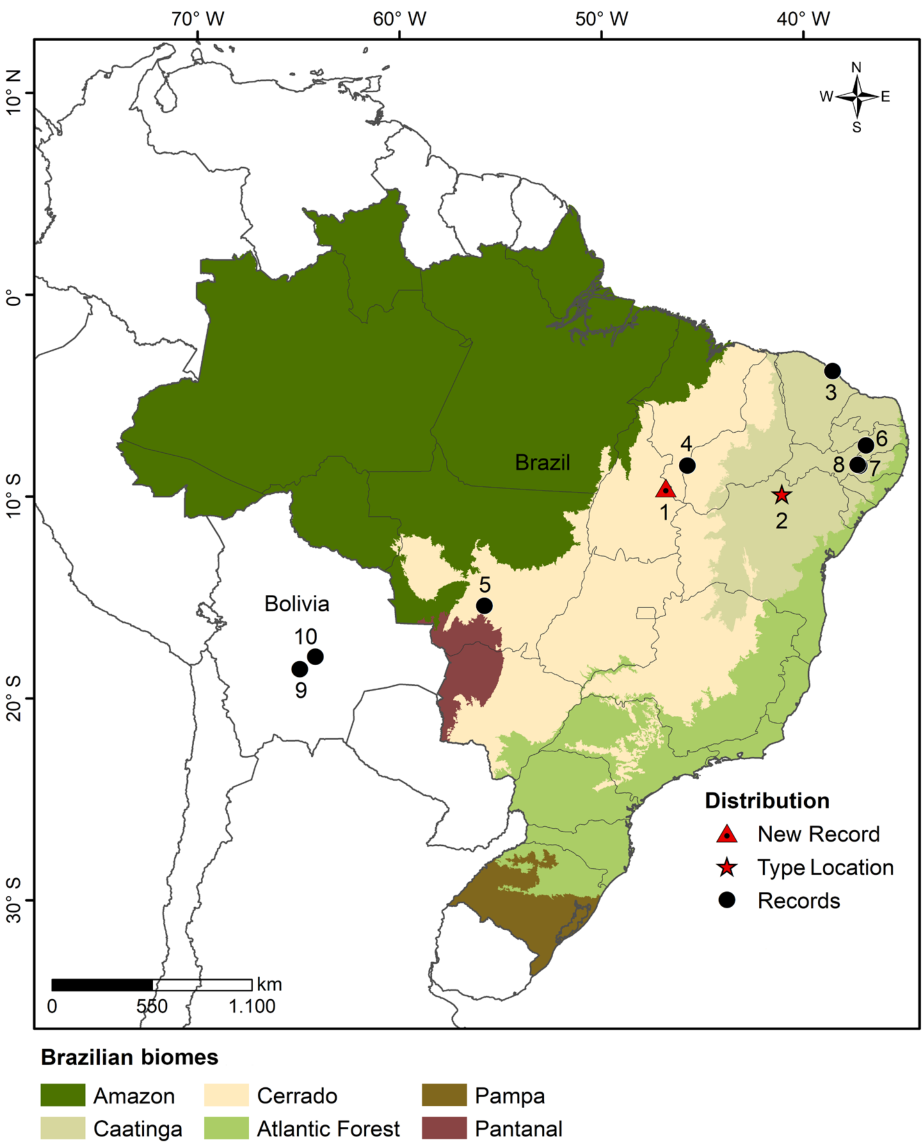

Figure 1. Records of *Histiotus diaphanopterus* in Brazil and Bolivia (see also Table 1). This study: 1 = Tocantins, Lizarda; Literature records: 2 = Bahia, Sento Sé, Boqueirão da Onça (type locality), 3 = Ceará, Fortaleza, Faculdade Veterinária do Ceará, 4 = Maranhão, Tasso Fragoso, Tranqueira, 5 = Mato Grosso, Cuiabá, Chapada dos Guimarães, Escola Evangélica Burit, 6 = Paraíba, São José dos Cordeiros, Reserva Particular do Patrimônio Natural Fazenda Almas, 7 = Pernambuco, Buíque, Parque Nacional do Catimbau, 8 = Pernambuco, Tupanatinga, Parque Nacional do Catimbau, 9 = Santa Cruz, Valle Grande, Potrerillos, and 10 = Santa Cruz, Pampagrande, Florida.

Table 1. Geographic records of *Histiotus diaphanopterus* in Brazil and Bolivia, including country, state/department, locality, coordinates, associated vegetation domain, and references. The new record from Tocantins (present study) represents the northernmost occurrence of the species in the Cerrado biome. No. = number relative to the locations in Figure 1.

No.	Country	State / department	Locality	Latitude	Longitude	Vegetation	Reference
1	Brazil	Tocantins	Lizarda	−9.5733	−46.8104	Cerrado	Present study
2	Brazil	Bahia	Sento Sé, Boqueirão da Onça	−9.8803	−41.0709	Caatinga	Feijó et al. 2015; ICMBio 2025
3	Brazil	Ceará	Fortaleza, Faculdade Veterinária do Ceará	−3.7860	−38.5525	Caatinga	Feijó et al. 2015; ICMBio 2025
4	Brazil	Maranhão	Tasso Fragoso, Tranqueira	−8.4725	−45.7428	Cerrado	Feijó et al. 2015; ICMBio 2025
5	Brazil	Mato Grosso	Cuiabá, Chapada dos Guimarães, Escola Evangélica Buriti	−15.4156	−55.8071	Cerrado	Semedo and Feijó 2016; ICMBio 2025
6	Brazil	Paraíba	São José dos Cordeiros, Reserva Particular Patrimônio Natural Fazenda Almas	−7.4708	−36.8975	Caatinga	Feijó et al. 2015; ICMBio 2025
7	Brazil	Pernambuco	Buíque, Parque Nacional do Catimbau	−8.4791	−37.2369	Caatinga	Bernard et al. 2023; ICMBio 2025
8	Brazil	Pernambuco	Tupanatinga, Parque Nacional do Catimbau	−8.4282	−37.3096	Caatinga	Bernard et al. 2023; ICMBio 2025
9	Bolivia	Santa Cruz	Valle Grande, Potrerillos	−18.5500	−64.9333	Chaco	Semedo and Feijó 2016; Poma-Urey et al. 2023
10	Bolivia	Santa Cruz	Pampagrande, Florida	−17.9297	−64.1633	Chaco	Feijó et al. 2015; Poma−Urey et al. 2023

Study area

The new record of *H. diaphanopterus* was made in the Lizarda municipality, Tocantins, Brazil (Figure 1). This region has a tropical climate with a dry winter (Aw type on the Köppen classification), characteristic of tropical savannas (Peel et al. 2007). The vegetation corresponds to Cerrado rupestre, a phytophysiognomy associated with rocky outcrops of quartzite–arenite (Ribeiro and Walter 1998). This environment is characterized by shallow, stony soils with low nutrient availability and high acidity, resulting in restrictive edaphic conditions for vegetation development. The vegetation cover is predominantly herbaceous-shrubby, sparse and discontinuous, interspersed with small woody species adapted to nutrient-poor substrates and seasonal drought. Such areas harbor a specialized flora, with high levels of endemism and functional traits that enhance resilience to fire and soil limitations (Ribeiro and Walter 1998).

Methods

In April 2019, we installed two sampling sets of five mist nets: one within the vegetation in front of a quartz–arenite rocky formation, approximately 120 m from the outcrop, and the other along an abandoned road about 100 m from the first set. Nets were opened at sunset and remained active for six hours. Inspections were carried out every 20 minutes. All captured specimens were placed in individual holding bags and field annotations included forearm length, body mass, sex, and reproductive condition. Preliminary identification was conducted in the field using taxonomic keys (Reis et al. 2017).

We measured the specimens in the laboratory using digital calipers (0.01 mm of precision) according to Feijó et al. (2015) and Semedo and Feijó (2016; Table 2). External measurements: weight (W), total length (TL), head–body length (HBL), tail length (T), hind-foot length (HF), ear length (E), height of skin between ears (HSE), forearm length (FA), tragus length (Tr), calcar length (CaL), ear breadth (EB). Cranial measurements: greatest length of skull (GLS), condyloincisive length (CIL), postorbital constriction (PC), zygomatic breadth (ZB), braincase breadth (BB), mastoid breadth (MB), height of postorbital process (HPP), palatal length (PL), maxillary toothrow length (C-M^3), palatal breadth (PB), breadth across M3–M3 (M^3-M^3), breadth across canines (C-C), mandible length (ML), mandibular toothrow length (C-M_3), mandible height (MH).

Results

Histiotus diaphanopterus **Feijó, Rocha & Althoff, 2015**

Figures 2, 3

New records. BRAZIL – **Tocantins** • Lizarda municipality; −9.5733, −46.8104; 362 m a.s.l.; 22.IV.2019; de Oliveira MB; 1 adult ♀, MN84764.

Figure 2. Dorsal, ventral, and lateral views of the skull and mandible of *Histiotus diaphanopterus* (MN84764).

Identification. The specimen weighs 8 g, with a head–body length of 110.86 mm, tail length 50.95 mm, forearm length 46.74 mm, and ear length 28.01 mm (Table 2). The ears are conspicuously large, translucent, connected by a high band across the forehead (4.62 mm), and with the tragus extending to about half their height (Figure 3A, C). Wings and uropatagium are translucent and well developed, with the tail slightly exceeding the distal margin of the uropatagium (Figure 3B, C). The dorsal fur is long (9.5 mm) and distinctly bicolored, with dorsal dark brown hairs at the base and golden at the tips, and ventral dark brown fur at the base with whitish tips (Figure 3B, C). Cranially, the inner upper incisors are widely spaced; the outer incisors are small, in contact with the inner incisors and slightly separated from the canines. The upper M^3 is narrow, about half the width of M^1 and M^2 (Figure 2). Dental formula: i: 2/3; c: 1/1; pm: 1/2; m: 3/3 = 32.

Comparison. Comparison with *H. velatus*, which occurs in Brazil and may also be present in the study region. *Histiotus diaphanopterus* and *H. velatus* are the most similar species within the genus, sharing a triangular ear (fine and acute) with a prominent inner lobe connected by a band across the forehead. However, they differ in a combination of external and cranial traits. *Histiotus diaphanopterus* exhibits well-defined bicolor hairs on the dorsum (with hairs tipped in pale), whereas *H. velatus* tends to have a subtly bicolored dorsum. The wing membranes of *H. diaphanopterus* are pale and translucent (similar to those of *H. laephotis*) in contrast to the darker membranes of *H. velatus*. Cranial and body measurements further support their distinction. Although the overall skull shape is similar, *H. diaphanopterus*

Figure 3. *Histiotus diaphanopterus* (MN84764). **A.** Lateral view showing conspicuously large ears. **B.** General golden-brown fur with distinctly bicolored dorsal hairs (dark brown at the base and golden at the tips) and translucent uropatagium. **C.** Translucent ears and wings.

is generally smaller than *H. velatus* in several dimensions, including total body and tail length, skull length, braincase width, mastoid width, width across M^3, and mandibular length. In the examined specimen, the combination of translucent wings, conspicuously bicolored dorsum, proportionally narrower M^3, and longer ventral fur supports its identification as *H. diaphanopterus*. When compared with other species occurring in Brazil but outside the study area, *H. laephotis* also has translucent wings but differs in pelage pattern (subtly bicolored dorsum) and in auricular (oval in shape) and cranial features. *Histiotus montanus* and *H. alienus* generally have darker pelage and wings, whereas the analyzed specimen is distinguished by its bicolored dorsum and translucent membranes. Moreover, these species tend to have a more oval ear morphology compared to *H. diaphanopterus*. The combination of transparent wings, bicolored fur, large ears connected by a high band, and reduced M^3 width distinguishes the specimen from all other *Histiotus*.

Table 2. External and cranial measurements (in mm) and body mass (g) of *Histiotus diaphanopterus* specimens examined in this study and from the literature. Specimens are represented by voucher MN84764 from Lizarda, Tocantins; UPFB 9490–9500 from Sento Sé, Bahia; UFPB 6014 and UFPB 6015 from São José dos Cordeiros, Paraíba; UFMT 2751 from Chapada dos Guimarães, Mato Grosso, Brazil; MNKM 3714 and AMNH 264086 from Valle Grande, Santa Cruz, Bolivia. Sex: female (♀) and male (♂). Museu Nacional, Universidade Federal do Rio de Janeiro (MN), Brazil; Universidade Federal da Paraíba (UFPB), Brazil; Universidade Federal de Mato Grosso (UFMT), Brazil; Museo Noel Kempff Mercado (MNKM), Bolivia; American Museum of Natural History (AMNH), USA. Abbreviations of measurements are explained in Methods.

	MN 84764	**UPFB 9490***	**UPFB 9491**	**UPFB 9492**	**UPFB 9493**	**UPFB 9494**	**UPFB 9495**	**UPFB 9496**	**UPFB 9497**	**UPFB 9498**	**UPFB 9499**	**UPFB 9500**	**UFPB 6015**	**UFPB 6014**	**MNKM 3714**	**UFMT 2751**	**AMNH 264086**
Sex	♀	♀	♂	♀	♀	♂	♀	♂	♀	♀	♂	♀	♀	♀	♀	♀	♀
W	8.00	10.00	8.50	9.50	9.00	8.00	–	8.00	11.00	10.00	8.00	8.50	10.50	9.00	9.00	–	10.90
TL	110.86	104.60	100.60	111.80	111.00	108.30	105.00	104.00	114.80	103.60	105.50	106.60	113.00	104.00	–	–	121.00
HBL	59.91	53.20	52.60	56.50	60.00	54.80	58.80	52.00	60.20	52.40	53.20	56.20	–	52.90	60.00	–	–
T	50.95	51.40	48.00	55.3	51.00	53.50	46.20	52.00	54.60	51.20	52.20	50.40	43.00	52.00	57.00	–	57
HF	9.64	10.10	10.00	7.90	9.30	8.00	10.90	8.10	8.40	10.50	9.30	10.10	8.00	7.60	8.00	–	8.00
E	28.01	31.40	33.10	32.10	30.40	30.30	31.40	28.80	31.70	29.90	30.90	30.60	29.30	28.20	27.00	–	31.00
HSE	4.62	4.00	–	–	–	3.90	4.50	–	4.40	3.40	3.80	–	–	–	–	–	–
FA	46.74	44.90	44.60	45.40	46.80	43.90	44.70	41.80	47.20	45.30	44.40	45.70	46.60	45.30	46.00	45.40	
Tr	13.62	13.50	12.90	13.50	13.80	13.30	13.00	13.20	13.20	13.00	14.10	13.50	14.70	13.10	–	–	17.00
CaL	17.86	17.70	18.90	17.20	17.20	23.30	17.50	17.90	17.70	20.30	17.80	20.10	–	–	–	–	–
EB	19.92	21.30	21.30	–	21.70	22.80	20.80	18.50	20.50	20.10	21.40	20.40	–	–	–	–	–
GLS	17.53	18.63	18.08	18.12	18.31	17.80	17.90	17.67	18.30	–	17.50	17.50	18.00	–	–	17.44	–
CIL	17.22	17.13	16.79	17.01	17.11	16.44	16.95	16.34	17.10	16.90	16.30	16.30	16.60	–	–	16.91	17.17
PC	3.73	4.05	4.05	4.06	3.87	4.00	3.73	3.86	4.00	3.90	4.10	3.85	4.25	–	–	3.89	3.79
ZB	–	10.65	10.00	10.29	10.34	10.04	9.90	10.06	10.26	9.90	10.10	10.00	10.41	–	–	10.48	10.43
BB	7.50	7.85	8.05	7.73	7.64	7.64	7.48	7.68	7.84	7.70	7.60	7.46	8.00	–	–	7.96	7.67
MB	8.20	6.96	7.04	6.95	6.86	6.60	6.90	6.62	7.10	6.90	6.40	6.55	7.22	–	–	8.11	6.35
HPP	2.19	2.05	1.76	02.01	2.00	1.96	1.90	1.76	1.82	2.02	2.40	1.90	2.38	–	–	1.89	1.76
PL	7.61	7.64	7.61	7.65	7.70	7.22	7.55	7.26	7.56	7.60	7.10	7.40	8.33	–	–	7.37	7.68
$C\text{-}M^3$	5.95	6.21	5.84	6.10	6.27	5.90	6.05	5.82	6.08	5.80	5.80	5.75	5.93	–	–	6.19	6.16
PB	3.77	3.61	3.33	3.26	3.31	3.36	2.96	3.28	3.16	3.10	3.00	3.42	3.09	–	–	3.70	3.41
$M^3\text{-}M^3$	6.38	6.89	6.23	6.4	6.18	6.30	6.22	6.32	6.62	6.40	6.10	6.18	6.46	–	–	6.77	6.52
C-C	4.98	5.20	4.81	4.92	–	4.60	4.67	4.73	5.14	4.70	4.80	4.68	4.78	–	–	5.16	4.91
ML	12.12	12.70	12.30	12.35	12.55	11.85	12.54	11.72	12.36	12.70	12.00	12.05	12.57	–	–	12.28	12.42
$C\text{-}M_3$	6.29	6.63	5.95	6.18	6.18	6.16	6.35	6.31	6.57	6.20	6.10	6.23	6.39	–	–	6.53	6.64
MH	3.97	4.46	3.85	4.20	4.20	4.16	4.36	4.08	4.32	4.10	4.00	4.04	4.20	–	–	5.45	4.40

Literature records. The distribution of *H. diaphanopterus* includes Brazil and Bolivia. In Brazil, there are records from the northeast (Bahia, Ceará, Maranhão, Paraíba, and Pernambuco) and the west (Mato Grosso). The type locality is in Brazil, in the state of Bahia, in Sento Sé municipality, at Boqueirão da Onça. In Bolivia, the department of Santa Cruz (Table 1). Moreover, the species occurs in the Caatinga, Cerrado, and Chaco ecoregions.

Ecological note on roost use and interactions. Roost sharing by *H. diaphanopterus* and *Molossus* sp., and a potential interaction between these bat species and an insect of the family Reduviidae, since an individual was observed in the same roost. Both bat species were observed in this vertical cavity within a quartz–arenite rocky formation (Figure 4), approximately 2 m above the ground, the roost measured approximately 6 cm in width, 25 cm in length, and 20 cm in depth.

Discussion

Histiotus diaphanopterus has been recorded from only 10 localities to date, occurring across the Caatinga, Cerrado, and Chaco ecoregions (Feijó et al. 2015; Semedo and Feijó 2016; Bernard et al. 2023). The record reported here extends the known geographic range of the species by approximately 170 km from the nearest locality in the State of Maranhão, within the Cerrado biome, now totaling three known localities in this biome (Figure 1, locality 4), and about 630 km from the type locality in the Caatinga biome (Figure 1, locality 2). Additionally, we increase the number of bat species recorded for the state of Tocantins to 87 (Souza et al. 2021). When compared with the 2024 mammal checklist published by the Sociedade Brasileira de Mastozoologia (Abreu et al. 2024), Tocantins ranks sixth in bat species richness, tied with Amapá. However, some of the values in that checklist may be outdated, since the species richness reported for Tocantins is considerably lower than that documented by Souza et al. (2021).

The specimen reported in this study, as well as those previously documented in the literature, was found in a region characterized by alternating wet and dry seasons, a climatic pattern typical of the Cerrado, Caatinga, and Chaco (Peel et al. 2007). These three ecoregions, where the species occurs, share ecological and climatic similarities and are often described as part of the South American diagonal of open formations (Werneck 2011). All are defined by pronounced climatic seasonality, with prolonged dry periods that shape vegetation adapted to water scarcity, heterogeneous habitat mosaics,

Figure 4. Area where voucher specimen MN84764 was collected. **A.** Rupestrian cerrado with quartzite–sandstone outcrops in the background. **B.** Colony of *Histiotus diaphanopterus* in a quartzite–sandstone outcrop at Lizarda, Tocantins, Brazil. The arrows black indicates (A) the roost location and (B) the insect belonging to the family Reduviidae.

and high diversity of species specialized in arid environments (Werneck 2011; Fernandes et al. 2022).

Within this system, the Cerrado biome plays a central role as a major source of floristic exchanges with neighboring ecoregions, notably the Caatinga, which represents the most species-rich nucleus of the Seasonally Dry Tropical Forests and has received substantial contributions from Cerrado lineages (Fernandes et al. 2022). Although connectivity with the Chaco has historically been more limited, all three ecoregions share diversification processes linked to global aridification since the Miocene, which fostered the evolution of drought-adapted faunas and floras (Carmignotto et al. 2012; Fernandes et al. 2022). From a faunal perspective, the Cerrado biome exhibits the highest mammalian richness and a high proportion of endemic species, followed by the Caatinga and then the Chaco, while both Caatinga and Chaco display relatively low levels of endemism, supporting their inclusion within a broader complex of interconnected open landscapes (Klink and Machado 2005; de Albuquerque et al. 2012; Abreu et al. 2024). Based on current records, *H. diaphanopterus* is the only species of the genus restricted to tropical regions with dry and shrubby vegetation (Feijó et al. 2015; Semedo and Feijó 2016; Bernard et al. 2023; Poma-Urey et al. 2023). The other species that occur in Brazil, *H. alienus*, *H. laephotis*, *H. montanus*, and *H. velatus*, are associated with the Atlantic Forest, whereas *H. velatus* is also recorded in the Caatinga, Cerrado, and Pampa biomes (ICMBio 2025).

Ultimately, morphological variation in *H. diaphanopterus* appears to be subtle, and the species can be readily distinguished from its congeners based on the traits described by Feijó et al. (2015), most notably its transparent wings. Most recorded measurements are consistent with the expected range for the species, with only minor variations. The height of skin between the ears and the mastoid breadth were slightly higher than the average observed in other individuals of the same species. In addition, our observation of *H. diaphanopterus* and *Molossus* sp. sharing a roost with an insect of the family Reduviidae suggests a potential ecological interaction between bats and reduviids. Although our observation is occasional, similar associations have been reported in the literature. Some reduviids found in bat roosts are species that may act as predators associated with guano deposits, contributing to the regulation of invertebrate populations and highlighting the complexity of guano-based food webs (Ferreira and Martins 1999). More recent studies based on fossil records preserved in Dominican amber have revealed one of the oldest known associations between a triatomine bug and a trypanosome, as well as the presence of bat hairs within the same specimens, indicating that bats may have served as vertebrate hosts for *Trypanosoma* parasites millions of years ago (Poinar 2005). Together, these findings underscore the ecological complexity of bat roost communities and suggest that interactions between bats and reduviids may range from ancient parasitic relationships to contemporary trophic associations.

However, as a recently described species with only scattered occurrence records, consistent information remains lacking regarding key aspects of its biology, including diet and population structure. Moreover, similar to the ecoregions it inhabits, the Caatinga, Cerrado, and Chaco, *H. diaphanopterus* faces threats from human activities, such as agricultural expansion, deforestation, and fire, which lead to habitat fragmentation and biodiversity loss (Werneck 2011; de Albuquerque et al. 2012). Historically, these regions have received less scientific and conservation attention compared to humid biomes such as the Amazon and the Atlantic Forest, further increasing the vulnerability of their native species (Werneck 2011; de Albuquerque et al. 2012). Climate change exacerbates these threats through rising temperatures, reduced rainfall, and the expansion and intensification of the dry season (Hofmann et al. 2021, 2023), exerting additional pressure on populations. In addition, the species is listed as Least Concern in the Brazilian List of Threatened Species (ICMBio 2025). However, there are few known records, and it has not yet been assessed by the International Union for Conservation of Nature (IUCN 2025). Taken together, these factors highlight the urgent need for comprehensive studies on *H. diaphanopterus* and for integrated conservation strategies that consider both the shared evolutionary history of these open biomes and the critical role of their species in maintaining continental biodiversity.

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Additional information

Conflict of interest

The authors declare that no competing interests exist.

Ethical statement

All procedures were conducted under authorization from the 'Sistema de Autorização e Informação em Biodiversidade' (SISBIO/ICMBio), permit No. 60058, and approved by the Animal Ethics Committee (CEUA/UFRJ), protocol No. 016/21.

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Author contributions

Conceptualization: MBO, MAG. Data curation: MBO, MAG. Investigation: MBO, MAG, GSH, IPC, JLPC. Methodology: MBO, MAG. Supervision: MBO. Visualization: MBO, MAG. Writing – original draft: MBO, MAG. Writing – review and editing: MBO, MAG, GSH, IPC, JLPC.

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Data availability

All data that support the findings of this study are available in the main text.

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