



First record of *Tonatia bidens* bats foraging on moss

Júlia Lins Luz^{1*}

 <https://orcid.org/0000-0003-4515-7442>

* Contato principal


Elizabete Captivo Lourenço²

 <https://orcid.org/0000-0002-6136-708X>


Luciana de Moraes Costa²

 <https://orcid.org/0000-0001-8080-4954>

Fernando Israel Carneiro³

 <https://orcid.org/0009-0000-8747-8223>

Martha Lima Brandão⁴

 <https://orcid.org/0000-0001-8529-8202>

Caio Salles⁵

 <https://orcid.org/0000-0002-9037-1942>

¹ Piper 3D – Pesquisa, Educação e Consultoria Ambiental, Rio de Janeiro/RJ, Brasil. <julialinsluz@yahoo.com.br>.

² Programa de Pós-Graduação em Ecologia e Evolução, Departamento de Ecologia, Instituto de Biologia, Universidade do Estado do Rio de Janeiro/ UERJ, Laboratório de Ecologia de Mamíferos, Rio de Janeiro/RJ, Brasil. <beteclouren1205@yahoo.com.br, costalucianam@gmail.com>.

³ Programa de Pós-Graduação em Botânica da Escola Nacional de Botânica Tropical/JBRJ, Rua Pacheco Leão, 2040, Solar da Imperatriz, Horto, Rio de Janeiro/RJ, Brasil. <fisraelcarneiro@gmail.com>.

⁴ Fioantar – Vice presidência de produção e inovação em saúde/VPPIS/Fiocruz, Rio de Janeiro/RJ, Brasil. <brandaomarthal@gmail.com>.

⁵ Associação Brasileira de Combate ao Lixo no Mar/ABLM; Programa de Pós-Graduação em Ecoturismo e Conservação/PPGEC, Universidade Federal do Estado do Rio de Janeiro/UNIRIO, Brasil. <caio@projetoeverdemar.com>.

Recebido em 31/01/2023 – Aceito em 31/07/2024

Como citar:

Luz JL, Lourenço EC, Costa LM, Carneiro FI, Brandão ML, Salles C. First record of *Tonatia bidens* bats foraging on moss. *Biodivers. Bras.* [Internet]. 2024; 14(3): 1-6. doi: 10.37002/biodiversidadebrasileira.v14i3.2397

Keywords: Bryophyte; Chiroptera; diet; dispersion.

ABSTRACT – Cases of bryophyte consumption by vertebrates are often presumed incidental. In this paper we reported, for the first time, the behavior of foraging in moss by bats, *Tonatia bidens* (Phyllostomidae), in the Cagarras Archipelago Natural Monument, Rio de Janeiro, Brazil. Due to bryophytes low nutritional value and digestibility, we suggest that obtaining water or forage for invertebrates may be the main objectives, and that this behavior can result in moss dispersion.



Primeiro registro de morcegos *Tonatia bidens* forrageando em musgo

Palavras-chave: Briófitas;
Chiroptera; dieta; dispersão.

RESUMO – Casos de consumo de briófitas por vertebrados são frequentemente considerados acidentais. Neste trabalho relatamos, pela primeira vez, o comportamento de forrageamento em musgo por morcegos, *Tonatia bidens* (Phyllostomidae), no Monumento Natural do Arquipélago das Ilhas Cagarras, Rio de Janeiro, Brasil. Devido ao baixo valor nutricional e digestibilidade das briófitas, sugerimos que a obtenção de água ou forrageio de invertebrados podem ser os principais objetivos, e que este comportamento pode resultar na dispersão de musgos.

Primer registro de murciélagos *Tonatia bidens* alimentándose de musgo

Palabras clave: Briofita;
Chiroptera; dieta; dispersión.

RESUMEN – Los casos de consumo de briofitas por parte de los vertebrados a menudo se presumen incidentales. En este artículo reportamos, por primera vez, el comportamiento de forrajeo en musgo por murciélagos, *Tonatia bidens* (Phyllostomidae), en el Monumento Natural Archipiélago de Islas Cagarras, Río de Janeiro, Brasil. Debido al bajo valor nutricional y digestibilidad de las briófitas, sugerimos que la obtención de agua o forraje para los invertebrados puede ser el objetivo principal, y que este comportamiento puede resultar en la dispersión del musgo.

Introduction

Bats have diverse feeding habits, and can be separated into guilds of carnivores, piscivores, insectivores, hematophagous, frugivorous, nectarivorous and omnivorous[1]. Parsons and others[2] recorded for the first and only time, until now, bryophyte consumption by bats. They demonstrate a case of bryophyte dispersal via the gut of the spectacled flying fox bats, *Pteropus conspicillatus* (Pteropodidae), in Australia. This study suggested that bryophytes were consumed coincidentally with grooming, rather than directly targeted as a dietary item. A variety of microorganisms and invertebrates commonly found in association with bryophytes (e.g. cyanobacteria, algae, and nematodes) were found living in the cultured bryophyte fragments[2].

Bryophytes contribute to water filtration, nutrient retention and nitrogen fixation[3]. However, due to their low nutritional value and digestibility, cases of bryophyte consumption by vertebrates are often presumed incidental[2][4]. Co-dispersal of other organisms by vertebrates is an area in need of

far greater investigation[5], as indicated by the fact that the first records of endozoochory of bryophyte fragments by bats were not published until the 21st Century.

Some studies demonstrated the dispersion of bryophytes by birds and mammals, through endo-, epi- or synzoochory. Barbé and others[6], Pauliuk and others[7], and Heinken and others[8] found in small mammals, in sheep, and in roe deer and wild boar, respectively, diaspores attached to the animal body. These studies suggests that dispersal of bryophytes by mammals might be underestimated in its importance. Lewis and others[9] found diaspore attached to the feather of a transequatorial migrant bird, and many birds use mosses as nesting material[4][10]. In South America, Russo and others[11] detected bryophyte fragments in more than 80% of birds' faecal samples. Wilkinson and others[12] demonstrated that viable fragments can be recovered from waterbird faeces. Larger rodents make use of bryophytes, particularly for nesting materials, but a few eat them. Many rodents have mosses in the gut and feces, but these often seem to be the result of accidental intake[13].

Bats provide ecosystem services that are critically important, as pollinators and seed dispersers for hundreds of plant species and as agents of suppression of arthropod herbivores and insect pest species[14]. Due to their ability to make large displacements, bats are able to disperse pollen and diaspores over long distances. However, we still do not know the importance of bryophytes in bat feeding, nor of bats in bryophytes dispersion[2].

Case description

In 2019 we started a project for preliminary survey of terrestrial mammals of the Cagarras Archipelago Natural Monument (MONA Cagarras), a protect area created in 2010 and located 5 km off Ipanema, a major beach of the southern Rio de Janeiro, Brazil. The Cagarras Islands and the surrounding waters have been declared a Hope Spot by international marine conservation nonprofit Mission Blue (<https://missionblue.org/hope-spots/>). In January 2021 we mist-netted five individuals of *Tonatia bidens* (Phyllostomidae, Chiroptera) in Redonda Island (23°04'09"S; 43°11'40"W), two at the beginning of the night and three already at dawn.

After data collection and marking, these three individuals were released between the rocks (Figure 1A). One individual then moved into a rocky crevice covered by bryophytes, and actively feeds on it. To the best of our knowledge, this is the first time that such a behavior of foraging on bryophytes by bats has been visualized and filmed (supplementary material – video).

Discussion

The known diet of *Tonatia bidens* consists of insects, especially Lepidoptera, Coleoptera and Orthoptera, small vertebrates, and fruits to a lesser extent[15][16][17][18]. It has been classified as a gleaning insectivore by Kalko and others[1] but Felix and others[18] suggests this bat as omnivorous as other food items, like birds, mammals and fruits, were also reported.

Considering the low nutritional value of bryophytes[4], we suggest that the ingestion by bats in the Cagarras Islands aims to obtain fresh water, since

no water bodies, like lakes or rivers, are available in this archipelago. In Scandinavia, Hansson[19] suggested that the need of water can explain the consumption of mosses by small rodents. Some chimpanzees (*Pan troglodytes*) in African rainforests have learned to use the pendent mosses as sponges to gather water from tree holes and other places difficult to be reached, while researchers suggested that wombats, in Austrália, might ingest mosses for drinking the water retained on them[20]. The Hawaii Mamo (*Drepanis pacifica*), in the Sandwich Isles of Hawaii, obtains water from the epiphytic mosses[21] and some snakes use bryophytes to rehydrate[22].

Another possibility is that bats forage for invertebrates among the bryophytes[4]. Many grubs, beetles, bugs, worms, mites, spiders, and other macroinvertebrates may reside among the bryophytes, and are desirable food for insectivorous bats. However, in the present study the behavior of licking the moss was also observed, suggesting that obtaining water may be the main objective.

It is possible that bats disperse bryophytes by epizoochory as fragments attaches to this mammal body (Figure 1B). Barbé and others[6] demonstrated that ground-dwelling small mammals represent important dispersers of bryophytes, since half of the trapped individuals carried viable bryophyte, and concluded that the persistence of bryophyte metapopulations depends on them in connecting fragmented populations. Pauliuk and others[7] conclude that sheep are important dispersal vectors with the potential of long-range dispersal for bryophytes. Heinken and others[8] found that the significance of epizoochorous transport of bryophytes is comparable to that of phanerogams in deciduous forest in Germany.

The next steps will be to analyze *T. bidens*'s faeces and to collect a Bryophyte sample for identification. It is possible that a greater number of bat species feed on moss and this result may have very general implications, from physiological to ecological perspectives. This note highlights the possibility of bats feeding on bryophytes themselves or consuming invertebrates or water contained on them, with potential consequences for bryophytes dispersal, thus encouraging researchers to look for these organisms in faeces of different bat species.

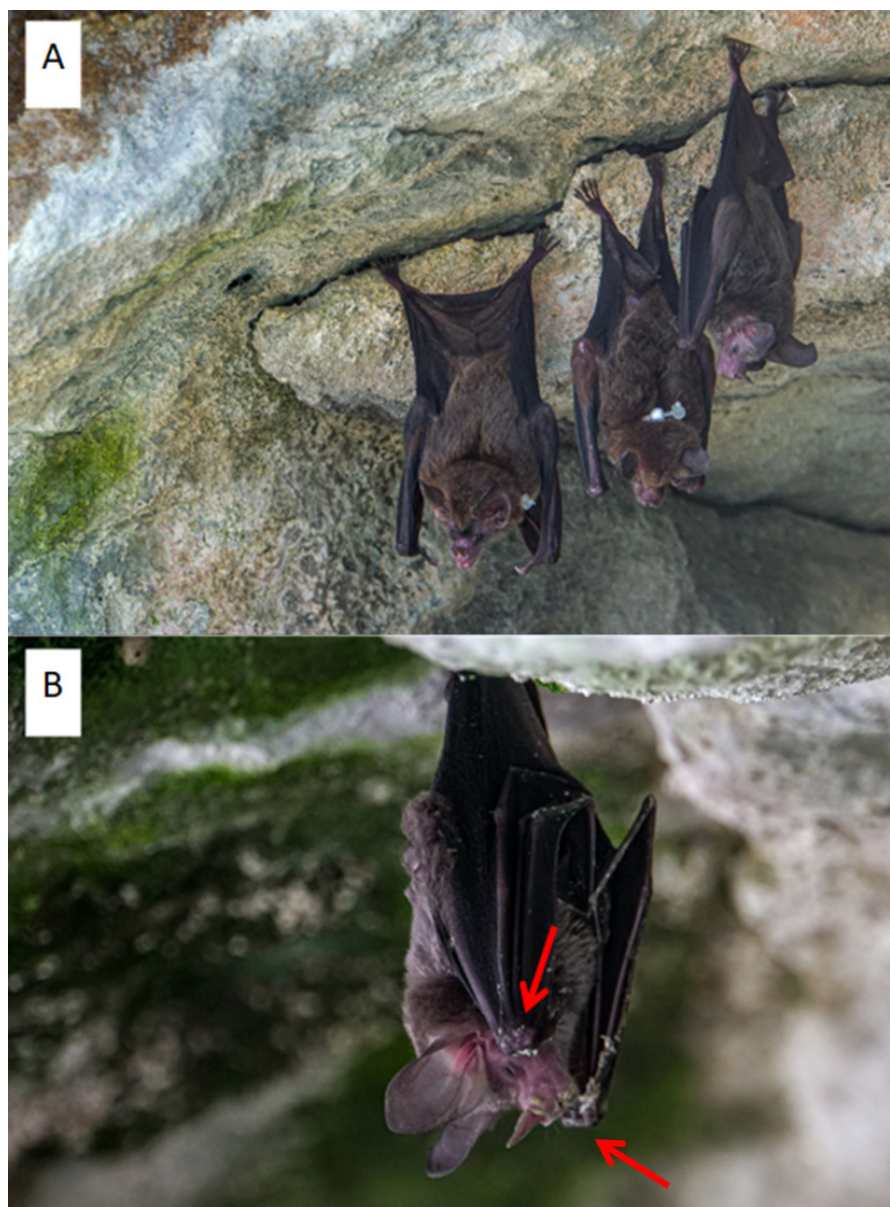


Figure 1 – A: Three individuals of *Tonatia bidens* (Phyllostomidae, Chiroptera) released between the rocks in Redonda Island, Rio de Janeiro, Brazil (Photo: Caio Salles). B: Individual of *Tonatia bidens* (Phyllostomidae, Chiroptera) with bryophytes fragments attached to its body in Redonda Island, Rio de Janeiro, Brazil (Photo: Caio Salles).

Acknowledgements

Flávio Carneiro Pinheiro, Helena de Godoy Bergallo, Lena Geise and Tatiana Teixeira Leite Ribeiro supported fieldwork. LMC and ECL thank Programa de Apoio à Pesquisa e Docência (PAPD) for the benefit granted by the Universidade do Estado do Rio de Janeiro (UERJ) and F.I.C. thanks

Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for scholarship.

Funding: Projeto Ilhas do Rio - Phase 4, curated by WWF-Brazil and sponsored by Associação IEP and JGP; Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio)/Monumento Natural do Arquipélago das Ilhas Cagarras.

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Biodiversidade Brasileira – BioBrasil.

Fluxo Contínuo e Edição Temática:

Programa Nacional de Monitoramento da Biodiversidade – Programa Monitora – 10 anos
n.3, 2024

<http://www.icmbio.gov.br/revistaeletronica/index.php/BioBR>

Biodiversidade Brasileira é uma publicação eletrônica científica do Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) que tem como objetivo fomentar a discussão e a disseminação de experiências em conservação e manejo, com foco em unidades de conservação e espécies ameaçadas.

ISSN: 2236-2886

