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## A REVIEW OF FOLIVORY BY NEOTROPICAL BATS<sup>1</sup>

UMA REVISÃO DA FOLIVORIA POR MORCEGOS NEOTROPICAIS

UNA REVISIÓN DE LA FOLIVORA  
DE LOS MURCIÉLAGOS NEOTROPICALES

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<sup>1</sup> Artigo baseado na Tese: “*Folivoria em Artibeus lituratus* (Olfers, 1818): uma análise experimental” defendida pelo Programa de Pós-graduação em Biologia Comparada da Universidade Estadual de Maringá, em fevereiro de 2020.

## ABSTRACT

Among the various items recorded in the diet of neotropical bats, leaves have been understood as resources aimed at food or water supplementation, and their consumption may be associated with different factors, from the preference of the bat for a given plant species to the age group of bat. Thus, the present study aimed to determine the state of knowledge of folivory performed by neotropical bats. The information was organized quantitatively and qualitatively, for all years available until 2019, when the studies were located in the academic databases: Web of Science, Google Scholar and Periodicals Capes. The following keywords and their combinations were used: “Folivory” and “Bats”; “Leaves” and “Bats”; “Chiroptera” and “Folivory”. This research returned 25 articles, 65.3% of which were carried out in Brazil. Most of them are occasional (56%), i.e., in which the main object of study was not folivory. Among those, leaf-eating by bats was described for nine species of neotropical bats, and *Artibeus lituratus* (Olfers, 1818) was the most extensively investigated species. The consumption of leaves by bats was described for 17 plant species. Only two articles pointed out the classes (age, reproductive and sexual) of the bats feeding on leaves; three investigated the foraging time; seven the seasonality; three sought to explain the reasons that contribute to folivory; and only one carried out an analysis of the chemical composition of the leaves. The preference for a determined leaf age was reported in three studies, whereas the folivory site (specific leaf portions preferably consumed) was described in four. Despite the increasing number of studies on folivory, there are still many gaps that limit the understanding of the real role of this behavior in the ecology of neotropical bats.

## KEYWORDS

Chiroptera. Leaf Consumption. Food Habits. Nutritional

## RESUMO

Entre os diversos itens registrados na dieta de morcegos neotropicais, as folhas têm sido compreendidas como recursos voltados à suplementação alimentar ou de água, podendo seu consumo estar associado a diferentes fatores, desde a preferência do morcego por determinada espécie vegetal a até a classe etária desse animal. Desta forma, o presente estudo teve por objetivo determinar o estado do conhecimento da folivoria realizada por morcegos neotropicais. As informações foram organizadas de forma quantitativa e qualitativa, para todos os anos disponíveis até 2019, período em que foram localizados os estudos nas bases de dados acadêmicos: Web of Science, Google Acadêmico e Periódicos Capes. Foram utilizadas as palavras-chave a seguir e suas combinações: “Folivory” e “Bats”; “Leaves” e “Bats”; “Chiroptera” e “Folivory”. Foram obtidos 25 artigos, dos quais 65,3% foram realizados no Brasil, sendo a maioria ocasional (56%), ou seja, quando o objeto central de estudo não era a folivoria. Além disso, verificamos que nove espécies de morcegos neotropicais realizavam a folivoria, sendo *Artibeus lituratus* (Olfers, 1818) a mais investigada. Dezessete espécies vegetais foram descritas tendo suas folhas consumidas por morcegos. Ademais, apenas dois artigos pontuaram as classes (etárias, reprodutivas e sexuais) dos quirópteros que utilizaram folhas, três averiguaram o horário de forrageio, sete a sazonalidade, três buscaram explicar os motivos que propiciavam a folivoria, porém, apenas um deles realizou análise da composição química das folhas. A preferência pela idade foliar foi registrada em três estudos, enquanto o local da folivoria foi abordado em quatro. Apesar do aumento dos estudos referentes à folivoria, existem ainda muitas lacunas que limitam a compreensão do real papel deste comportamento na ecologia de morcegos Neotropicais.

## PALAVRAS-CHAVE

Chiroptera. Consumo de Folhas. Hábito Alimentar. Suplementação Nutricional.

## RESUMEN

Entre los variados elementos registrados en la alimentación de los murciélagos neotropicales, las hojas son comprendidas como recursos relacionados a la suplementación del alimento o del agua, así que su consumo puede estar asociado a diferentes factores, que van desde la preferencia del murciélago por una determinada especie vegetal hasta a su franja etaria. Así pues, este estudio tiene como objetivo determinar el estado de conocimiento de la alimentación de murciélagos neotropicales que se alimentan de hojas. Las informaciones fueron organizadas de manera cualitativa y cuantitativa

para todos los años disponibles hasta 2019, periodo en que fueron encontrados los estudios en las bases de los datos académicos: Web of Science, Google Acadêmico e Periódicos Capes. Fueron utilizadas las palabras-claves siguientes y sus combinaciones: “Folivory” e “Bats”; “Leaves” e “Bats”; “Chiroptera” e “Folivory”. Se obtuvieron 25 artículos, de los cuales, 65,3% fueron realizados en Brasil, puesto que la mayoría fue ocasional, es decir, el objeto del estudio no era, específicamente, la nutrición foliar. Además, se comprueba que nueve especies de murciélagos neotropicales tienen la costumbre de alimentarse de hojas, dado que *Artibeus lituratus* (Olfers, 1818) fue la más investigada. Diecisiete especies vegetales fueron descritas como sus hojas consumidas por murciélagos. Más allá de eso, justo dos artículos resaltaron las categorías (de edad, de reproducción y de sexualidad) de los quirópteros que utilizaron las hojas, tres averiguaron el horario de forrajeo, siete la estacionalidad, tres intentaron explicar los motivos que propiciaron la nutrición foliar. Sin embargo, solo uno de ellos realizó el análisis de composición química de las hojas. La preferencia por la edad foliar fue registrada en tres estudios, mientras el sitio de la nutrición foliar fue analizado en cuatro. A pesar del aumento de los estudios que se refieren a la nutrición foliar, hay todavía muchos huecos que limitan la comprensión del real papel de este comportamiento en la ecología de los murciélagos neotropicales.

## PALABRAS CLAVE

Chiroptera, Consumo de hojas, Hábitos alimentarios, Suplementación nutricional.

## 1 INTRODUCTION

The habit of consuming leaves evolved independently in different taxa (KUNZ; INGALLS, 1994). Among bats (Order Chiroptera), folivory by leaf fractionation was reported for two families (KUNZ; DIAZ, 1995), Pteropodidae (Old World) (KUNZ; DIAZ, 1995; ALCAZAR et al., 2019) and Phyllostomidae (New World) (ZORTÉA, 1993; KUNZ; DIAZ, 1995; CORDERO-SCHIMIDT et al., 2016; DUQUE-MÁRQUEZ et al., 2019).

These mammals masticate the leaves and press them against their palate to obtain the liquid fraction of the bolus and then expel the fibrous portion, which is known as oral pellet (LOWRY, 1989). Although the first record of folivory by neotropical bats dates back more than 60 years (GREENHALL, 1957), this eating habit has been overlooked for long as the methodologies employed have frequently ignored the consumption of the liquid fraction of the leaves and have only looked into the stomach contents or feces of these animals (ZORTÉA, 1993; KUNZ; INGALLS, 1994).

The consumption of leaves by bats can be deduced from the analysis of the discarded material, partially consumed leaves or oral pellets (KUNZ; INGALLS, 1994; NOGUEIRA; PERACCHI, 2008), from monitoring colonies and feeding roosts with the aid of camera traps (SILVESTRE et al., 2016; ROCHA et al., 2016; PEREIRA et al., 2017), from direct observation (ZORTÉA; MENDES, 1993; KUNZ; DIAZ, 1995; CORDERO-SCHIMIDT et al., 2016; DUQUE-MÁRQUEZ et al., 2019), and from experimental tests (NELSON et al., 2005).

There are still many uncertainties regarding folivory in bats, and there is no consensus, for example, if it is done only by specific groups within a colony (SAZIMA et al., 1994; KUNZ; DIAZ, 1995; NELSON et al., 2005; ROCHA et al., 2016), if there is a preference for a certain leaf age (ZORTÉA; MENDES, 1993; KUNZ; DIAZ, 1995; PEREIRA et al., 2017) or for a specific portion of the leaves (KUNZ; DIAZ, 1995; CORDERO-SCHIMIDT et al., 2016; DUQUE-MÁRQUEZ et al., 2019). The seasonality of this event is also unclear and debated (ZORTÉA; MENDES, 1993; TAN et al., 1998; BOBROWIEC; CUNHA, 2010; RUIZ-RAMONI et al., 2011; CORDERO-SCHIMIDT et al., 2016).

The chemical analyses of the leaves extracted from the plant species consumed suggest that folivory is a strategy bats use to supplement their preferably frugivorous diet. It has been theorized that these animals seek specific nutrients, or even the metabolites present in greater quantity in this resource when compared to the fruits they consume; however, no consensus has been reached over which the nutrients they look for are (LOWRY, 1989; KUNZ; DIAZ, 1995; RAJAMANI et al., 1999; NELSON et al., 2000; RUBY et al., 2000; NELSON et al., 2005; KRISHNARATHI et al., 2014).

Recently, a hypothesis was put forward stating that the leaves in the Caatinga, a wilderness area in Northeast Brazil, were used as a source of water (CORDERO-SCHIMIDT et al., 2016). Furthermore, leaves are more abundant and widely distributed resources, and therefore they are not targeted by other major competitors, unlike the fruits (KUNZ; DIAZ, 1995; BOBROWIEC; CUNHA, 2010).

Knowing the gaps regarding leaf-eating by bats, this study aims to analyze the existing bibliography on neotropical bats folivory, conducting a quantitative and qualitative review of the literature to list the available information on this topic.

## 2 MATERIAL AND METHODS

Articles on folivory in neotropical bats were searched and selected using some of the main academic databases, Web of Science, Google Scholar, Capes Periodicals, Scopus, ResearchGate, with the following keywords and combinations: “Folivory” and “Bats”; “Leaves” and “Bats”; “Chiroptera” and “Folivory”, for all years available up to 2019. Furthermore, the references of the articles found were reviewed to check for other manuscripts on the topic. The articles looking into the use of leaves for building roosts and those describing bats from the Old World were excluded, as well as the repeated articles and other manuscripts not covering the subject investigated here.

For the tabulation, the following data was taken into consideration: the authors and year of publication; country where each study was carried out; and bat and plant species involved. Afterward, the data was categorized into: literature review; occasional, i.e., when the main object of study was not folivory; observational or monitoring work at colonies or consumption trees; and experimental, in which experiments *ex situ* were carried out. Data such as age, reproductive and sexual classes, foraging times and the motivation for using determined food item was listed as provided by each author. For the plants, the data selected for the tabulation included the species consumed, leaf age (immature/mature), folivory site (basal region/leaf lamina), analysis of the chemical composition, and also whether the consumption was a seasonal event or not.

### 3 RESULTS

Our search in the academic databases returned a total of 24 studies, including manuscripts, articles and notes on folivory by neotropical bats. Checking the works used as a reference for the aforementioned studies, one additional article was included, adding up 25. The analyzed papers were tabulated according to the year and the journal in which they were published, authors and other information contained in the manuscripts (Table 1 available on: <https://cutt.ly/LfZVFiQ> If clicking on the hyperlink does not open the spreadsheet, copy and paste the link into your browser's address bar).

The first article on leaf-eating by New World bats found was published in 1957, and the studies became more frequent after the 1990s, reaching an average of one article per year until 2019.

When categorizing the manuscripts, 56% fell into the occasional class (n = 14); 36%, observational (n = 9); and 8%, literature reviews (n = 2). No experimental study was found within the evaluated period. The other results were obtained from the occasional and observational articles, that is, 92% (n = 23) of the total. A closer look into them revealed that most of the research was produced in Brazil (65.3%), followed by Venezuela (13.1%), Puerto Rico (8.7%), Panama, Mexico, and Trinidad and Tobago (4.3% each).

Leaf-eating was reported for nine species from four neotropical bat genera, all of them belonging to the Phyllostomidae family. The most substantial number of records accounted for *Artibeus lituratus* (Olfers, 1818) (n=9), followed by *A. jamaicensis* (Leach 1821) (n=3), *Platyrrhinus lineatus* (Linnaeus, 1766) (n=4), *A. amplus* (Handley, 1987) (n=2), *A. planirostris* (Spix, 1823) (n=2), *A. fimbriatus* (Gray, 1838) (n=1), *A. concolor* (Peters, 1865) (n=1), *Carollia perspicillata* (Linnaeus, 1758) (n=1), and *Micronycteris hirsuta* (Peters, 1869) (n=1).

Seven of the studies reviewed, all of them belonging to the occasional class, did not describe the species of the plants consumed, and two of them did not have the leaves identified at any taxonomic level due to the small leaf fragment found or some limitation in the botanical area. The other researches (14), when possible, presented a definition at the species level, or identified the genus or family of the foliage consumed.

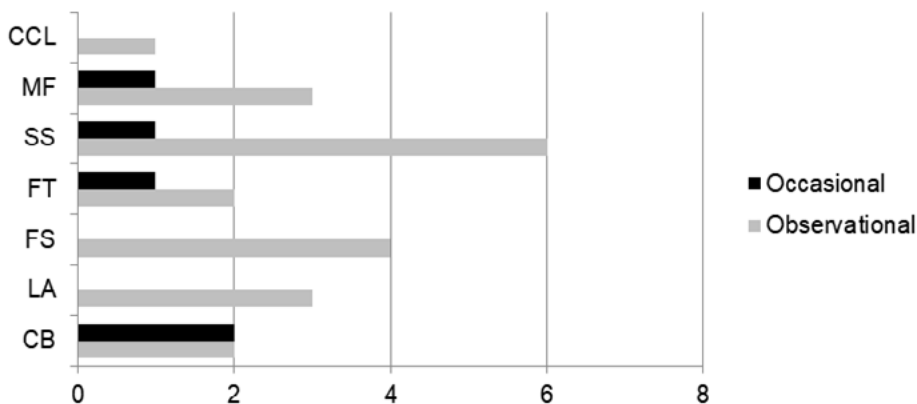
Thereupon, folivory in bats was reportedly associated with 11 families, 16 genera and 17 species of plants. The consumption of the families Fabaceae and Moraceae was reported for five different species of bats, accounting for the most significant number of records. The other seven families (Apocynaceae, Dichapetalaceae, Melastomataceae, Euphorbiaceae, Caricaceae, Anacardiaceae, Calophyllaceae) had their leaves consumed by one species of bat each. Most of the plant species identified belonged to the Fabaceae (n = 5) and Solanaceae (n = 4) families (Table 2. Available on: <https://cutt.ly/ZfZBHZb> If clicking on the hyperlink does not open the spreadsheet, copy and paste the link into your browser's address bar)

For the bats, the reports showed that *A. amplus* and *A. planirostris* consumed the broadest variety of botanical families (n = 6). Moreover, the consumption of three families by *Artibeus lituratus* and *A. jamaicensis* was described, whereas the other species consumed only one each. Regarding specific preferences, the exclusive consumption of leaves of *Ficus religiosa* L. (Moraceae) and *Senna georgica*

H. S Irwin; Barneby (Fabaceae) was described for *Artibeus fimbriatus* and *C. perspicillata*, respectively. The reports also described that some bat species of the genus *Artibeus* can share the use of a plant species even when in different countries, for example, *Erythrina poeppigiana* Walp. O.F.Cook (Fabaceae), which was consumed by *A. amplus* and *A. lituratus* in Venezuela and by *A. jamaicensis* in Puerto Rico, and *F. religiosa* (Moraceae), consumed by *A. fimbriatus* in Brazil and *A. lituratus* in Trinidad and Tobago (Table 2. Available on: <https://cutt.ly/ZfzBHZb> If clicking on the hyperlink does not open the spreadsheet, copy and paste the link into your browser's address bar)

As most of the manuscripts among the reviewed articles described occasional studies, only three of them characterized the classes (age, reproductive and sexual) of the bats consuming leaves; other three looked into the foraging time and seven verified whether this feeding habit was a seasonal event. In addition, four of the studies sought to explain the reasons that contribute to folivory; however, only one of them carried out an analysis of the chemical composition of the leaves that would justify their consumption. Although data on the physical aspects of the leaves consumed is deemed important, it was pointed out only by a few authors. Information on leaf age was recorded in three studies, whereas the folivory site appeared in four (Figure 1).

**Figure 1** – Topics covered in the works on folivory by neotropical bats exhibited quantitatively: Chemical composition of leaves (CCL); Motivation for folivory (MF); Seasonality (SS); Foraging time (FT); Folivory site (FS); Leaf age (LA); and Age, reproductive and sexual classes of the bats (CB), in the articles categorized as occasional (main object of study was not folivory) and observational (main object was folivory), selected from the entries returned by Web of Science, Google Scholar, Capes Periodicals, Scopus, ResearchGate when inputting the keywords “Folivory” and “Bats”; “Leaves” and “Bats”; “Chiroptera” and “Folivory”, for all years available up to 2019



Source: Elaborated by the authors

## 4 DISCUSSION

The number of manuscripts that address neotropical bats folivory is rather limited. Therefore, there is a scarce set of data on the physical and chemical characteristics of the foliage of the plant species consumed, the motivation for the consumption of this food item, and the classes (age, reproductive and sexual) of the bats.

The few studies carried out with species from the New World were mostly occasional, which suggests that this feeding habit may have been neglected because the methodologies employed, which often analyzed only the stomach and fecal contents of the animals, were not very efficient for folivory (ZORTÉA, 1993; KUNZ; INGALLS, 1994).

To understand neotropical bats folivory, observational researches were initiated in the 1990s (ZORTÉA, 1993; ZORTÉA; MENDES, 1993; KUNZ; DIAZ, 1995). They were resumed some years later with observations at trees that had their leaves consumed, (BOBROWIEC; CUNHA, 2010) through the direct monitoring of colonies (RUIZ-RAMONI et al., 2011; CORDERO-SCHIMIDT et al., 2016; DUQUE-MÁRQUEZ et al., 2019), and also camera traps (ROCHA et al., 2016; PEREIRA et al., 2017). In addition to fieldwork, Kunz and Ingalls (1994) and Dudley and Vermeij (1994) compiled data from the literature on leaf-eating by bats and ranked some hypotheses to be tested. Experimental tests have not been performed on neotropical bats, and up to now only *Pteropus tonganus* (Quoy; Gaimard, 1830), an Old World species, has been investigated both in an *ex situ* and controlled situation (NELSON et al., 2005).

Leaf-eating was described for 26 species of bats, 17 of which were from the Old World (KUNZ; DIAZ, 1995; ELANGOVA et al., 2001; REITER; TOMASCHEWSKI, 2003; NELSON et al., 2005; ALCAZAR et al., 2019; AUNG; HTAY, 2019), and the other nine were the neotropical bats showed in this study.

Leaf-eating was more thoroughly investigated in *A. lituratus*, a predominantly frugivorous bat, perhaps because of its widespread geographic distribution, occurring from Mexico to Northern Argentina (SIMMONS, 2005), and its high tolerance and abundance in anthropized environments, which facilitates the study of its ecology (ZORTÉA; CHIARELLO, 1994; BREDT; UIEDA, 1996; BREDT et al., 2012).

Folivory was mostly described for phytophagous bats. And this habit was admittedly described evolving from the accidental consumption of leaves while foraging for fruit (FREEMAN, 2000). In addition, it was suggested that fruit-eating bats particularly use leaves to supplement their protein intake because, although they can consume insects, their adaptations to do so are limited; moreover, leaves are an abundant resource, which makes them more advantageous in energetic terms (KUNZ; DIAZ, 1995; TAN et al., 1998). However, a single report made in Panama showed the use of leaves by an insectivorous species, *M. hirsuta*. The author who described it assumed this apparently isolated fact as a nonintentional event, which suggests that the leaves were caught accidentally while foraging for insects on its surface (WILSON, 1971).

Descriptions of the plant species consumed pointed out *A. planirostris* and *A. amplus* were the bats using the greatest diversity of leaves, each of which used species from six distinct botanical families. However, when considering all plant resources (fruits, leaves and flowers), *C. perspicillata* and *A. jamaicensis* were the greatest generalists, consuming 219 and 212 plant species, respectively (BRE-

DT et al., 2012). *A. amplus*, *A. lituratus* and *A. jamaicensis* were reported consuming *E. poeppigiana* (Fabaceae), and *A. fimbriatus* and *A. lituratus* were spotted eating *F. religiosa* (Moraceae) leaves even in distinct regions. These species are also known to share a preference for the fruits of the Moraceae family, more specifically for the species of the genus *Ficus* L. (PAROLIN et al., 2016).

Phytophagous bats consumption of fruits, flowers and leaves were reported for 89 botanical families (BREDT et al., 2012). This present review found folivory was specifically described for only 11 of them, and Fabaceae and Moraceae were the families visited by the largest number of bat species. These two plant families are among the fundamental sources of foraging for bats (BREDT et al., 2012). Among the 17 plants identified at the species level only eight had their leaves consumed, whereas one species had their leaves and flowers used, and other eight their leaves and fruits (BREDT et al., 2012).

The age, reproductive and sexual classes of bats including leaves in their diet were described only in four articles, three of which reported adult males (SAZIMA et al., 1994; KUNZ; DIAZ, 1995; ROCHA et al., 2016) and one adult females (BERNARD, 1997) as the potential consumers of this food item. The former are believed to be harem males avoiding being away for long periods to protect their colonies and thereby ending up consuming items near their roosts (KUNZ; DIAZ, 1995). However, some authors also proposed that folivory is a means to supplement the diet of pregnant and/or lactating females with protein and calcium both for the formation of the pup and for the production of milk (KUNZ; DIAZ, 1995; NELSON et al., 2005). It was also theorized that young individuals of both sexes feed by folivory to support their rapid growth (NELSON et al., 2005) or to get the metabolites that stimulate their reproductive activity (KUNZ; INGALLS, 1994; KUNZ; DIAZ, 1995).

Another theory proposed that folivory bats tend to consume the rich in water and carbohydrates fruits first so that their energy demand associated with the flight can be supplied (ELANGO VAN et al., 2001) and also because the fruits are a resource both temporally and spatially limited, subjected to more intense competition during the early evening, whereas the leaves, the most abundant and widely distributed of the resources, can be consumed at any other time (KUNZ; DIAZ, 1995; BOBROWIEC; CUNHA, 2010; ELANGO VAN et al., 2001).

Some authors observed that *P. lineatus* (AGUIAR, 2005) and *A. lituratus* (BOBROWIEC; CUNHA, 2010) showed folivorous behavior after consuming fruit, as well as *Cynopterus sphinx* (Vahl, 1791), an Old World species (ELANGO VAN et al., 2001). However, during the monitoring of a colony of *P. lineatus*, leaf-eating was spotted concomitantly with the beginning of fruit consumption at the early evening and lasting until 2 am (ROCHA et al., 2016). The authors did not corroborate the existence of a time pattern for the foliage foraging.

In addition, these folivory events were taken as nonseasonal (RUIZ-RAMONI et al., 2011; CORDEIRO-SCHIMIDT et al., 2016), although a certain predominance of occurrences during the dry season (BOBROWIEC; CUNHA, 2010; ROCHA et al., 2016) or prior to the appearance of males with exposed scrotum and pregnant females (DUQUE-MÁRQUEZ et al., 2019), only Zortéa and Mendes (1993) may suggest some seasonality. Therefore, folivory by neotropical bats can be regarded as a nonseasonal habit according to what was verified for *Cynopterus brachyotis* (Muller, 1838), bat of the family Pteropodidae, in Malaysia (TAN et al., 1998).



Mammals such as primates, rodents and marsupials including leaves in their diet try to select the plant species having the most advantageous nutritional values and avoid those containing possible toxins (WATERMAN, 1984; MATSUDA et al., 2013; FARMER, 2014; JENSEN et al., 2015; ITO; HAYASHI, 2018). In addition to that, the choice of high sugar content food sources was described both for bats (AYALA-BERDON et al., 2011) and large mammals such as deer and primates (TIXIER et al., 1997; REMIS, 2002; REMIS; KEER, 2002), since fruits or leaves with a bitter taste suggest that they may have toxins or compounds that reduce their digestibility (CRITCHTEY; ROLLS, 1996).

Consequently, the chemical composition of the leaves consumed by bats was appointed by many authors the determining factor for choosing the plant species. Nutritional analysis of the foliage Old World bats were reported consuming suggests that the amount of nutrients present in it is higher than the content found in the fruits these animals usually eat (RAJAMANI et al., 1999; NELSON et al., 2000; RUBY et al., 2000; REITER; TOMASCHEWSKI, 2003; NELSON et al., 2005; KRISHNARATHI et al., 2014). Among the works carried out with neotropical bats, only one quantified the proteins and lipids present in the leaves consumed, thereby proposing that these animals seek to complement their deficient in protein diet by means of folivory (KUNZ; DIAZ, 1995). This was also suggested for Old World bats (LOWRY, 1989; RAJAMANI et al., 1999; NELSON et al., 2000; RUBY et al., 2000) and for primates (NORSCIA et al., 2012; GANZHORN et al., 2017).

However, there is no consensus among the Old World researchers that protein is in fact the nutrient sought. Some claim that the higher concentration of calcium in the leaves attracts animals (RAJAMANI et al., 1999; NELSON et al., 2000; RUBY et al., 2000; NELSON et al., 2005). An experiment carried out with *P. tonganus* found that folivory bats increased their calcium intake by 46% compared to those not consuming leaves (NELSON et al., 2005). Nonetheless, leaves can also be selected according to their content of sodium (NELSON et al., 2000) or alkaloids and flavonoids (KRISHNARATHI et al., 2014). Reiter and Tomaschewski (2003) sustained that a combination of nutrients in the chemical composition of the foliage, not specifically a single one, would explain why folivory occurs.

Although different studies may have led to believe that nutrients are the only key factor for searching and choosing leaves as a food source, a recent study put forward that neotropical bats inhabiting the semiarid Brazilian Caatinga may seek leaves for water (CORDERO-SCHIMIDT et al., 2016) to withstand the extreme weather conditions found in this specific biome, categorized as BShw (hot and dry) with an average annual rainfall inferior to 800 mm, according to the Köppen classification (ALVARES et al., 2013). Corroborating with this hypothesis, some flying squirrels were described preferring leaves with a greater volume of water, although this factor does not seem to be important for other mammals such as primates (ITO; HAYASHI, 2018).

Moreover, the nutritional content may vary according to the leaf age (MAGALHÃES; BLUM, 1999); therefore, checking for preference while choosing between immature and mature leaves is essential to understand folivory. However, the studies carried out on the chemical composition of leaves consumed by bats so far have not differed in this regard (KUNZ; DIAZ, 1995; NELSON et al., 2005; KRISHNARATHI et al., 2014).

Studies showed that different species of mammals prefer to use immature over mature leaves (ITO; HAYASHI, 2018), likely because the latter are lower in fiber, and thus more palatable (WATERMAN, 1984; HILL; LUCAS, 1996), besides being richer in protein (RIIPI et al., 2002; BARBEHENN et al., 2017). Data on this possible preference for neotropical bats is incongruous. Pereira and collaborators (2017), for example, when monitoring a colony of *C. perspicillata*, observed a highest consumption of immature leaves; whereas *A. jamaicensis* was reported consuming a larger number of mature leaves (KUNZ; DIAZ, 1995); and *A. lituratus* did not show any preference for leaf ages at all (ZORTÉA; MENDES, 1993).

Likewise, the folivory site (basal region or leaf lamina) has been somewhat overlooked. Only four studies looking into that were found, and the results thereon described the basal region as the preferred for consumption (ZORTÉA; MENDES, 1993; KUNZ; DIAZ, 1995; CORDERO-SCHIMIDT et al., 2016; DUQUE-MÁRQUEZ et al., 2019). Knowing that the concentrations of nutrients vary according to the leaf regions (RIOS et al., 2012), the basal region was appointed as the preferable choice due to its richer water and lower fiber content (SANDARS et al., 2010), as well as its a highest concentration of important nutrients for the bats diet (CORDERO-SCHIMIDT et al., 2016).

Despite the number of studies on neotropical bats folivory has increased in recent years, there are still many gaps to be bridged. Thus, the following questions and hypotheses are yet to be tested: (I) Do all the classes (age, reproductive and sexual) eat leaves? (II) Is there a consumption preference for a certain leaf age and/or leaf portion? (III) Are nutrients and/or secondary compounds determining factors for the selection of a given plant species by the bats?

To better understand these and other questions, there is a need to deepen the research through either direct monitoring or camera traps, carrying out experimental tests in controlled environments, and analyzing the chemical composition of the plant species used tests in controlled environments, and analyzing the chemical composition of the plant species used.

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