Two in one: the little bat that pollinates and disperses plants at an urban site in Southeastern Brazil

Ivan Sazima1* & Marlies Sazima2

1Universidade Estadual de Campinas, Instituto de Biologia, Museu de Biodiversidade Biológica, Campinas, SP, Brasil.
2Universidade Estadual de Campinas, Instituto de Biologia, Departamento de Biologia Vegetal, Campinas, SP, Brasil.

*Corresponding author: isazima@gmail.com

SAZIMA, I., SAZIMA, M. Two in one: the little bat that pollinates and disperses plants at an urban site in Southeastern Brazil. Biota Neotropica 22(2): e20211290. https://doi.org/10.1590/1676-0611-BN-2021-1290

Abstract: The glossophagine Pallas’s long-tongued bat (Glossophaga soricina) fares well in urban environments across its range. In addition to roost sites, there are nectar and fruit sources available in diverse situations across the urban gradient. Phyllostomid bats that thrive in urbanized situations are behaviorally plastic generalists and rely on patches of ornamental or feral plants as food sources. Herein we report on G. soricina and its food sources at an urbanized site in Southeastern Brazil. This small phyllostomid bat consumes nectar from landscaping ornamental plants, besides consuming the soft pulp along with the tiny seeds of pioneer trees and shrubs. In addition to these natural sources, the bat exploits hummingbird feeders to consume the sugared water. Ingested small seeds are defecated in flight, the bat acting as a disperser of pioneer plants that favor cleared areas.

Glossophaga soricina role as flower-pollinator and seed-disperser at Neotropical urban areas merits further attention due both to the maintenance of urban biodiversity and delivery of ecosystem services.

Keywords: Ecosystem services; Flowers; Foraging behavior; Fruits; Phyllostomidae.

Dois em um: o pequeno morcego que poliniza e dispersa plantas em local urbano no Sudeste do Brasil

Resumo: O morcego beija-flor (Glossophaga soricina) adapta-se a ambientes urbanos na sua área de distribuição. Além de abrigos diurnos, há fontes de néctar e frutos ao longo do gradiente urbano. Morcegos filostomídeos que se adaptam a situações urbanas são generalistas comportamentalmente flexíveis e dependem de trechos com plantas ornamentais ou ferais como fonte alimentar. Relatamos aqui informações sobre o morcego beija-flor e suas fontes alimentares em um local urbanizado no sudeste do Brasil. Este pequeno morcego glossofágneo busca néctar em plantas usadas em paisagismo, além de consumir a polpa macia, juntamente com as sementes minúsculas, de plantas pioneiras. Além das fontes naturais, o morcego explora água açucarada dos bebedouros de beija-flores. Sementes pequenas são defecadas em voo e o morcego age como dispersor de plantas poineiras em áreas sem vegetação. A função de G. soricina como polinizador de flores e dispersor de sementes em áreas urbanas nos Neotrópicos merece atenção adicional devido à manutenção da biodiversidade urbana e da prestação de serviços ecossistêmicos.

Palavras-chave: Comportamento alimentar; Flores; Frutos; Phyllostomidae; Serviços ecossistêmicos.
Introduction

The Pallas’s long-tongued bat (*Glossophaga soricina*) is a phyllostomid widespread in South America east of the Andes (Alvarez 1991, Dias et al. 2017, Calahorra-Oliart et al. 2021), and fares well in urbanized environments across its distribution (e.g., Lemke 1985, Ballesteros et al. 2012, Nunes et al. 2017, Turcios-Casco et al. 2021). In addition to roost sites, there are nectar and fruit sources available for phyllostomid bats in diverse situations across the urban gradient (Bredt et al. 2002, Silva et al. 2005, Kruszynski et al. 2016, Vilar et al. 2016, Nunes et al. 2017). Phyllostomid bats that thrive in urbanized situations are behaviorally plastic and rely on patches of ornamental or feral plants as food sources (Bredt et al. 2002, Kruszynski et al. 2016, Garcia et al. 2000, Pellón et al. 2021, Turcios-Casco et al. 2021).

Notwithstanding its widespread occurrence in South America and commonness in urban areas, Pallas’s long-tongued bat remains understudied from the perspective of food resources at a given urban area (but see Pellón et al. 2021). We had the opportunity to sporadically observe and record this phyllostomid bat at a very small urbanized site in Southeastern Brazil for a period spanning about 10 years. Herein, we present a snapshot report on the food sources of *G. soricina* and the behavior displayed on these resources at the site.

Material and Methods

The study area is a block of about 60.000 m², including streets, sidewalks, gardens, and backyards at an urban area (22°49’36”S, 47°04’15”W, 621 m.a.s.l.) in the vicinity of the Universidade Estadual de Campinas, São Paulo, South-eastern Brazil. We sporadically observed Pallas’s bats feeding activity on trees and shrubs used in landscaping and gardening, besides some feral ones for a period spanning 10 years. We observed the bats with bare eyes and documented its behavior with a 70-300 mm telephoto lens mounted on a SLR camera (2009-2019). We observed the bats with bare eyes and documented its behavior with a 70-300 mm telephoto lens mounted on a SLR camera (2009-2019). We observed the bats with bare eyes and documented its behavior with a 70-300 mm telephoto lens mounted on a SLR camera (2009-2019).

**Table 1.** Food sources used by the phyllostomid bat *Glossophaga soricina* at a small urban site in Campinas, São Paulo, Southeastern Brazil. Plant families, genera, and species in alphabetical order. E= exotic. Last line is provisioned food. Color flower/fruit is color visible to humans.

| Plants                          | Habit  | Food type        | Color flower/fruit |
|---------------------------------|--------|------------------|--------------------|
| Lythraceae                      | Tree   | Nectar           | White              |
| *Lafioensia pacari*             |        |                  |                    |
| Malvaceae                       | Shrub  | Nectar           | Light yellow       |
| *Callianthe fluviatilis*        |        |                  |                    |
| Moraceae                        | Tree   | Nectar           | White              |
| *Morus nigra*                   | Tree   | Infructescence pulp | Purple            |
| Muntingiaceae                   |        |                  |                    |
| *Muntingia calabura*            | Tree   | Fruit            | Yellowish green    |
| Piperaceae                      | Shrub  | Infructescence pulp | Light green       |
| *Piper aduncum*                 |        |                  |                    |
| Urticaceae                      | Tree   | Infructescence pulp | Greyish yellow    |
| *Cecropia pachystachya*         |        |                  |                    |
| Provisioned food source         | Hummingbird feeder | Sugared water | Yellow base       |
| NA                              |        |                  |                    |
nectar content before the actual visit. After this exploratory flight, the bat visited up to 10-15 flowers in succession, making rounds over the tree during up to 5 min. It visited the flowers hovering fleetingly, tenths of a second. Visits to a given L. pacari tree were at intervals of up to 30 min, but sometimes the intermissions were shorter (about 10-15 min), possibly due to the bats being different individuals. The bat visited the Luehea alternifolia tree at intervals of 50-60 min, exploiting all the available flowers at each visit (we recognized the bat due to a natural marking). Its visits were similar to those described on L. pacari flowers. The flowers of C. fluviatilis were visited by the bat at irregular intervals of up to 60 min, and even more fleetingly than the visits to the L. pacari and L. alternifolia flowers. During visits to flowers of these three plant species, the bats touched the reproductive parts, which would result in pollination.

When visiting the Cecropia pachystachya tree and the Piper aduncum shrub, the bat chewed out a portion of the infructescences while hovering and flew away with a mouthful. It visited these two food sources at irregular intervals that lasted about 5-40 min. We often observed bats defecating along their pathway, spraying small seeds on the ground or house walls. We also found seeds of both C. pachystachya and P. aduncum in the feces scattered on vegetation after the bat’s visits to a given food source.

Pallas’s long-tongued bat took out a portion of the Morus nigra tree in a way similar to those described above, also at irregular intervals that lasted about 5-30 min. Due to poor illumination of the single Muntingia calabura tree, we were unable to observe whether the bat grabbed a fruit while hovering or had to cling to be able to tear the fruit from its stalk and fly away with the fruit in its mouth.

The bat visited hummingbird feeders at irregular intervals that lasted 5-15 min, lapping the sugared water while hovering fleetingly. It combined its visits to the feeder with those on a few L. pacari flowers available at the time, and the P. aduncum shrub that was close to the sugared water source.

Discussion

Our observations centered on Pallas’s long-tongued bat constitute the second study about food sources used by this bat species at an urban site. Plants used as food by Glossophaga soricina were recently studied at an urban site in Lima, Peru (Pellón et al. 2021). However, judging from the recent review of the genus by Calahorra-Aliart et al. (2021), the species that occurs in Peru is Glossophaga valens (distribution in Handley et al. 1991 as G. soricina valens), which renders our snapshot study as the first that address diverse food sources of G. soricina at an urban site.

The visits of Glossophaga soricina to nectar-offering flowers did not differ from available studies on flower-visiting bats to night-blooming plants, including Lafoensia pacari and Luehea alternifolia (Silva & Peracchi 1999, Sazima et al. 1982). However, visits of this bat to flowers of Callianthe flaviatilis are not available in the scientific literature, besides a brief mention to its one night-lasting flowers in Buzato et al. (1994) as Abutilon peltatum. We were surprised by the exceedingly fleeting visits, which precluded photographic records with the equipment we had. Pollination of the three plant species would be expected, as the flowers fit within the known types usually pollinated by bats (Buzato et al. 1999).

Figure 1. The Pallas’s long-tongued bat (Glossophaga soricina) exploits three food source types at an urbanized site in Campinas, São Paulo, Southeastern Brazil: (a) the bat laps the copious nectar from the flowers of a Lafoensia pacari tree, (b) the bat laps nectar from a flower of a Luehea alternifolia tree, (c) the bat chews a portion of the soft pulp of Piper aduncum, swallowing the tiny seeds along - note pulp already chewed out, (d) the bat laps sugared water from a hummingbird feeder left in place overnight. Glossophaga soricina visits each food source hovering fleetingly.
Visits to fruits by *G. soricina* apparently remain undescribed in the scientific literature to date. This small bat secures the pulp of *Cecropia pachystachya*, *Piper aduncum*, and *Morus nigra* infructescences with a hovering flight similar to that it displays when visiting flowers for nectar. We expected that it would cling to the infructescence to chew a mouthful as displayed by some phyllostomid bats such as Seba’s short-tailed bat *Carollia perspicillata*, which is able to hover while feeding on flowers but also cling to some fruits (Sazima & Sazima 1978, Sazima et al. 2003). We were unable to observe how *G. soricina* secures the *Muntingia calabura* fruits, but conceive it would cling on a branch.

Visits of Pallas’s long-tongued bat to hummingbird feeders left unattended at night were observed since the nineteen-nineties in Southeastern Brazil. In Vitória, a seaside town in Espírito Santo, visits of this bat to feeders are known since about 1995 (J.L. Gasparini, pers. comm.), and we photographed the visits there in 1997. This behavior spread through *G. soricina* populations and now is a common view at several urban and suburban regions in Brazil (Esbérad et al. 1999, Santos & Uidea 2002). However, visits to hummingbird feeders are not restricted to urban sites. We recorded this bat species exploiting bird feeders on the veranda of a hotel within the Atlantic forest at the Itatiaia National Park, Rio de Janeiro state, at about 1.200 m a.s.l.

Despite its use of sugared-water feeders, Pallas’s long-tongued bat still relies on flowers and fruits for its nutritional and energy intakes. This is likely due to its low energy reserves and failure to maintain an adequate level of blood glucose after a short-fasting period, contrary to which happens with essentially fruit-feeding phyllostomid species (Pinheiro et al. 2006, Amaral et al. 2019). There is some evidence that the use of hummingbird feeders interfere with pollination of plants in a given area covered by flower-visiting birds (Arizmendi et al. 2007, Maruyama et al. 1999). Even if the breeding success of a given plant is lower in the close presence of the feeder (Arizmendi et al. 2007), or the hummingbird assemblage may change with provision of feeders (Maruyama et al. 1999), the plants still are visited and pollinated. A similar situation is likely to occur with *G. soricina*.

In conclusion, Pallas’s long-tongued bat exploited a variety of food sources available at our very small urbanized study site, including nectar, fruit pulp, and sugared water. Even in an urban settings, the bat retained its ecological functions as a flower-pollinator and seed-disperser. Some of these two ecosystem services are recorded in other urbanized regions available at our very small urbanized study site, including nectar, fruit pulp, and sugared water. Even in an urban settings, the bat retained its ecological functions as a flower-pollinator and seed-disperser. Some of these two ecosystem services are recorded in other urbanized regions

Acknowledgments

We thank J. L. Gasparini for comments on the first appearance of Pallas’s bat exploiting hummingbird feeders in the city of Vitória, Espírito Santo, SE Brazil. We acknowledge the CNPq - National Council of Scientific and Technological Development for grants 300992/79-ZO (IS) and 302781/2016-1 (MS). Comments and suggestions of two anonymous reviewers and the associate editor improved our manuscript.

Associate Editor

Márcia Alexandra Rocca

Author Contributions

Ivan Sazima: Data collection; data analysis and interpretation; manuscript preparation; critical revision.

Marlies Sazima: Data collection; data analysis and interpretation; critical revision.

Conflicts of Interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

References

AGUIAR, L.M.S., BERNARD, E., MACHADO, R.B. 2014. Habitat use and movements of *Glossophaga soricina* and *Lonchopylla dekeyseri* (Chiroptera: Phyllostomidae) in a Neotropical savannah. Zoologia 31(3): 223-229. https://doi.org/10.1590/S1984-46702014000300003

ALTMANN, J. 1974. Observational study of behaviour: sampling methods. Behaviour 49:227–267. https://doi.org/10.1163/156853974X00534

ALVAREZ, J., WILLIG M.R., KNOX JONES JR. J., WEBSTER W.D. 1991. *Glossophaga soricina*. Mammm. Species 379: 1-7.

AMARAL, T.S., PINHEIRO, E.C., FREITAS, M.B., AGUIAR, L.M.S. 2019. Low energy reserves are associated with fasting susceptibility in Neotropical nectar bats *Glossophaga soricina*. Braz. J. Biol. 79(2): 165-168. https://doi.org/10.1590/1519-6984.169674

ARIZMENDI, M. DEL C., CONSTANZA, M.S., LOURDES, J., IVONNE, F.M., EDGAR, L.S. 2007. Effect of the presence of nectar feeders on the breeding success of *Salvia mexicana* and *Salvia fulgens* in a suburban park near México City. Bio. Conserv. 136(1): 155–158. https://doi.org/10.1016/j.biocon.2006.11.016

AUGUSTO, E.L., HAYASHI, M.M. 2004. Morcegos do Parque Chico Mendes, Osasco, São Paulo, como dispensadores de sementes. Rev. PIBIC 1(1): 15-19.

BALLESTEROS, C.J., RACERO-CASARRUBIA, J. 2012. Murciélagos del área urbana en la ciudad de Montería, Córdoba - Colombia. Rev. MVZ Córdoba 17(3): 3193-3199. https://doi.org/10.21897/rmvz.220

BREDT, A., UIEDA, W., PINTO, P.P. 2002. Visitas de morcegos fitófagos a *Muntingia calabura* L. (Muntingiaceae) em Brasília, Centro-Oeste do Brasil. Rev. Bras. Zoologiç. 4(1): 111-122.

BUZATO, S., SAZIMA, M., SAZIMA, I. 1994. Pollination of three species of *Abutilon* (Malvaceae) intermediate between bat and hummingbird flower syndromes. Flora 189(4): 327-334. https://doi.org/10.1016/s0367-2530(17)30613-8

BUZATO, S., SAZIMA, M., SAZIMA, I. 1999. Bat-pollinated flower assemblages and bat visitors at two Atlantic forest sites in Brazil. Ann. Bot. 83(6): 705-712. https://doi.org/10.1006/anbo.1999.0876

CALAHORRA-OLIART, A., OSPINA-GARCES, S.M., LEON-PANIAGUA, L. 2021. Cryptic species in *Glossophaga soricina* (Chiroptera: Phyllostomidae): do morphological data support molecular evidence? J. Mamm. 102(1): 54-68. https://doi.org/10.1093/jmammal/gyaa116

DIAS, C.A.R., SANTOS JR., E.E., PERINI, F.A., SANTOS, F.R. 2017. Biogeographic scenarios for the diversification of a widespread Neotropical species, *Glossophaga soricina* (Chiroptera: Phyllostomidae). Syst. Biodivers. 15(5): 440-450. https://doi.org/10.1080/14772001.2016.1271060
Glossophaga soricina food sources urban site

ESBÉRARD, C., LIUZ, E.M., NUNES, M.S., CRUZ, R.C., CARNEIRO, R. 1999. Um falso perigo: morcegos urbanos. Vetores e Pragas 19-28.

GARCIA, Q.S., REZENDE, J.L.P., AGUIAR, L.M.S. 2000. Seed dispersal by bats in a disturbed area of Southeastern Brazil. Rev. Biol. Trop. 48(1): 125-128. http://www.scielo.sa.cr/scielo.php?script=sci_arttext&pid=S0034-77442000000100014&lng=en&nrm=iso

KRUSZYNSKI, C., DINIZ-REIS, T.R., PEDROZO, A.R. 2016. A new food resource for Glossophaga soricina (Mammalia: Chiroptera) in southeast Brazil. Bol. Soc. Bras. Mastozool. 77: 124-130.

LEMKE, T.O. 1985. Pollen carrying by the nectar-feeding bat Glossophaga soricina in a suburban environment. Biotropica 17(2): 107-111. https://doi.org/10.2307/2388502

LOBOVA, T.A., MORI, S.A., BLANCHARD, F., PECKHAM, H., CHARLES-DOMINIQUE, P. 2003. Cecropia as a food source for bats in French Guiana and the significance of fruit structure in seed dispersal and longevity. Am. J. Bot. 90(3): 388-403. https://doi.org/10.3732/ajb.90.3.388

MARUYAMA, P.K., BONIZÁRIO, C., MARCON, A.P., D’ANGELO, G., SILVA, M.M., SILVA-NETO, E.N., OLIVEIRA, P.E., SAZIMA, I., SAZIMA, M., VIZENTIN-BUGONI, J., ANJOS, L., RUI, A.M., MARÇAL JR. O. 2019. Plant-hummingbird interaction networks in urban areas: Generalization and the importance of trees with specialized flowers as a nectar resource for pollinator conservation. Biol. Conserv. 230: 187-194. https://doi.org/10.1016/j.biocon.2018.12.012

NUNES, H., ROCHA, F.L., CORDEIRO-ESTRELA. P. 2017. Bats in urban areas of Brazil: roosts, food resources and parasites in disturbed environments. Urban Ecosyst. 20(0): 953-969. https://doi.org/10.1007/s11252-016-0632-3

PELLÓN, J.J., MENDOZA, J.L., QUISPE-HURE, O., CONDO, F., WILLIAMS, M. 2021. Exotic cultivated plants in the diet of the nectar-feeding bat Glossophaga soricina (Phyllostomidae: Glossophaginae) in the city of Lima, Peru. Acta Chiropt. 23(1): 107-117. https://doi.org/10.3161/15081109ACC2021.23.1.009

PINHEIRO, E.C., TADDEI, V.A., MIGLIORINI, R.H., KETTELHUT, I.C. 2006. Effect of fasting on carbohydrate metabolism in frugivorous bats (Artibeus lituratus and Artibeus jamaicensis). Comp. Physiol. B, Biochem. Mol. Biol. 143(3): 279-284. http://dx.doi.org/10.1016/j.cbpb.2005.11.013

SANTOS, C.F., UIEDA, W. 2002. Comportamento de visitas á bebedouros de beija-flor do morego nectarívoro Glossophaga soricina. Anais do II Simpósio de Ecologia Comportamental e de Interações: 75.

SAZIMA, M., BUZATO, S., SAZIMA, I. 2003. Dyssochroma viridiflorum (Solanaeaceae): a reproductively bat-dependent epiphyte from the Atlantic rainforest in Brazil. Ann. Bot. 92(5): 725-730. https://doi.org/10.1093/aob/mcg190

SAZIMA, M., FABIÁN, M.E., SAZIMA, I. 1982. Polinização de Luehea speciosa (Tiliaceae) por Glossophaga soricina (Chiroptera, Phyllostomidae). Rev. Bras. Biol. 42(3): 505-513.

VILAR, E.M., SILVA-FILHO, T.P., SILVA, L.A.M. 2016. Abrigos antrópicos utilizados por morcegos no semiárido pernambucano. Bol. Soc. Bras. Mastozool. 77: 79-86.

WINTER, Y., STICH, K.P. 2005. Foraging in a complex naturalistic environment: capacity of spatial working memory in flower bats. J. Exp. Biol. 208(3): 539-548. https://doi.org/10.1242/jeb.01416

Received: 25/09/2021
Accepted: 03/03/2022
Published online: 04/04/2022