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RESEARCH ARTICLE

On the feeding behavior of *Sturnira ludovici* (Chiroptera: Phyllostomidae) in northwestern Ecuador

Sobre el comportamiento alimenticio de *Sturnira ludovici* (Chiroptera: Phyllostomidae) en el noroccidente de Ecuador

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Abstract

Sturnira ludovici is a common phyllostomid bat distributed along the western slopes of the northern Andes. However, little is known about its behavior and diet in the wild. In 2021, during a study in northwestern Pichincha, Ecuador, I filmed a subadult female feeding on a mature *Piper aduncum* fruit; this was the first audiovisual record of *S. ludovici* consuming fruit. The bat bit the fruit bilaterally with its post-canine teeth, moving its head medio-laterally and using its tongue to ingest the pulp, occasionally pausing to smell it. Feeding lasted two minutes and 26 seconds. This record highlights understory fruit handling by *S. ludovici*, providing novel insights into its dietary and ecological behavior. Additionally, this study demonstrates the value of mobile devices for behavioral documentation and encourages further experimental studies to explore feeding strategies involving *P. aduncum* and other understory fruits.

Keywords: behavior, frugivory, fruit handling, Phyllostomidae, understory bats.

Resumen

Sturnira ludovici es un murciélago filostómico común distribuido a lo largo de las laderas occidentales de los Andes septentrionales. Sin embargo, se sabe poco sobre su comportamiento

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y dieta en estado silvestre. En 2021, durante un estudio en el noroccidente de Pichincha, Ecuador, filmé a una hembra subadulta mientras se alimentaba de un fruto maduro de *Piper aduncum*, que constituye el primer registro audiovisual de *S. ludovici* procesando fruta. El murciélago exhibió una mordida bilateral postcanina con su hocico, combinada con movimientos de cabeza medio-laterales y el uso de la lengua para ingerir la fruta, oliéndola ocasionalmente. La alimentación duró 2:26 minutos. Este registro resalta la manipulación de frutos en el sotobosque por parte de *S. ludovici* y proporciona información novedosa sobre su comportamiento alimentario y ecológico. Este estudio demuestra el valor de los dispositivos móviles para documentar comportamientos y recomienda estudios experimentales adicionales para explorar las estrategias de alimentación sobre *P. aduncum* y otros frutos del sotobosque.

Palabras clave: comportamiento, frugivoría, manipulación de frutos, murciélagos de sotobosque, Phyllostomidae.

INTRODUCTION

Sturnira ludovici (Anthony, 1924) is a common phyllostomid bat species primarily distributed along the western slopes of the northern Andes in South America (Velazco & Patterson, 2013). Its geographic range extends through Venezuela, Colombia, and Ecuador (Solari et al., 2019; Velazco & Patterson, 2013). Despite its broad geographic distribution and its current classification as a species of Least Concern (Tirira, 2021), little is known about its behavior and diet in the wild.

Notwithstanding the numerous descriptions and observations in the literature on the foraging strategies of phyllostomid bats (Gardner, 1977; Saldaña-Vázquez, 2014), there is a lack of photographic material documenting food ingestion and processing behaviors (Dumont, 1999). Furthermore, the feeding habits of both common and rarely recorded species in the field remain largely undocumented (Gardner, 1977).

The use of mobile devices has become increasingly accessible to researchers in recent years, enabling the photography and filming of mammal behavior, noteworthy records, coloration disorders, and ecological relationships (de Roux et al., 2019; Dines & Gennari, 2020; Guerrero et al., 2022; Sielfeld et al., 2024). The main objective of this paper is to describe the feeding behavior of *S. ludovici* based on a video recorded with a smartphone.

METHODS

On May 13, 2021, at 20:23 h, I captured an individual of the genus *Sturnira* (original field

number MARS 113, Marco Antonio Rodríguez-Segovia) in a mist net placed in a secondary forest undergoing assisted regeneration within the Chontaloma Reserve (00°10'51.5" N, 78°54'19" W; altitude 602 m), Pichincha Province, Ecuador. This individual was biting a mature, elongated fruit. I placed the bat in a cloth bag and left the fruit sample in the mist net.

To identify the individual, I examined its dentition, following standard field procedures and specialized field guides (Díaz et al., 2016, 2021; Solari et al., 2019; Tirira, 2017). At 23:07 h, I carefully opened its mouth by pulling the nape hair in order to observe the lower molars. To examine the shape of the upper inner and lower incisors, I gently pulled back the upper and lower lips.

Furthermore, I measured and weighed this individual using a digital caliper and a digital scale, following standard measurements (McCarthy et al., 2006). I determined its age and reproductive status by examining the degree of fusion of the hand-wing epiphyses, the development of nipples, and pelage coloration (Kunz & Parsons, 2009; Molinari & Soriano, 2014).

After measuring MARS 113, I retrieved the mature fruit sample carried by this individual from the mist net. A field assistant released the bat while I offered it the fruit. I filmed the feeding behavior of this individual with a cellphone, illuminating it with a white flashlight. The following day, I explored the surrounding study area and photographed the leaves and fruits of the plant species available in the understory. I compared these photos and the video recording with relevant literature (Lobova & Mori, 2007).

The video was played at slow speed on a computer to analyze the bat movements and the fruit handling time (Bonaccorso & Gush, 1987). A copy of the video has been deposited in the Zenodo repository (Rodríguez-Segovia, 2025). To classify the type of biting and head movements, the patterns of tooth use were categorized into four types: 1. Postcanine-bilateral, 2. Postcanine-unilateral, 3. Precanine-unilateral, and 4. Precanine-bilateral. Head movements were grouped into two categories: 1. Tearing (medio-lateral motions), and 2. Pulling (cranio-caudal motions) (Dumont, 1999).

RESULTS

I identified the individual catalogued in the field as MARS 113 (Figure 1A) as *Sturnira ludovici* based on the presence of flattened lower molars, bicuspid central upper and lower incisors, brown skin coloration, and a medium body size relative to other bat species. From this individual, I recorded the following measurements: head and body length = 75.54 mm, hindfoot length = 12.79 mm, ear length = 13.96 mm, forearm length = 47.28 mm, and weight = 25 g.

The film presented here has a duration of two minutes and 47 seconds and shows a sub-adult female *Sturnira ludovici* (MARS 113) feeding on a mature fruit identified as *Piper aduncum*, resting in the hand of a field assistant (Figure 1B). This female handled the fruit for two minutes and 26 seconds, only using its molars to process it, which coincides with a postcanine-bilateral bite (Figure 1C–D, I).

This individual constantly used its tongue to lick the fruit and ingest its content (Figure 1E). On some occasions, it appeared to be smelling the fruit (Figure 1G). It also performed several quick lateral head movements to bite the fruit and shifted the position of the fruit at two minutes and two seconds (Figure 1F).

Head movements were classified as tearing, medio-lateral motions. Pulling, cranio-caudal motions, were not observed. The individual escaped at the end of the video (Figure 1H). The rachis of the fruit was not ingested. *P. aduncum* was a common shrub in the study area (Figure

2), indicating that this dietary item was obtained from the understory.

DISCUSSION

This paper presents the first audiovisual material that documents *Sturnira ludovici* processing and ingesting *Piper aduncum*. Because the film represents a single sample of this behavior, some implications must be discussed; nevertheless, important dietary and ecological data were obtained. These data make a valuable contribution to the knowledge of Ecuadorian bats.

A study suggests that food processing varies both within and among bat species (Dumont, 1999). In the Curú Wildlife Reserve, Costa Rica, an experiment quantified the frequency of bite types, the number of chews used to process a mouthful, and the frequency of head movements in relation to food hardness in *Sturnira lilium*, a lowland species (Dumont, 1999). This species is currently classified as *S. parvidens* (Hernández-Canchola & León-Paniagua, 2020). During the experiment, many individuals were captured and released into a 13 m² screened enclosure with a canvas ceiling and no floor. A tree was placed inside this artificial habitat to provide roosting sites as well as a feeding station. Bats were offered hard native figs and soft pieces of non-native ripe, skinned papaya. Their feeding behavior was filmed using red light in several repetitions.

The experiment conducted in the Curú Wildlife Reserve found that *S. lilium* exhibited three bite types at different frequencies when fed with papaya (postcanine-bilateral, precanine-unilateral and precanine-bilateral) and four bite types when fed with *Ficus*. For both fruits, a postcanine-bilateral bite was the most frequently observed. The study concluded that bat feeding behavior shifts in response to differences in food hardness, shape, size, and mass. Given that only a single *Piper* sample was analyzed, further studies are needed to determine whether *S. ludovici* exhibits different bite types in response to other dietary items.

Similarly, in Santa Rosa National Park, Costa Rica, another experiment was conducted (Bonaccorso & Gush, 1987). On this occasion, bats



Figure 1. Feeding behavior of *Sturnira ludovici*. **A** = individual MARS 113. **B** = the individual accepted the fruit at 00:17 h. **C–D** = the individual bit the fruit, at 00:27 and 01:08 h, respectively. **E** = at 01:08 h, the same individual used its tongue to process the fruit. **F** = the individual shifted the position of the fruit at 02:02 h. **G** = the individual smelled the fruit between 02:23 and 02:24 h. **H** = the individual escaped. **I** = representation of the postcanine-bilateral bite in dorsal view. Triangles indicate the postcanine-bilateral position. Photos and video by Marco A. Rodríguez-Segovia. Video available at: <https://www.youtube.com/watch?v=PgZvbC8OSvA>

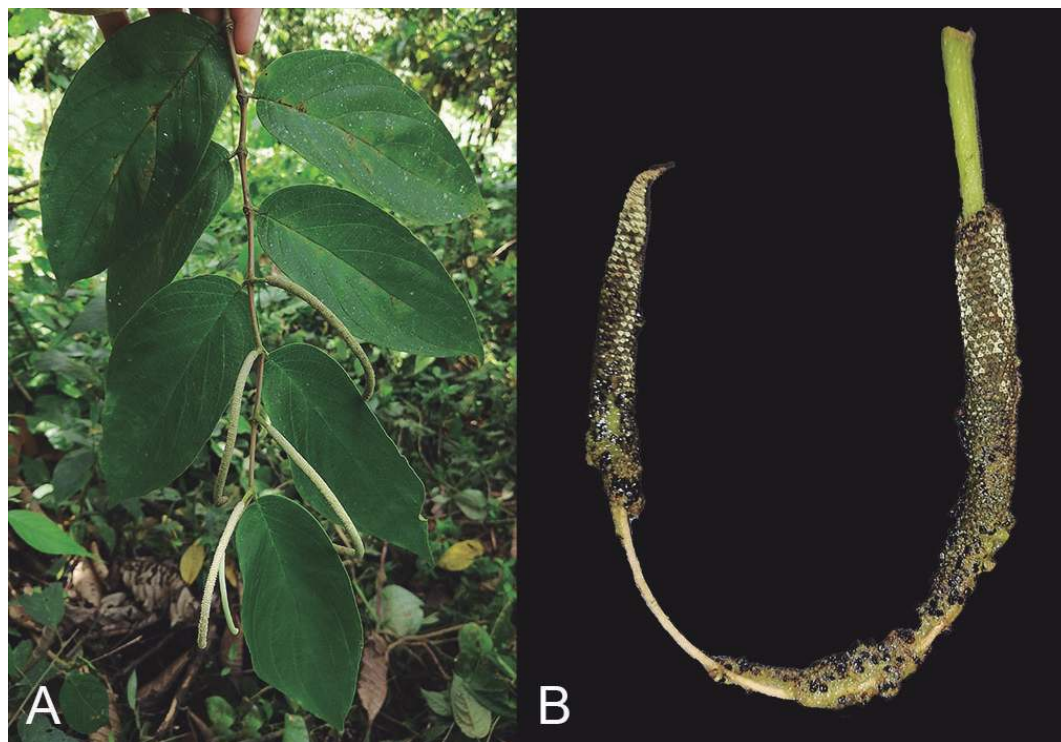


Figure 2. *Piper aduncum*. **A** = detail of the leaves and immature fruits. **B** = detail of a mature fruit photographed in the surrounding study area, with visible bites caused by bats. Photos by Marco A. Rodríguez-Segovia.

were captured and released into a flight cage containing fruits from two plant species per trial. During the experiment, feeding rhythms, rates, and fruit selectivity were recorded using a stopwatch. According to the results of this experiment, one *S. lilium* individual was observed feeding continuously, handling many fruits in succession (> 18), with long feeding bouts and no roosting periods in between. This individual rapidly processed understory fruits of *Muntingia calabura*, a sugar-rich but scarce resource, but slowly processed canopy fruits of *Ficus ovalis*, a superabundant but lower-quality resource.

The results of the experiment conducted in Santa Rosa also classified *Sturnira lilium* with other understory bats as a fast-handling species (Bonaccorso & Gush, 1987). In fact, many understory bats feed primarily on high-quality fruits (Saldaña-Vázquez, 2014). *Sturnira ludovici* (MARS 113) processed the *Piper* sample rapidly; the recorded handling time (two

minutes and 26 seconds) was very similar to those reported for *M. calabura* (3.29 ± 0.85 minutes) and *F. ovalis* (1.12 ± 0.88 minutes; Bonaccorso & Gush, 1987). Additional samples of understory and canopy fruits are needed to improve quantification of the feeding rhythms and fruit selectivity of *S. ludovici*.

Moreover, during the Curú Wildlife Reserve experiment, many dramatic head movements were observed in *Sturnira lilium*, particularly when feeding on *Ficus* (Dumont, 1999). These movements were classified as tearing. This bat species also used its wings and shoulders to stabilize the fruit. Moreover, *S. ludovici* was filmed perching head-up. Phyllostomids have typically been photographed or illustrated feeding and perching upside down as well as using their thumbs, wings, and shoulders to manipulate fruit (Jarrín-V., 2001). However, these behaviors are rarely possible to observe or film directly in nature, and the use of captive bats is the

only known method to conduct experiments that isolate behavioral phenomena in artificial conditions (Bonaccorso & Gush, 1987; Dumont, 1999; Villalobos-Chaves et al., 2016).

A study found that phyllostomids feed perched on fruit-bearing trees only in exceptional cases, when fruits are too large or too firmly attached to be carried away, but it does not explain how this feeding occurs (Bonaccorso et al., 1980). How often *S. ludovici* roosts in a horizontal position is currently unknown. It has been proposed that the evolutionary advantage of lacking a tail membrane in the genus *Sturnira* can be appreciated by holding a bat in the hand, as these bats can twist and turn their legs and body like contortionists (Emmons & Feer, 1997). In this sense, the absence of this trait confers greater mobility, potentially facilitating feeding (Jarrín-V., 2001). Yellow-shouldered bats are probably adapted for clambering quadrupedally among flowers and fruits (Emmons & Feer, 1997). Many bat species can use their feet and wings to crawl in horizontal surfaces (Kunz, 1982).

The roosting ecology of many species of *Sturnira*, including *S. ludovici*, remains largely unknown. There are a few records from caves, tunnels, abandoned houses, hollow trees, and palm leaves (Fenton et al., 2000). It is difficult to determine how the presence of researchers, white light, and the perching position affected the feeding behavior of *S. ludovici* in this recorded case. One of the previously mentioned studies documented two people inside the artificial habitat during the experiments, one person to record the bats and another to illuminate the bats with red light (Dumont, 1999). Another study found that the presence of people inside the cage and the use of light did not affect the bat's behavior, evidenced by the fact that bats frequently roosted, ate fruit, and defecated directly on people (Bonaccorso & Gush, 1987). The present study hypothesizes that the researchers' hands did not disrupt the behavior of *S. ludovici*.

Some studies recommend using blue or red light to film bats since green, white, and yellow light induce adverse behaviors (Dumont, 1999; Voigt et al., 2018; Zhou et al., 2024). The inten-

sity of the light (lumens) also affects the tolerance of bats and their behavioral responses (Voigt et al., 2018; Zhou et al., 2024). As is inferred, the use of a powerful light could temporarily blind or hurt any bat. However, since many bat species tend to be relatively tolerant of white and yellow artificial light (Voigt et al., 2018), this would likely be the case for *S. ludovici*.

The use of the tongue to process fruit and the use of olfaction had never been filmed in *S. ludovici* until this study. Other phyllostomids use their tongues to lick nectar, taste the food, perform self-grooming, and engage in social grooming (Carter & Leffer, 2015; Winter & von Helversen, 2003). Many fruits dispersed by bats have strong odors (e.g., rancid, sour, or stale) and greenish colors to attract bats (Nyhagen, 2004); *P. aduncum* is no exception. Phyllostomids have well-developed olfactory senses and combine them with echolocation to find fruit at night (Korine & Kalko, 2005). It has been demonstrated that olfaction is used by phyllostomids to evaluate the ripeness of fruit and reject insect-infested fruit (Korine & Kalko, 2005; Saldaña-Vázquez, 2014).

The unique recording presented here does not show all the behaviors described by the literature (Dumont, 1999), but it coincides in that postcanine-bilateral was the most frequent bite type and tearing the most frequent head motion. For the moment, I consider that this study provides a possible record of how *S. ludovici* processes *Piper* in nature. This study demonstrates the value of mobile devices for behavioral documentation and recommends further experimental studies in Chontaloma to explore feeding strategies associated with *P. aduncum* and other understory fruits. This is highly feasible because *P. aduncum* is a common pioneer shrub growing in the understory of secondary forests in northwestern Pichincha (Terán-Valdez et al., 2018).

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Conflict of interest: The author declares that he has no conflict of interest with the publication of this article.

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