

## Division of care or hormonal alterations? Report on male lactation in *Sturnira lilium* (Phyllostomidae) in the Atlantic Forest of Southern Brazil

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### Resumo

**Divisão de cuidados ou alteração hormonal? Relato de lactação masculina em *Sturnira lilium* (Phyllostomidae) na Mata Atlântica, Sul do Brasil.** Não existem barreiras morfofisiológicas para o desenvolvimento das glândulas mamárias em machos, porém, o fato de não amamentarem sua prole é intrigante e tem levantado inúmeras questões há muito tempo. Relatamos o primeiro registro de lactação de machos na espécie de *Sturnira lilium* para um indivíduo capturado na Mata Atlântica brasileira. O indivíduo apresentou as mesmas características morfológicas externas encontradas em fêmeas lactantes. Não podemos concluir que a amamentação masculina seja uma característica comum da espécie. O efeito de fitoestrógenos e pesticidas necessita de investigações mais profundas sobre as populações de morcegos, bem como sobre o comportamento social de *S. lilium*.

**Palavras-chave:** Amamentação; Cuidado parental; Glândula mamária; Macho lactante

### Abstract

There are no morphophysiological barriers to the development of mammary glands in males, however, the fact that they do not breastfeed their offspring is intriguing and has raised numerous questions for a long time. We report the first record of male lactation in the species of *Sturnira lilium* for an individual captured in the Brazilian Atlantic Forest. The individual presented the same external morphological characteristics found in lactating females. We cannot conclude that male breastfeeding is a common species feature. The effect of phytoestrogens and pesticides on bat populations needs more deep investigations, as well as into the social behavior of *S. lilium*.

**Key words:** Breastfeeding; Lactating male; Mammary gland; Parental care



Lactation is a characteristic feature of the Mammalia. The development of the mammary gland, as well as the composition of the milk, presents a common basic structure in all species (OFTEDAL, 2020). Moreover, the development of nipples and teats is identical among males and females up to puberty (DALY, 1979). Considering this, the fact that males do not breastfeed their offspring is intriguing and has long been questioned. To discuss lactation, it is important to define a few terms. Galactorrhea is characterized by the production of milk caused by a physiological or pathological dysfunction without the purpose of offspring nourishment, occurring both in male and female individuals (RACEY et al., 2009). On the other hand, male lactation is the production of milk with no pathological or pup stimulated origin, while male breastfeeding is when the male feeds their offspring with milk produced by their own developed glands (COHEN, 2017).

Male lactation is feasible in the physiological point of view (FRANCIS et al., 1994; KUNZ; HOSKEN, 2009), however, it is a rare and poorly understood fact. It is believed that male lactation and breastfeeding did not evolve due to the fact that the paternity of their offspring cannot be assured (HOUSTON; MCNAMARA, 2002; KUNZ; HOSKEN, 2009). Bonding among males and their offspring occurs when there is a high level of certainty of paternity (KLEIMAN, 1977; DALY, 1979). Indeed, some authors suggest that if male lactation and breastfeeding occurs in mammals, it will probably be found in monogamous species (SMITH, 1977). However, this issue is complex, as many species develop binary parental care, where the male takes care of the offspring even with extrapair paternity, or even, there are cases in which female parental care influences the increase of male parental care (MARASCO et al., 2020; ASPILLAGA-CID et al., 2021).

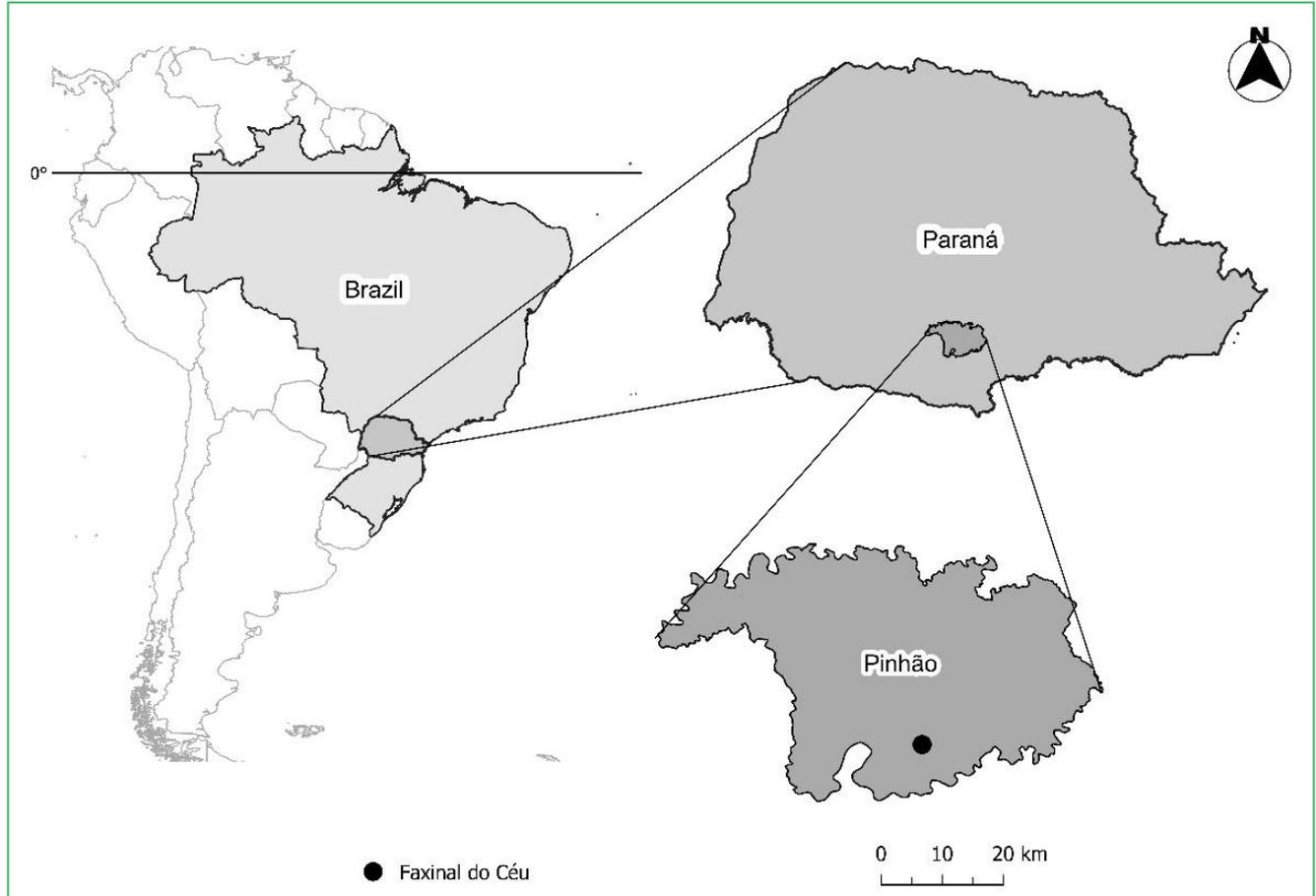
Cases of milk production by hormone administration have been reported in some mammals (HUGGINS; DAO, 1954; WILLIAMS; TURNER, 1961; KUNZ; HOSKEN, 2009; COHEN, 2017). Interestingly, the above reported cases of male lactation in wild populations occurred in frugivorous bats of the Pteropodidae family. In the first case, 10 adult males of *Dyacopterus spadiceus*

(Thomas, 1890) were captured in Malaysia (FRANCIS et al., 1994). These individuals had functioning mammary glands with milk secretion. The nipples were smaller and less cornified than the females', which was interpreted by the authors as indication of less or no suckling by the pups. The second case was reported in *Pteropus capistratus* Peters 1876 species, in Papua New Guinea (CRICHTON; KRUTZSCH, 2000; FENTON; SIMMONS, 2014). These studies were not conclusive on the occurrence of male breastfeeding. In this work we report the first case of lactation in a male specimen of the phyllostomid bat *Stunira lilium* (É. Geoffroy, 1810) in the Brazilian Atlantic Forest.

The individual in question was captured in the Atlantic Forest of Southern Brazil. The capture occurred during a sampling of Jardim Botânico Faxinal do Céu, in the city of Pinhão, in the state of Paraná (25°54'28.32"S; 51°35'50.84"W), in December 2014 (Figure 1). This study was conducted using mist nets with a sampling effort of 155.520 m<sup>2</sup>.h. 93 specimens of 14 different species were captured, *S. lilium* being the most abundant (57%), with 53 individuals, where 23 were males and only one of them was lactating.

The climate of the region is defined as Cfb according to Köppen climate classification system, characterized as humid subtropical and mesothermic with no defined dry season. Mean annual temperature is of 17.1°C, with around 12.8°C in the coldest month and approximately 20.8°C in the warmest. The accumulated precipitation varies between 1.800 and 2.000 mm (WREGE et al., 2012; MIRANDA; ZAGO, 2015). This research was authorized through capturing and collection licenses issued by the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), the Ministry of the Environment (SISBIO process numbers 44129-2 and 44193-1), also adhering to the ethical standards of the American Society of Mammalogists (SIKES et al., 2019).

FIGURE 1: Map of South America highlighting Brazil and the state of Paraná. Map of the state of Paraná highlighting the city of Pinhão and pinpointing the location of Jardim Botânico Faxinal do Céu.



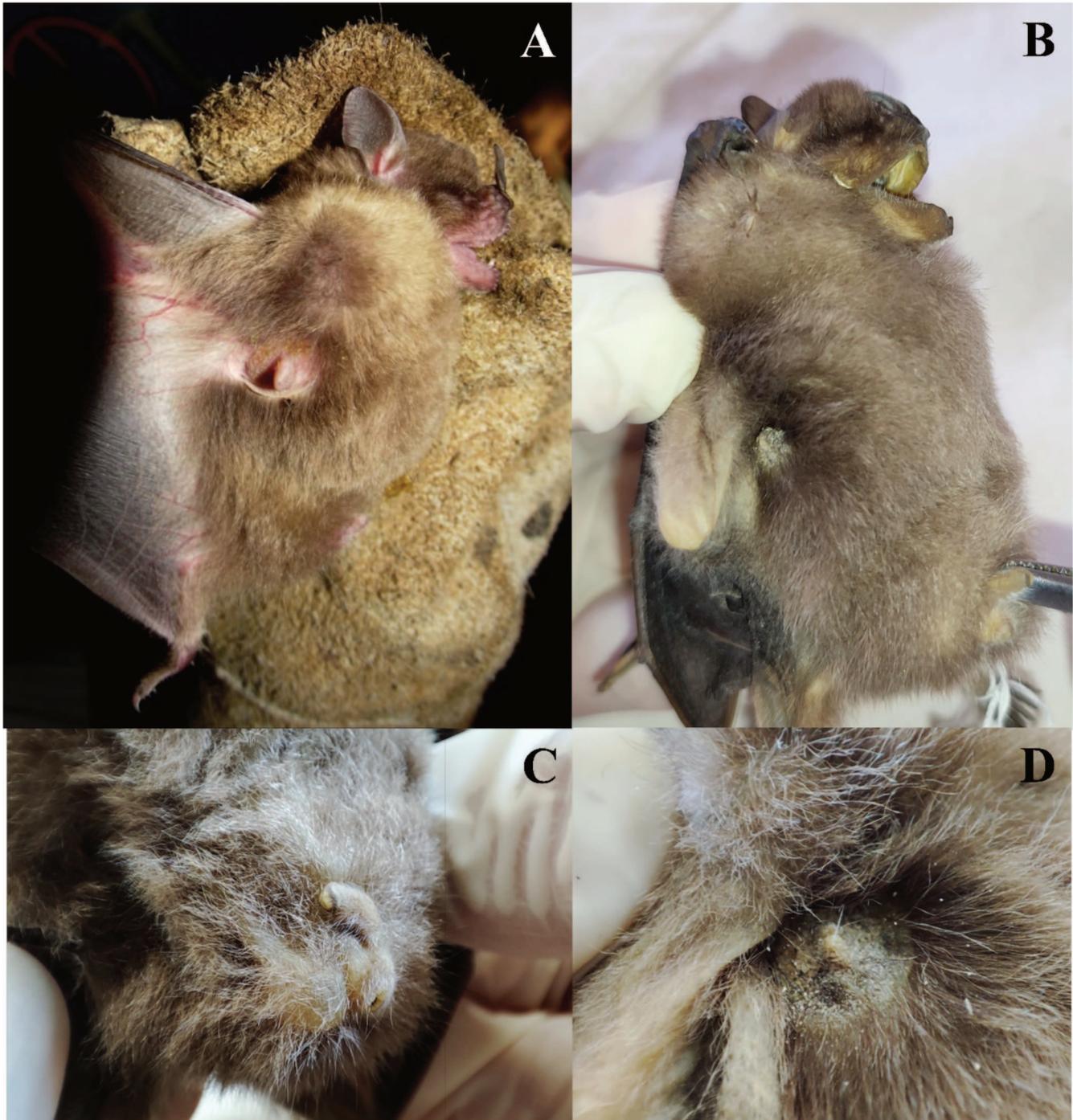
According to the ossification patterns of the epiphyses of the wing digits, the individual is adult and was captured by a mist net set in a clearing. The specimen had a forearm length of 44.6 mm and weighed 23 g. The male presented functional mammary glands from which milk could be extracted through manual palpation. The nipples were significantly cornified, with absence of surrounding hair, like observed in lactating females of the same species, suggesting suckling activity by the pups (Figure 2). The specimen was collected and deposited in the Coleção de Mastozoologia (Mastozoology Collection) of Universidade Federal do Paraná (DZUP - UFPR), under the collection number DZUP 2119.

*Sturnira lilium* occurs in the central, southwest and southern regions of South America (VELAZCO;

PATTERSON, 2013). It is a frugivorous bat that feeds specially on fruits of the family Solanaceae (MELLO et al., 2008; ARIAS; PACHECO, 2019). Only one young is born per gestation and the reproductive seasonality varies according to resource provision, but it is generally polyestrous (CRICHTON; KRUTZSCH, 2000; MELLO et al., 2009).

It is not possible to conclude if the case here registered represents common events of male breastfeeding in *S. lilium* populations, because as the species is among the most abundant and amply distributed bats of the New World tropics (VELAZCO; PATTERSON, 2013), one should expect previous records of this phenomenon. Endocrine changes might occur due to the presence of phytoestrogens in the diet and buildup of agricultural defensives in the environment (USUI, 2006; PANZICA et al., 2007; KUNZ; HOSKEN, 2009).

FIGURE 2: Adult male of *Sturnira lilium* captured in Jardim Botânico Faxinal do Céu, Paraná, Brazil. A: image of the newly captured individual showing a penis and developed breasts. B: image of the individual after being deposited in the Coleção de Mastozoologia of Universidade Federal do Paraná (DZUP – UFPR) showing a penis and developed breasts. C: detail showing the individual's penis. D: detail showing the individual's breast.



Further studies on the occurrence of phytoestrogens in the plant species utilized in the diet of *S. lilium* and on the seasonal variation patterns of the availability of such compounds in the species diet could help understanding this phenomenon, since it has been previously observed that phytoestrogens cause reproductive alterations in phyllostomid bats (PEREZ-RIVERO et al., 2004; SERRANO et al., 2007).

There is a considerable number of studies on the bioaccumulation of pesticides in the physiology of bats, mostly in insectivorous species (OLIVEIRA et al., 2021; TORQUETTI et al., 2021). These studies demonstrate that the main consequences of the influence of this accumulation of pesticides are oxidative stress, increased basal metabolic rate, which leads to a reduction in body energy reserves, impaired echolocation performance, various liver injuries and endocrine disruption (OLIVEIRA et al., 2021). Despite all these problems, there is no evidence that this endocrine disruption leads to hormonal changes that end up triggering lactation in males. Gathering a better understanding of these relations and interferences might help to understand if these exogenous substances can cause lactation in bats. In addition, a histological study can help to understand and examine the development of the mammary glands in this individual. Monitoring of individuals in their roosts could provide informative conclusions, since although *S. lilium* is a common species and has been relatively well studied in terms of reproduction patterns (MELLO et al., 2009; GODOY et al., 2014), its social behaviour is not fully known.

We can conclude that even though we observed milk production by a male of *S. lilium*, the inquiry on the active role of males in offspring care remains, especially in regards to male lactation/breastfeeding.

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