

Scientific Note

First record of non-carnivore feeding behavior in a wild praying mantis (Mantodea: Mantidae)

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Edited by: Francisco J. S. Duque

Received: September 30, 2020. Accepted: January 04, 2021. Published: January 18, 2021.

Abstract. Praying mantises are recognized as carnivorous, exclusively feeding on live prey. Field observations during a praying mantis survey in the Atlantic Rainforest of Rio de Janeiro, Brazil, revealed an adult male of *Stagmatoptera precaria* (Linnaeus, 1758) feeding on latex exudes of a papaya tree (*Carica papaya* L). This anecdote is the first record of non-carnivorous feeding behavior in wild praying mantises.

Keywords: Dictyoptera, Natural History, Neotropical, Mantises, Stagmatoptera.

Praying mantises (Insecta: Mantodea) are predatory insects distinguished by having big compound eyes, highly mobile head and raptorial forelegs used for capturing prey. Their strength and agility make them exceptional predators, able to prey on any animals of adequate size, whether arthropods or small vertebrates (Prete 1999; Nyffeler et al. 2017). In the past few years, the Mantodea has been gaining increased attention from researchers worldwide (Rivera & Svenson 2014). For instance, Santos et al. (2018), Brannoch et al. (2017) and Rivera & Svenson (2016, 2020) are currently addressing questions about their evolution, biogeography, phylogenetics and taxonomy within the Neotropical taxa. These formerly controversial topics are now flowing with new genera descriptions, such as *Hondurantemna* Rodrigues, Rivera, Reid & Svenson, 2017 (Rodrigues et al. 2017), and taxonomic revisions (Rodrigues & Cancellato 2016; Rivera & Svenson 2016, 2020).

Tropical regions have the greatest mantis species diversity (Otte & Spearman 2005), which exhibit very distinct behavior from their relatives in temperate and cold areas (Terra 1992, 1996; Rivera & Svenson 2016). *Stagmatoptera* Burmeister, 1838 is a Neotropical genus with 14 species, occurring in Central and South America. Individuals have medium to large dimensions (49.8 to 98.7mm) (Rodrigues & Cancellato 2016) and are distinct for having a circular spot on each forewing and 2-4 carinae on the head's frontal shield. The most common species in Rio de Janeiro's Atlantic Rainforest is *Stagmatoptera precaria* (Linnaeus, 1758). This species' diagnostic characters are the circular and small spot on the stigma and the absence of a spot on the middle of the foretibia anterior surface (Rodrigues & Cancellato 2016).

Despite isolated studies, the natural history of praying mantises is not well known. In studies done with captive-bred *S. precaria*, the mantis fed on insects of various orders, including Mantodea, and vertebrates, like the dwarf tree frog, *Hyla fuscovaria* (Lutz, 1925) (Hathaway 1946). In the same genus, research on *Stagmatoptera biocellata* Saussure, 1869 analyzed deimatic reactions (Balderrama & Maldonado 1971) and prey catching range throughout the specimens' development (Maldonado et al. 1967). However, with few exceptions, most Mantodea behavioral observations come from captivity animals, possibly exhibiting different behaviors from those displayed in their natural environment (Eisenberg et al. 1981).

Natural history is a discipline that has faced a steady decline since the early 20th Century (Hampton & Wheeler 2012) but it has

crucial value for a better comprehension and hypothesis formulation of misunderstood phenomena in their actual occurrence locus. This traditionally descriptive discipline is key to fields such as ecology and evolutionary biology, but "pure" natural history reports are more difficult to be published, as journals prioritize hypothesis-driven research (Allen et al. 2020). In this contribution, we describe a field observation of a *S. precaria* wild individual eating exudates from a plant. This non-carnivore feeding behavior has never been documented for the order Mantodea in the wild.

Mantis field surveys were carried out between October, 2015 and September, 2016, at Fazenda Recanto, Valença municipality, Rio de Janeiro State, Brazil (22°07'15"S 43°51'01"W), as part of Projeto Mantis, a project focused on research, conservation and photography of the praying mantises of the Atlantic Rainforest.

On April 11th and 12th, 2016, the seventh fieldwork weekend, a light trap was set up during the night from 6 p.m. to 12 p.m., using a white cloth and a 250 W mixed vapor mercury light bulb. While the trap was on, the team carried active searches on the surroundings with flashlights.

The trap guided seven adult males of *S. precaria* to the cloth during this survey. Males were collected alive and stored in suitable artificial habitats. As part of Projeto Mantis principles, mantises are collected alive and reared in captivity until natural death, allowing observation of behaviors and life cycle. Also, over-collecting is avoided, taking out from nature only necessary specimens for research. Therefore, on April 13th morning, three males of *S. precaria* were released. Males were freed randomly on plants away from each other by about 15 meters. Specimens were photographed until flying.

The third specimen was freed on a papaya tree, *Carica papaya* (Linnaeus), over a hanging dead leaf (Fig. 1). While photographing the mantis, a fruit was removed from the tree for later consumption, causing latex to drip from the peduncle's wound. The specimen, about a meter away from the peduncle, climbed straight to the location where the latex was dripping and started to ingest it, assuming the same position which mantises have when drinking water or feeding on honey in captivity (Fig. 2). This behavior lasted for about eight minutes, during which the animal seldom stopped feeding. When there was a small amount of latex left, the individual continued to climb up the tree, flying away after about ten minutes.

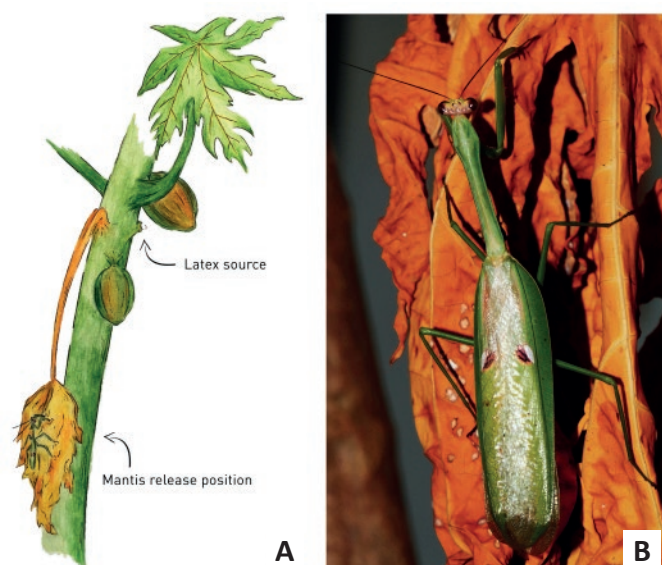


Figure 1. *Stagmatoptera precaria* position after being freed. (A) Illustration representing the release position of the mantis on the papaya tree and the latex source, about a meter away. (B) The mantis hanging on the dead leaf.

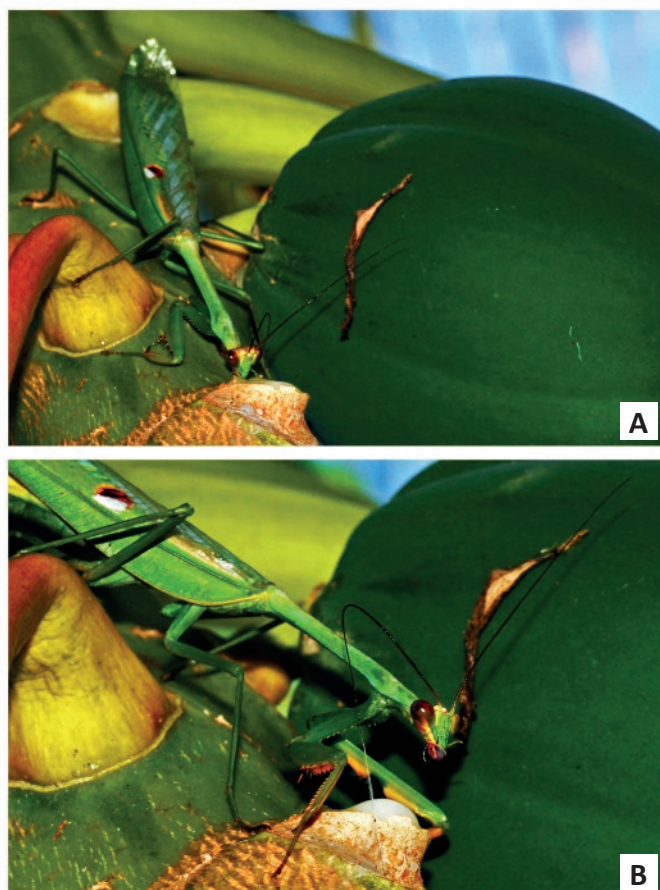


Figure 2. *Stagmatoptera precaria* feeding on *C. papaya* latex. (A) Feeding position with open raptorial legs. Mantis assume the same position when feeding on honey or drinking water in captivity. (B) Latex dripping from the mantis mouthpart.

It is known by mantis breeders that praying mantises do feed on non-carnivore sources in captivity, like honey (PI). Laboratory tests have shown that the Chinese mantis, *Tenodera aridifolia sinensis* Saussure, 1871 is able to complete its development feeding on pollen, and a diet including both pollen and live prey leads to faster development rates than just pollen or just live preys (Beckman & Hurd 2003). However, *S. precaria* was successfully reared in captivity when fed on live prey but did not thrive when fed on bananas or blood rennet (Hathaway 1946). The released individual detected the papaya sap and ingested

it voluntarily. There are no previous records of *S. precaria* or any other mantis species in the world feeding on non-carnivore sources in the wild. There is also no clue on how the individual detected the food source, whether visually or chemically. This anecdotal observation documented and described a novel behavior for the group, contributing to and expanding our knowledge of praying mantises' natural history. Anecdotes like this are important as they confirm or reveal curious, unexpected behavior that may be further researched to illuminate ecological and evolutionary consequences when considering the existence of the novelty.

Furthermore, the latex of *C. papaya* has high concentrations of papain, a cysteine protease with anti-herbivory effects (Konno et al. 2003) capable of quickly killing insects. The individual in question, however, did not die right after ingesting the sap, suggesting it may possess the capability to process it. Adaptations enabling insects to eat toxic compounds are not novelty. For example, mulberry leaves are rich on alkaloidal sugar-mimic glycosidase inhibitors, being highly toxic to caterpillars except the silkworm, *Bombix mori* (Linnaeus, 1758), indicating that the silkworm also can circumvent the mulberry tree's defense (Konno et al. 2006). Mebs et al. (2017) fed mantises with caterpillars that had been fed toxic plants. Even though the mantises discarded the preys' intestines before ingestion, toxic compounds were still found through the caterpillar body. Nevertheless, those compounds were not absorbed by the mantises' midgut, enabling mantises to feed on toxic prey without damage. Possibly *S. precaria* employs a similar physiological mechanism to be able to consume the toxic latex, a characteristic that deserves future research.

This record describes an unprecedented and unexpected behavior, evidencing the need to expand studies on praying mantises' natural history, their feeding behavior in nature and its evolutionary and ecological implications.

Acknowledgements

We thank Julio Rivera for the continuous support on Projeto Mantis; Antonio Agudelo and Henrique Rodrigues for confirming the species; Julia Moragas for her help in the field work; Fazenda Recanto for allowing the research on their area.

Author's Contributions

LL and JFH are part of Projeto Mantis, organization which leads field work and research on praying mantises, including this one. SC was part of the team on the year of this discovery. MLT was their advisor. DG was a partner of the team, participating on field work. Observation, photography and illustration done by LL. All authors contributed to the writing and reviewing of this anecdotal register.

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