

New record of *Padaeus trivittatus* (Hemiptera: Pentatomidae) as a predator of the monarch butterfly *Danaus plexippus* (Lepidoptera: Nymphalidae) in Central Mexico

Nuevo registro de *Padaeus trivittatus* (Hemiptera: Pentatomidae) como depredador de la mariposa monarca *Danaus plexippus* (Lepidoptera: Nymphalidae) en el Centro de México

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Suggested Citation

Bernal-Pichardo, S. F., Zarco-González, M. M., & Monroy-Vilchis, O. (2024). New record of *Padaeus trivittatus* (Hemiptera: Pentatomidae) as a predator of the monarch butterfly *Danaus plexippus* (Lepidoptera: Nymphalidae) in Central Mexico. *Revista Colombiana de Entomología*, 50(2), e13300. <https://doi.org/10.25100/socolen.v50i2.13300>

Received: 23-Oct-2023

Accepted: 24-Mar-2024

Published: 9-Sep-2024

Subject Editor

Alex Bustillo, Cenipalma, Bogotá, Colombia.

Revista Colombiana de Entomología

ISSN (Print): 0120-0488

ISSN (On Line): 2665-4385

<https://revistacolombianaentomologia.univalle.edu.co>

Open access



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Publishers: Sociedad Colombiana de Entomología
SOCOLEN (Bogotá, D. C., Colombia)
<https://www.socolen.org.co>
Universidad del Valle (Cali, Colombia)
<https://www.univalle.edu.co>

Abstract: Lepidoptera includes agricultural pests, pollinators, and bioindicators of the environment quality. Adults of *Danaus plexippus* (Lepidoptera: Nymphalidae) are preyed by some birds, and rodents; in its immature stages are preyed mainly by arthropod predators. Arthropod predation is a factor that decreases the survival of *D. plexippus*. Two adult males of *Padaeus trivittatus* (Hemiptera: Pentatomidae) were found preying on *D. plexippus* for the first time.

Keywords: Insect, interactions, milkweed, predation, stinkbug.

Resumen: Los lepidópteros son importantes principalmente como plagas agrícolas, polinizadores, e indicadores de calidad ambiental. Adultos de *Danaus plexippus* (Lepidoptera, Nymphalidae) son depredados por algunas especies de aves y roedores; en su estadio inmaduro sus principales depredadores son artrópodos. La depredación por artrópodos es un factor que disminuye la sobrevivencia de *D. plexippus*. Se identificaron por primera vez dos machos adultos de *Padaeus trivittatus* (Hemiptera: Pentatomidae) depredando a *D. plexippus*.

Palabras clave: Asclepia, chinche, depredación, insecto, interacción.

Introduction

The family Nymphalidae has 160,000 species described worldwide, of which 570 are recorded for Mexico (Prado et al., 2011). The order Lepidoptera includes insects that are important pollinators, and bioindicators of environment quality (Wilcox et al., 2019), and many are considered agricultural pests (Basari et al., 2019). In Mexico, the monarch butterflies, *Danaus plexippus* (Linnaeus, 1758) is the most representative species of this group, recognized for its annual migration from Canada and the United States to Mexico (Wilcox et al., 2019). In Central Mexico, the hibernation sites (lasting between 4 to 5 months) of monarch butterfly were decreed as Monarch Butterfly Biosphere Reserve (MBBR). These sites are composed of fir forests located up to 2,200 meters above sea level, in addition to milkweed crops (Ramírez et al., 2013). *Asclepias* is a genus of host plants of the family Apocynaceae that include species commonly known as milkweeds which serve as host plants of the monarch butterfly (Ramírez et al., 2013). The butterfly oviposits on this toxic plant, and the larval stages can consume leaves that contain cardiac glycosides, which are toxic substances that act as secondary metabolites favoring aposematic coloration in larvae and butterflies for protection against predators and parasites (Zalucki & Brower, 1992). However, there are species of animals that tolerate toxic substances due to an exaptation of their feeding behavior, preying on the different stages of the monarch butterfly (Zalucki & Brower, 1992).

Adults of *D. plexippus* are preyed on by some birds (Alonso-Mejía et al., 1998) and rodents (Glendinning & Brower, 1990). *Danaus plexippus* in its immature stages faces predators, mainly arthropods such as insects of the orders Coleoptera, Dermaptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera, Orthoptera, Neuroptera, and arachnids such as Araneae and Opiliones; many of these predators were reported under laboratory conditions. (Baker & Potter, 2020; Hermann et al., 2019; McCoshum et al., 2016; Myers et al., 2020; Wilcox et al., 2019). Pentatomidae or stink bugs are the third family with more species in the suborder Heteroptera (Hemiptera), with approximately 5000 species distributed in 950 genera (Brailovsky, 2022). The main characteristic of this group is their stinky odour, due to their glandular secretions, composed of aldehydes against predators and the presence of five-segmented antennae (Dzerefos et al., 2013). Only one species of Pentatomidae (*Podisus maculiventris*) is reported as a predator of monarch butterfly larvae under laboratory conditions. There are a few reports of pentatomid predators under natural conditions, hence, the objective of the present study was to identify the specimens of Heteroptera that were found preying on monarch butterfly larvae in a natural environment of Central Mexico.

Materials and Methods

In an experimental study in a natural environment, taking advantage of the common management done by flower growers, at 2 sites in temperate oyamel fir forest, in Central Mexico; the effect of pesticides on the survival of the monarch butterfly (*D. plexippus*) was analyzed. Twenty-three adult specimens of stinkbugs were found preying on larvae of *D. plexippus* of the Vth-larval stage in crops of commercial asclepias, *Asclepias physocarpa* (E. Mey.) Schltr. (Apocynaceae). At site one

(19°14'28"N, 100°05'14"W, 1720 m a.s.l.), on 24/X/2019, 7 stinkbugs were recorded, while at site two (19°13'56"N, 100°04'44"W, 1690 m a.s.l.) 16 stink bugs were recorded; and on October 28 of 2019, 2 specimens of stink bugs were collected. The specimens were transferred to the Autonomous University of the State of Mexico in bottles with 70 % alcohol (Schauff, 2013), labelled with the following data: date of observation, site and stage of the predating larva. The stink bug specimens were identified to the species level with the help of the citizen science electronic database iNaturalist (iNaturalist, 2021) and the Pentatomoidea database (Brailovsky, 2022), and a key of the tribe Pentomini (Torres, 2004). The specimens were deposited on the Museum of Natural Sciences, Toluca, State of Mexico; with catalog numbers MNS-H115 and MNS-H116.

Results and Discussion

Documenting predation events in natural conditions is highly valuable but complicated, due to the above, this is an important reason for this study. The information is useful for understand the ecology of an internationally important butterfly species, namely the monarch butterfly. It can contribute to improving the management of its populations to conserve and continue understanding its migration process. The two collected stink bug individuals were identified as male adults of the species *Padaeus trivittatus* Stål, 1862 (Hemiptera: Pentatomidae) (Figure 1).

The distinctive feature of the species is the yellowish-brown ventral body, with three distinct black bands; posterolateral angles of the pronotum, with spine-shaped and lateral margin of the connective with a yellowish-brown half-spot (Froeschner, 1978) (Figure 2).

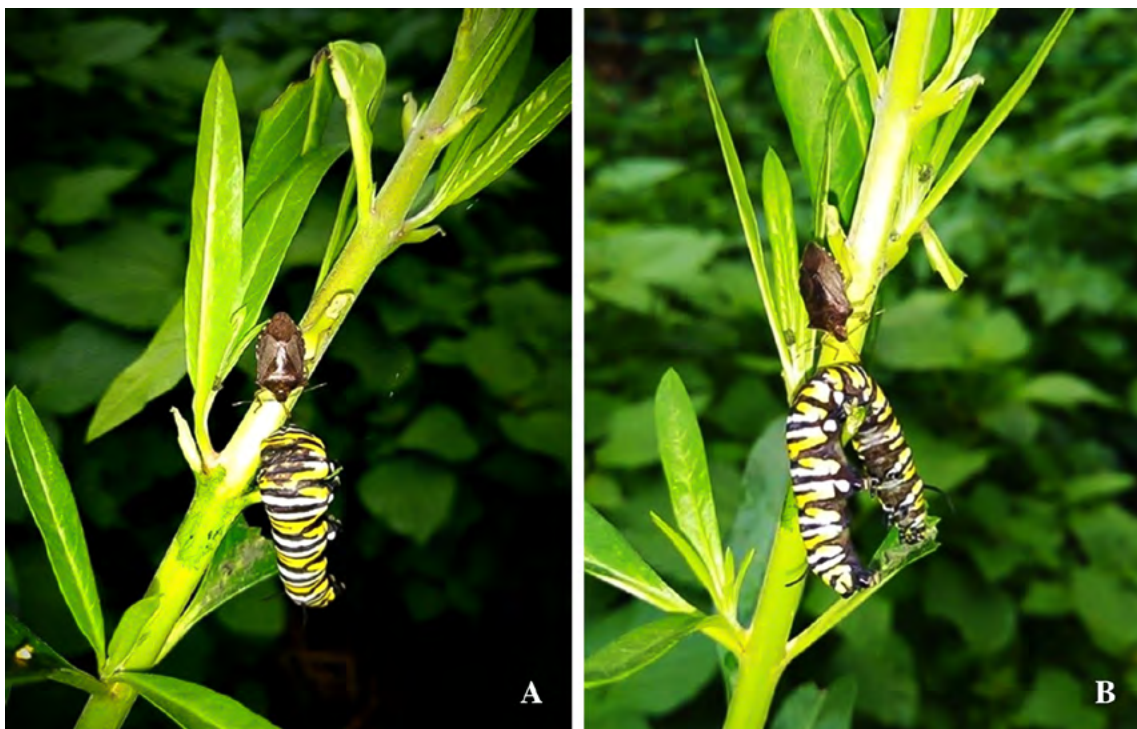


Figure 1. Adult males of the stink bug *Padaeus trivittatus* preying on larvae of Vth-larval stage of *Danaus plexippus*. **A.** A stink bug collected at site one. **B.** A stink bug collected at site two.

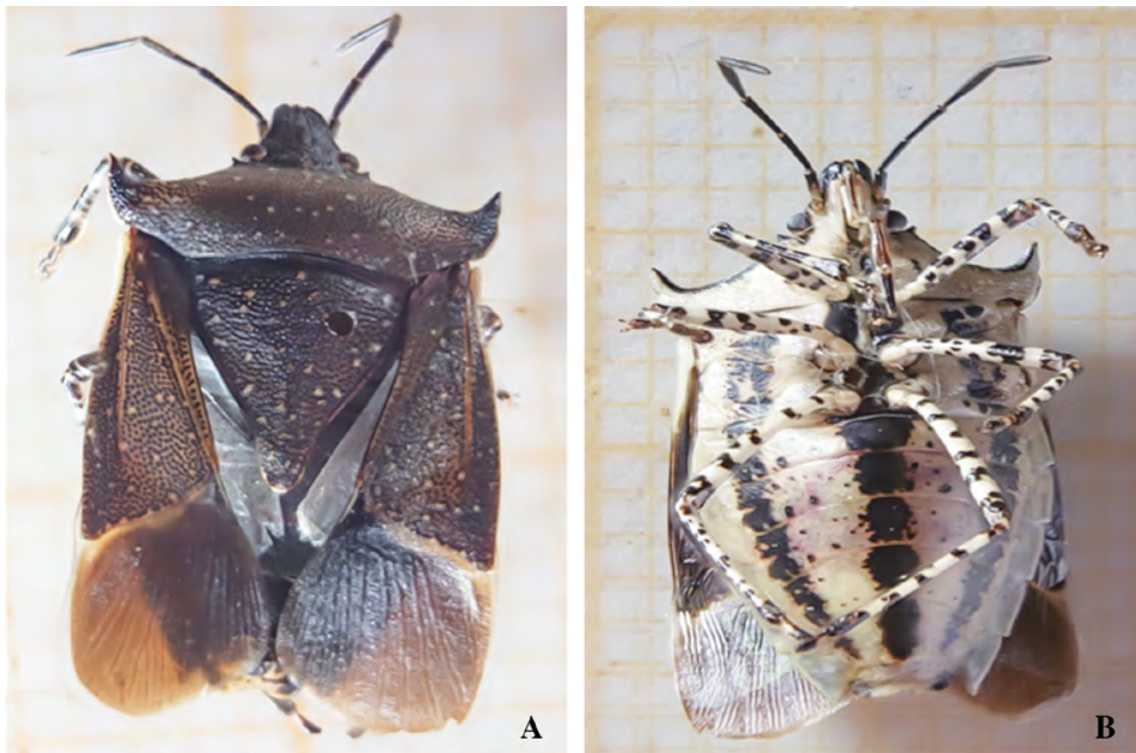


Figure 2. Adult male of the stink bug, *Padaeus trivittatus*. **A.** Dorsal view. Notice the shaped spine-like posterolateral angles of the pronotum. **B.** Ventral view. Notice the yellowish-brown ventral body with three black bands, lateral margin of the connective with a yellowish-brown medium spot.

There are some studies of species of the family Pentatomidae preying on monarch butterfly eggs and/or larvae (Myers et al., 2020; Stevenson et al., 2021). However, *P. trivittatus* has been hitherto not reported as a monarch butterfly predator. There is little information on the species, but there are reports of its presence in North America, mainly in urban sites in Central Mexico, Mexico City, and surroundings (INaturalist, 2021). Some species of Heteroptera are specialist or generalist herbivorous insects that feed on several plant structures and fungi (Rider, 2015). However, there are hematophagous species in various heteropteran families that feed on the hemolymph of *D. plexippus* larvae, i.e., *Orius insidiosus* Say, 1832 (Anthracoridae), *Geocoris* spp. (Geocoridae), *Lygaeus kalmii* Stal, 1874 (Lygaeidae), *Adelphocoris lineolatus* Goeze, 1778, *Engytatus varians* Distant, 1884 (Miridae), *Nabis acericoferus* Latreille, 1802; *Nabis subcoleopratus* Latreille, 1802, and *Nabis* spp. (Nabidae) and *Podisus maculiventris* Say, 1832 (Pentatomidae) (Hermann et al., 2019). This is the first record of *P. trivittatus* preying on larvae of the monarch butterfly. *Padaeus trivittatus* is usually found in rural and urban environments which suggests its tolerance to disturbed areas. Agriculture and other human activities transform the landscape and the biodiversity structure, frequently decreasing the number of specialist species and increasing the number of generalist species. Then, the presence of stink bugs can be favored by the pesticides applied on cultivated flowers, due to the elimination of potential competitors. On the other hand, pesticides decrease the survival of butterfly larvae by decreasing their antipredator ability, placing them at a higher level of prey for predators that are more resistant to pesticides.

Conclusions

Two adult males of *Padaeus trivittatus* were recorded for the first time as predators of *D. plexippus*.

Acknowledgments

Universidad Autónoma del Estado de México for: 4997/2020CIF. To Dr. Lupoli Roland specialist in taxonomy and biology of Heteroptera (HEMIPTERA: PENTATOMIDAE), for his support in determining the species of *Padaeus trivittatus*. To M. S. Dulce García for her support in the field work. Carl Mitchell reviews the version English.

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Origin and Funding

This study was with project 4997/2020CIF (Universidad Autónoma del Estado de México).

Author Contribution

SFB-P: Field work, data analysis, manuscript writing. MMZ-G: Study planning and design, data analysis, manuscript writing. OM-V: Study planning and design, data analysis, manuscript writing.

Conflict of Interest

The authors declare they have no financial interest.