



## **Localized Overabundance of an Otherwise Rare Butterfly Threatens Endangered Cycads**

Authors: Whitaker, Melissa R. L., Salzman, Shayla, Gratacos, Xavier, and Tucker Lima, Joanna M.

Source: Florida Entomologist, 103(4) : 519-522

Published By: Florida Entomological Society

URL: <https://doi.org/10.1653/024.103.00416>

---

BioOne Complete ([complete.BioOne.org](https://complete.BioOne.org)) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at [www.bioone.org/terms-of-use](https://www.bioone.org/terms-of-use).

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

---

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

# Localized overabundance of an otherwise rare butterfly threatens endangered cycads

Melissa R. L. Whitaker<sup>1,\*</sup>, Shayla Salzman<sup>2</sup>, Xavier Gratacos<sup>3</sup>,  
and Joanna M. Tucker Lima<sup>3</sup>

The butterfly *Eumaeus atala* (Poey) (Lepidoptera: Lycaenidae) is native to southern Florida, the Bahamas, and Cuba, where the larvae feed on cycads in the genus *Zamia* (Zamiaceae). Though once so common as to be called “the most conspicuous insect” in Florida (Schwartz 1888), overharvesting of the butterfly’s only native food plant, *Zamia integrifolia* L.f. (Zamiaceae), led to drastic population declines in the early 1900s, and *E. atala* was considered locally extinct by the 1930s (Klots 1951). In 1959, a small breeding population was discovered in southern Miami, though unpublished “guarded reports” of sightings circulated earlier (Rawson 1961). Grassroots conservation efforts have since rallied around the butterfly’s recovery, and over 300 ephemeral populations have been documented across Florida since 2001, largely in urban and semi-natural habitats where *Zamia* are planted as ornamentals (Ramírez-Restrepo et al. 2017).

A large, persistent population inhabits the Montgomery Botanical Center, a research and conservation garden in Coral Gables, Florida, USA. During peak butterfly season, it is possible to find over 300 *E. atala* larvae on the 49 ha (120 acres) property in a single d, plus many more eggs, pupae, and adults. Given the rarity of *E. atala* and the limited success of reintroduction efforts across Florida, it is worth examining why the butterfly flourishes at the Montgomery Botanical Center.

Cycads have been cultivated at the Montgomery Botanical Center since 1932, and their collection has steadily grown in species richness and abundance, with new additions made annually. In 2020, the center cultivated 235 cycad species endemic to Asia, Africa, Australia, and the Americas, including many species that are considered threatened or endangered (IUCN 2020). We evaluated the species richness and abundance of *Zamia* plantings at the Montgomery Botanical Center between 2000 and 2020 and found a steady increase in both metrics (Fig. 1), with 2,838 *Zamia* plants belonging to 55 species as of Jan 2020.

Because *E. atala* populations never have been formally quantified or monitored at the Montgomery Botanical Center, we consulted the Center’s staff about the butterfly’s population dynamics on the property. We spoke with the Center’s director, current and former cycad curators, resident cycad biologist, and landscape designer, representing over 40 yr of cumulative experience at Montgomery Botanical Center. Long-term staff report that *E. atala* always have been present on the Center property in small numbers, with seasonal abundance fluctuating in typical boom or bust cycles. However, over the past approximately 10 yr, *E. atala* numbers have repeatedly reached outbreak levels with boom cycles becoming bigger, longer, and more frequent, such that Floridian and Caribbean *Zamia* plants are repeatedly defoliated and butterfly larvae are found feeding on an expanded host range.

In Aug 2018, Jan 2019, and Jan 2020, authors MRLW and SS spent an estimated 130 h (combined) inspecting the Center’s cycads for *E. atala* eggs and larvae. We estimate that 90% of the Center’s cultivated cycad species and 80% of individual cycad plants were inspected during these surveys. Eggs and larvae were found on more than 20 cycad species, while other authors have reported *E. atala* feeding on additional cycad species elsewhere in Florida (Table 1).

*Eumaeus atala* larvae feed gregariously (Fig. 1) and can cause severe damage to their slow-growing host plants, often completely defoliating large cycads. As part of the Center’s pest management strategy, Center staff conduct daily inspections of *Zamia integrifolia* plants to manually collect butterfly eggs, larvae, and pupae from leaves. All other Caribbean *Zamia* plants are cleaned during regular routine maintenance, and collected insects are sent to nearby education, conservation, and research groups, many of which are trying to establish breeding colonies elsewhere in Florida. The Center staff estimate that over 2,000 *E. atala* individuals were relocated in 2019, requiring approximately 4 to 8 h of dedicated effort per wk.

The abundance of *E. atala* at the Montgomery Botanical Center is at least partially attributable to the ample availability of host plants on the property; as of 2020 the Montgomery Botanical Center maintains 431 *Z. integrifolia* individuals. More curious is why *E. atala* are not found in greater abundance in surrounding areas. There is no shortage of *Z. integrifolia* in the immediate vicinity of the Montgomery Botanical Center, because these plants are commonly found in residential and public gardens, and several large plantings of this species occupy road medians, parks, and other public spaces nearby. According to the Coral Gables Public Works Department, Coral Gables, Florida, USA, at least 220 *Z. integrifolia* plants are grown in public spaces within an 11 km radius of the Montgomery Botanical Center (Bob Boberman, Coral Gables Public Works Department, personal communication), with many more plants grown in neighboring home gardens and road medians. The Fairchild Tropical Garden is located less than 1 km from the Montgomery Botanical Center and grows 201 *Z. integrifolia* plants, 84 of which were planted in the last yr (Yisu Santamarina, Fairchild Tropical Garden, personal communication). Though *E. atala* butterflies are commonly found in small numbers in these areas, we have heard of no population explosions similar to the one at the Montgomery Botanical Center. These observations, while anecdotal, suggest that host plant abundance likely is not the only factor limiting butterfly abundance.

Given that *E. atala* larvae feed on many other non-native cycad species, host plant diversity likely influences local population dynamics. With 55 species in cultivation in 2020, the diversity of *Zamia* at the

<sup>1</sup>ETH Zurich Entomological Collection, Department of Environmental Systems Science, Zürich 8092, Switzerland; E-mail: mrl.whitaker@gmail.com (M. R. L. W.)

<sup>2</sup>Cornell University, School of Integrative Plant Science, 502 Mann Library, Ithaca, New York 14853, USA; E-mail: sms728@cornell.edu (S. S.)

<sup>3</sup>Montgomery Botanical Center, Coral Gables, Florida 33156, USA; E-mail: xavierg@montgomerybotanical.org (X. G.); joannat@montgomerybotanical.org (J. M. T. L.)

\*Corresponding author; E-mail: mrl.whitaker@gmail.com

**Table 1.** Cycad species on which *Eumaeus atala* larvae have been observed feeding.

Cycad species	IUCN status	Native range	Source
<i>Zamia integrifolia</i>	Near threatened	Florida, Bahamas	Authors' observations
<i>Zamia angustifolia</i>	Vulnerable	Bahamas	Authors' observations
<i>Zamia pumila</i>	Near threatened	Cuba, Dominican Republic, Puerto Rico	Authors' observations
<i>Zamia lucayana</i>	Endangered	Bahamas	Authors' observations
<i>Zamia portoricensis</i>	Endangered	Puerto Rico	Authors' observations
<i>Zamia vazquezii</i>	Critically endangered	Mexico	Authors' observations
<i>Zamia furfuracea</i>	Endangered	Mexico	Authors' observations
<i>Zamia decumbens</i>	Not listed	Belize	Authors' observations
<i>Zamia soconuscensis</i>	Vulnerable	Mexico	Authors' observations
<i>Zamia neurophyllidia</i>	Vulnerable	Costa Rica, Nicaragua, Panama	Authors' observations
<i>Zamia variegata</i>	Endangered	Belize, Guatemala, Mexico	Authors' observations
<i>Zamia nana</i>	Not listed	Panama	Authors' observations
<i>Zamia pseudomonticola</i>	Near threatened	Costa Rica, Panama	Authors' observations
<i>Zamia stevensonii</i>	Not listed	Panama	Authors' observations
<i>Zamia elegantissima</i>	Endangered	Panama	Authors' observations
<i>Zamia erosa</i>	Vulnerable	Cuba, Jamaica, Puerto Rico	Authors' observations
<i>Zamia fischeri</i>	Endangered	Mexico	Authors' observations
<i>Zamia loddigesii</i>	Near threatened	Mexico	Authors' observations
<i>Zamia inermis</i>	Critically endangered	Mexico	Authors' observations
<i>Zamia onan-reyesii</i>	Not listed	Honduras	Authors' observations
<i>Zamia paucijuga</i>	Near threatened	Mexico	Authors' observations
<i>Zamia lindenii</i>	Near threatened	Ecuador, Peru	Authors' observations
<i>Zamia pygmaea</i>	Critically endangered	Cuba	Hammer 1996
<i>Zamia skinneri</i>	Endangered	Panama	Hammer 1996
<i>Zamia encephalartoides</i>	Vulnerable	Colombia	Koi 2013
<i>Ceratozamia chamberlainii</i>	Not listed	Mexico	Authors' observations
<i>Encephalartos villosus</i>	Least concern	South Africa, Swaziland	Hammer 1996
<i>Encephalartos hildebrandtii</i>	Near threatened	Kenya, Tanzania	Hammer 1996
<i>Macrozamia lucida</i>	Least concern	Australia	Authors' observations
<i>Cycas cairnsiana</i>	Vulnerable	Australia	Hammer 1996
<i>Cycas revoluta</i>	Least concern	China, Japan	Hammer 1996

Montgomery Botanical Center is higher than anywhere else in Florida. This expanded host range may enable the butterfly's continuous reproduction if seasonal differences across cycad species allow for year-round availability of key plant resources. The butterflies preferentially oviposit on young, tender cycad leaves because these are required by early larval instars. That most *Zamia* produce just 1 new leaf flush per year may have historically constrained the butterfly's reproductive cycles, whereas increased plant diversity could confer year-round availability of fresh new leaves. A systematic evaluation of leaf phenology across *Zamia* species at the Montgomery Botanical Center would shed light on this possibility.

Other factors influencing the butterfly's local population size might include availability of adult nectar sources or roosting sites, changes in regional climate, local adaptive evolution, or heterogeneity in host plant quality. Given the abundance of acceptable nectar plants in home gardens and public spaces near the Montgomery Botanical Center, nectar limitation seems unlikely to play a major role in constraining population size. Shelter plants at the Center may be important for adult butterflies, which are commonly seen roosting in native trees and shrubs such as *Quercus virginiana* Mill. (Fabaceae), *Hamelia patens* Jacq. (Rubiaceae), *Psychotria nervosa* Benth. (Rubiaceae), *Metopium toxiferum* (L.) Krug & Urb (Anacardiaceae), and *Sabal palmetto* (Walter) Lodd. ex Schult. & Schult.f. (Araceae). Cold temperatures limit many aspects of butterflies' biology, and monthly minimum temperatures have been steadily increasing in Florida (Fig. 1; NOAA 2020). Several Center staff members have noted that the butterflies are easier to manage in year with a relatively cold winter. However, any effect of

weather would presumably lead to similar *E. atala* population dynamics across Florida, not just at the Montgomery Botanical Center. Alternatively, depending on dispersal abilities and site fidelity of *E. atala*, there may be opportunities for local adaptive evolution, e.g., expanded host range. Finally, *Zamia* plants at the Montgomery Botanical Center may provide a higher quality food source than plants grown elsewhere, because horticultural practices such as irrigation and fertilization can affect plant nutritional quality dramatically by altering the ratios of water, nutrients, and phytotoxins within plant tissues (Couture et al. 2010). Perhaps the care that plants receive at the Montgomery Botanical Center makes them nutritionally superior or less chemically defended than plants grown offsite.

The increasing availability of non-native cycads as novel host plants for *E. atala* could lead to new population dynamics, even within the butterfly's native range. A similar scenario has been documented for *Luthrodes pandava* (Horsfield) (Lepidoptera: Lycaenidae), a cycad-feeding lycaenid butterfly native to southern Asia. As a specialist of paleotropical cycads in the genus *Cycas* (Cycadaceae), *L. pandava* has emerged as a chronic naturalized pest—even within parts of its native range—following widespread horticultural use of *Cycas* plants (Wu et al. 2010). The butterfly has been introduced to other parts of Asia, Africa, the Middle East, and Guam, where it threatens both introduced and endemic *Cycas* species (Feulner et al. 2014; Fric et al. 2014; Marler et al. 2012). Another cycad-feeding lycaenid butterfly, *Theclinessthes onycha* (Hewitson) (Lepidoptera: Lycaenidae), has attracted the attention of cycad conservationists due to increased outbreaks on native and introduced *Cycas* plants in Australia (Manners 2015). Several addi-

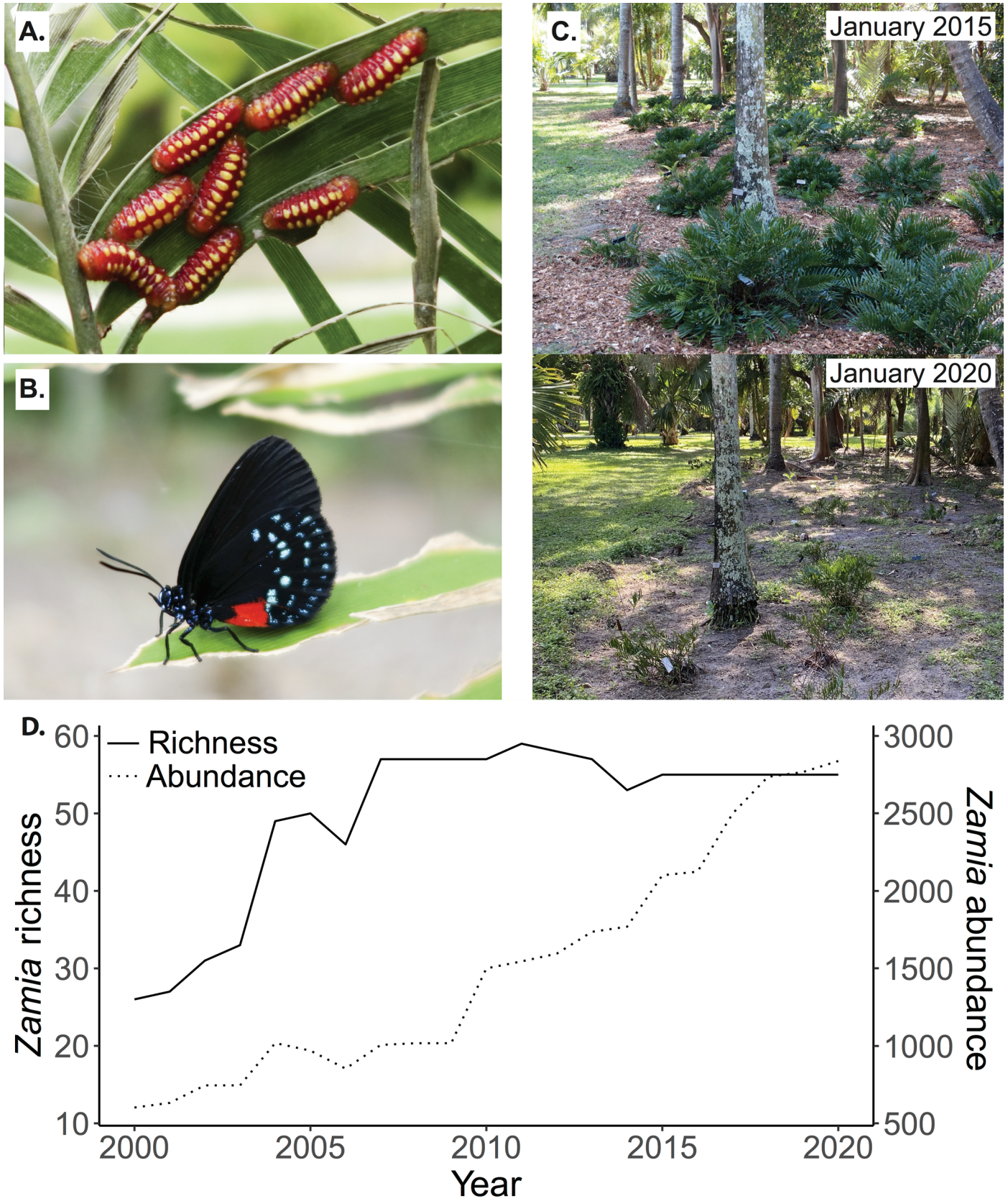


Fig. 1. (A) Gregarious feeding by *Eumaeus atala* larvae on a *Zamia integrifolia* plant; (B) *Eumaeus atala* adult on a damaged *Zamia integrifolia* plant; (C) exemplary planting of *Zamia integrifolia* at the Montgomery Botanical Center photographed from the same vantage point in (top) Jan 2015 (photo by Joseph Hibbard) and (bottom) Jan 2020 (photo by Jessica Lambert), showing extensive damage inflicted by *Eumaeus atala* herbivory; (D) *Zamia* species richness and abundance have increased at the Montgomery Botanical Center between 2000 and 2020.

tional Lepidoptera feed on cycads (Whitaker & Salzman 2020) but their status as pests or conservation targets is largely unknown.

The Montgomery Botanical Center manages one of the world's most important research and conservation collections of cycads, which are globally threatened by habitat loss, poaching, and insect pests. The fate of *E. atala* across the Caribbean is linked inextricably to the availability of suitable host plants. Conservation efforts that prioritize butterflies over plants (or vice versa) could have unintended consequences, and effective conservation should prioritize the co-existence of these interacting species (Koi 2017). We suggest that host plant availability may not be the only factor underlying the localized abundance of *E. atala*, and we propose testable hypotheses regarding the abiotic and biotic forces that may constrain population size. Ultimately, a better understanding of the factors influencing local population dynamics will aid butterfly conservation across the native range of *E. atala*, while also informing pest management strategies at the Montgomery Botanical Center.

We thank Joseph Hibbard, Bob Boberman, and Yisu Santamarina for providing thoughtful advice and information about *Z. integrifolia* plantings at the Montgomery Botanical Center and surrounding areas. This work was made possible by the dedicated staff of the Montgomery Botanical Center, especially Patrick Griffith, Vince Ramirez, Stella Cuestas, Michael Calonje, Claudia Calonje, Eliza Gonzalez, and Vickie Murphy.

## Summary

Though once considered extinct in Florida, the *Eumaeus atala* butterfly (Poey) (Lepidoptera: Lycaenidae) has made a slow but steady recovery thanks to grassroots conservation efforts targeting the butterfly and its only native foodplant, the cycad *Zamia integrifolia* L.f. (Cycadales: Zamiaceae). A robust *E. atala* population occurs at the Montgomery Botanical Center, a research and conservation facility in Coral Gables, Florida, USA, that cultivates a living collection of global cycads, many of which are critically endangered in the wild. Since the early 2000s, the *E. atala* population at the Montgomery Botanical Center has grown and adopted an expanded host range, much to the detriment of the plants; both native and exotic cycads incur consistent and severe damage from larval herbivory. This presents a complex situation in which in situ butterfly conservation conflicts with ex situ cycad conservation. Here we describe the local population of *E. atala* at the Montgomery Botanical Center, suggest testable hypotheses for explaining the butterfly's localized abundance, and discuss implications for butterfly and cycad conservation efforts in Florida.

**Key Words:** *Eumaeus atala*; *Zamia integrifolia*; coontie; conservation; pest management

## Sumario

Aunque se le consideró localmente extinta en la Florida, la mariposa *Eumaeus atala* (Poey) (Lepidoptera: Lycaenidae) ha tenido una recuperación lenta pero constante gracias a los esfuerzos de conservación dirigidos a la mariposa y su única planta alimenticia nativa, la cícada *Zamia integrifolia* L.f. (Cycadales: Zamiaceae). Una población robusta de *E. atala* se encuentra en el Centro Botánico de Montgomery, una instalación de investigación y conservación en Coral Gables, Florida,

EE.UU., que cultiva una colección viviente de cícadas globales, muchas de las cuales están en peligro crítico en la naturaleza. Desde el principio de la década del 2000, la población de *E. atala* en el Centro Botánico de Montgomery ha crecido y ha adoptado un rango de hospederos más amplio, en detrimento de las plantas; tanto las cícadas nativas como las exóticas sufren un daño constante y severo por la herbivoría de las larvas. Esto presenta una situación compleja en la que la conservación de mariposas in situ entra en conflicto con la conservación ex situ de las cícadas. Aquí describimos la población local de *E. atala* en el Centro Botánico de Montgomery, sugerimos hipótesis comprobables para explicar la abundancia localizada de mariposas y discutimos las implicaciones para los esfuerzos de conservación de mariposas y cícadas en Florida.

**Palabras Clave:** *Eumaeus atala*; *Zamia integrifolia*; sagú sagrado; conservación; manejo de plagas

## References Cited

- Couture JJ, Servi JS, Lindroth RL. 2010. Increased nitrogen availability influences predator-prey interactions by altering host-plant quality. *Chemoecology* 20: 277–284.
- Feulner G, Roobas B, Carlisle T, Meyer H. 2014. First UAE and Arabian records of *Chilades pandava*, the Cycad Cupid butterfly, an introduced oriental species (Lepidoptera: Lycaenidae) hosted by the ornamental sago plant *Cycas revoluta*. *Tribulus* 22: 48–57.
- Fric Z, Dickinson R, Fetouh G, Larsen TB, Schön W, Wiemers M. 2014. First record of the cycad blue, *Chilades pandava*, in Egypt—a new invasive butterfly species in the Mediterranean region and on the African continent (Lepidoptera: Lycaenidae). *African Entomology* 22: 315–319.
- Hammer R. 1996. New food plants for *Eumaeus atala* in Florida. *News of the Lepidopterists' Society* 38: 10.
- IUCN – International Union for Conservation of Nature. 2020. The IUCN Red List of Threatened Species. Version 2020-1. <https://www.iucnredlist.org/> (last accessed 24 Sep 2020).
- Klots AB. 1951. *A Field Guide to the Butterflies of North America, East of the Great Plains*. Houghton Mifflin, Boston, Massachusetts, USA.
- Koi S. 2013. *Ecology and conservation of Eumaeus atala Poey 1832* (Lepidoptera: Lycaenidae). MS thesis, University of Florida, Gainesville, Florida, USA.
- Koi S. 2017. A butterfly picks its poison: Cycads (Cycadaceae), integrated pest management and *Eumaeus atala* Poey (Lepidoptera: Lycaenidae). *Entomology, Ornithology and Herpetology: Current Research* 6: 1. DOI: 10.4172/2161-0983.1000191.
- Manners A. 2015. Cycad blue butterfly: a pretty name for an ugly problem. Pest FactSheet No. NY11001, Plant Health Biosecurity, Risk Management and Capacity Building for the Nursery Industry. Agri-science Queensland, Department of Agriculture and Fisheries, Ecosciences Precinct, Brisbane, Queensland, Australia. <https://www.horticulture.com.au/globalassets/hort-innovation/resource-assets/ny11001-cycad-blue-butterfly.pdf> (last accessed 6 Sep 2020).
- Marler TE, Lindström AJ, Terry LI. 2012. *Chilades pandava* damage among 85 *Cycas* species in a common garden setting. *HortScience* 47: 1832–1836.
- NOAA – National Oceanic and Atmospheric Administration. 2020. National Centers for Environmental Information: Climate Data Online. <https://www.ncdc.noaa.gov/cdo-web/datasets#GSOM> (last accessed 6 Sep 2020).
- Ramírez-Restrepo L, Koi S, MacGregor-Fors I. 2017. Tales of urban conservation: *Eumaeus* butterflies and their threatened cycad hostplants. *Urban Ecosystems* 20: 375–378.
- Rawson GW. 1961. The recent re-discovery of *Eumaeus atala* (Lycaenidae) in southern Florida. *Journal of the Lepidopterists' Society* 15: 237–244.
- Schwartz EA. 1888. Notes on *Eumaeus atala*. *Insect Life* 1: 37–40.
- Whitaker MRL, Salzman S. 2020. Ecology and evolution of Cycad-feeding Lepidoptera. *Ecology Letters* <https://doi.org/10.1111/ele.13581>.
- Wu LW, Yen SH, Lees DC, Hsu YF. 2010. Elucidating genetic signatures of native and introduced populations of the Cycad Blue, *Chilades pandava* to Taiwan: a threat both to Sago Palm and to native *Cycas* populations worldwide. *Biological Invasions* 12: 2649–2669.