Lepidoptera research in Puerto Rico: Reconnecting with historical legacies to guide future priorities

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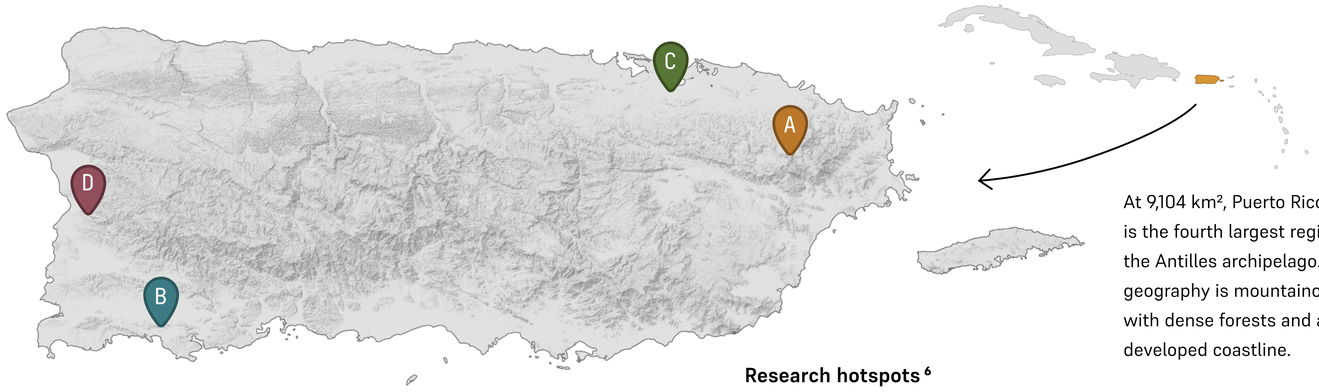
Rationale

- The Caribbean archipelago of Puerto Rico supports a diverse fauna and is located in a region characterized by complex socioeconomic and environmental change.
- Despite the great diversity of habitats found in Puerto Rico, there is little knowledge of the complex distribution patterns of Lepidoptera species within Puerto Rico's relatively small (and relatively accessible) geographic area.
- Lepidoptera are remarkably diverse and, as short-lived ectotherms, are important indicator species, making them a charismatic and traceable system for understanding the impact of global change on insect populations.

Here, we synthesized the long history of Lepidoptera research in Puerto Rico to shed light on gray literature and identify priorities for future ecological research.



At 9,104 km², Puerto Rico is the fourth largest region in the Antilles archipelago. The geography is mountainous, with dense forests and a developed coastline.

Research hotspots [6]

A **Luquillo Experimental Forest**
A densely forested UNESCO Biosphere Reserve and Long-Term Ecological Research site that is frequently the subject of successional forest change research involving Lepidoptera.

B **Guánica Biosphere Reserve**
A subtropical dry forest along the coast which is often used for short-term monitoring of lepidopterans, especially pests.

C **University of Puerto Rico - Río Piedras**
Areas surrounding the University of Puerto Rico campuses in Río Piedras and Mayagüez also displayed significant frequencies of digitized Lepidoptera specimens.

D **University of Puerto Rico - Mayagüez**

Taxonomic history

1700-1800s
Early nomenclature established by European taxonomists, though not guided by direct observation, provided groundwork for Caribbean insect taxonomy.

1900s
U.S. research entities and local academic institutions, particularly the University of Puerto Rico, facilitated projects to document native insect fauna. Many surveys and taxonomic checklists were published during this time.

2000s
New taxonomic methods and genetic tools provided further clarity regarding distinctions between butterfly species and subspecies.

Today
The approach of wide-scale surveying has largely been abandoned in recent years, leaving gaps in our knowledge of Lepidoptera in ever-changing tropical ecosystems. Native moths remain particularly understudied, despite making up approximately 90% of Puerto Rican Lepidoptera species.

Siproeta stelenes stelenes
A common butterfly in Puerto Rico

Conservation

- The Caribbean is a biodiversity hotspot and an area of high conservation priority.[8]
- Few insect species in Puerto Rico have been identified as at-risk due to the complicated nature of invertebrate population monitoring.
- The only insect listed as "threatened" in Puerto Rico by the U.S. Fish and Wildlife Service is the "quebradillana" or harlequin butterfly, *Atlantea tulita* (Nymphalidae).[9]
- Ecological researchers should seek to collaborate with local conservation organizations (e.g., the Conservation Trust of Puerto Rico, Casa Pueblo, Liga Ecológica Quebradillana) by identifying species of concern and providing concrete recommendations for their preservation.

92% of known wildlife species in PR are insects[7]

Ecology

Much of Puerto Rico is undergoing successional forest recovery, particularly in abandoned agricultural lands and areas disturbed by hurricanes. Evaluating insect responses to these successional changes has been of particular research interest, though much is yet to be understood, especially within the context of global change. Other key areas of ecological research are discussed below.

Community-level interactions

Butterflies and moths interact with organisms of other trophic levels as herbivores, pollinators, hosts for parasitic insects, and prey. Notably, Lepidoptera are a key food source for many at-risk vertebrate species, including birds, coquí frogs, and anole lizards.

Hurricane response

Research suggests that Lepidoptera diversity is negatively impacted by hurricane-induced defoliation events,[1] but that some species thrive in early successional conditions.[2]

Forest conditions

Lepidoptera diversity has been found to generally decline with elevation in PR forests.[3] Additionally, wing size and color are likely correlated with changes in canopy cover, suggesting that forest conditions select for certain functional traits.[4]

Climate change

Lepidoptera diversity and distribution patterns are likely to shift in response to shifting temperature and precipitation regimes.[5] However, no studies evaluating lepidopteran responses to climate change exist that are specific to PR or the Caribbean at large. This is a significant knowledge gap.

Priority research areas

1. **Long-term monitoring**
The paucity of long-term Lepidoptera studies in Puerto Rico has left gaps in our knowledge about the impact of environmental factors like climate change, hurricanes, and seasonality on their abundance, diversity, and distribution. Future research should aim to be long-term, transparent, wide-scale, and consistent in location and methods.

2. **Understudied regions**
Lepidoptera research in Puerto Rico has generally been limited to a few key research sites. We argue for the prioritization of Lepidoptera monitoring in topographically complex regions and artificial ecosystems to better understand patterns of diversity and community dynamics across the archipelago.

3. **Digitization**
Puerto Rican Lepidoptera specimens are housed across disparate collections, making them difficult to access for local researchers. Standardized digitization would therefore be particularly useful for quantifying the impact of global change on traits and distributions.

4. **Native moths**
Despite a rich taxonomic legacy for butterflies, native moth taxonomy remains poorly understood, except for a few major pests. Given that the vast majority of Lepidoptera species in Puerto Rico are moths, their taxonomy and ecology should become a priority.

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