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Invasive Teak Defoliator *Hyblaea puera* Outbreak Threatens Mangrove Ecosystems in Kerala, India: Implications for Biodiversity and Coastal Resilience

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Abstract: Mangroves play a vital role in coastal resilience by supporting biodiversity, preventing soil erosion, and sustaining local livelihoods. This study reports the first major outbreak of the invasive moth *Hyblaea puera* (teak defoliator) on mangroves in Kannur and Kasaragod Districts, Kerala, India. The larvae caused severe defoliation of *Avicennia officinalis*, Kerala's dominant mangrove species, leaving vast areas with a burned appearance. This infestation threatens the ecological and socio-economic value of mangroves, impacting their protective functions and local biodiversity. Similar outbreaks have occurred in Maharashtra's Airoli and Vashi Creek, primarily affecting *Avicennia marina*. The epidemic-level infestation in Kerala was noted in 2024, especially during monsoon and post monsoon months, with larvae also targeting species like *Acanthus ilicifolius*, *Bruguiera cylindrica*, *Derris trifoliata*, *Derris trifoliata*, *Rhizophora mucronata*, and *Volkameria inermis*. Pest identification was confirmed via mitochondrial COI gene sequencing. Natural predators, including birds, snails, spiders, and parasitoids, were observed, indicating potential for biological control. Future studies will focus on assessing the ecological impact and exploring management strategies like biological control, chemical treatments, and physical removal to protect mangrove ecosystems in Kerala, India.

Introduction

Mangrove forests are among the most productive and ecologically significant ecosystems in the world, offering a wide range of essential services. They support biodiversity, provide resources like wood, fishery products, and medicinal plants, and serve as natural bio-shields against natural disasters such as tsunamis and cyclones (1-3). Additionally, mangroves play a crucial role in coastal protection by stabilizing shorelines, aiding sediment accretion, and reducing erosion. Their capacity for carbon sequestration contributes to mitigating climate change, while their unique habitats promote ecotourism, thereby providing substantial economic benefits to coastal communities (4-5). Despite their global importance, mangrove forests are rapidly declining, and this trend is evident in Kerala, located on the west coast of India. Over the past three decades, Kerala has lost a large portions of its mangrove cover (4). The state hosts 18 species of true mangroves, with *Sonneratia alba*, *Avicennia alba*, and *Ceriops tagal* being particularly rare (4). According to the India State of Forest Report (ISFR) 2023, India's total mangrove cover is recorded at approximately 4,992 square kilometers, representing about 3.5% of the global mangrove area (6). Within Kerala, the mangrove cover is a mere 9 sq. km, with Kannur District holding the largest share at 6.399 sq. km, followed by Ernakulam and Alappuzha (6, 7). The mangrove flora of Kannur includes species such as *Acanthus ilicifolius*, *Avicennia marina*, *A. officinalis*, *Bruguiera cylindrica*, *Rhizophora mucronata*, *R. apiculata*, and *Kandelia candel* (7).

Mangrove ecosystems are under severe threat due

to various anthropogenic and abiotic factors. Urban expansion and industrial development have led to significant habitat loss and degradation, encroaching upon these delicate ecosystems (8). Additionally, extreme weather events such as hurricanes and flooding exacerbate their vulnerability, making mangroves more susceptible to damage from opportunistic pests and these pests are major contributors to mangrove decline (9-.11). The present study reports a newly identified threat to mangrove ecosystems in Kerala, India: the heavy infestation of *Avicennia officinalis* L. by the invasive moth *Hyblaea puera* (Lepidoptera: Hyblaeidae), known as the teak defoliator. *H. puera* is a significant defoliator of teak trees in nurseries, plantations, and natural forests. Although teak is its main host in India, the larvae are polyphagous, utilizing 46 alternative food plants (12). The infestation of *A. officinalis* by this pest adds to the pressures on Kerala's mangroves, which are already threatened by climate change and human activities.

Materials and Methods

Comprehensive field surveys were conducted across several sites in Kannur and Kassragod Districts to assess the extent and impact of the *H. puera* infestation. Different life stages of the insect pest were collected from *Avicennia officinalis* trees, which showed severe defoliation. Late instars and pupae were also found on other mangrove species, including *Acanthus ilicifolius* (Acanthaceae), *Bruguiera cylindrica* (Rhizophoraceae), *Derris trifoliata* (Fabaceae), *Rhizophora mucronata* (Rhizophoraceae), and *Volkameria inermis* (Lamiaceae). Species identification was carried out through morphological analysis and further confirmed using mitochondrial COI gene sequencing, which verified *Hyblaea puera* as the primary pest. This dual approach provided a reliable diagnostic method for accurately identifying this destructive species, ensuring precise pest management and control strategies.

Results

High levels of defoliation were observed at nearly all surveyed sites across northern Kerala, the infestation spread extensively, leaving large areas of mangroves with an ashy, burned appearance, with intensive defoliation significantly impacting the ecosystem across northern Kerala (**Figure 1**, **2**, and **3**). The infestation of *Avicennia officinalis* by this pest has worsened the already critical condition of Kerala's mangroves, which are under continuous threat from climate change and human activities. Initial observations during the 2023 monsoon season indicated a minor infestation. However, by the 2024 monsoon and post-monsoon periods, the situation had escalated drastically, leading to severe damage. While *A. officinalis* was the primary species impacted, larvae were also observed damaging and pupating on other mangrove species such as *Acanthus ilicifolius* (Acanthaceae), *Bruguiera cylindrica* (Rhizophoraceae), *Derris trifoliata* (Fabaceae), *Rhizophora mucronata* (Rhizophoraceae) and *Volkameria inermis* (Lamiaceae), suggesting a broader host range that could facilitate further spread (**Figure 4**). Several natural predators, including predatory birds, snails, spiders, and multiple parasitoids, were observed interacting with *H. puera* larvae, indicating potential biocontrol agents within the ecosystem.

Figure 1. Defoliated *A. officinalis* tree.

Figure 2. Infested leaves along with pupa of *Hyblea peura*.

Figure 3. Infestation of Avecennia officianalis by *Hyblea puera*.

Figure 4. Infestation on Acanthus ilicifolius.

Discussion

Mangrove ecosystems are highly dynamic and productive, yet they face significant challenges from anthropogenic pressures, climate change, and biological stressors (13). Rising atmospheric temperatures, altered precipitation patterns, and sea-level rise disrupt mangrove habitats, pushing their boundaries inland and affecting their growth and survival (14, 15). The impact of herbivory on mangroves is well-documented, with various insect pests damaging stems, roots, seedlings, and fruits. In Kerala, patterns of insect infestation vary seasonally and geographically (16). Outbreaks of the teak defoliator (*Hyblaea puera*), which targets *Avicennia marina*, have been reported in India and Brazil, typically occurring post-monsoon (17-21). However, no confirmed outbreaks have been reported on *A. officinalis*. Seasonal infestations often align with climatic transitions, as observed in Kerala, where teak plantations face outbreaks after pre-monsoon rains (22). Similarly, *A. marina* experiences defoliation during post-monsoon months, while *A. officinalis* in Kerala is affected between August and October. These seasonal patterns highlight the influence of climatic factors in driving pest activity and underscore their potential impacts on mangrove ecosystems.

While herbivory predominantly exerts negative effects, it may also provide ecological benefits. Defoliation can enhance light penetration, promoting the growth of understory vegetation and increasing biodiversity. Additionally, decomposed leaves and insect frass contribute to nutrient cycling, enriching soils and supporting microbial activity (17). Organic debris from outbreaks may further boost detrital food availability, benefiting aquatic organisms and fisheries (17).

Despite these potential benefits, the long-term ecological impacts of herbivory, particularly on sapling survival and recruitment, remain unclear. Future research should focus on monitoring sapling regeneration, quantifying nutrient cycling, evaluating biodiversity changes, and assessing fishery resource augmentation. Such studies are essential to balance conservation efforts with the ecological roles of herbivory, ensuring sustainable management of mangrove ecosystems. Effective management strategies are vital to mitigate the impact of *H. puera* in Kerala. Potential approaches include conserving natural predators as biological control agents, exploring targeted chemical treatments that are environmentally compatible with mangrove ecosystems, and employing physical removal methods to contain larval spread.

Conclusion

This study reports the first confirmed infestation of *H. puera* in Kerala's mangrove ecosystems, verified by mitochondrial COI gene sequencing. The severe defoliation of *A. officinalis* in various sites of Kannur and Kasargod Districts of Kerala, along with the broad host range observed, presents a critical threat to coastal resilience, biodiversity, and local livelihoods. Urgent implementation of integrated pest management strategies is needed to protect Kerala's mangrove ecosystems, ensuring their role in coastal protection, biodiversity conservation, and community sustenance.

Declarations

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Conflict of Interest

The authors declare no conflicts of interest.

Data Availability

The unpublished data is available upon request to the corresponding author.

Ethics Statement

Not applicable.

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Not applicable.

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