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OCCURRENCE OF FOLIVOROUS INSECT ON MANGROVE SEEDLINGS IN PANTAI PANJANG NATURE RECREATION PARK

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Abstract

Mangrove seedling are vulnerable to pest disturbances that can affect stand health and regeneration success. This study aimed to identify leaf-eating insect species and analyze pest attack incidence and damage intensity on Rhizophora apiculata and Bruguiera gymnorhiza in Pantai Panjang Nature Tourism Park. Observations were conducted over four months (March–June) using direct field observation methods on established sampling plots. Four leaf-eating insect pest species were recorded: Attacus atlas (Atlas Moth), Metisa plana and Mahasena corbetti (Bagworms), and Oxya japonica (Migratory Grasshopper). Pest attack incidence on R. apiculata was consistently higher than on B. gymnorhiza throughout the observation period, with the highest values recorded in June. Damage intensity on both species ranged from 15–23%, peaking in April–May, and was classified as very light and light on leaf damage scoring criteria. These findings are expected to serve as a reference for developing appropriate pest monitoring and management strategies to support the sustainability of mangrove ecosystems in Pantai Panjang Nature Tourism Park.

***Keywords**: Folivorous insect, damage intensity, pest incidence, Rhizophora apiculata, Bruguiera gymnorhiza.*

Abstrak

Anakan mangrove memiliki kerentanan terhadap gangguan organisme pengganggu tanaman yang dapat memengaruhi kesehatan dan keberhasilan regenerasi tegakan. Penelitian ini bertujuan untuk mengidentifikasi jenis serangga pemakan daun (hama) serta menganalisis kejadian serangan dan intensitas kerusakan pada *Rhizophora apiculata* dan *Bruguiera gymnorhiza* di Taman Wisata Alam Pantai Panjang. Pengamatan dilakukan selama empat bulan (Maret–Juni) menggunakan metode pengamatan langsung pada plot-plot yang telah ditetapkan. Hasil penelitian menemukan empat jenis serangga pemakan daun, yaitu *Attacus atlas* (Ngengat Gajah), *Metisa plana* dan *Mahasena corbetti* (Ulat Kantong), serta *Oxya japonica* (Belalang Kelana). Kejadian serangan pada *R. apiculata* secara konsisten lebih tinggi dibanding *B. gymnorhiza* sepanjang periode pengamatan, dengan nilai tertinggi tercatat pada bulan Juni masing-masing sebesar 61% dan 49%. Intensitas kerusakan pada kedua spesies berkisar antara 15–23%, dengan puncak tertinggi terjadi pada bulan April–Mei, dan tergolong dalam kategori serangan sangat ringan dan ringan untuk skoring kerusakan daun. Hasil penelitian ini diharapkan menjadi acuan dalam penyusunan strategi pemantauan dan pengendalian hama yang tepat guna mendukung keberlanjutan ekosistem mangrove di TWA Pantai Panjang.

Kata Kunci: Serangga pemakan daun, intensitas kerusakan, kejadian serangan, *Rhizophora apiculata*, *Bruguiera gymnorhiza*

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INTRODUCTION

Mangrove ecosystems play a crucial role as a buffer zone between terrestrial and marine environments, functioning as an effective carbon sink, protecting coastlines from abrasion, and providing habitats for various aquatic biota. In Indonesia, *Rhizophora* typically dominates zones

inundated by average tides, while *Bruguiera* prevails in areas inundated during high tides; both genera possess high ecological value in maintaining coastal substrate stability (Noor *et al*., 2006). These genera not only play a role in wetland conservation but are also key species in rehabilitation efforts for degraded mangrove areas. However, the success of these rehabilitation efforts is often hindered by infestations of folivorous insects (pests), which can decline seedling health and field growth rates (Primantara *et al*., 2019). Furthermore, study confirm that mangrove rehabilitation failures can be caused by environmental constraints as well as pest and disease attacks, such as the pagoda bagworm (*Pagodiella spp*.), bagworm (*Acanthopsyche sp.*), stem-boring beetle (*Xanthochroa sp.*), and leaf mites, which directly disrupt the growth and survival of young mangrove stands (Arifanti *et al*., 2022).

The Pantai Panjang Nature Recreation Park (TWA Pantai Panjang) is one of the primary area of concern in mangrove vegetation conservation efforts in Bengkulu Province. As an area with dual functions ecological stability and tourist destination. The mangrove vegetation in this region plays a vital role in maintaining coastline stability. However, the successful growth and regeneration of mangrove stands in the Pantai Panjang Nature Recreation Park are often impeded by the presence of plant-disrupting organisms, particularly pests. Pest attacks on leaves can reduce photosynthetic capacity, inhibit growth rates, and under high intensity, even lead to mortality in both seedlings and mature trees (Abulaiti *et al*., 2024).

Although studies on mangrove ecology have been widely conducted, specific information regarding the types of pests and the intensity of damage inflicted on Rhizophora and Bruguiera in the Pantai Panjang Nature Recreation Park remains highly limited. Differences in leaf morphological characteristics, secondary metabolite content (such as tannins and polyphenols), and microenvironmental conditions between these two genera are presumed to influence pest host preferences. The bitterness produced by tannins can protect leaves and deter herbivores, as well as limit leaf nutrient availability through anti digestive properties (Perkovich & Ward, 2022). Furthermore, the occurrence of forivorous insects on mangrove seedlings is a critical concern, as damage to reproductive structures directly impacts the sexual recruitment and long-term regeneration potential of these species. Furthermore, the presence of folivorous insects on mangrove seedlings is a critical concern, as damage to foliage and reproductive structures directly impacts the species' growth. Filling the knowledge gap regarding these insects attacks is essential for understanding the biotic threats that jeopardize seedling survival and community composition. The lack of data on the dynamics of these pest attacks poses a distinct challenge in area management, particularly in developing appropriate control strategies to ensure the sustainability of the mangrove ecosystem in Pantai Panjang Nature Recreation Park.

This study aims to identify the types of pests attacking *Rhizophora* and *Bruguiera* plants in Pantai Panjang Nature Recreation Park, as well as to analyze the intensity of leaf damage in both genera. Mangrove rehabilitation worldwide frequently experiences low success rates; thus, a comprehensive assessment of biotic factors influencing rehabilitation success, including pest infestations, is an essential prerequisite for designing more effective and sustainable mangrove management programs (Arifanti *et al*., 2022). Consequently, the results of this study are expected to serve as a scientific reference for mitigating biotic disturbances in mangrove maintenance and rehabilitation programs within Pantai Panjang Nature Recreation Park and other mangrove areas with similar ecological characteristics.

METHOD

This study was conducted on rehabilitated mangrove seedlings in the Pantai Panjang Nature Recreation Park, Bengkulu City. Observations were made biweekly for a total of 7 observation periods. The coordinates of the research location were 3°49'58.08"S and 102°17'15.63"E. The equipment utilized included cameras, calipers, measuring tapes, raffia strings, stakes, and waterproof labels. The materials used consisted of *Rhizophora apiculata* seedlings, *Bruguiera gymnorhiza* seedlings, and folivorous insects (pests).

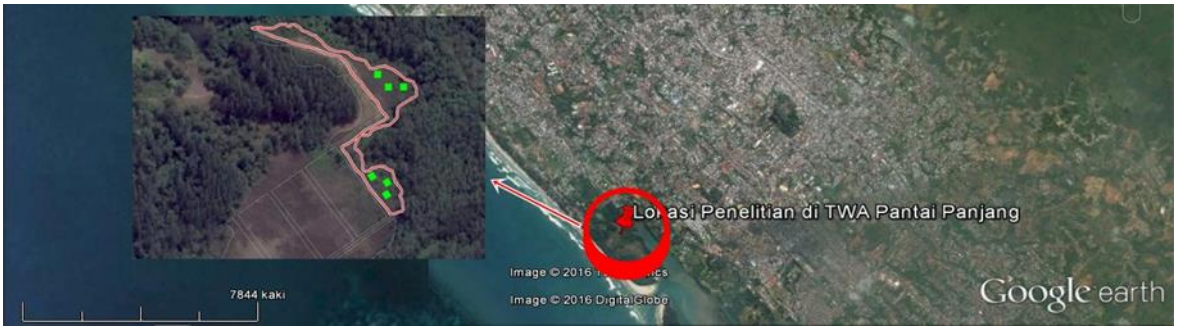

Figure 1. Research location in Pantai Panjang Nature Recreation Park

The occurrence rate was calculated using the following equation:

$$K = \frac{n}{N} x\ 100\%$$

Where:
K = Infestation incidence per leaf (%)
n = Number of infested leaves on a single plant
N = Total number of leaves on a single plant

Plant damage intensity was measured using the equation by Kilmaskosso and Nerokouw (1993):

$$I = \frac{ni.Vi}{NxV} x\ 100\%$$

Where:
I = Damage intensity per leaf (%)
ni = Number of leaves with the i-th score
Vi = Attack score value
N = Total number of observed leaves
V = Highest score value

Table 1. Classification of leaf damage levels caused by pests

Damage Level	Percentage of Visible Leaf Damage	Score
Healthy	No damage 0 %	0
Very light	Leaf damage area of 1 % - 20 %	1
Light	Leaf damage area of 21 % - 40 %	2
Moderate	Leaf damage area of 41 % - 60 %	3
Severe	Leaf damage area of 61 % - 80 %	4
Very severe	Leaf damage area of 81 - 100 %	5

Source: Kilmaskosso and Nerokouw (1993)

RESULTS AND DISCUSSION

Folivorous Insect

Four insect pest species were found attacking the leaves of rehabilitated *Rhizophora apiculata* and *Bruguiera gymnorhiza* in Pantai Panjang Nature Recreation Park, namely the atlas moth (*Attacus atlas*), bagworm (*Metisa plana*), coconut bagworm (*Mahasena corbetti*), and Javanese grasshopper (*Oxya japonica*), as presented in Table 2. The diversity of these pest species indicates that the mangrove ecosystem at the study site provides a supportive habitat for various herbivorous insects. The variation in insect populations within this mangrove ecosystem can be influenced by several factors, such as shifting environmental conditions including temperature and rainfall-photoperiod, predation, competition, migration, dormancy, and the availability of other flowering plant species within the community. Furthermore, leaf palatability, nutritional value that varies with leaf age, and high tannin concentrations in the leaves are considered to influence pest infestation levels (Trisnawati *et al.*, 2019; Ferreira *et al.*, 2024). Inter species variation in tannin content is also driven by multiple factors, including phytogeography, soil conditions, and the harvesting season, which induce plants to modify their phenolic and phytochemical contents (Soni *et al.*, 2015; Indriaty *et al.*, 2023).

Table 2. Pest species on mangrove seedlings in Pantai Panjang Nature Recreation Park

No	Species	Order	Local name	Type of damage	Insects form
1	*Attacus atlas*	Lepidoptera	Ngengat gajah		
2	*Metisa plana*	Lepidoptera	Ulat kantong		
3	*Mahasena corbetti*	Lepidoptera	Ulat kantong kelapa		
4	*Oxya japonica*	Orthoptera	Belalang kelana		

The presence of *A. atlas* is noteworthy due to its large size and high leaf consumption rate during the larval stage (Figure 2). These caterpillars (larva) preferentially consume young foliage, typically starting with one or two leaves from the shoot tip. Throughout this phase, the caterpillars require a continuous food supply. If young leaves are no longer available, they will consume all remaining leaves on the plant to meet their nutritional demands from the larval stage until pupation.

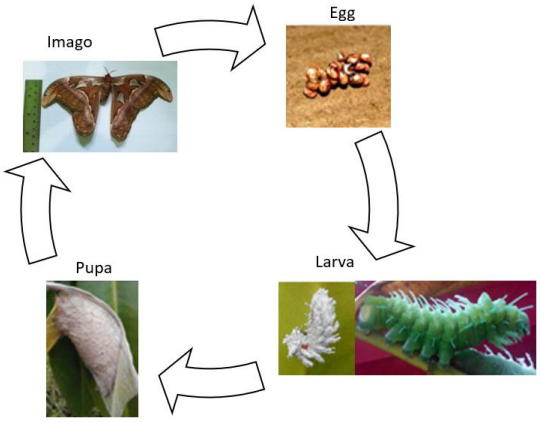

Figure 2. Metamorphosis of *A. atlas* over observation period

During the observation period, *A. atlas* was found on a single *R. apiculata* seedling with an abundance of two individuals. Over the course of the monitoring period, nearly all leaves on this single 90 cm tall plant were consumed by *A. atlas* before they entered the pupal stage. This research aligns with Anggraeni & Wuliandari (2024), who demonstrated that the consumption rate, nutritional requirements, and feed utilization of *A. atlas* increase progressively as the larvae develop toward the prepupal stage. Nevertheless, this species was the least frequently encountered compared to the other three pest species (Figure 3).

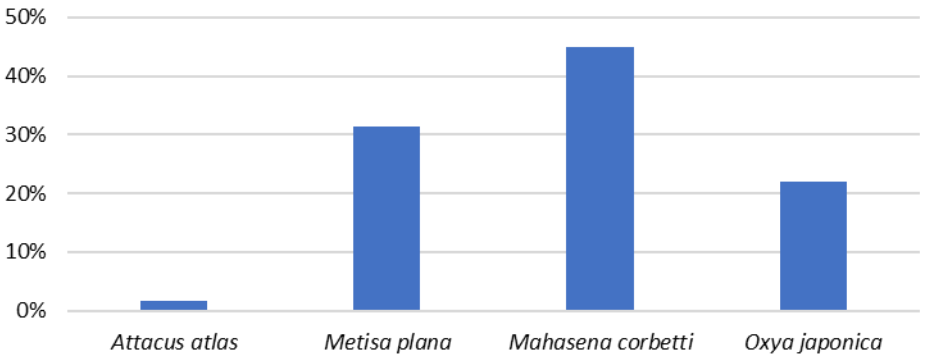

Figure 3. Percentage of pest frequency on mangrove seedlings

The highest frequency of pest occurrence was recorded for *Mahasena corbetti*, followed by *Metisa plana*. Both species exhibit strong persistence due to their ability to construct protective bag structures that shield them from natural predators and extreme coastal weather conditions. The high frequency of *M. corbetti* warrants serious attention, as it is classified as a pest capable of exacerbating infestation rates due to rapid population growth (Lubis *et al.*, 2024). Furthermore, the presence of *Oxya japonica* indicates a dynamic interaction between mangrove vegetation and folivorous insects. As a polyphagous insect, *O. japonica* possesses high mobility in host selection, causing its population to be widely distributed across the mangrove seedlings.

Incidence Rate and Damage Intensity on Mangrove Seedlings

R. apiculata seedlings were consistently infested by pests, with an occurrence rate exceeding 50% throughout the 4-month observation period (Figure 4). The highest infestation incidence on *R. apiculata* was recorded in June, while the lowest value occurred in May. Meanwhile, the infestation incidence on *B. gymnorhiza* tended to decline from April to June. This indicates that the pest infestation rate on *B. gymnorhiza* exhibits a more dynamic fluctuating pattern compared to *R. apiculata*. It is presumed that these two plant species exhibit differing responses to shifting environmental conditions, such as temperature, rainfall, and their respective pest pressure.

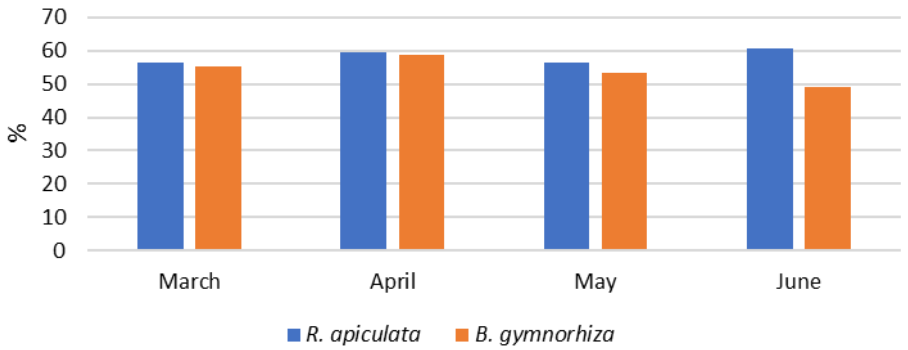

Figure 4. Pest incidence percentage on leaves.

The decline in infestation incidence on *B. gymnorhiza* in June, while *R. apiculata* reached its peak, indicates distinct host preferences within the insect community. The high percentage of infestation incidence on *R. apiculata* is presumed to be closely related to its morphological and

chemical leaf characteristics, which may be more palatable to herbivorous insects. Abulaiti *et al.* (2024) asserted that variations in herbivory across species result from differing plant traits, both in vertical structure and secondary chemical components. Chemical constituents, such as tannin content along with other phenolic compounds, have been proven to provide natural defense mechanisms against insect and pathogen attacks through antibacterial and insecticidal properties, as well as by reducing nutrient availability for pests (Mappiasse & Mukhlisa, 2024).

In contrast to the infestation incidence pattern, the intensity of pest damage on both mangrove seedling species demonstrated more varied dynamics across the months (Figure 5). In March, the damage intensity on *B. gymnorhiza* was higher than that on *R. apiculata*, despite their infestation incidences being nearly identical. By April, both species reached a nearly balanced peak in damage intensity. In May, *R. apiculata* attained its highest damage intensity (22.8%), whereas *B. gymnorhiza* began to decrease to 18.2%. The declining trend in damage intensity for *B. gymnorhiza* continued into June (14.7%), while *R. apiculata* maintained a relatively high damage intensity (21%). These results indicate that the pest infestation level on *R. apiculata* is classified as mild, whereas on *B. gymnorhiza*, it is categorized as very mild, both of which remain within thresholds that do not threaten the overall survival of the mangrove vegetation in Pantai Panjang Nature Recreation Park.

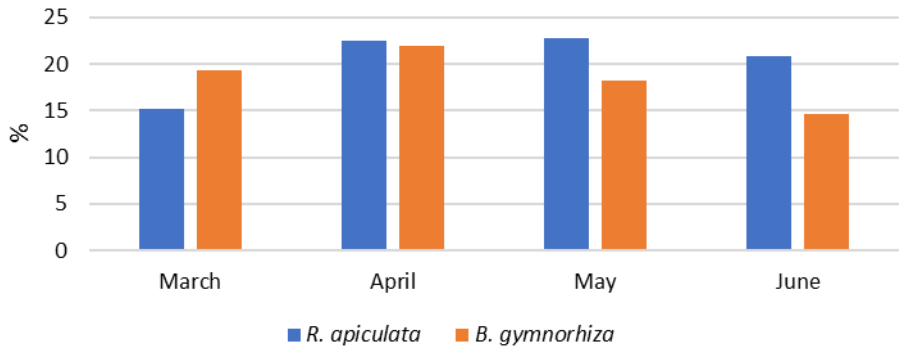

Figure 5. Pest damage intensity

There is a discrepancy between the incidence pattern of attacks (Figure 4) and the damage intensity (Figure 5) in *B. gymnorhiza*. This is evident from the fact that the damage intensity of *B. gymnorhiza* was higher than that of *R. apiculata* in March, even though the attack incidence in the following month was lower in *B. gymnorhiza* compared to *R. apiculata*. Damage intensity is determined not solely by the frequency of infestation, but also by the recovery capacity of each species and the composition of leaf defense compounds. Laksono *et al.* (2023) explained that several factor including vegetation type, leaf age, leaf nutrient content, tree height, chemical composition of the leaf, and tannin concentrations localized in the epidermis—can protect plants from herbivore attacks by reducing leaf palatability and digestibility for folivorous insects.

The significant decrease in damage intensity for *B. gymnorhiza* from May to June (dropping from 18% to 15%) stands in contrast to *R. apiculata*, which remained relatively stable in the range of 21–23% during the same period. This aligns with the findings of Hirano *et al.* (2024), who stated that herbivory rates in mangroves decrease with increasing concentrations of condensed tannins or the leaf tannin-to-nitrogen ratio. Furthermore, these rates vary by season and leaf phenotype, meaning that species with higher tannin content tend to exhibit better recovery from herbivore attacks. Decline in mangrove ecosystem health caused by leaf pests and diseases can result in the failure of mangrove forest rehabilitation efforts if not properly managed (Aznawi *et al.*, 2024).

CONCLUSION

There were four species of folivorous insects found attacking *Rhizophora apiculata* and *Bruguiera gymnorhiza*, namely *Attacus atlas*, *Metisa plana*, *Mahasena corbetti*, and *Oxya japonica*. Their presence indicates that the mangrove ecosystem in this area serves as a supportive habitat for herbivorous insect communities with diverse life strategies. *R. apiculata* consistently experienced a higher infestation incidence than *B. gymnorhiza* throughout the four-month observation period,

peaking in June. Meanwhile, the pest damage intensity on *R. apiculata* was classified as mild, whereas on *B. gymnorhiza*, it was categorized as very mild, suggesting that this damage intensity does not yet threaten the overall survival of the seedlings.

RECOMMENDATION

Large-scale infestations of folivorous insects (pests) can adversely affect the success of rehabilitation programs. Consequently, periodic pest monitoring and ecologically based management are required to maintain the health and long-term sustainability of the mangrove ecosystem functions in the Pantai Panjang Nature Recreation Park.

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