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Functional Roles and Arthropod Diversity Associated with Mangrove Forest in Tanjung Api-Api, Banyuasin

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ABSTRACT

Studies of mangrove arthropods in Indonesia are limited, and research in the Banyuasin mangrove forest at Tanjung Api-Api remains scarce. Most studies focus on general biodiversity rather than on the specific ecological roles these species play in mangrove productivity. The objectives of the research are to analyze the species composition, ecological roles, and population dynamics of arthropods to understand their contributions to mangrove forest resilience. Arthropod sampling was conducted using purposive sampling, including arthropod morphology. Samples are collected from the Tanjung Api-Api mangrove forest. Arthropod specimens were subsequently identified, counted, and recorded in the laboratory. Diversity indices and community structure analyses were then used to evaluate the data. Results showed 380 individuals across multiple arthropod orders, with Decapoda and Hymenoptera emerging as the dominant groups. Key findings indicate that decapod crabs improve soil quality, while Hymenoptera enhance canopy and vegetation. Diversity revealed medium species richness, low dominance, and high evenness, suggesting a balanced community. Notably, stable dynamics between detritivores and predators control herbivore populations, whereas few pollinators suggest pollination is limited by short flowering periods. In summary, the arthropod community maintains a resilient trophic structure that underpins ecosystem processes, demonstrating that species composition and ecological roles directly support mangrove productivity.

1. Introduction

Mangrove forests support extraordinarily productive coastal ecosystems that stabilize shorelines, protect communities, and maintain a diverse array of flora and fauna that depend on them. Indonesia maintains the world's most extensive mangrove forest coverage, including 158,734 hectares in South Sumatra, where the Tanjung Api-Api mangrove forest forms a dominant coastal forest landscape (Adriani *et al.* 2025). These forest habitats rely on alluvial substrates and tidal regimes that generate specialized niches essential for feeding, breeding, and sheltering a wide range of terrestrial and aquatic organisms. Global forest studies indicate that mangrove systems regulate nutrient cycles, sustain biodiversity, and enhance ecological resilience in coastal forest zones (Alongi 2018). This research context positions mangrove forests as critical components of tropical forest science and requires detailed ecological explanations for forestry readers.

Arthropods constitute the largest faunal group within tropical forest ecosystems, including mangrove forests, with over 900,000 known species that contribute essential ecological functions (Polgar and Jaafar 2018). Their

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forest-based roles encompass pollination, predation, decomposition, herbivory, and parasitism, all of which support the productivity and stability of mangrove forest vegetation. Studies across Asia, Africa, and the Americas show that arthropod assemblages are shaped by forest vegetation structure, tidal gradients, and microhabitat complexity, with ants, spiders, crabs, and other groups acting as primary ecological contributors (Scogings and Sankaran 2020). Their functional activities enhance soil aeration, accelerate decomposition, provide natural pest regulation, and indicate environmental change within forested mangrove landscapes. These roles make arthropods central to forest ecological processes that forestry audiences must understand.

Despite global progress in mangrove forest ecology, information on arthropod diversity in Indonesian mangrove forests remains uneven and fragmented. Studies in Kalimantan, Java, and Sulawesi often focus on fish community structure and mangrove rehabilitation (Basyuni *et al.* 2024). These studies include carbon stock assessments in restored mangrove ecosystems, which is a dominant research direction. Terrestrial arthropods such as Coleoptera, Hymenoptera, Diptera, and Araneae remain underexplored in forest-based ecological analyses (Nsengimana *et al.* 2025). South Sumatra, especially the Tanjung Api-Api mangrove forest, lacks comprehensive studies on arthropod communities despite its ecological significance. This knowledge gap limits understanding of forest ecosystem dynamics and constrains conservation strategies that rely on faunal indicators of forest health. Addressing this gap becomes essential for strengthening forest-focused biodiversity assessment in tropical mangrove regions.

Ecological theory highlights that species interactions, forest community structure, and trophic processes must be assessed holistically to evaluate ecosystem stability. Arthropods regulate forest processes through feedback mechanisms similar to those in Integrated Pest Management systems, where natural enemies and habitat conditions shape community dynamics (Fischbein and Corley 2022). Global forestry and coastal management practices show that ecological monitoring effectively assesses biodiversity and forest environmental quality. These principles emphasize that arthropods function not merely as taxonomic units but as ecological drivers vital for the functioning of mangrove forests. Understanding these functional roles enables forestry audiences to appreciate the processes that sustain forest resilience.

Given these conditions, a systematic investigation of arthropod diversity and ecological functions in the Tanjung Api-Api mangrove forest is urgently required. This study presents new findings on species composition, ecological roles, and habitat associations of arthropods within a major South Sumatran Forest landscape. The results fill critical knowledge gaps in forest biodiversity and strengthen conservation frameworks for mangrove forest management. These findings also provide foundational ecological insights essential to understanding the processes that support forest resilience in Indonesia. The objectives of the research are to analyze the species composition, ecological roles, and population dynamics of arthropods to understand their contributions to mangrove forest resilience.

2. Materials and Methods

2.1. Research Preparation

The field research was conducted in the mangrove forest complex surrounding the Tanjung Api-Api Port, Banyuasin Regency, South Sumatra, an area recognized for its relatively intact mangrove stands and high biological activity. The site was selected based on its ecological representativeness and accessibility for purposive sampling of arthropods. Field activities were conducted from June to December 2024, encompassing both the dry and transitional seasons to collect ecologically representative data. All specimen processing, preservation, and taxonomic identification were performed at the Laboratory of Plant Pest and Disease, Department of Plant Protection, Faculty of Agriculture, Sriwijaya University, Indralaya. The field equipment consisted of standard stationery, vial bottles, macro-lens-equipped digital cameras, scissors, forceps, documentation folders, and boundary ropes for delimiting sampling stations. The materials used in the study included 70% ethanol for specimen preservation, labeling paper, and arthropod specimens collected from the site. A stereomicroscope and macroscopic lens were used for morphological examination and species description.

2.2. Research Implementation

A field survey was conducted to document arthropod groups and their relationships with mangrove tree species in Tanjung Api-Api, Banyuasin, South Sumatra. Surveys were conducted weekly for 5 weeks at set morning (08:00–10:00 WIB) and afternoon (15:30–17:00 WIB) times, chosen to observe active arthropods best. Trees were specifically chosen if they showed signs of arthropod activity, including feeding marks, head, thorax, abdomen, and body color. Observations of arthropod-tree interactions at 30 mangrove trees were tagged as repeat observation points to enable consistent monitoring. To document their features, arthropod specimens were observed in situ and, when necessary, placed on a flat surface to make key details visible (Hutchins 2020). Photos were taken with a macro lens, and body, leg, and wing measurements were taken using calibrated tools at 40x magnification. All data and images were stored securely in the institution's cloud storage and can be requested by the corresponding author for academic review, in accordance with the institution's privacy rules.

2.3. Arthropod Sampling

Arthropod sampling was conducted using a purposive sampling strategy designed to capture the structural, taxonomic, and functional heterogeneity of arthropod assemblages within the mangrove forest (Setyawan *et al.* 2020). Sampling points were deliberately selected based on dominant vegetation architecture, microhabitat diversity, and preliminary visual indicators of arthropod activity. The term taxonomic recovery in this study refers to obtaining the widest possible representation of arthropod taxa. Therefore, the sampling design emphasized maximizing taxonomic coverage across functional guilds and habitat-specific assemblages. Each sampling location was coordinated and associated with identified mangrove plant species and clearly defined arthropod communities, each representing a distinct ecological niche.

Two complementary sampling techniques were employed to maximize taxonomic coverage. First, hand collecting (direct) to identify the diversity of arthropods in the mangrove involved careful inspection of mangrove foliage, stems, flowers, fruiting bodies, and root structures to detect mobile and sessile arthropods (Yulianti and Sazali 2026). Specimens were gently removed using fine-tipped forceps or manually, depending on the accessibility, mobility, and fragility of the organisms, ensuring minimal structural damage during collection. Each captured arthropod was immediately placed into an individual sterile Ziploc bag or 5–10 mL vial containing 70% ethanol to arrest enzymatic activity and preserve external morphological traits critical for subsequent identification. This approach enabled the efficient retrieval of both conspicuous and semicryptic taxa inhabiting plant-associated microhabitats.

Second, targeted microhabitat searching was conducted to detect cryptic, nocturnal, or low-mobility arthropods that are often underrepresented in conventional sampling methods. This procedure included systematic examination of bark crevices, abaxial leaf surfaces, decaying wood fragments, upper sediment layers surrounding mangrove roots, and accumulated organic debris (Madhava *et al.* 2025). These microhabitats frequently harbor small-bodied taxa such as Collembola, Psocoptera, Acari, and juvenile arachnids, which require fine-scale searching due to their concealment behavior and microspatial distribution.

All collected specimens were processed in accordance with a strict labeling and metadata standardization protocol. Each vial was assigned a unique collection code linking arthropod specimens to plant species identity. This integrated metadata system ensured traceability and supported multi-factor ecological analysis, including species–habitat association and spatial distribution patterns. Specimens were stored in insulated transport containers to minimize thermal stress and mechanical damage during transport to the laboratory. This rigorous sampling and preservation workflow ensured high-quality specimens with minimal loss of diagnostic morphological characters, thereby supporting robust taxonomic identification and enabling comprehensive ecological interpretation.

2.4. Arthropod Identification

Taxonomic identification of arthropod specimens was conducted at the Laboratory of Plant Pest and Disease, Sriwijaya University, using a systematic, multi-tiered analytical framework. Initial screening was conducted under a stereomicroscope equipped with adjustable LED illumination to ensure optimal visualization of delicate morphological structures. Specimens were examined on clean, non-reflective Petri dishes to minimize optical distortion and to facilitate precise manipulation during observation.

Identification procedures focused on a comprehensive suite of morphological traits that are taxonomically informative across major arthropod orders. Particular attention was given to head morphology, including antenna segmentation, mandibular architecture, clypeus shape, and the arrangement of compound eyes. Thoracic characteristics were also examined in detail, such as segment differentiation, leg articulation, tarsal formula, and the presence of specialized appendages that may serve diagnostic or ecological functions. For winged taxa, wing morphology was assessed based on venation patterns, membrane texture, folding mechanisms, and pigmentation features. Mouthpart configuration was classified into functional categories: mandibulate, haustellate, piercing–sucking, siphoning, or sponging, reflecting the feeding guild and taxonomic affinity of each specimen. Abdominal traits were evaluated through observations of segment number, external genitalia (when externally visible), color patterning, and setae distribution (Ribeiro and Espíndola 2024). Together, these morphological parameters provided an integrated framework for accurate taxonomic placement and differentiation among closely related arthropod species. Specimens were then cross-referenced with authoritative identification keys, including "The Insects: An Outline of Entomology" (Gullan and Cranston 2014) and "The Insects of Australia" (CSIRO 1991), as well as regional Southeast Asian entomological monographs, to ensure taxonomic reliability. When ambiguities arose, multiple characters were triangulated, and photographic documentation was reevaluated to safeguard against misidentification.

High-resolution macro photographs taken during the documentation stage served as permanent reference vouchers, enabling validation of morphological interpretations and supporting transparency in species delimitation. These visual vouchers were cataloged within a digital database along with metadata on the collection site, ecological role, and microhabitat. This standardized identification workflow ensured taxonomic consistency, enabling subsequent ecological analyses of arthropod guild structure, diversity patterns, and functional contributions within the Tanjung Api-Api mangrove ecosystem.

2.5. Data Analysis

The data recorded included species abundance, frequency of occurrence, and ecological functional roles (predators, herbivores, pollinators, detritivores, and parasitoids). Quantitative ecological indices were used to describe the community structure:

Shannon-Wiener Diversity Index (H') (Odum and Barrett 2004):

$$H' = -\sum_{i=0}^{n} \binom{n}{k} Pi \ln Pi$$

Where:
H' : Diversity Index
Pi : The ratio of the number of individuals to the total number of species
In : The total number of individuals of all species
Ni : The total number of individuals of a species

The diversity index criteria according to Shannon-Wiener were defined as follows:
H' < 1 : Low diversity
1 < H' < 3 : Medium diversity
H' > 3 : High diversity

Barger Parker's Dominance Index (D) (Odum and Barrett 2004):

$$D = \frac{N_{max}}{N}$$

Where:
D : Barger Parker Index
N_{max} : Number of the most dominant individuals
N : Total number of all individuals of the species

Dominance value criteria:
0.75 < D < 1 : High dominance
0 < D < 0.5 : Low dominance
0.5 < D < 0.75 : Medium dominance

Evenness Index (E) (Odum and Barrett 2004):

$$H' = \frac{H'}{\ln(S)}$$

Where:
E : Evenness Index
H' : Shannon-Wiener Species Diversity Index
In : Number of individuals of all species

Evenness values ranged from 0 to 1, with the following categories:
0 < E < 0.4 : Low evenness, stressed community
0.4 < E < 0.6 : Medium evenness, unstable community
0.6 < E < 1 : High evenness, stable community

The dataset was conducted using MS Excel 2021, while diversity computations were analyzed using PAST 4 to calculate the diversity index, and RStudio 2025 to display all data visually in the result (Stander and Dalla Valle 2017; Karthiyayini *et al.* 2025).

3. Results

3.1. Arthropods Found in the Mangrove Forest

A total of 380 arthropod individuals were documented within the mangrove forest ecosystem of Tanjung Api-Api, Banyuasin, South Sumatra. The recorded assemblage comprised several taxonomic groups, with Decapoda showing the highest abundance, at 177 individuals (46.6%). Within Decapoda, the individuals were recorded as *Tubuca* sp. (54 individuals), *Uca* sp. (48 individuals), *Macrophthalmus* sp. (37 individuals), and *Episesarma* sp. (38 individuals), all observed across intertidal substrate zones during sampling.

Hymenoptera was the second most abundant order, with 129 individuals (33.9%), comprising *Oecophylla* sp. (77 individuals), *Camponotus* sp. (27 individuals), and *Formica* sp. (21 individuals), collected from vegetation strata within the mangrove forest. The remaining individuals were distributed among other arthropod groups recorded in lower abundances, contributing to the overall community composition observed in the study area. All taxa were identified and recorded based on morphological characteristics observed during field sampling and laboratory identification procedures.

Additional groups, including Hemiptera (21 individuals), Coleoptera (15 individuals), Araneae (12 individuals), and Lepidoptera (12 individuals), were described as supporting elements of the forest food web, helping forestry readers connect these taxa to broader ecological functions in tropical coastal forests. Low-frequency taxa such as *Phintella* sp., *Paidiscura* sp., *Crematopsyche* sp., and *Trombidium* sp. were interpreted as indicators of microhabitat heterogeneity, allowing the forestry audience to appreciate how mangrove forest environments sustain structurally diverse arthropod communities (Table 1).

The arthropod community in the Tanjung Api-Api mangrove forest was interpreted as evidence of a layered, interdependent system, with detritivore crabs serving as key drivers of sediment processes central to forest productivity. Arthropod diversity in the Tanjung Api-Api mangrove forest was documented to exhibit a distinctive structure shaped by mud-climbing decapods that play essential roles in sediment turnover and nutrient cycling, processes fundamental to sustained forest growth. The distribution of both high-density ecosystem engineers and low-abundance specialists is considered to sustain natural nursery functions that influence long-term forest regeneration. Thus, documenting arthropod diversity in mangrove

Table 1. Arthropod morphospecies associated with the mangrove forest of Tanjung Api-Api

Order	Family	Morphospecies	Common name	Number of individuals
Araneae	Salticidae	*Phintella* sp.	Jumping spider	1
	Salticidae	*Maratus* sp.	Peacock spider	2
	Salticidae	*Evarcha* sp.	Jumping spider	1
	Salticidae	*Lycidas* sp.	Jumping spider	4
	Oxyopidae	*Oxyopes* sp.	Lynx spider	2
	Theridiidae	*Paidiscura* sp.	Comb-footed spider	1
	Salticidae	*Pseudoeuophrys* sp.	Jumping spider	1
Coleoptera	Curculionidae	*Hylobius* sp.	Weevil	3
	Chrysomelidae	*Aphthona* sp.	Leaf beetle	5
	Coccinellidae	*Harmonia* sp.	Lady beetle	3
	Coccinellidae	*Coccinella* sp.	Lady beetle	4
Decapoda	Ocypodidae	*Tubuca* sp.	Fiddler crab	54
	Ocypodidae	*Uca* sp.	Fiddler crab	48
	Macrophthalmidae	*Macrophthalmus* sp.	Sentinel crab	37
	Sesarmidae	*Episesarma* sp.	Sesarmid crab	38
Hemiptera	Pseudococcidae	*Planococcus* sp.	Mealybug	6
	Pseudococcidae	*Pseudococcus* sp.	Mealybug	4
	Membracidae	*Thelia* sp.	Treehopper	3
	Membracidae	*Leptocentrus* sp.	Treehopper	6
	Scutelleridae	*Poecilocoris* sp.	Jewel bug	2
Hymenoptera	Formicidae	*Camponotus* sp.	Carpenter ant	27
	Formicidae	*Formica* sp.	Field ant	21
	Formicidae	*Oecophylla* sp.	Weaver ant	77
	Halictidae	*Lipotriches* sp.	Sweat bee	4
Lepidoptera	Psychidae	*Metisa* sp.	Bagworm	3
	Psychidae	*Pagodiella* sp.	Bagworm	3
	Hyblaeidae	*Hyblaea* sp.	Defoliator moth	5
	Psychidae	*Crematopsyche* sp.	Bagworm	1
Odonata	Libellulidae	*Orthetrum* sp.	Dragonfly	6
Orthoptera	Hymenopodidae	*Odontomantis* sp.	Praying mantis	4
Trombidiformes	Trombidiidae	*Trombidium* sp.	Velvet mite	4

forests is considered essential for providing forestry researchers and forest managers with insights that sustain ecosystem functions and forest resilience.

The temporal dynamics of detritivores were observed to remain consistent in the mangrove forest, with *Tubuca* sp. increasing steadily. In contrast, *Uca* sp. and *Macrophthalmus* sp. remained stable, thereby supporting soil–fauna processes relevant to forest productivity. Sediment enrichment and organic matter accumulation have been shown to shape benthic activity, which directly influences the substrate quality essential for mangrove timber formation. Localized pulses of *Lycidas* sp. in the 3rd weeks and *Orthetrum* sp. toward the 5th weeks were interpreted as emergence cycles driven by forest-floor microclimate cues that affect seedling establishment. Early but declining occurrences of *Planococcus* sp., *Aphthona* sp., and *Hylobius* sp. were attributed to resource limitations and strong top-down control within the forest trophic web, conditions that stabilize vegetation dynamics, which are important for wood yield. The contrasting patterns of dominant Hymenoptera, transient herbivores, episodic predators, and stable detritivores were interpreted as reflections of a finely partitioned ecological mosaic whose resilience enables the Tanjung Api-Api mangrove forest to maintain functional balance under fluctuating environmental conditions. Moreover, Moderate-abundance arthropods, including sap-feeding insects, leaf beetles, and predatory spiders, were shown to regulate populations and sustain trophic balance that underpins long-term forest stability.

3.2. Arthropod Diversity and Community Structure in the Mangrove Forest

Analysis of the arthropod community revealed that the Shannon-Wiener diversity index (H') reached 2.315, which falls within the medium diversity category ($1 < H' < 3$) according to Shannon-Wiener criteria. This indicates that the mangrove forest of Tanjung Api-Api supports a moderately diverse arthropod community with a variety of morphospecies spread across multiple orders, reflecting a balanced ecological network. The Berger-Parker dominance index (D) was calculated at 0.207, which is classified as low dominance ($0 < D < 0.5$) (Figure 1). Such a low dominance value suggests that no single morphospecies overwhelmingly dominates the community. This pattern indicates a more equitable distribution among species, which is essential for maintaining ecological stability in mangrove habitats. In this forest, even species with naturally higher populations, such as *Uca* sp. and *Episesarma* sp., did not significantly skew the community structure.

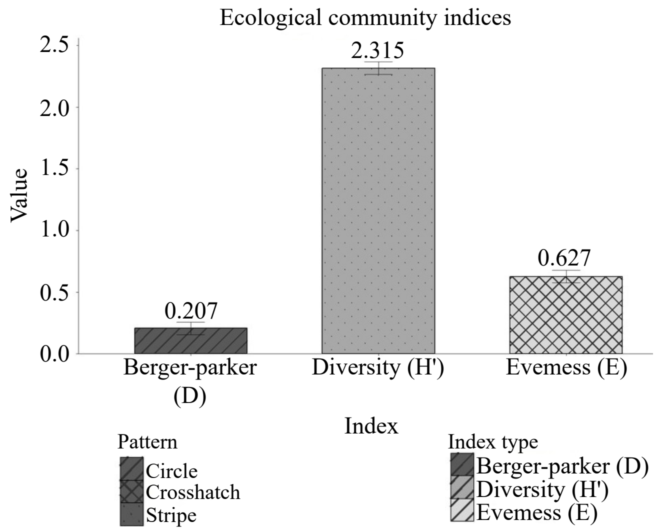


Figure 1. Diversity of the arthropod community in the mangrove forest of Tanjung Api-Api

The evenness index (E) measured 0.627, indicating high evenness, which shows that arthropod individuals are distributed relatively evenly among morphospecies in the Tanjung Api-Api mangrove forest. Medium Shannon-Wiener diversity and low Berger-Parker dominance, together with high evenness, suggest a balanced and stable arthropod community. This balanced structure supports essential functions of the forest ecosystem, including predation, pollination, and decomposition. High evenness indicates that no single species dominates, which is important for maintaining functional stability in tropical forest habitats. The data demonstrate that the mangrove arthropod assemblage is diverse, resilient, and ecologically robust, reflecting the health of the forest ecosystem.

Weekly monitoring revealed that predatory arthropods were the most abundant, with totals of 51, 22, 20, 36, and 29 individuals over five weeks, indicating their key role in regulating herbivore populations. Herbivores were comparatively fewer, with 15, 8, 8, 5, and 5 individuals weekly, reflecting moderate pressure on mangrove vegetation. The dominance of predators highlights the forest's natural control mechanisms, which help maintain a balance in the vegetation. These patterns indicate that functional interactions among arthropods are crucial for maintaining ecosystem stability in tropical mangrove forests. Hence, the Tanjung Api-Api mangrove exemplifies how species distribution and abundance influence ecological processes crucial for forest health.

In the Tanjung Api-Api mangrove forest, detritivores were highly active, with weekly counts totaling 177 individuals, emphasizing their role in organic matter decomposition and nutrient cycling (Figure 2). Pollinators were rare, with only four individuals recorded across five weeks, reflecting limited pollination activity in this forest ecosystem.

3.3. Morphological Features of Arthropods in the Mangrove Forest

Observations of arthropods in the mangrove forest of Tanjung Api-Api revealed a wide range of morphological traits. Identification focused on body size, coloration, antenna type, mouthpart structure, wing presence, and leg morphology. These primary traits provided insight into ecological roles and feeding behaviors (Table 2).

Accurate species-level data allow researchers to link functional roles to forest ecosystem processes. The ecological significance of dominant and minor taxa extends to litter decomposition, predation, pollination, and habitat engineering. These findings reinforce the idea that forest arthropods are integral to maintaining ecosystem structure and function.

Arthropod diversity in the Tanjung Api-Api mangrove forest was documented to include Hymenoptera, Coleoptera, Lepidoptera, Hemiptera, Orthoptera, Arachnida, and Malacostraca, indicating a complex community important to forest function. Key groups such as *Camponotus* sp., *Lasius* sp., *Oecophylla* sp., and *Heterotrigona* sp. were observed to display morphological traits that supported canopy foraging, soil activity, and pollination.

Decapod crustaceans, including *Macrophthalmus* sp., *Uca* sp., *Austruca* sp., and *Episesarma* sp., were found to exhibit sediment-engineering behaviors that maintained soil aeration and nutrient turnover vital for mangrove wood formation. Their burrowing, feeding, and territorial activities were identified as sustaining substrate conditions that affect tree root development and forest growth. Diversity metrics indicated a resilient mangrove community, with structure reflecting habitat quality, vegetation stability, and resource distribution and demonstrating consistent patterns between mangrove forests and agroforestry systems.

4. Discussion

Decomposition and predation were the dominant ecological processes, while herbivory and pollination played more minor roles. The dominance of *Oecophylla* sp. and decapods in quantitative terms, contrasting with the low but consistent abundance of herbivores and predators in this forest environment. This contrast was interpreted

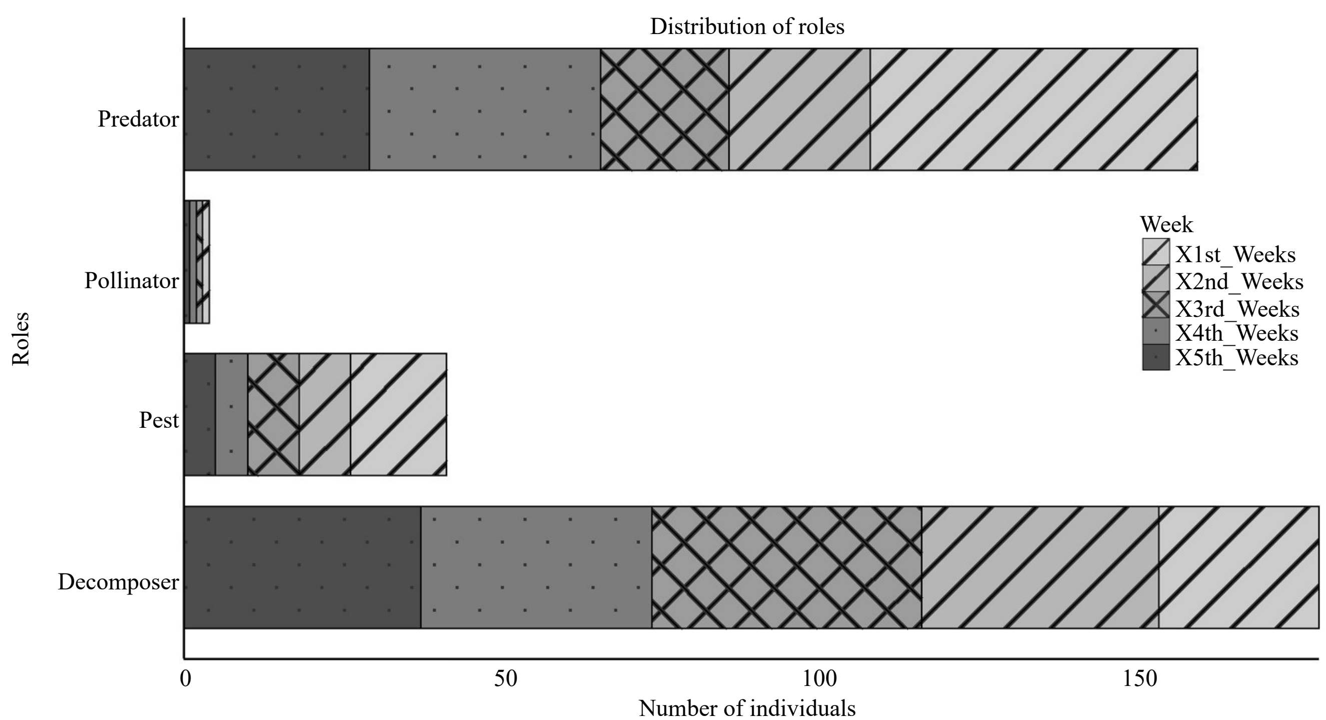


Figure 2. Distribution of arthropod ecological roles in the mangrove forest of Tanjung Api-Api

Table 2. Morphological characteristics of arthropods in the mangrove forest of Tanjung Api-Api

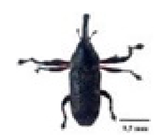
Morphospecies	Morphology	Figure
Camponotus sp.	This arthropod belongs to the class Insecta, order Hymenoptera, family Formicidae—body length ±6 mm, reddish-brown. The head has large compound eyes, geniculate antennae, and strong mandibles. Thorax is brown, smooth, and wingless in workers. Abdomen dark with clearly visible segments. Legs are long with well-arranged tarsi. Morphology conforms to the Hymenoptera description standards	
Lasius sp.	This species belongs to the class Insecta, order Hymenoptera, family Formicidae. Body length ±5 mm, shiny black. Head small with short antennae and small mandibles. Thorax smooth; workers are wingless. Abdomen dark, rounded, segmented. Legs relatively short with distinct tarsi. Morphology follows general descriptions of *Lasius* spp.	
Oecophylla sp.	Known as weaver ants, they belong to the class Insecta, order Hymenoptera, family Formicidae. Body ±6.1 mm, red. Head with long geniculate antennae, strong mandibles, and large compound eyes. Thorax glossy; males and queens winged; workers wingless. Abdomen red, segments distinct. Legs long and strong, with corbiculae for carrying food. This typical morphology aligns with descriptions of weaver ants	
Heterotrigona sp.	Belongs to class Insecta, order Hymenoptera, family Apidae. Body ±5 mm, black. Head with short antennae, small mandibles, and compound eyes. Thorax hairy with transparent wings for flight. Abdomen black with corbiculae for pollen transport. Legs short, tarsi distinct. This species is a key pollinator in mangrove ecosystems	
Menochilus sp.	This species belongs to the class Insecta, order Coleoptera, family Coccinellidae. Body red, ±6.7 mm, elytra with parallel spots and a black transverse line in the middle. Head black with short antennae and strong mandibles—Thorax red, covering hind wings. Abdomen hidden beneath elytra. Legs black with strong femora and arranged tarsi. Morphology matches Chrysomelidae and Coccinellidae descriptions	
Harmonia sp.	Belongs to class Insecta, order Coleoptera, family Coccinellidae. Body red with black spots, ±6 mm. Head black, short antennae, small mandibles. Thorax covering elytra, abdomen hidden. Legs black, tarsi distinct, ladybird morphology	
Aulacophora sp.	Class Insecta, order Coleoptera, family Chrysomelidae. Body ±5 mm, head orange with filiform antennae, small mandibles. Thorax orange, elytra black, abdomen orange. Legs long, thin, tarsi distinct. Conforms to Chrysomelidae descriptions	
Hylobius sp.	Class Insecta, order Coleoptera, family Curculionidae. Body ±6.5 mm, dark brown. Head with geniculate antennae and strong mandibles. Thorax coarse, wings covering abdomen. Abdomen brown, segmented. Legs strong with large femora. Morphology matches Curculionidae	
Metisa sp.	Class Insecta, order Lepidoptera, family Psychidae. Body ±2.8 cm; head dark green with dark projections. Thorax winged; abdomen dark green; larva instar 3. Legs thin, tarsi visible Hyblaeidae larvae	

Table 2. Continued

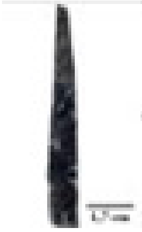
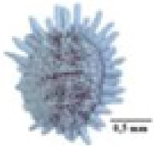
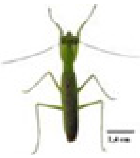
Morphospecies	Morphology	Figure
Cremastopsyche sp.	Class Insecta, order Lepidoptera, family Psychidae. Body ±2.5 cm, small head with filiform antennae. Thorax hairy, wings fringed. Abdomen elongated; legs thin with distinct tarsi	
Pagodiella sp.	Class Insecta, order Lepidoptera, family Crambidae. Body ±2.6 cm, small head, filiform antennae, small mandibles. Thorax smooth, wings transparent, abdomen elongated. Legs thin, tarsi distinct	
Hyblaea sp.	Class Insecta, order Lepidoptera, family Hyblaeidae. Larval body ±2.8 cm, head dark green with black spots. Thorax and abdomen dark green, five instars. Legs thin, tarsi distinct. Predominant in mangrove	
Leptocentrus sp.	Class Insecta, order Hemiptera, family Cicadellidae. Body ±7 mm, dark brown with elongated dorsal projections, two horns on head. Thorax and abdomen brown, legs thin with arranged tarsi. Morphology matches treehopper descriptions	
Pseudococcus sp.	Class Insecta, order Hemiptera, family Pseudococcidae. Small body ±3 mm, white; head small, short antennae, vestigial mandibles. Thorax soft, abdomen white with waxy hair, legs short. Matches Pseudococcidae descriptions	
Thelia sp.	Class Insecta, order Hemiptera, family Cicadellidae. Body ±5 mm, head black, short antennae, small mandibles. Thorax smooth, wings transparent, abdomen black with spots. Legs thin, tarsi distinct. Matches Hemiptera	
Poecilocoris sp.	Class Insecta, order Hemiptera, family Scutelleridae. Body ±6 mm, head green, long antennae, small mandibles. Thorax metallic, wings covering abdomen, legs long. Description according to references	
Planococcus sp.	Class Insecta, order Hemiptera, family Pseudococcidae. Small body ±3 mm, white with a wax layer; head small, short antennae, vestigial mandibles. Thorax soft, abdomen white, legs short, tarsi small	
Ailopus sp.	Class Insecta, order Orthoptera, family Acrididae. Body ±1.4 cm, green; head small, short antennae, small mandibles. Thorax and abdomen green; hind legs strong, forelegs raptorial	
Odontomantis sp.	Class Insecta, order Orthoptera, family Hymenopodidae. Body ±1.4 cm, green; head small, short antennae, strong mandibles. Thorax slender, abdomen green; forelegs raptorial, other legs thin	

Table 2. Continued

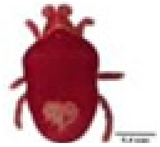
Morphospecies	Morphology	Figure
Lycidas sp.	Class Arachnida, order Araneae, family Salticidae. Body ±3 mm, black with yellow hair on abdomen and cephalothorax. Head with large eyes, four pairs of yellow legs	
Epocilla sp.	Class Arachnida, order Araneae, family Salticidae. Body ±3 mm, orange, four pairs of long legs. Head with large eyes, abdomen orange with short hair	
Evarcha sp.	Class Arachnida, order Araneae, family Salticidae. Body ±3 mm, black, four pairs of legs. Head with large eyes, abdomen covered with fine hairs	
Pseudoeuophrys sp.	Class Arachnida, order Araneae, family Salticidae. Body ±3 mm, brown, four pairs of long legs, head with large eyes, abdomen hairy	
Pardosa sp.	Class Arachnida, order Araneae, family Lycosidae. Body ±3 mm, brown, four pairs of long legs, head with large eyes, abdomen hairy	
Paidiscura sp.	Class Arachnida, order Araneae, family Theridiidae. Body ±3 mm, pale, four pairs of legs, head with eyes, abdomen rounded	
Trombidium sp.	Class Arachnida, order Trombidiformes, family Trombidiidae. Body ±0.4 mm, bright red, four pairs of legs, small head	
Macrophthalmus sp.	Class Malacostraca, order Decapoda, family Ocypodidae. Body ±2.4 cm, hard carapace, four pairs of brown legs, two claws, one larger	
Uca sp.	Class Malacostraca, order Decapoda, family Ocypodidae. Body ±2.4 cm, hard carapace, four pairs of legs, two claws, one larger	

Table 2. Continued

Morphospecies	Morphology	Figure
Austruca sp.	Class Malacostraca, order Decapoda, family Ocypodidae. Body ±2.4 cm, hard carapace with blue pattern, four pairs of legs, two claws, one larger	
Episesarma sp.	Class Malacostraca, order Decapoda, family Sesarmidae. Body ±2.4 cm, hard carapace, four pairs of legs, two claws, one larger	

as an indicator of a stable yet competitively structured community, thereby supporting ecological functions relevant to wood-producing mangrove stands (Erienti and Dewata 2019). The trophic configuration was considered to support the functional resilience commonly expected in tropical forest systems and highly valued in forestry science. Crustaceans are reliable indicators of forest-floor conditions because their sensitivity to salinity, moisture, and substrate stability is well established (Schneider *et al.* 2023). Similar stability-dependent patterns were reported by Diadara and Herlin (2025) in shaded Arenga plantations, where canopy cover and soil conditions were shown to determine arthropod composition, demonstrating ecological parallels across tropical forest types. The arthropod communities directly influence soil fertility, litter processing, and forest productivity, thereby linking biodiversity patterns to wood-yield outcomes (Nsengimana *et al.* 2018).

The natural equilibrium of the Tanjung Api-Api mangrove was interpreted as characteristic of mature forest ecosystems, which are known to maintain stable wood-production processes under limited anthropogenic disturbance. However, it is important to clarify that no direct measurements of water quality or chemical residues, including pesticide concentrations, were conducted in this study. Therefore, the statement regarding the absence of pesticides should be understood as an ecological inference based on field observations of minimal visible anthropogenic disturbance and the absence of obvious pollution sources during sampling, rather than as an experimentally verified condition. The importance of minimizing chemical stressors in forestry management was supported by Herlin *et al.* (2025), who demonstrated that botanical pesticides preserved balanced arthropod communities. Thus, the mangrove ecosystem was assumed to experience relatively low chemical disturbance, although no physicochemical analyses were performed. The absence of pesticides in this mangrove was therefore considered to allow undisturbed ecological interactions that influence litter decomposition, nutrient turnover, and forest regeneration. These observations highlighted that moderate-abundance arthropods play a critical role in maintaining ecosystem stability, a finding directly relevant to sustainable mangrove-forest productivity.

Diversity metrics, including Shannon-Wiener index (H'), Berger-Parker dominance index (D), and evenness index (E), indicated medium diversity, low dominance, and high evenness. These results collectively suggest that Tanjung Api-Api mangrove hosts a balanced, resilient arthropod community capable of sustaining key ecological functions, including decomposition, predation, and pollination. High abundance of *Oecophylla* sp. and decapod crabs, coupled with persistent low-frequency herbivores and predators, indicates competitive structuring in a stable ecosystem. Weekly observations confirmed that detritivores and predators were consistently the most active groups, influencing sediment dynamics and regulating herbivore populations. Minimal pollinator activity indicates limited flowering, underscoring the importance of pollinator monitoring in forest management. Understanding these functional dynamics allows forestry researchers to predict ecosystem responses to environmental changes. Therefore, integrating arthropod metrics into forestry studies enhances the assessment of ecosystem health and stability. The Tanjung Api-Api mangrove exemplifies how species distribution and abundance influence ecological processes crucial to forest health, particularly herbivore and detritivore populations, which are essential to a natural balance in vegetation and forest-floor processes. In line with the research of Forde *et al.* (2022), predators effectively regulate herbivore populations, thereby maintaining a natural balance in vegetation, and detritivores primarily drive forest floor processes. Furthermore, the mangrove arthropod community exhibits a stable and functionally complex structure, in which decomposition and predation are the primary processes sustaining ecological stability. Morphological characteristics, including variations in mouthpart types, were consistent with insect orders and families, reflecting adaptations to different ecological niches. Morphological verification of key arthropods, including weaver ants (CSIRO 1991), carpenter ants (Gullan and Cranston 2014), fiddler crabs (Hutchins and Hutchins 2025), and predatory spiders (Davies and Zabka 1989) Supported taxonomic identification at the genus and higher taxonomic levels as well as functional classification. This rigorous identification is essential for forestry studies, where misidentification can mislead management decisions.

Coleopteran and lepidopteran larvae were identified as having herbivorous and detritivorous ecological roles that potentially contribute to vegetation dynamics and nutrient cycling within mangrove forest stands (Gullan and Cranston 2014). Predatory arachnids and sap-feeding hemipterans were also observed as components of trophic interactions commonly associated with arthropod-mediated ecological regulation in mangrove ecosystems. Although seedling survival and canopy vigor were not directly measured in this study, the presence of these functional groups indicates their potential ecological contribution to maintaining food-web balance and ecosystem stability. Overall, the recorded arthropod assemblages demonstrated ecological functions associated with biomass turnover, nutrient cycling, and mangrove forest resilience, all of which are important components of tropical forest ecosystems.

In conclusion, arthropod diversity and ecological functions in the mangrove forest of Tanjung Api-Api can be clearly characterized through detailed observations of species composition, functional roles, and population dynamics within this major South Sumatran Forest landscape. The community structure was confirmed to be dominated by detritivores, decapods, and canopy-forming Hymenoptera, whose combined roles in sediment turnover, nutrient cycling, and vegetation regulation underpin key ecological processes that sustain mangrove forest productivity. The presence of moderate-abundance herbivores and predators, along with low-frequency microhabitat specialists, was shown to contribute to a balanced and resilient trophic system indicative of a healthy, mature mangrove forest ecosystem (Stukalyuk 2017; Muro-torres *et al.* 2020; Diarra & Osborne-naikatini 2024). Diversity indices further validated that the forest supports a stable and evenly distributed arthropod assemblage, reinforcing the importance of these taxa in maintaining decomposition, predation, and limited pollination processes that influence forest regeneration and wood-yield potential. Overall, the findings provide strong evidence that arthropods in the Tanjung Api-Api mangrove forest play indispensable roles in ecosystem functioning, offering new insights that support forest management, conservation planning, and future ecological research within South Sumatra's coastal forest landscapes.

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References

Adriani, D., Putri, T.W.S., Febrianti, E., 2025. Exploring tourist commitment: willingness to pay for mangrove ecotourism in Sungsang IV Village. *Banyuasin.* 11, 118–127. https://doi.org/10.29303/jppipa.v11i7.11788

Alongi, D.M., 2018. Impact of global change on nutrient dynamics in Mangrove. *Forests*. 9, 596. https://doi.org/10.3390/f9100596

Basyuni, M., Puspita, M., Rahmania, R., Albasri, H., Pratama, I., Purbani, D., Aznawi, A.A., Mubaraq, A., Al Mustaniroh, S.S., Menne, F., Rahmila, Y.I., Salmo III, S.G., Susilowati, A., Larekeng, S.H., Ardli, E., Kajita, T., 2024. Current biodiversity status, distribution, and prospects of seaweed in Indonesia: a systematic review. *Heliyon.* 10, e31073. https://doi.org/10.1016/j.heliyon.2024.e31073

CSIRO, 1991. *The Insects of Australia Volume I.* CSIRO Publishing, Melbourne.

Davies, V.T., Zabka, M., 1989. Illustrated keys to the genera of jumping spiders Araneae Salticidae in Australia. *Nature.* 27, 189–266.

Diadara, D.K., Herlin, W., 2025. Diversity and role of insects on vegetation around sugar palm (*Arenga pinnata*) plants in Tanjung Miring Village, Muara Enim Regency. *Journal of Suboptimal Lands.* 14, 216–227. https://doi.org/10.36706/JLSO.14.2.2025.745

Diarra, U., Osborne-naikatini, T., 2024. Actinomycetes associated with hymenopteran insects: a promising source of bioactive natural products. *Frontiers in Microbiology*. 15, 1303010. https://doi.org/10.3389/fmicb.2024.1303010

Erienti, S., Dewata, I., 2019. Community participation of mangrove forest preservation in Batang Gasang Padang Pariaman District. *Science and Environmental Journals for Postgraduate.* 2, 63–75.

Fischbein, D., Corley, J.C., 2022. Forest ecology and management population ecology and classical biological control of forest insect pests in a changing world. *Forest Ecology and Management*. 520, 120400. https://doi.org/10.1016/j.foreco.2022.120400

Forde, A.J., Feller, I.C., Parker, J.D., 2022. Insectivorous birds reduce herbivory but do not increase mangrove growth across productivity zones. *Ecology.* 103, e3768. https://doi.org/10.1002/ecy.3768

Gullan, P.J., Cranston, P.S., 2014. The Insects: an Outline of Entomology.

Herlin, W., Irsan, C., Pujiastuti, Y., Cahyani, C., Pakpahan, T., 2025. Arthropods diversity on sugar palm plantation with vegetation addition refugia flowering plants. *International Seminar on Plant Protection*. 1, 283–292.

Hutchins, A., Hutchins, A., 2025. A High Resolution Photographic Guide for Identifying Fiddler Crabs from the Shores of the Atlantic Ocean A High-Resolution Photographic Guide for Identifying Fiddler Crabs from the Shores of the Atlantic Ocean Biology, Bachelor of Arts Honors Research Em. University of Northern Iowa.

Hutchins, S.H., 2020. *Techniques for Sampling Arthropods in Integrated Pest Management*, first ed. CRC Press, Boca Raton. https://doi.org/10.1201/9781003067900-7

Karthiyayini, B., Vishnuraja, V., Gowdhami, B., Dhanasekaran, D., 2025. Multivariate analysis of plant microbiome diversity using paleontological statistics (PAST), in: Dharumadurai, D., Narayanan, A.S. (Eds.), *Plant Microbiome Engineering. Methods and Protocols in Food Science*. Humana: New York, pp. 257–265. https://doi.org/10.1007/978-1-0716-4180-4_32

Madhavan, C., Meera, S.P., Kumar, A., 2025. Anatomical adaptations of mangroves to the intertidal environment and their dynamic responses to various stresses. *Biological Reviews.* 100, 1019-1046. https://doi.org/10.1111/brv.13172

Muro-torres, V.M., Amezcua, F., Soto-Jiménez, M., Balart, E.F., Serviere-Zaragoza, E., Green, L., Rajnohova, J., 2020. Primary sources and food web structure of a tropical wetland with high density of mangrove forest. *Water*. 12, 1–18.

Nsengimana, V., Kaplin, B.A., Francis, F., 2018. Use of soil and litter arthropods as biological indicators of soil quality in forest plantations and agricultural lands: a review. *Entomologie Faunistique–Faunistic Entomology*. 71, 1–13.

Nsengimana, V., Iradukunda, C.S., Habiyaremye, J.D.D., Nsanganwimana, F., 2025. Contribution of savanna and forest restoration outcomes on terrestrial arthropod communities in eastern Rwanda. *Discover Environment.* 3, 124. https://doi.org/10.1007/s44274-025-00333-4

Odum, E.P., Barrett, G.W., 2004. *Fundamentals of Ecology,* fifth ed. Thomson Brooks/Cole, Belmont, CA.

Polgar, G., Jaafar, Z., 2018. *Endangered Forested Wetlands of Sundaland*. Springer Nature, Switzerland.

Ribeiro, T.M., Espíndola, A., 2024. Integrated phylogenomic approaches in insect systematics. *Current Opinion in Insect Science*. 61, 101150. https://doi.org/10.1016/j.cois.2023.101150

Schneider, A.K., Fabrizio, M.C., Lipcius, R.N., 2023. Reproductive potential of the blue crab spawning stock in Chesapeake Bay across eras and exploitation rates using nemertean worms as biomarkers. *Marine Ecology Progress Series.* 716, 77–91. https://doi.org/10.3354/meps14365

Scogings, P.F., Sankaran, M., 2020. African and Asian Savannas, in: Scogings, P.F., Sankaran, M. (Eds.), *Savanna Woody Plants and Large Herbivores.* John Wiley & Sons, Hoboken, NJ, pp. 25–49.

Setyawan, Y.P., Wakhid, Suhadi, 2020. The denser canopy of mangrove drives the structure of insect communities. *Tropical Life Sciences Research.* 31, 77–90. https://doi.org/10.21315/tlsr2020.31.3.6

Stander, J., Dalla Valle, L., 2017. On enthusing students about big data and social media visualization and analysis using R, RStudio, and RMarkdown. *Journal of Statistics Education*. 25, 60-67. https://doi.org/10.1080/10691898.2017.1322474

Stukalyuk, S.V., 2017. Interactions of three dominant ant species, *Lasius emarginatus* (Ol.), *Formica rufa* L., and *Lasius fuliginosus* (Latr.) (Hymenoptera, Formicidae) among themselves and with subordinate species in Broadleaf Forests. *Communication 1*. 97, 747–767. https://doi.org/10.1134/S0013873817060057

Yulianti, Y., Sazali, M., 2026. Identification of arthropod diversity in the cemara beach mangrove ecosystem. *International Journal of Science, Technology and Applications*. 3, 40-49. https://doi.org/10.70115/ijsta.v3i1.322