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Insect Diversity and Ecological Functions in the Isyo Hills Rhepang Muaif Nimbokrang Forest Park, Jayapura Regency

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ABSTRACT

Insects have a very important role in maintaining the balance of the forest ecosystem and supporting the continuity of life in the forest. The main roles of insects in the forest include as pollinators, predators, decomposers, pest controllers and as indicators of environmental health. However, there is no data regarding the diversity and ecological function of insects in the Isyo Hills Rhepang Muaif tourist forest. Insect sampling technique uses the scan sampling method. Insect diversity data is analyzed using the Shannon-Wiener species diversity index. Based on research conducted in the Isyo Hills Rhepang Muaif Tourism Forest, Nimbokrang District, Jayapura Regency, a total of 606 individual insects were found with 54 types of insects representing 8 different orders, namely: Order Lepidoptera (26 types= 48%), Orthoptera (7 types= 13%), Coleoptera (6 types= 11%), Hemiptera (6 types= 11%), Odonata (4 types= 7%), Hymenoptera (2 types = 4%), Diptera (2 types = 4%) and the Order Blattodea (1 type= 2%). The results of the analysis show that species diversity in each insect order is in the medium and low categories. The Shannon-Wiener index (H') value for each order ranges from 0–2.99. Insects obtained from sampling results fall into eight levels of important ecological roles (feeding groups/ functional groups/trophic guilds) in nature, namely pollinators, phytophagous, xylophagous, predators, omnivores, carnivores, granivores and detrivores.

Key words: insect bioindicators, Rhepang Muaif, iInsecta, insect diversity, scan sampling technique.

INTRODUCTION

Insects are an important element in ecosystems and more than 5.5 million species have been described. The most numerous order of insects is Coleoptera (beetles). The order Coleoptera has 390,000 described species, making it the largest order in the class Insecta (insects). Beetles are widely distributed in various habitats around the world and have diverse ecological roles in ecosystems. The order Lepidoptera (butterflies and moths) has more than 180,000 species. The order Hymenoptera (bees, ants, and wasps) has more than 150,000 species. The order Diptera (flies and mosquitoes) has more than 150,000 species. The order Hemiptera (bugs and stink bugs) has more than 80,000 species (Eggleton, 2020). Insects play a very important role in maintaining the balance of forest ecosystems and supporting the sustainability of life in forests. The main roles of insects in forests include pollinators, predators, decomposers, pest controllers, and indicators of environmental health (Herdiawan *et al*., 2021; Glenny *et al*., 2022; Seni & Halder, 2022; Chowdhury *et al*., 2023).

The village of Rhepang Muaif is administratively part of the Nimbokrang District, Jayapura Regency, Papua Province, with an area of 190.5 km2 (BPS Nimbokrang District, 2020). This village is quite famous for its beautiful flora and fauna, such as various types of birds of

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paradise. Therefore, the village forest area is managed and developed by the local community into a bird watching tourist village. This activity is a form of community-based conservation effort in which the community preserves birds of paradise in their natural habitat (Lahallo *et al*., 2022). However, indirectly, the local community in this area also participates in other biodiversity conservation efforts, such as insects.

Research that has been conducted in the Rhepang Muaif tourist forest includes research on the diversity of moths of the Superfamily Bombycoidea (Mauri *et al*., 2022) and butterflies of the Superfamily Papilionoidea (Warikar *et al*., 2024) the diversity of birds of paradise (Lahallo *et al*., 2022), the development of bird watching ecotourism (Wandikbo, 2023), and the role of Isyo Hill's bird watching development as an effort to counter palm oil companies (Murib & Therik, 2023). However, there is no data on the diversity and ecological function of insects in the Isyo Hills Rhepang Muaif tourist forest, Jayapura Regency.

Attention to research on insect diversity or data on their role, as well as conservation efforts in Papua's forests, is still very lacking. Therefore, research on the diversity and ecological function of insects in the Isyo Hills Forest, Rhepang Muaif Nimbokrang, Jayapura Regency is needed. The purpose of this study is to determine the diversity and ecological function of insects in the Isyo Hills Forest, Rhepang Muaif Nimbokrang, Jayapura Regency. This study is expected to serve as a basis for further research and conservation objectives with scientific information about the diversity and ecological function of insects in the forest.

MATERIALS AND METHODS

Research location and time

This research on insect diversity and ecological function was conducted in the Isyo Hills Rhepang Muaif Forest, Nimbokrang District, Jayapura Regency for six months from June to November 2024. The population in this study was all insect species in Rhepang Muaif, Nimbokrang District, Jayapura Regency, while the sample was all insect species (larger than 2 cm) that were seen and caught during observations in the Rhepang Muaif Forest Park, Nimbokrang District, Jayapura Regency.

Equipment and materials

The tools used are a ground insect net (sweeping net), Garmin 76 Csx Global Positioning System (GPS), altimeter, cork/stretching board, tweezers/clamps, tissue, parchment paper, magnifying glass, plastic box/specimen box, thermohygrometer, writing equipment, insect pins, label paper, Nikon D7200 camera, Identification books: Insect Identification (Borror *et al*., 1996), "The Butterflies of Papua New Guinea (Their Systematics & Biology)" by Parsons (1999) and "Field Guide to Butterflies of the Mamberamo to Cyclops Mountains Region" by van Mastrigt & Rosariyanto (2013). The materials used were: 70% alcohol, acetyl acetate, potassium cyanide.

Data collection

This study used the scan sampling method, which involves exploring an area with a radius of ± 100–250 m^2. The insect sampling technique used the scan sampling method (Tarigan *et al*., 2022), which involves observing, documenting (photographing), and counting the number of species that land on plants in the forest. Insects of unknown species were captured using a sweeping net/insect net and photographed for identification purposes. Insect observation and sampling were conducted in several insect-preferred habitats, such as former plantation land, around river flows, and forest areas.

Insect observation and sampling were conducted twice a week with a 10-day observation interval for two consecutive weeks. Insect species observation was conducted for four hours, starting at 08:00–12:00 WIT when the weather was sunny. This is in accordance with the statement by Masawet *et al*. (2019) that generally the humidity in the morning is optimal due to the cool weather conditions, and the peak of insect activity occurs between 10:00 a.m. and 12:00 p.m.

The data collected at the observation site included the number of species and individuals to

determine diversity, and insect species identification was carried out directly during observation at the research site. Species that could not be identified directly were captured using insect nets, placed in insect envelopes, and subsequently identified at the Papua Insect Collection Room (KSP) in the Entomology Laboratory of the Biology Department, Faculty of Mathematics and Natural Sciences, Cenderawasih University. The observed and collected insect samples were preserved and identified using identification books. During the observation, environmental parameters such as temperature and humidity were measured using a thermohygrometer, along with other supporting factors.

Data analysis

Insect diversity data were analyzed using the Shannon-Wiener Index of species diversity (Kantartzi *et al*., 2010; Saka *et al*., 2022), calculated using Biodiversity Pro software (free download). The formula for the Shannon-Wiener species diversity index is as follows.

$$H' = -\Sigma[(ni/N) \times \ln (ni/N)]$$

where:

H': Shannon Wiener Diversity Index

ni: Number of individuals in one species

Table 1. Types of insects in the Isyo Hills Rhepang Muaif tourism forest, Jayapura.

No.	Taxa				
	Ordo	Subordo	Family	Subfamily	Species
1.	Lepidoptera	Heterocera	Noctuidae	-	*Spodoptera picta*
		Rhopalocera	Papilionidae	-	*Graphium agamemnon*
					Papilio aegeus
					Papilio ambrax
					Papilio ulysses
					Papilio euchenor
					Papilio demoleus
			Hesperiidae	-	*Tagiades nestes*
					Hasora sp.
			Pieridae	-	*Catopsilia pomona*
					Catopsilia scylla
			Lycaenidae	-	*Hypochrysops pythias*
					Anthene lycaenoides
					Philiris sp.
					Danis-danis
					Zizula hilax
			Nymphalidae	-	*Parthenos aspila*
					Cethosia cydippe
					Vindula arsinoe
					Euploea netscheri
					Euploea sp.
					Mycalesis perseus
					Junonia hedonia
					Junonia villida
					Ideopsis juventa
					Tirumala hamata

N: Total number of individuals of species found

According to Odum (1993), the diversity index (H′) has a numerical range of 0–3, with the interpretation that if the H′ value is close to 3, the level of diversity is high, and conversely, if the H′ value is close to 0, the level of diversity is low. The diversity index criteria follow the three categories according to Wilhm and Dorris (1986) in Insafitri (2010) as follows: H' < 1 = low diversity; 1 < H' < 3 = moderate diversity; and H' > 3 = high diversity.

RESULTS AND DISCUSSIONS

Based on the research findings, a total of 606 individual insects were recorded, comprising 54 species across 8 different orders. These include: Lepidoptera (26 species = 48%), Orthoptera (7 species = 13%), Coleoptera (6 species = 11%), Hemiptera (6 species = 11%), Odonata (4 species = 7%), Hymenoptera (2 species = 4%), Diptera (2 species = 4%), and Blattodea (1 species = 2%) (Figure 1; Table 1). The results indicate that several

Table 1. *Continued*.

No.	Taxa				
	Ordo	Subordo	Family	Subfamily	Species
2.	Coleoptera		Curculionidae		*Eusomus ovulum*
				Cryptorhynchinae	Unidenfied sp.1
			Cicindelidae		*Calomera durvillei*
					Tricondyla aptera
			Scarabaeidae		*Serica* sp.
			Lycidae		*Metriorrhynchus* sp.
3.	Odonata	Anisoptera	Libellulidae		*Neurothemis stigmatizans*
					Neurothemis decora
					Unidenfied sp.1
		Zygoptera	Chlorocyphidae		*Rhinocypha tincta*
4.	Orthoptera		Grylludae		*Gryllus assimillis*
			Tettigoniidae		*Tettigonia* sp.
		Caelifera	Acrididae	Gomphocerinae	*Dociostaurus* sp.
				Oedipodinae	*Oedaleus infernalis*
				Catantopinae	*Coryphistes* sp.
			Acrididae		Unidenfied sp.1
					Unidenfied sp.2
5.	Hymenoptera		Halictidae	Nomiinae	*Dieunomia* sp.
			Formicidae		Unidenfied sp.1
6.	Hemiptera	Heteroptera	Plataspidae		*Coptosoma xanthogramma*
			Reduviidae		*Helonotus* sp.
					Sycanus sp.
			Tessaratomidae		*Agapophyta viridula*
			Gelastocoridae		Unidenfied sp.1
			Rhyparochromidae		Unidenfied sp.1
7.	Blattodea		Blattidae		*Periplaneta* sp.
8.	Diptera		Tachinidae	Exoristinae	*Exoistini* sp.
			Micropezidae		Unidenfied sp.1

insect species—other than those in the Order Lepidoptera—found in the Isyo Hills Rhepang Muaif Tourism Forest could only be identified as morphospecies at the family and subfamily levels. This is due to the presence of several undescribed species that are new to science. Consequently, detailed morphological comparisons and further molecular identification are required, which will necessitate a significant amount of time.

Based on the survey, out of the total 606 individual insects recorded, Hemiptera was the most abundant order (287 individuals = 47%), followed by Lepidoptera (130 individuals = 21%) and Hymenoptera (97 individuals = 16%). Furthermore, the lowest number of individuals (5 and 4) were found in the orders Blattodea and Diptera, respectively (Figure 1).

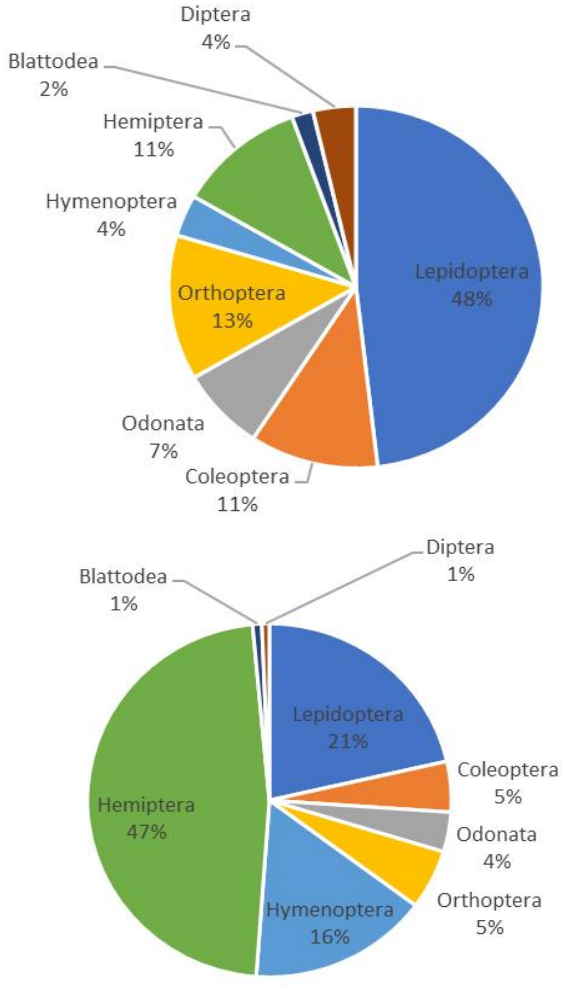

Figure 1. Proportion of species richness (A) and incest abundance (B) in the Isyo Hills Rhepang Muaif Tourism Forest.

The insect diversity observed in the Isyo Hills Rhepang Muaif Tourism Forest can be characterized by the number of species within each order, while their abundance is estimated based on the number of individuals per order. The Shannon-Wiener Index was calculated to assess the level of insect species diversity in the Isyo Hills Rhepang Muaif Tourism Forest (Table 2). Analysis results show that the species diversity for each insect order falls into the moderate and low categories. The Shannon-Wiener index values (H') for each order range from 0 to 2.99. These values indicate that the diversity of species or morphospecies within each order is uniform and tends to follow a similar pattern to their species abundance.

This moderate diversity is attributed to moderate species richness and uneven species abundance, or a situation where only a few species exhibit high abundance. The results show that Lepidoptera is the insect group with the highest number of species recorded and the second-highest species abundance (H'=2.99). In contrast, although the order Hemiptera was the most frequently encountered group (high abundance), it was represented by low species richness (H'=0.79).

Diversity is the result of a combination of two components: the number of species (species richness) and the number of individuals of each species (species abundance) (Allifah *et al.*, 2020). According to Hidayat *et al.* (2016), a community is considered to have high species diversity if it is composed of many species with equal or nearly equal abundance. Conversely, a community is said to have low species diversity if it consists of very few species or is dominated by only a few species.

The insects obtained from the sampling results are categorized into eight essential ecological roles (*feeding groups/functional groups/trophic guilds*) in nature, namely pollinators, phytophagous, xylophagous, predators, omnivores, carnivores, granivores, and detritivores. The term "pollinator" refers to groups of insects that assist in plant pollination; "phytophagous" refers to groups of insects that utilize plants as a food source

Table 2. Insect diversity and abundance index in the Isyo Hills Rhepang Muaif Tourism Forest, Jayapura.

Ordo	Insect abundance (individu)	Species richness	Value analysis (H')	Category
Lepidoptera	130	26	2.99	Moderate
Coleoptera	28	6	1.69	Moderate
Odonata	22	4	1.08	Moderate
Orthoptera	33	7	1.84	Moderate
Hymenoptera	97	2	0.26	Low
Hemiptera	287	6	0.79	Low
Blattodea	5	1	0.00	Low
Diptera	4	2	0.56	Low
Total	606	54	2.75	Moderate

(herbivores); and "xylophagous" refers to groups of wood-eating insects. "Predator" is used to describe insect groups that prey on pests or other insects, while "omnivore" refers to insect groups that consume all types of food. "Carnivore" refers to insect groups that consume herbivorous insects, which include predators and parasitoids that function as natural enemies of herbivores. Furthermore, "granivore" refers to insect groups that prey on mature seeds on the ground, and "detritivore" refers to insect groups that consume dead plant matter and assist in the decomposition process of soil organic matter, acting as primary decomposers on the forest floor.

Figure 2 illustrates contrasting trends between the abundance and species richness of insect ecological roles. The abundance of the predator group is the highest compared to other ecological functional groups; however, its species richness remains low. Lower abundance within an ecological group does not necessarily correlate with low diversity or species richness. This is evident in the pollinator group, where species richness is notably high despite low abundance. A similar pattern is also observed in the phytophagous insect group. The high abundance of predatory insects is attributed to the presence of two species from the genera *Helonotus* sp. and *Sycanus* sp. (Family Reduviidae, Order Hemiptera).

The high abundance of predatory insects is attributed to the presence of two species from the genera *Helonotus* sp. and *Sycanus* sp. within the Family Reduviidae, Suborder Heteroptera, Order Hemiptera. According to Walker *et al*. (2018), members of Heteroptera from the Family Reduviidae—commonly known as "assassin bugs" or "true bugs"—are predatory insects that prey on a wide range of other insect species. Hendarjanti (2022) also reported that insects of the Reduviidae family are characteristically predators, primarily targeting pest insects, particularly in oil palm plantations. Predatory insects from the Reduviidae family are utilized as biological control agents in oil palm plantation pest management, where they play a crucial role in regulating pest populations.

During field observations, insects of the genera *Helonotus* sp. and *Sycanus* sp. were found to be quite abundant on the stems or bark of plants that produce sap, latex, or resin, where they were also observed copulating (Figure 3). Research by Hendarjanti (2022) states that predatory insects from the Reduviidae family have the ability to respond to latex from the bark of *Cratoxylum* spp. as a signal—not only to determine habitat preference but also as a mating site for males and females to copulate. The behavior of the Reduviidae family is also influenced by the resin produced by plants of the genus *Cratoxylum*. Some species utilize it as a tactic to protect their eggs from predation, infection, water loss, and other risks. Another behavior involves utilizing plant substances, such as resin, to safeguard their eggs;

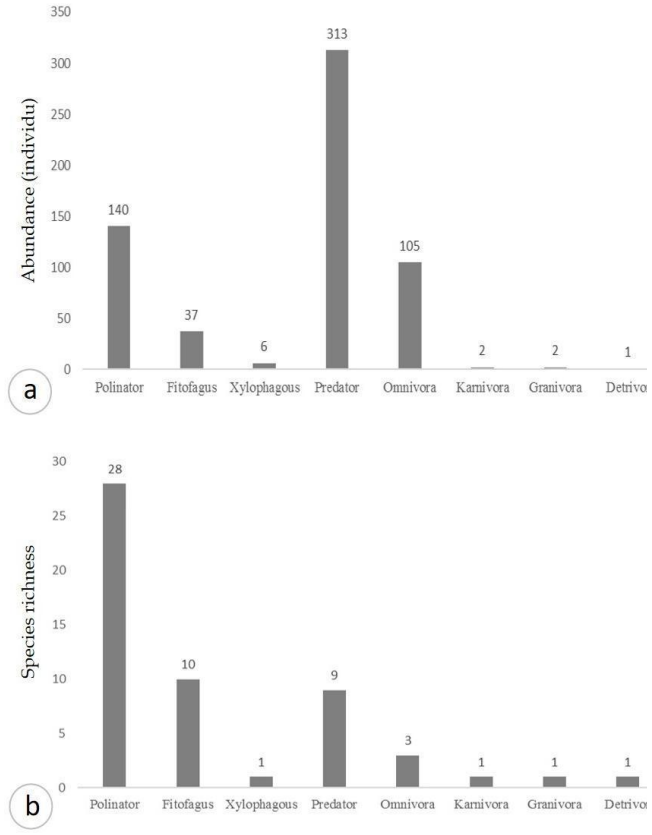

Figure 2. Proportion of species richness (A) and incest abundance (B) in the Isyo Hills Rhepang Muaif Tourism Forest.

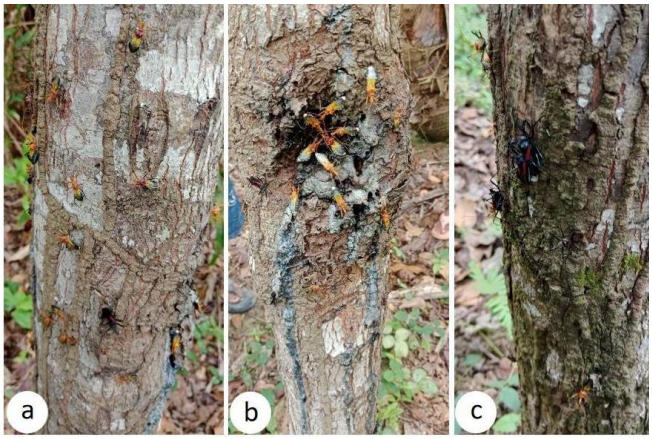

Figure 3. *Helonotus* sp. (a and b) And *Sycanus* sp. (c) are abudant and copulate on latex/bark resin in the Isyo Hills Rhepang Muaif Tourism Forest.

adult female Reduviidae store resin in their sub-rectal glands, and the plant-derived substances covering their egg masses are sourced from these plant resins.

CLONCLUSION

Based on the research findings, it can be concluded that a total of 606 individual insects were recorded, comprising 54 species representing eight different orders: Lepidoptera (26 species = 48%), Orthoptera (7 species = 13%), Coleoptera (6 species = 11%), Hemiptera (6 species = 11%), Odonata (4 species = 7%), Hymenoptera (2 species = 4%), Diptera (2 species = 4%), and Blattodea (1 species = 2%). The analysis indicates that the species diversity within each insect order falls into the moderate and low categories, with Shannon-Wiener Index (H') values ranging from 0 to 2.99. Furthermore, the insects collected are categorized into eight essential ecological roles (*feeding groups/functional groups/trophic guilds*): pollinators, phytophagous, xylophagous, predators, omnivores, carnivores, granivores, and detritivores.

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