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Insects found in different ages of coconut viridis variety in Sri Tiga Village, Banyuasin District, South Sumatra, Indonesia

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Abstract. *Anggraini E, Sinaga TM, Irsan C, Herlinda S, Muslim A, Hamidson H, Sefrila M, Kurnianingsih A, Aryani D, Antoni M, Ikhsan Z. 2024. Insects found in different ages of coconut viridis variety in Sri Tiga Village, Banyuasin District, South Sumatra, Indonesia. Biodiversitas 25: 2637-2647.* Coconut (*Cocos nucifera* L.) is a high-value export commodity and has promising potential on the global market. The existence of insect species is very important in coconut cultivation. The coexistence of insects and plants is interconnected because plants provide habitat and food sources for insects. However, the correlation between plants and insects still needs to be discovered to many people. Therefore, a comprehensive assessment of insect biodiversity in an environment is important to be carried out. This study revealed the structure of the insect community associated with coconut plants and weeds around coconut trees. Therefore, this is a novel and pioneering study that aims to determine the insects associated with coconut plants. This study was conducted by surveying community-owned coconut plantations in Sri Tiga Village, Sumber Marga Telang Sub-district, Banyuasin District, South Sumatera, Indonesia. The observation was carried out during July and September of 2023. The data-gathering process involved identifying three coconut plantations with varying ages of coconut trees (8, 5, and 2 years old). Data collection was carried out using the purposive sampling method by direct observations and using traps such as insect nets, light traps, and pheromone traps. Collected specimens were identified using a microscope in the Laboratory of Entomology, Department of Plant Pests and Disease, Faculty of Agriculture, Universitas Sriwijaya. The results of this study found 12 insect species in coconut trees, namely *Oryctes rhinoceros* Linnaeus 1758, *Aspidiotus* sp., *Nipaecoccus nipae* Maskell 1893, *Aleurocanthus* sp., *Apis cerana* Fabricius 1793, *Cotesia congregata* Say 1836, *Dolichoderus thoracicus* Smith 1860, *Oecophylla smaragdina* Fabricus 1775, *Provespa* sp., *Pteroma pendula* de Joannis 1929, *Metura* sp., *Metisa plana* Walker 1883. The predominant insect pests identified were *Aspidiotus* sp., *N. nipae*, and *Aleurocanthus* sp. Furthermore, the most predominant insects that served as insect scavengers were *Polyrhachis* sp. and *O. smaragdina*. Meanwhile, in the weeds around coconut trees, there were found six insect species, namely *Aulacophora lewisii* Baly 1866, *Eumorphus westwoodi* Guérin 1858, *Mactrotermes* sp., *Conocephalus* sp., *Dianemobius* sp., and *Tettigidea* sp.

Keywords: Coconut, *Cocos nucifera*, insects, viridis variety

INTRODUCTION

Indonesia encompasses diverse agricultural sectors, including plantations, horticulture, food crops, and forestry. The plantation sector in Indonesia plays a substantial role in the nation's economy (Purnomo et al. 2020). Coconut plantations in Indonesia have undergone extensive development and now serve as the primary source of income for coconut farmers. Coconut contributes significantly to the economy, social fabric, and government revenue derived from non-oil and gas commodities (Ximenes et al. 2021). The primary utilization of coconut production is for consumption and industrial purposes (Hoe 2019). The cultivated coconut plants have yielded various products, such as coconut oil, coconut sugar, desiccated coconut, coconut milk, coconut shells, coconut juice, and coconut fiber (Henrietta et al. 2022). Coconut (*Cocos nucifera* L.) is a tropical plantation commodity that is widespread in Indonesia, the Philippines, India, and several Asia Pacific countries (Hoe 2019). Coconut is a lucrative export product with promising opportunities in the global market. Indonesia is the leading coconut-producing nation globally, with the Philippines and India ranking second and third, respectively (Zainol et al. 2023). In 2022, the Banyuasin District in Indonesia had a total area of coconut plantations measuring 42,599.00 hectares, which yielded a productivity of 46,760.00 tons (Badan Pusat Statistik 2023).

Understanding the life cycle of the plant from germination to harvest is crucial in the cultivation of coconuts. This stage necessitates consistent monitoring and care. Coconut cultivation necessitates selecting high-quality seedlings, the cultivation of appropriate soil, and

the provision of appropriate care (Thomas et al. 2018). Coconuts thrive in sufficient sunlight, appropriate rainfall, and nutrient-rich soil with effective drainage (Tiemann et al. 2018). The ideal pH range for coconut plant growth is between 5 and 8 (Henrietta et al. 2022). A deep understanding of these elements can lead to the establishment of coconut plantations that can be maintained over a long period. In addition, it is necessary to give attention to frequent pruning, fertilizing, and managing pests and diseases (Aulia et al. 2020); a thorough understanding of these characteristics can lead to profitable and sustainable coconut production. However, in many coconut-producing locations, especially in small-scale coconut farms, there is a lack of intensive fertilizer application and insect management (Zainol et al. 2023). This need for improvement should motivate us to strive for better practices. Coconut cultivation is closely related to the presence of insects on plants and is interconnected since plants serve as both a habitat and a source of sustenance for insects (Stam et al. 2014). Plants rely on insects for the process of plant pollination (Moreira and Reitas 2020). Understanding the insects that contribute to pollination can assist in increasing coconut production by preserving and protecting these pollinators. Conversely, insects possess the capacity to cause damage to cultivated plants (Manosathiyadevan et al. 2017). Therefore, identifying the insect pest species in coconut is critical for developing effective pest management strategies. Understanding which insects are harmful and which are beneficial can assist farmers in controlling pest populations while protecting beneficial insects.

The age of coconut trees in coconut plantations varies across different regions. This leads to variations in plant growth and development among different trees, impacting not only their nutritional needs but also the timing of harvest and total production (Arumugam 2022). Effective management practices tailored to the age of the coconut plant are crucial for optimizing its overall health and productivity. Coconut trees at different phases of growth may attract distinct insect pests, which may prefer specific developmental stages of the plants due to physiological disparities. It is crucial to accurately identify and effectively manage these pests, considering the age of the coconut trees, in order to achieve successful pest control. In addition, insects fulfill diverse functions within ecosystems and exert substantial influence on human culture and the environment, serving as pollinators, decomposers, and pests (Chandra et al. 2023). Current information regarding the prevalence of insects on coconut trees still needs to be improved, especially regarding their age. Therefore, it is imperative to conduct an inventory of insect biodiversity in the coconut plantation ecosystem at various plant ages. The ecosystem's alterations can be inferred from the diversity of insect species (Chowdhury et al. 2023). The number of insect populations is influenced by the season (Tougeron et al. 2020). The study was conducted in South Sumatera, Indonesia, during the dry season in July and September 2023. Hence, it is crucial to identify insects on coconut trees at various stages of development in dry season. Acquiring data on various insect species can provide valuable knowledge to develop integrated pest management strategies that can be directly applied to the management of coconut plantations.

MATERIALS AND METHODS

Study area

The study was carried out in people's coconut plantations in Sri Tiga Village, Sumber Marga Telang Sub-district, Banyuasin District, South Sumatra, Indonesia (Figure 1). Insect identification was conducted at the Entomology Laboratory, Department of Plant Pests and Diseases, Faculty of Agriculture, Universitas Sriwijaya, South Sumatra. The study was carried out from July to September 2023. Three coconut plantations of different ages, specifically 8 years, 5 years, and 2 years, were selected as observation sites. Each plantation covers an area of around 5 hectares.

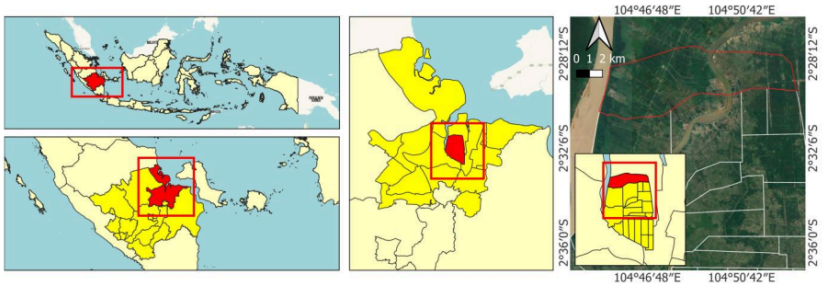

Figure 1. The sampling location is in Sri Tiga Village, Banyuasin District, South Sumatra, Indonesia. The samples are taken from different ages of the coconut viridis variety

Procedures

Field survey and sampling

An initial survey was undertaken to choose the sampling sites. In addition, a study was undertaken to gather information from the community regarding the utilization of coconut in Sri Tiga Village, Banyuasin District. Data was collected using the purpose sampling method. Insect sampling was carried out weekly for three months, started July to September 2023. A total of 12 observations were made, and the collection of arthropods was conducted during the early morning hours, specifically from 06:00 to 07:00 AM. The insects were collected by sweep nets, which had a net handgrip length of 100 cm, a length of 75 cm, and a diameter of 30 cm. This collection method was based on the techniques described by Karenina et al. (2019). The swinging net was intentionally contacted with weeds around coconut trees. The arthropods were caught by employing a swinging net in a single motion, utilizing two swings that align linearly at a depth of 30 cm towards the interior of weeds. The light traps were employed to gather the nocturnal insects. A total of four light traps were utilized by three coconut plantations of varying ages, namely 8 years, 5 years, and 2 years. The nocturnal insects were captured in light traps throughout the period from 7 to 9 pm. A synthetic pheromone trap containing ethyl-4-methyloctanoate as the active ingredient was used to capture adults of *Oryctes rhinoceros* Linnaeus 1758 beetles. Each of the three coconut plantations utilized a total of four *Oryctes* pheromone traps. The collected insects were stored in glass vials containing a solution of 70% alcohol. They were then labeled and transported to the Entomology Laboratory at the Department of Plant Pests and Diseases, Faculty of Agriculture, Universitas Sriwijaya, South Sumatra, Indonesia.

Identification

Dr. Chandra Irsan, an insect taxonomist, was assigned the responsibility of identifying the insect specimens. The collected insects were visually identified using the references by (Borror and Delong 1971), Kalshoven (1981), McAlpine et al. (1987), Heinrichs (1994), Hill (1994, 1997), Howard et al. (2001). The collected insects were classified according to their roles.

Data analysis

The total individual of collected insects was recorded and presented in the table. The insect abundance data (average number of individuals) was subsequently transformed using the Square Root transformation. The transformed data was examined using R Statistical software version 4.4.0 (de Micheaux et al. 2013). The species diversity index was used to describe the diversity of insect species found in the research area. The diversity index was expressed using the Shannon-Wiener species diversity formula (Keylock 2005):

$$H' = -\sum pi * (Ln\ pi)$$

Where:

H' : Shannon-Wiener Diversity Index,

Pi : ni/N (comparison between the number of a species and all species)

The description of criteria: H'<1 is low diversity; 1 <H'<3 is medium diversity; and H'>3 is high diversity.

The species evenness index was used to describe the degree of evenness of insect species found in the research area. The evenness index was expressed using the formula:

$$E = \frac{H'}{Ln\ S}$$

Where:

E : the Evenness index (value between 0-1)

H' : the Shannon-Wiener diversity index, and S is the number of species.

The description of criteria: E < 0.4 is small population uniformity, 0.4 < E < 0.6 is moderate population uniformity, and E > 0.6 is high population uniformity.

The species dominance index was used to describe the level of dominance of insect species found in the research area. The dominance index is expressed using the formula:

$$D = \sum_{i=1}^{s} \left(\frac{ni}{N}\right)^2$$

Where:

ni : The number of individuals in species i

N : Total number of individuals of all species

ni/N : pi (proportion of individuals of species i

S : Species richness.

Description of criteria: 0<D<0.5 is low dominance, 0.5<D<0.75 is moderate dominance, 0.75<D< 1.0 is high dominance.

RESULTS AND DISCUSSION

Abundance of insects found in coconut trees

The insect species found in three coconut fields with varying plant ages, namely 8 years, 5 years, and 2 years, were very diverse. There were 12 species from 4 orders. The most frequently observed orders were Coleoptera, Hemiptera, Hymenoptera, and Lepidoptera. The most abundant species discovered in coconut plantations that were 8 years old was *Nipaecoccus nipae* Maskell 1893, belonging to the Hemiptera order, with an average population density of approximately 256.33 individuals. The findings of this study also observed a similar pattern in coconut fields that had reached the age of 5 years. Specifically, the dominant species seen was *N. nipae*, with an average population density of up to 265.67 individuals. On 2-year-old coconut fields, the insect species commonly found were *Aspidiotus* sp., belonging to the Hemiptera Order, with an average population of approximately 96,000 individuals. There were no *Apis cerana* Fabricius 1793 or *Provespa* sp. species in the 2-year-old plantation. The comparison of species abundance in coconut fields of varying ages revealed significant variations in species diversity (Table 1).

Abundance of insects found in weeds around coconut trees

Insect species found in weeds around coconuts were also observed. Six species of insects from three orders were found. The orders include Coleoptera, Isoptera, and

Orthoptera. In weeds around 8-year-old and 5-year-old coconuts, the most *Mactrotermes* sp. insects were found, originating from the Order Isoptera, namely 18.00 individuals and 13.67 individuals, respectively. Meanwhile, in the plants around coconuts that are 2 years old, the most common insects are *Conocephalus* sp. from the Order Orthoptera, namely 10.00 individuals (Table 2).

Characteristics of insect communities found in coconut trees

The investigated characteristics of the insect community on coconuts of different ages (8 years, 5 years, and 2 years) comprised the diversity index, evenness index, and dominance index. The findings indicated that the community attributes of coconut plants at the ages of 8 years, 5 years, and 2 years exhibited a progressive increase with each assessment. The diversity, evenness, and dominance indices of 8-year-old coconut plants were greater than those of 5- and 2-year-old coconut plants (Table 3). The results revealed a direct relationship between the age of the coconut and the number of insects observed in the field. A higher diversity index value indicates a greater range of species within the community. This indicator quantifies the level of biodiversity within the community. A high evenness index signifies a more balanced distribution of individuals among species within the group, whereas a low value suggests an uneven distribution. The dominance index quantifies the degree to which one or more species exert substantial influence or possess ownership within a community.

Table 1. An abundance of insects (average number of individuals) found on coconut trees in Sri Tiga Village, Banyuasin, South Sumatera, Indonesia

Order/Species	Abundance of insects on coconuts (average number of individuals/plot)			P value	F value	Tukey HSD at alpha 0.05
	8 years old Coconut tree	5 years old Coconut tree	2 years old Coconut tree			
Coleoptera						
Oryctes rhinoceros Linnaeus 1758	28.00	29.00	22.67	3.20×10^{-1}	1.54^{ns}	-
Hemiptera						
Aspidiotus sp.	173.33a	116.33b	96.00b	3.62×10^{-3}	31.24^{*}	1.55
Nipaecoccus nipae Maskell 1893	256.33a	265.67a	18.00b	5.16×10^{-5}	276.40^{*}	2.07
Aleurocanthus sp.	50.67a	44.33a	27.67b	58.7×10^{-4}	80.55^{*}	0.54
Hymenoptera						
Apis cerana Fabricius 1793	5.67a	4.33b	0.00c	3.13×10^{-5}	355.22^{*}	0.25
Cotesia congregata Say 1836	30.00a	25.33b	18.00c	6.14×10^{-4}	78.70^{*}	0.35
Dolichoderus thoracicus Smith 1860	113.33a	103.67a	81.33b	45.1×10^{-3}	27.78^{*}	0.81
Oecophylla smaragdina Fabricus 1775	98.00a	87.33a	60.33b	1.15×10^{-3}	56.91^{*}	0.75
Provespa sp.	4.00a	2.33b	0.00c	4.52×10^{-4}	92.12^{*}	0.38
Lepidoptera						
Pteroma pendula de Joannis 1929	16.33a	13.67ab	10.00b	2.64×10^{-2}	10.31^{*}	0.68
Metura sp.	20.67a	16.67ab	13.00b	6.15×10^{-3}	23.50^{*}	0.48
Metisa plana Walker 1883	24.00a	19.00ab	14.00b	6.78×10^{-3}	22.28^{*}	0.61

Note: ns: Not significantly different; *: Significantly different; This original data was transformed using the Square Root transformation before the analysis

Table 2. An abundance of insects (average number of individuals) found in weeds around coconut trees in Sri Tiga Village, Banyuasin, South Sumatera, Indonesia

Order/Species	Abundance of Insects in weeds around Coconuts (individual/plot)			P value	F value	Tukey HSD at alpha 0.05
	8 years old coconut tree	5 years old coconut tree	2 years old Coconut tree			
Coleoptera						
Aulacophora lewisii Baly 1866	14.67a	8.00b	7.00b	9.09×10^{-3}	18.98^{*}	0.71
Eumorphus westwoodi Guérin 1858	12.33a	8.33b	3.00c	3.21×10^{-4}	109.67^{*}	0.42
Isoptera						
Mactrotermes sp.	18.00a	13.67b	0.00c	3.52×10^{-5}	335.07^{*}	0.53
Orthoptera						
Conocephalus sp.	17.00a	12.00b	10.00c	38.9×10^{-4}	99.47^{*}	0.24
Dianemobius sp.	16.67a	13.00b	9.00c	6.50×10^{-5}	246.00^{*}	0.17
Tettigidea sp.	10.67a	8.33ab	6.67b	8.19×10^{-3}	20.10^{*}	0.39

Note: ns: Not significantly different; *: Significantly different; This original data was transformed using the Square Root transformation before the analysis

The characteristics of insects on weeds around coconut trees

The analysis revealed that the coconut farms that were 8 years old had the highest index. At the age of 2 years, the analysis results were shown to be lower (Table 4). This finding demonstrates that the age of the coconut has a significant impact on the diversity of weed species found in its vicinity. The diversity, evenness, and dominance indices of coconut plants at ages 8, 5, and 2 years exhibited fluctuations in population numbers. The diversity index of weeds surrounding 8-year-old coconut plants is greater than that of 5- and 2-year-old coconut plants. Conversely, the level of uniformity and prevalence of weeds surrounding coconut plants that are 2 years old was greater compared to coconut plants that are 8 and 5 years old.

The role of the insects found on coconut trees and weeds around coconut trees

According to this study, insects found on coconut palms are often phytophagous and predatory, whereas insects located in weeds frequently operate as phytophagous and decomposers (Table 5).

Relative abundance of insects found in coconut trees

There was a significant variation in the relative number of insects on coconuts of different ages, specifically 8 years, 5 years, and 2 years. The abundance of insects in the Order Hemiptera was observed at plant ages of 8 years and 5 years, with percentages of 59.00% and 58.00% correspondingly. The order Coleoptera has the lowest representation, accounting for only 3.00% and 4.00%, respectively. At the age of 2 years, most insect species discovered belonged to the Order Hymenoptera, specifically 48.00%, while the lowest number of species were found in the Orders Lepidoptera and Hymenoptera, accounting for only 7.00% (Figure 2).

Relative abundance of insects found in weeds around coconut trees

The insects identified in weeds around coconut plants were limited to three orders: Coleoptera, Isoptera, and Orthoptera. The highest proportions of Orthoptera orders were observed in coconut trees that were 8 years old (50.00%), 5 years old (53.00%), and 2 years old (72.00%). Meanwhile, in the weeds area near 2-year-old coconut trees, only two orders of insects were found, namely Coleoptera and Orthoptera (Figure 3).

Table 3. Characteristics of insect communities found in coconut trees in Sri Tiga Village, Banyuasin, South Sumatera, Indonesia

Coconut trees (age)	Community characteristics	Index values		
		July	August	September
8 years old	Number of individuals	847.00	853.00	761.00
	Diversity index (H')	1.90	1.95	2.04
	Evenness index (E)	0.28	0.29	0.31
	Dominance index (D)	0.34	0.32	0.28
5 years old	Number of individuals	754.00	734.00	695.00
	Diversity index (H')	1.86	1.90	1.97
	Evenness index (E)	0.28	0.29	0.30
	Dominance index (D)	0.16	0.16	0.17
2 years old	Number of individuals	622.00	617.00	544.00
	Diversity index (H')	1.75	1.76	1.80
	Evenness index (E)	0.27	0.27	0.29
	Dominance index (D)	0.16	0.15	0.18

Table 4. Characteristics of insect communities in weeds around coconut trees in Sri Tiga Village, Banyuasin, South Sumatera, Indonesia

Insect community in the weeds around the coconut trees (age)	Community characteristics	Index values		
		July	August	September
Insect community in the weeds around the coconut trees (8 years old)	Number of individuals	99.00	92.00	77.00
	Diversity index (H')	1.78	1.77	1.77
	Evenness index (E)	0.39	0.39	0.41
	Dominance index (D)	0.19	0.22	0.21
Insect community in the weeds around the coconut trees (5 years old)	Number of individuals	72.00	65.00	53.00
	Diversity index (H')	1.77	1.75	1.76
	Evenness index (E)	0.41	0.42	0.44
	Dominance index (D)	0.21	0.23	0.23
Insect community in the weeds around the coconut trees (2 years old)	Number of individuals	42.00	37.00	28.00
	Diversity index (H')	1.54	1.53	1.54
	Evenness index (E)	0.41	0.42	0.46
	Dominance index (D)	0.26	0.30	0.32

Table 5. The role of the insects found on coconut trees and weeds around coconut trees in Sri Tiga Village, Banyuasin, South Sumatera, Indonesia

Order/Species	Total Individual	Insect role in environment	Collection method
Insects found in weeds around coconut trees			
Coleoptera			
Oryctes rhinoceros Linnaeus 1758	239	Phytophagous	Pheromone trap
Hemiptera			
Aspidiotus sp.	368	Phytophagous	Direct observation
Nipaecoccus nipae Maskell 1893	1157	Phytophagous	Direct observation
Aleurocanthus sp.	2320	Phytophagous	Direct observation
Hymenoptera			
Apis cerana Fabricius 1793	30	Pollinator	Sweep net
Cotesia congregata Say 1836	220	Parasitoid	Sweep net
Dolichoderus thoracicus Smith 1860	737	Predatory insect	Direct observation
Oecophylla smaragdina Fabricius 1775	19	Predatory insect	Direct observation
Provespa sp.	895	Predatory insect	Sweep net
Lepidoptera			
Pteroma pendula de Joannis 1929	151	Phytophagous	Direct observation
Metura sp.	120	Phytophagous	Direct observation
Metisa plana Walker 1883	171	Phytophagous	Direct observation
Insects found in weeds around coconut trees			
Coleoptera			
Aulacophora lewisii Baly 1866	89	Phytophagous	Sweep net
Eumorphus westwoodi Guérin 1858	71	Pollinator	Sweep net
Isoptera			
Mactrotermes sp.	95	Decomposer	Light trap
Orthoptera			
Conocephalus sp.	117	Phytophagous	Sweep net
Dianemobius sp.	116	Phytophagous	Sweep net
Tettigidea sp.	77	Phytophagous	Sweep net

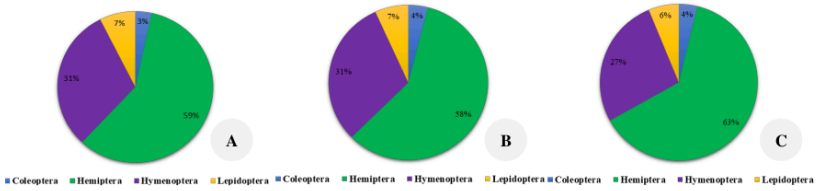

Figure 2. An abundance of insects was seen in coconut trees at three different stages of growth: A. 8-year-old coconut tree; B. 5-year-old coconut tree; and C. 2-year-old coconut tree

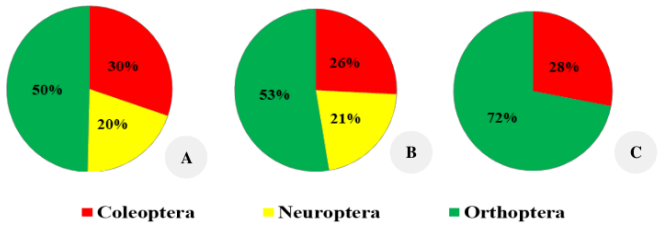

Figure 3. Abundance of insects on weeds around coconut trees at different ages of coconut: A. 8 years old; B. 5 years old; C. 2 years old

The insects found in coconut trees and around the weeds revealed the presence of 18 insect species that are closely linked to coconut palms and the vegetation in their vicinity. The 18 insect species serve as phytophagous, pollinators, and predators. The most abundant insects collected in coconut trees were categorized into Hemiptera and Hymenoptera (Figure 4). As shown in Figure 2, the most abundant insects found belonged to the order Homoptera, specifically *Aspidiotus* sp. (Figure 4.A), *N. nipae* (Figure 4.B), and *Aleurocanthus* sp. (Figure 4.C). Additionally, the most abundant insects observed belonged to the Hymenoptera order, specifically *Polyrhachis* sp. (Figure 4.D) and *Oecophylla smaragdina* Fabricus 1775 (Figure 4.E).

The less numerous insects collected in this study were classified as Lepidoptera, Orthoptera, Coleoptera, Hymenoptera, and Isoptera (Figure 5). The Lepidoptera species identified in this study were bagworms, specifically *Pteroma pendula* de Joannis 1929, *Metura* sp., and *Metisa plana* Walker 1883. The Orthoptera species identified in this study were *Dianemobius* sp., *Conocephalus* sp., and *Tettigidea* sp.. The Coleoptera species identified in this study include *Eumorphus westwoodi* Guérin 1858, *Aulacophora lewisii* Baly 1866, and *O. rhinoceros*. The Hymenoptera species identified in this study were *Cotesia congregata* Say 1836, *A. cerana*, and *Provespa* sp. The Isoptera discovered in this investigation were of the species *Mactrotermes* sp.

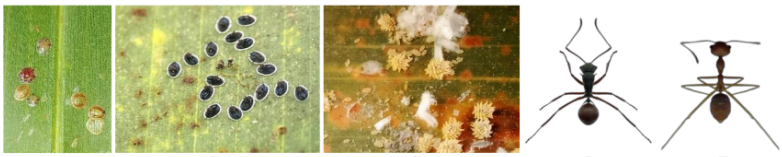

Figure 4. Coconut plants and surrounding plants host the dominant insects. A. *Aspidiotus* sp., B. *Nipaecoccus nipae*; C. *Aleurocanthus* sp.; D. *Polyrhachis* sp.; and E. *Oecophylla smaragdina*

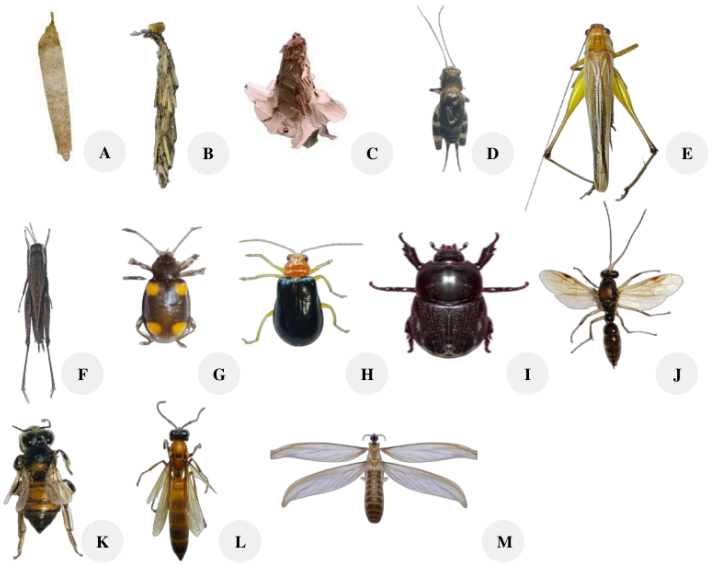

Figure 5. The non-dominant insects are found on coconut plants and surrounding plants. A. *Pteroma pendula*; B. *Metura* sp., C. *Metisa plana*.; D. *Dianemobius* sp.; E. *Conocephalus* sp.; F. *Tettigidea* sp.; G. *Eumorphus westwoodi*; H. *Aulacophora lewisii*; I. *Oryctes rhinoceros*; J. *Cotesia congregata*; K. *Apis cerana*; L. *Provespa* sp.; and M. *Mactrotermes* sp.

Discussion

The results of observations in the field showed that the number of insects caught using traps in coconut plantations was identified as 6 orders, 18 species with a total of 2,330 individuals. However, this research observation was divided into two parts: on coconut plants and on weeds around coconuts, which have various ages. Observations on coconuts of various ages showed findings of 4 orders and 12 species of insects. The highest number of species found in 8-year-old coconut fields was *N. nipae,* which comes from the order Hemiptera, namely 256 individuals. This finding was supported by Ganganalli et al. (2023), that the species of aphids are most often found on coconuts. Meanwhile, in the weed plants around coconut, there are 3 orders and 6 species. The 6 insect species belong to the orders Coleoptera, Isoptera, and Orthoptera. *Mactrotermes* sp. dominated coconuts aged 8 years. Meanwhile, in coconuts aged 2 years old, the most common insect was *Conocephalus* sp., which comes from the order Orthoptera. The seven orders found, including the orders Hemiptera, Hymenoptera, Lepidoptera, Coleoptera, Isoptera, and Orthoptera, have various roles in the ecosystem. These coconut plant species were found that have roles as pests, predators, parasitoids, and also pollinators (Kavitha et al. 2023). Direct observation was carried out by recording the condition or behavior of the object being observed (Vislobokov 2017). There were species *Aspidiotus* sp., *N. nipae, Aleurocanthus* sp., *P. pendula, Metura* sp., and *M. plana* were recorded using the direct observation method. On the other hand, the traps were used to collect the fly or active insects, such as insect nets, light traps, and pheromone traps (Haneda et al. 2017). According to Iswara et al. (2022), traps are designed based on insect behavior and attraction to certain lights, shapes, or colors. The species obtained using the insect nets and the light trap were *E. westwoodi*. *A. lewisii*, *A. cerana, Provespa* sp., *Conocephalus* sp., and *Tettigidea* sp.. Meanwhile, *O. rhinoceros* was captured using a pheromone trap. According to Maruthadurai and Ramesh (2020), synthetic pheromone traps are designed to attract male insects. These traps proved effective in monitoring and controlling adult *O. rhinoceros* (Paudel et al. 2023).

The present study revealed that *Aspidiotus* sp. exhibited the largest population densities across all three age groups of coconut trees: 8-year-old, 5-year-old, and 2-year-old. *Aspidiotus* sp. (Hemiptera: Diaspididae) is a scale insect (Serrana et al. 2023). The genus of *Aspidiotus*, namely *Aspidiotus rigidus* Reyne, 1947 (Hemiptera: Diaspididae), has also been confirmed, causing significant economic losses to the coconut industry in the Philippines (Serrana et al. 2019). Moreover, Coconut shoot borer beetle (*O. rhinoceros*) were found at all ages of coconut. The *O. rhinoceros* is one of the main pests that damage germplasm in coconut (Paudel et al. 2022). In Indonesia, *O. rhinoceros* is also a threat to both coconut and oil palm plants (Rahayuwati et al. 2020). These beetles are known to attack palm trees by boring into the crown and eating developing fronds (leaves that have not yet opened), which can cause death or stunted growth in young palm trees if the infestation is severe (Rao et al. 2018; Paudel et al. 2021; 2023). For mature oil palm trees, this damage can result in reduced productivity. This was also confirmed by Parnidi et al. (2022), that the average damage caused by this pest investment ranges from 0 to 16.7%. This study showed that there were different insects at each age of coconut. The plant age can influence the number of species and the number of individuals (Myers and Sarfraz 2017; Santi et al. 2023). As plants grow and mature, they provide different habitats and resources that can support a variety of insect species (Schowalter 2016). Older plants tend to have more developed and complex ecosystems with greater insect species diversity (Schowalter 2017). Additionally, mature plants are often larger and have more resources; hence, they can support more individuals in their ecosystem (Lindenmayer and Laurance 2016). However, the specific impact of plant age on insect species and the number of insect individuals may vary depending on plant species, environmental conditions, and other factors (Myers and Sarfraz 2017).

This study also identified another abundant insect species, namely *N. nipae*. The *N. nipae* is a mealybug that serves as an insect pest in coconut plantations (Hassan et al. 2023). Additionally, the mealybug's secretion of honeydew has the potential to attract ants and other insects, which may result in the establishment of sooty mold (Souza et al. 2008). This mold can induce further damage to plants. The genus *Aleurocanthus* (Hemiptera: Aleyrodidae) is also a dominant insect found in coconut in this research. *Aleurocanthus* sp. is an important pest that inflicts substantial economic damage on numerous crops (Kapantaidaki et al. 2019). They subsist on plant sap and can induce yellowing, wilting, and general plant stress (Mohan et al. 2022). *Aleurocanthus* can also act as vectors for plant pathogens (da Silva Santos et al. 2023). They produce honeydew, which can attract other pests and cause sooty mold (Melone et al. 2024). The *Aleurocanthus* genus found in this study, potentially associated with the arecanut whitefly, was first identified in coconut trees in 2003 in arecanut palms located in Karnataka and Andhra Pradesh (David and Manjunatha 2003). The insect was later identified as the Arecanut whitefly, scientifically known as *Aleurocanthus arecae* David & Manjunatha, 2003 (David and Manjunatha 2003). In this current study, colonies of *Aleurocanthus* found in coconut were found on the underside of arecanut leaves and are similar in appearance to *A. arecae*.

Two dominant ants found in this study were *Polyrhachis* sp. and *O. smaragdina*. The genus *Polyrhachis* often protects plants from insect pests, acting as biological control agents (Ofer 1970). In some cases, these ants have mutualistic relationships with plants, protecting them from pests in exchange for shelter or food resources like nectar (Andersen et al. 2013). The *O. smaragdina* (weaver ant) is also found in this research. The ant is a highly effective biological control agent (Exélis et al. 2023). The *O. smaragdina* ants have shown foraging and predation behaviors in oil palm plantations in Southeast Asia. The initial study specifically examined the use of weaver ants as a potential biological control agent to manage the population of dominant bagworm defoliators (*P. pendula*)

(Exélis et al. 2023). In this current research, *O. smaragdina*. being present on coconut trees indicates that these ants feed on insect pests, such as bagworms, that are prevalent on the coconut trees. This, in turn, offers a natural method of controlling pests. This study found bagworms, namely *P. pendula*, *Metura* sp., and *M. plana*. The two species of bagworms, *P. pendula* and *M. plana*, are insect pest defoliators in oil palms (Egonyu et al. 2022). *Metura* sp. was identified in coconut fronds during this investigation. This species is extremely polyphagous, and the larvae have been observed feeding on a diverse array of plants, including both angiosperms and gymnosperms (Beaver 2020). The *P. pendula* was also found infested sago palm in the Philippines (Okazaki et al. 2012). The bagworm is a highly destructive insect pest that feeds on leaves and is classified as a voracious eater. It is particularly challenging to control these pests due to their habit of hiding inside their bags (Manurung and Anwar 2023). In this study, in the coconut, the bagworms were found to be a minor insect pest.

The diversity index of insects found on coconut trees and the diversity index of insects found in weeds around the coconut trees in Sri Tiga Village showed a diversity value of 1<H'<3, which means the diversity of the insects found was in the medium category. This criterion showed the diversity of pests and natural enemies, which increased in number as the population increased towards balance. According to Hasibuan et al. (2019), there are 3 criteria for insect species diversity, namely species diversity if H<1 (unstable environmental conditions), species diversity if H 1-3 (medium environmental conditions), and species diversity if H>3 (stable environmental conditions). The results of the dominance index calculation obtained on coconut plants and surrounding weeds from week 1 to week 3 showed a dominance value of 0<D<0.5; this means that these insects' dominance was relatively low. The Evenness Index (E) value is 0.29-0.31 in the depressed category. According to Hasibuan et al. (2019), there are 3 criteria for the community environment based on its evenness value, namely, if E<0.50, then the community is in a depressed condition. If E 0.50<0.75, then society is in a stable condition, while E 0.75<1.00 means society is in an unstable condition. The evenness index value (E') can describe the stability of a community. The smaller the value of E' or closer to zero, the more uneven the distribution of organisms in a community that is dominated by a certain species, and conversely, the greater the value of E' or close to one, the organisms in that community will be evenly distributed (Dewi et al. 2023). Apart from being influenced by plant age, insect diversity can be influenced by climate and weather factors (Subedi et al. 2023). From July to September 2023, Sri Tiga Village faced the dry season. The dry season is characterized by decreased rainfall and increased temperatures, disrupting the life cycle of insects. According to Paliama et al. (2022), increasing global temperatures can affect the life cycle of insects. In addition, dry seasons can cause drought and reduce water availability for insects (Benoit et al. 2023). However, further research is necessary to understand the diversity of insects in coconuts. In Indonesia, the two main seasons are the rainy season and the dry season. Each season can significantly impact the diversity and abundance of insects in the area.

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