



Implementation of Attractant Ratios to Attract Insects in the Clove Plant Ecosystem in West Langowan District, Minahasa

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Abstract: The purpose of this study was to examine insects trapped using bioethanol-methanol attractant traps, examine the types of clove plant pests, natural enemies, detritivores, and pollinators, and calculate insect diversity in the clove plant ecosystem. The research was conducted in Manembo Village, West Langowan District. This study used a qualitative method with bioethanol-methanol traps as attractants to capture insects in the clove plantation ecosystem. The location was divided into two areas, and the attractant traps were placed randomly. The results showed that 12 orders were identified: Coleoptera, Diptera, Hymenoptera, Hemiptera, Blattodea, Orthoptera, Odonata, Neuroptera, Thysanoptera, Arachnida, and Acariformes. The population abundance at Location A was 1063 individuals, and at Location B, 748 individuals. The diversity analysis results showed that H' was still classified as moderate, which was influenced by the lack of a dominant family in clove plantations. The dominance index (d') indicated that no insects were highly dominant in clove plantations.

Keywords: Bioethanol-methanol attractant; Clove plants; Diversity index

Introduction

Clove plants are an important plantation commodity in North Sulawesi because, in addition to providing farmers with income, they also contribute to the region's foreign exchange earnings. Clove production in North Sulawesi ranges from 8,001 to 10,509 tons, which is lower than South Sulawesi's 19,869 to 20,973 tons on the same area of land (Anonim, 2022). Previous research in North Sulawesi has identified several herbivorous insects (pests) in clove plantations, namely the stem borer *Hexamithodera semiveluntina*, the twig/branch borer *Cryptophasa watungi*, *Coptocercus biguttatus*, and *Xyloborus* sp. (Nuraini et al., 2020; Rimbing & Engka, 2022; Runaweri et al., 2017).

The latest research report on clove plants found insects captured using attractants in Poigar District, including Coleoptera, Hemiptera, Homoptera, Lepidoptera, and Odonata (Rondonuwu et al., 2022). The use of attractants is a more effective and efficient control measure than other insecticides. Attractants

using bioethanol (rat-methanol ethanol (1:1)) have been reported to be more effective on other plantation crops, such as coffee plants. These attractants can capture approximately 23 genera from 10 orders of insects, including Coleoptera, Lepidoptera, and Diptera (Rimbing et al., 2021; Sinaga et al., 2015; Situmorang et al., 2018; Sinaga, 2019). The insects captured consist of pests, natural enemies, and detritivores. Attractant traps or insect attractants are increasingly used for monitoring and controlling plant pests (Priawandiputra et al., 2015; Yi et al., 2012). The bioethanol-methanol attractants can attract the order Coleoptera, namely the imago Curculionidae and Cerambycidae, to coffee plants (Langkai et al., 2023; Rimbing et al., 2021; Safitri et al., 2025).

Therefore, the use of attractants in clove plant ecosystems is expected to attract herbivorous insects, especially *H. semiveluntina*, a member of the Cerambycidae family, which is the main pest, and other insects for studying the Clove Plant Ecosystem. Pest problems in clove plantations have become increasingly

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complex, as evidenced by the presence of *H. semivelutina* and *C. watungi*. Pest control in clove plantations using insecticides is considered ineffective and inefficient because it fails to suppress pest development; therefore, pest control using attractants—which will be examined in this study—can be implemented. The objectives of this study are to examine insects trapped using bioethanol-methanol attractant traps, examine the types of clove plant pests, natural enemies, detritivores, and pollinators, and calculate insect diversity in the clove plant ecosystem.

Method

Time and Location of the Study

This study was conducted at a clove production center in Minahasa Regency, which was determined purposively methods (Mukhlis et al., 2019; Mukhlis et al., 2024; Asgaf et al., 2025), namely Manembo Village, West Langowan District, with an altitude of 624 meters above sea level. It was then continued at the Entomology Laboratory of the Faculty of Agriculture, University of Sam Ratulangi. The experiment was conducted at two locations in Manembo Village, approximately 1 km apart. The activity was carried out on clove plantations that were more than seven years old.

Research Method

The study used a qualitative method in the research land by installing 16 bioethanol attractant traps. The attractant traps were located in rows of plants. Each point had one trap, so there were 4 traps in each row. The distance between traps in the plant rows was 10 m, while the distance between observation blocks was 20 m.

Observations of insect types and populations were conducted 5 times since the traps were set up: 7 days, 14 days, 21 days, 28 days, and 35 s. The size of the clove plant experiment site was ± 1 ha. Visual observations were made in the field to identify trapped insects and determine the most dominant insects. The treatment application procedure was as follows: A 1.5-liter mineral bottle was made with a 6 x 8 cm hole as an insect entry point. A 3 x 5 cm plastic bottle contained bioethanol-methanol as an insect attractant. Each plastic bottle contained 10 ml of attractant. The plastic bottles were inserted into the mineral water bottles, then tied to the lids with a string, while the bottoms of the mineral water bottles were filled with 200 ml of water + 5 ml of detergent to trap insects. The 3 x 5 cm plastic bottles had holes to allow the attractant to diffuse out to attract insects. The attractant trap is hung on a clove tree approximately 2 m above the ground. The attractant is replaced with a new one each time the insect population is collected. The bioethanol is produced through distillation by farmers in South Minahasa.

Data Analysis Method

Insects captured in the traps were sorted by order and then identified based on morphological characteristics using an insect identification key. The identified insects were then counted to determine the insect population. The insect diversity index on clove plants was calculated using the following indices:

Species diversity index (Shannon-Weiner)

$$H' = - \sum p_i \ln p_i. \tag{1}$$

Explanation: H' = Diversity Index, p_i = Proportion of each species, Index value criteria

Dominance Index (D), Simpson's dominance index formula (Odum, 1996)

$$D = \sum (n_i/N)^2 \tag{2}$$

D = Simpson's Dominance Index N_i = Number of individuals of each species N = Total number of individuals of all species

Evenness Index (Krebs, 1989)

$$E = H' / \ln S \tag{3}$$

E = Evenness Index; H' is the diversity index; and S is the total number of species.

Result and Discussion

Insect Types in the Clove Plant Ecosystem

Based on the results of research on clove plant ecosystems using bioethanol-methanol traps, insects were found from the orders Coleoptera, Diptera, Hymenoptera, Lepidoptera, Hemiptera, Orthoptera, Blattodea, Thysanoptera, Odonata, Neuroptera, Acariformis, and Arachnida.

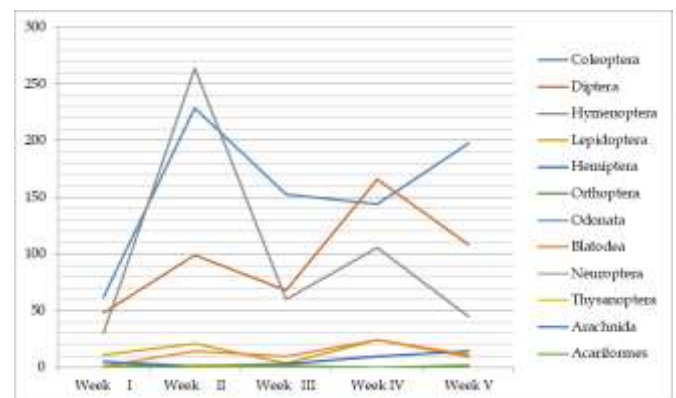


Figure 1. Fluctuations in the presence of insects found in clove plantations

The distribution of insect species captured using bioethanol-methanol traps is shown in Figure 1. Although it was the rainy season during the placement of bioethanol-methanol attractant traps in this experiment, the number of insect species caught was high. A high number of insect species indicates that the community is highly complex, as interactions among them occur in the clove plant ecosystem. Species diversity tends to be low in locations that use monoculture planting systems (Fajarfika, 2020).

The experiment was conducted on monoculture clove plants in Langowan, but the number of insect species found was relatively high. Insect capture methods and techniques greatly influence the types of insects obtained in relation to insect traps in the clove plant ecosystem. Bioethanol-methanol attractants were used (Ningsih & Ceri, 2023). Tumanduk et al. (2017), Suparman et al. (2020), Wahid et al. (2024) reported that insects associated with clove plants using insect nets and pitfall traps yielded only 5 families from 3 orders. This indicates that insect nets and pitfall traps are ineffective in capturing insects in the clove plant ecosystem. In the clove plant ecosystem, insects play different roles that must be understood to maintain its balance.

Insects in the clove plant ecosystem play complex ecological roles, namely as pests, predators, parasitoids, and decomposers (Odum, 1971). The roles of insects in clove plant ecosystems are diverse. Insects such as Ichneumonidae, Braconidae, Drynidae, and Phoridae act as parasitoids, while Miridae, Staphylinidae, Coccinellidae, Asilidae, Carabidae, and Formicidae act as predators. Insects that are plant pests include Thripidae, Aleyrodidae, Delphacidae, Acrididae, Tabanidae, Tephritidae, Scolytidae, Chrysomelidae, Nirtidulidae, and Cerambycidae.

Insect Populations

As mentioned earlier, there are several types of insects, indicating that bioethanol-methanol attractants are not specific to any one insect but can also attract others (Priawandiputra & Permana, 2015; Zahra et al., 2025). Rimbing et al (2021) reported that the dominant insect population on coffee plants is *Hypothenemus hampei*, but bioethanol traps can capture Hymenoptera, Lepidoptera, Hemiptera, Orthoptera, and Dipterainsects. Coleoptera generally act as pests, while Hymenoptera act as parasitoids. The high abundance of Hymenoptera in both plots indicates the potential for natural biological control (Letourneau et al., 2009). According to a study by Tylianakis et al. (2007), increased parasitoid diversity can enhance ecosystem stability through complex trophic interactions (Wonorahardjo et al., 2015).

The dominant orders were Coleoptera and Hymenoptera. The number of insects visiting the

bioethanol-methanol traps in Location A was 1,063 individuals, and in Location B, 748 individuals. The status of insect populations captured in traps in the clove plant ecosystem is shown in Tables 1 and 2.

Table 1. Insect Population Abundance in the Clove Plant Ecosystem at Location One: 1063 Individuals

Ordo	Observation					Amount
	I	II	III	IV	V	
Coleoptera	33	150	79	72	99	433
Diptera	32	46	17	93	67	255
Hymenoptera	14	184	58	13	15	284
Lepidoptera	6	8	-	12	8	34
Hemiptera	4	1	2	5	7	19
Orthoptera	-	1	2	-	2	5
Blattodea	-	8	6	12	7	33

Table 2. Insect Population Abundance in the Clove Plant Ecosystem at Location Two: 748 Individuals

Ordo	Observation					Amount
	I	II	III	IV	V	
Coleoptera	29	79	74	72	99	253
Diptera	16	53	51	73	41	234
Hymenoptera	16	80	43	13	30	182
Lepidoptera	5	13	4	12	1	35
Hemiptera	1	-	1	5	7	14
Orthoptera	1	1	-	-	-	2
Odonata	-	1	-	-	-	1
Blattodea	1	6	4	12	4	27
Neuroptera	-	-	1	-	-	1
Thysanoptera	-	1	-	-	-	1

Based on Tables 1 and 2, the highest population abundance was found in the order Coleoptera. The Coleoptera population was high due to the greater number of species than in other insect orders. Insects belonging to the order Coleoptera are attracted to bioethanol-methanol traps, causing the population to be high. Although the Coleoptera population is high, there are natural enemies, such as Coccinellidae. The presence of natural enemy insects in the clove plant ecosystem can cause an ecosystem balance. Ants have the highest population compared to other insects. According to Ricklefs (2001), the dominance of certain species within a community may be due to their greater ability to adapt to environmental conditions.

Diversity Index

Species diversity is an important characteristic of a community. The diversity of insect species in an ecosystem can be quantified using the Shannon index. The species diversity value (*H'*) indicates the number of species found at the first five observation sites in the clove plant ecosystem.

The Shannon-Weiner species diversity index (*H'*) in Figure 1 during the five observation periods shows that

H' is still classified as moderate. This is influenced by the lack of a family that is highly dominant in clove plantations. The level of H' is influenced by the number of families and the population size. Oka (1995) states that communities with low diversity of one or two species can become dominant. Based on the data obtained, the highest diversity index was observed in the first observation, then decreased in the second to fifth observations compared to subsequent observations.

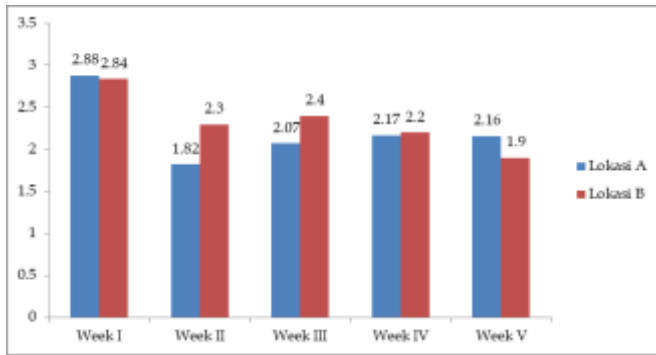


Figure 2. Insect species diversity index at location A and location B

In general, species diversity tends to be lower in agroecosystem plantations because they are disturbed by human activities, compared to plantations where vegetation is still natural, well-preserved, and untouched by humans Odum (1996). A moderate diversity index value means that the clove plant ecosystem is sufficient to support insect life. This is due to the availability of food as a source of nutrition for insects. Data on the dominance index is shown in Figure 3.

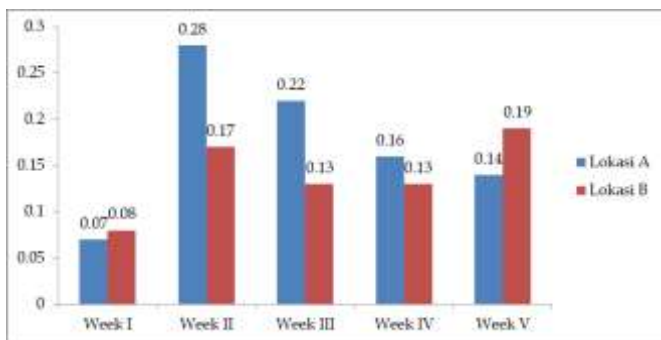


Figure 3. Insect dominance index in clove plant ecosystems

Odum (1996), the dominance index ranges from 0 to 1, where lower values indicate no dominant species and higher values indicate a dominant species. Based on Figure 3, there are no highly dominant insects in clove plantations. In other words, based on the evenness index, the ecosystem can still be considered stable, as shown in Figure 4.

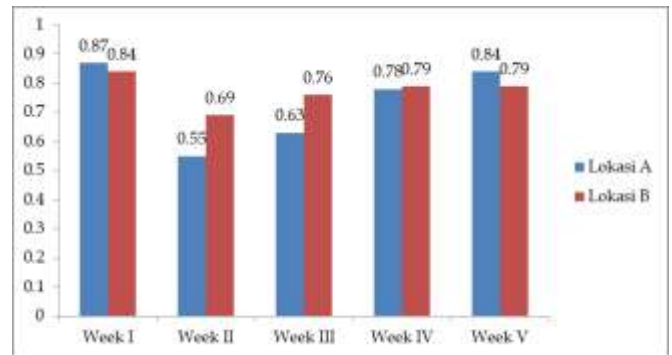


Figure 4. Insect evenness index in the clove plant ecosystem

Conclusion

Based on the research conducted, the following conclusions can be drawn: (1) Insects collected from bioethanol-methanol attractant traps in clove plant ecosystems comprised 12 orders: Coleoptera, Diptera, Hymenoptera, Hemiptera, Blattodea, Orthoptera, Odonata, Neuroptera, Thysanoptera, Arachnida, and Acariformes. The population abundance at Location A was 1063 individuals, and at Location B, 748 individuals; (2) The insect diversity indices at Locations A and B are classified as moderate; (3) The dominance index is still low because there are no dominant insects at Locations A and B.

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Author Contributions

D.A.S.T.: Developing ideas, analyzing, writing, reviewing, responding to reviewers' comments; F.H.R., R.W.T: analyzing data, overseeing data collection, reviewing scripts, and writing.

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Conflicts of Interest

The authors declare no conflict of interest.

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