

# Diversity of Insect Pests, Parasitoids, and Predators on Rice Plants (*Oryza Sativa* L.) in Minahasa Regency

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**Abstract:** Rice (*Oryza sativa* L.) is one of the most important crops as a major source of carbohydrates for the majority of the world's population. However, to date, rice farming in West Kakas District, Minahasa Regency, still faces problems due to pest attacks. The purpose of this study was to determine the types and diversity of insects on rice plants in West Kakas District, Minahasa Regency. The research was conducted in West Kakas Subdistrict, which was determined using the purposive method, at four locations with five observation points. Insects were captured directly using insect nets. The captured insect samples were collected and grouped according to type. The types and population densities of the captured insects were counted and identified, then analyzed for diversity using the Shenon and Wivier formula to obtain the diversity index (H), similarity index (E), richness index (R), and dominance index (C). The results of the study show that there are insect pests and natural enemies (parasitoids and predators). The insect pests consist of 5 orders, 12 families, and 16 species, namely *Dolycorus* sp, *Scotinopharasp.*, *Stenodema* sp, *Leptocorisa* sp, *Paraecosmetus* sp, *Cofana spectra*, *Recilia* sp., *Nephotetix* sp, *Oxya* sp. , *Anacridium* sp, *Chilo* sp, *Parnara* sp, *Cnaphalocrocis* sp. , *Orseolia* sp , *Chlorops* sp, and *Phyllotreta* sp. Meanwhile, natural enemies consist of 3 orders, 9 families, and 9 species, namely *Cyrtohinus* sp. , sp, *Agryophylax* sp. , *Sepedon* sp., *Encarsia* sp., *Menochilus* sp. , *Ophionea* sp. , *Paederus* sp., *Sceliphron* sp. and *Agriocnemis* sp. The results of the Shannon and Wiever diversity analysis are  $H' = 3.04$  or a high diversity index, the richness index  $R = 4.67$  or moderate criterion value, the evenness index  $E = 0.52$  or moderate and unstable evenness index, and the dominance index  $C = 0.377$  or low dominance.

**Keywords:** Insect diversity; Insect species; Shannon and Weaver formula

## Introduction

Agricultural development is crucial to the country's economy in Indonesia. Agriculture development policies had an impact on Indonesian agriculture policy during the start of the New Order government (Mukhlis et al., 2024). Indonesia's achievements in meeting its food needs are marked by its success from a rice-importing country to a self-sufficient country (Sutanto, 2002; Mukhlis et al., 2023).

Rice (*Oryza sativa* L.) is an agricultural crop that remains a staple food source in many tropical countries,

particularly in Asia and Africa (Herawati, 2012). In 2019, Indonesia produced a total of 54.60 million tons of milled dry grain (GKG), a decrease of 7.76 per cent (4.60 million tons) from 2018, when it produced 59.20 million tons of GKG (Anonim, 2020). Rice crop production can be affected by various factors, especially insect pests. Insect pests are organisms that damage plants or crop yields due to their activities, especially their search for food, which can cause physical damage and losses in agriculture (Hasyim et al., 2014; Hasyim et al., 2015).

Minahasa Regency, including West Kakas District, has a climate suitable for paddy rice cultivation, and

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this crop is widely cultivated by farmers because it has been done for generations (Najoan et al., 2021). Kakas District is one of the centres of paddy rice production in Minahasa Regency. To date, rice farming in Tountimomor Village has faced many obstacles in the field, including pest and disease attacks. Several rice pests identified in previous studies include the brown planthopper (*Nilaparvata lugens*), green planthopper (*Nephotettix virescens*), white planthopper (*Nymphula depunctalis*), leaf folder (*Cnaphalocrocis medinalis*), rice stem borer (*Orseolia orizae*), White Rice Stem Borer (*Scirpophaga innotata*), Walang Sangit (*Leptocorisa oratorius*) (Heviyanti & Syahril, 2018), Black Stink Bug (*Pareaucosmetus* sp), (Manueke et al., 2017), Red Mango Stem Borer (*Sesamia inferens*), Soil Beetle (*Scotinophara coarctata*), Mole Cricket (*Gryllotalpa* sp.) (Li et al., 2017; Iswanto et al., 2020).

According to Gharekhani et al (2014); Rante & Manengkey (2017), control measures for a particular type of insect pest can be effective and targeted. However, to minimise the adverse effects of chemical insecticide use, it is necessary to first monitor the type, population density, and diversity of these insect pests. The types and diversity of insects in a rice field ecosystem can be determined by identifying and analysing the insect diversity index. Insect capture methods can be carried out in various ways, such as sweeping techniques using insect nets, and using a well-designed, correct method so that all types of insects can be captured and identified, and their diversity can be analysed using the Shannon and Wiener indices.

The existence of insect species and population density will be widely found, and efforts to evaluate the existence of insects in the rice paddy ecosystem are considered necessary in the form of research, so that control efforts against attacks and damage can be implemented in the concept of integrated pest management.

The objective of this research is to determine the types and diversity of insects on rice paddy plants in the Kakas Barat sub-district of Minahasa Regency.

## Method

### *Time and Place*

This research was conducted from April to October 2025 in Tountimomor Village, West Kakas Subdistrict, and then continued at the Laboratory of the Plant Pests and Diseases Department, Plant Protection

Study Program, Faculty of Agriculture, Sam Ratulangi University, Manado.

### *Tools and Materials*

The tools and materials used in this study were rice fields, adhesive glue (rat glue), bamboo, name tags, brushes, measuring tapes, transparent plastic, cameras, and *hand counters*. Microscope, magnifying glass, writing tools, and insect identification reference books, namely (Shepard et al., 1991; Holland, 2012; Kim et al., 2014).

### *Research Method*

This study used purposive sampling, in which insects were directly captured by sweeping them with an insect net. Insect samples were collected at three rice cultivation sites that were entering the generative stage, when the panicles had formed. Samples were collected three times at each site. All captured insects, regardless of type or population, were taken to the laboratory, counted by type or species, and then identified to the species and genus levels. Based on the data on the number of insect species captured during the three observations, the data could be analysed to obtain diversity indices, namely the H' index, E index, R index, and C index.

### *Observation Parameters*

The parameters observed consist of: (1). Species Identification of Insects Captured During Sweeping; (2). Species and population numbers are used as data to analyse the diversity index of insects found on rice plants

### *Data Analysis*

The identification results provide data on insect species and the number of each species caught, serving as population data for each species/type. The species data will be displayed in a table and described narratively. For species and population data based on the location/sampling point at 4 observation locations, the analysis of insect species diversity can be carried out using the Shannon and Wiener indices.

## Result and Discussion

### *Insect Species Identification*

Based on the research results, insect pests comprise 5 orders, 12 families, and 16 species, while natural enemies, namely parasitoids and predators, comprise 3 orders, 9 families, and 9 species, as shown in Table 1.

**Table 1.** Results of Identification of Pest Insect Species and Natural Enemies Found on Rice Plants in Tontimomor Village, Kakas Barat Subdistrict, Minahasa Regency

No.	Species/Type	Order: Family	Status
Pest Insects			
1.	<i>Scotinophara</i> sp.	Hemiptera: Pentatomidae	Pest
2.	<i>Dolycorus</i> sp.	Hemiptera: Pentatomidae	Pest
3.	<i>Stenodema</i> sp.	Hemiptera: Miridae	Pest
4.	<i>Leptocorisa</i> sp	Hemiptera: Alydidae	Pest
5.	<i>Paraecosmetus</i> sp	Hemiptera: Lygaeidea	Pest
6.	<i>Cofana</i> sp.	Hemiptera: Cicadellidae	Pests
7.	<i>Recilia</i> sp.	Hemiptera: Cicadellidae	Pest
8.	<i>Nephotetix</i> spp.	Hemiptera: Cicadellidae	Pests
9.	<i>Oxya</i> sp.	Orthoptera: Acrididae	Pests
10.	<i>Anacridium</i> sp	Orthoptera: Acrididae	Pest
11.	<i>Chilo</i> sp	Lepidoptera: Crambidae	Pest
12.	<i>Parnara</i> sp	Lepidoptera: Hespiriidae	Pest
13.	<i>Cnaphalocrocis</i> sp.	Lepidoptera: Pyralidae	Pest
14.	<i>Orseolia</i> sp	Diptera: Cecidomyiidae	Pest
15.	<i>Chlorops</i> sp	Diptera: Chloropidae	Pests
16.	<i>Phyllotreta</i> sp	Coleoptera: Chrysomelidae	Pests
Natural Enemies (Parasitoids and Predators)			
1.	<i>Cyrtohinus</i> sp.	Hemiptera: Miridae	Predator
2.	<i>Conocephalus</i> sp	Orthoptera: Tettigoniidae	Predator
3.	<i>Agryophylax</i> sp.	Diptera: Tachinidae	Predator
4.	<i>Sepedon</i> sp.	Diptera: Sciomyzidae	Predator
5.	<i>Encarsia</i> sp	Diptera: Aphelenidae	Parasitoid
6.	<i>Menochilus</i> sp.	Diptera: Coccinellidae	Predator
7.	<i>Ophionea</i> sp.	Coleoptera: Carabidae	Predator
8.	<i>Paederus</i> sp	Coleoptera: Staphylinidae	Predator
9.	<i>Sceliphron</i> sp	Hymenoptera: Sphecidae	Predator
10.	<i>Agriocnemis</i> sp	Odonata: Coenagrionidae	Predator
11.	<i>Tetragnatha</i> sp.	Aranea: Tetragnathidae	Predator
12.	<i>Oxyopes</i> sp	Aranea: Oxyopidae	Predator

Based on Table 1 above, observations conducted at the research site identified various insect types, including pests and natural enemies (predators and parasitoids). The existence of these two groups of organisms indicates that the crop ecosystem has complex ecological interactions between organisms that harm plants and organisms that play a role in controlling pest populations naturally. Overall, the pest insects found belonged to several major orders, namely Hemiptera, Orthoptera, Lepidoptera, Diptera, and Coleoptera, while the natural enemies found belonged to Hemiptera, Orthoptera, Diptera, Coleoptera, Hymenoptera, Odonata, and Araneae.

Based on observations, the most commonly found group of insect pests belongs to the order Hemiptera. This order includes several species such as *Scotinophara* sp., *Dolycorus* sp., *Stenodema* sp., *Leptocorisa* sp., *Paraecosmetus* sp., *Cofana* sp., *Recilia* sp., and *Nephotetix* spp. Insects of the order Hemiptera generally have piercing and sucking mouthparts that extract fluids

from plant tissues, causing physiological damage to plants (Kalshoven, 1981).

One important pest found is *Leptocorisa* sp., also known as brown planthoppers. These pests attack rice plants during the grain-filling phase by sucking the liquid from the grains, leaving them empty or reducing their quality. According to Heinrichs et al (1985), brown planthopper attacks during the grain-filling stage can cause a significant reduction in crop yield, especially when the population is high during the plant's generative phase.

In addition, *Nephotetix* spp., known as green leafhoppers, were also found. These insects not only damage plants by sucking sap from leaves, but also act as vectors of the tungro virus in rice. Tungro disease is one of the major diseases that can drastically reduce rice productivity (Pathak & Khan, 1994). The presence of this pest in the research field indicates a potential risk of plant disease spread. Other Hemiptera pests found were *Cofana* sp. and *Recilia* sp., both belonging to

the Cicadellidae family. This group of insects, known as leafhoppers, damages plants by sucking fluids from leaves, causing them to turn yellow and inhibiting photosynthesis (Heinrichs et al, 1985). In addition to Hemiptera, pests from the order Orthoptera were also found, namely *Oxya* sp. and *Anacridium* sp., both belonging to the family Acrididae. These insects are leaf-eating grasshoppers that can damage plant leaves. According to Capinera (2008), grasshoppers of the family Acrididae are herbivores with a high leaf consumption rate, which can cause significant damage to cultivated plants if their populations increase. In the order Lepidoptera, several species were found, such as *Chilo* sp., *Parnara* sp., and *Cnaphalocrocis* sp. The larvae of the Lepidoptera group are important pests on various cultivated plants, including rice. *Chilo* sp. is a rice stem borer that attacks stem tissue, causing lodging symptoms in the vegetative phase and stunting in the generative phase (Pathak & Khan, 1994). Meanwhile, *Cnaphalocrocis* sp. is known as a rice leaf roller that attacks leaves by rolling them up and eating the leaf tissue inside, thereby reducing the leaf surface area for photosynthesis. Pests from the order Diptera found in this study include *Orseolia* sp. and *Chlorops* sp.. *Orseolia* sp. is known as the rice gall midge, which attacks the growing points of plants, causing galls to form on rice plants. Gall midge attacks can inhibit plant growth and reduce production (Heinrichs et al., 1985). Meanwhile, *Chlorops* sp. is a fly that can also damage plants by attacking plant tissue during certain growth phases. In addition, pests of the order Coleoptera were found, namely *Phyllotreta* sp., a member of the family Chrysomelidae. This insect is known as a leaf beetle that damages plants by eating leaf tissue, causing small holes to form on the leaf surface. This damage can reduce the plant's ability to photosynthesize (Capinera, 2008).

In addition to insect pests, observations also revealed the presence of various natural enemies, including predators and parasitoids. The presence of these natural enemies is very important in maintaining the balance of the agricultural ecosystem because they can help suppress pest populations naturally. One of the predators found was *Cyrtohinus* sp., a member of the Miridae family. This insect is known as a predator that preys on planthopper eggs and other small insects on rice plants. According to Shepard et al (1991), *Cyrtohinus lividipennis* is one of the main predators of planthopper eggs that plays an important role in controlling planthopper populations in rice agroecosystems. Another predator found is *Menochilus* sp., a member of the Coccinellidae family, commonly

known as ladybugs. This insect is a predator that preys on various small insects, including aphids, insect eggs, and pest larvae. According to Hodek et al. (2012), Coccinellidae beetles are among the most effective groups of predators in biological control because they possess strong predatory abilities and a wide distribution.

In addition, the predator *Paederus* sp. (Staphylinidae), known as the tomcat beetle, was found. This insect is an active predator that preys on various small insects in agricultural areas (Shepard et al., 1991). The presence of this predator in the research area indicates that the ecosystem still supports natural enemies that play a role in pest control. Another predator found was *Ophionea* sp., a ground beetle (Carabidae). These beetles are active predators on the soil surface, preying on various types of eggs and pest larvae in the soil. A group of predators was also found from the Odonata order, namely *Agriocnemis* sp., known as needle dragonflies. These insects are predators that prey on various types of small insects, including plant pests. In addition, predators from the Araneae (spiders) group were also found, such as *Tetragnatha* sp. and *Oxyopes* sp.. Spiders are generalist predators that play an important role in suppressing pest populations in agroecosystems. According to Nyffeler & Sunderland (2003), spiders can prey on various insect pests, thereby playing an important role in biological control.

In addition to predators, *Encarsia* sp. parasitoids were found, which parasitize various insect pests. Parasitoids are insects that lay their eggs on or inside the host's body so that the parasitoid larvae will develop by utilising the host's body as a food source (Godfray, 1994). The presence of these parasitoids indicates the existence of a natural control mechanism for pest populations in the ecosystem.

Overall, the presence of various types of predators and parasitoids found in this study indicates that the crop ecosystem still has good biological control potential. According to Altieri and Nicholls (2004), the diversity of natural enemies in an agroecosystem is an important factor in maintaining pest population balance and supporting the implementation of integrated pest management (IPM).

#### *Diversity of Pest Insects and Natural Enemies*

The results of the identification of species and population numbers of insect pests and natural enemies found at the observation site can be seen in Table 2 below

**Table 2.** Diversity of Pest Insect Species and Natural Enemies Found on Rice Plants

No.	Kinds/Species	Family	Observation					Number	Average
			1	2	3	4	5		
1.	<i>Scotinophara</i> sp.	Pentatomidae	5	10	11	10	6	42	8.4
2	<i>Dolycorus</i> sp.	Pentatomidae	17	41	19	25	22	124	24.8
3	<i>Stenodema</i> sp.	Miridae	12	9	7	15	12	55	11.0
4	<i>Leptocorisa</i> sp.	Alydidae	41	53	22	36	34	186	37.2
5	<i>Paraecosmetus</i> sp.	Lygaeidae	31	40	29	37	46	183	36.6
6	<i>Cofana</i> sp.	Cicadellidae	43	52	55	46	41	237	47.4
7	<i>Recilia</i> sp.	Cicadellidae	54	46	63	67	52	282	56.4
8	<i>Nephotetix</i> spp.	Cicadellidae	55	65	51	45	57	273	54.6
9	<i>Oxya</i> sp.	Acrididae	28	37	42	19	35	161	32.2
10	<i>Anacridium</i> sp.	Acrididae	12	21	27	25	33	115	23.6
11	<i>Chilo</i> sp.	Crambidae	19	27	11	17	18	92	18.4
12.	<i>Parnara</i> sp.	Hesperiidae	15	12	11	7	9	54	10.8
13.	<i>Cnaphalocrocis</i> sp.	Pyrilidae	12	23	31	2	42	110	22.0
14	<i>Orseolia</i> sp.	Cecidomyiidae	10	19	15	10	14	68	13.6
15	<i>Chlorops</i> sp.	Chloropidae	15	9	21	14	15	74	14.8
16.	<i>Phyllotreta</i> sp.	Chrysomelidae	23	41	18	28	31	141	28.2
17	<i>Cyrtohinus</i> sp.	Miridae	12	17	22	14	29	94	18.8
18.	<i>Conocephalus</i> sp.	Tettigoniidae	9	7	13	10	11	50	10.0
19	<i>Agryophylax</i> sp.	Tachinidae	8	11	9	8	14	50	10.0
20	<i>Sepedon</i> sp.	Sciomyzidae	43	51	36	45	48	223	44.6
21	<i>Encarsia</i> sp.	Aphelenidae	12	8	10	32	11	73	14.6
22	<i>Menochilus</i> sp.	Coccinellidae	54	64	50	47	61	276	55.2
23	<i>Ophionea</i> sp.	Carabidae	17	9	8	5	16	55	11.0
24	<i>Paederus</i> sp.	Staphylinidae	21	16	31	22	8	98	19.5
25.	<i>Sceliphron</i> sp.	Sphexidae	7	7	11	9	10	44	8.8
26	<i>Agriocnemis</i> sp.	Coenagrionidae	13	10	9	12	5	49	9.8
27.	<i>Tetragnatha</i> sp.	Tetragnathidae	22	12	11	20	17	82	16.4
28	<i>Oxyopes</i> sp.	Oxyopidae	8	7	14	18	11	58	11.6

Based on the observations in Table 2, 28 insect species were found, consisting of insect pests and natural enemies (predators and parasitoids) in the rice plant ecosystem, with a total of 3,688 individuals. The results of the analysis using the Shannon–Wiener diversity index (H') showed a value of 3.04, which is classified as high diversity. A high diversity value indicates that the insect community in the rice ecosystem at the study site has a fairly diverse and relatively stable species composition. According to Magurran (2021), a high Shannon–Wiener index value indicates that an ecosystem has a relatively even distribution of individuals among existing species and shows a good level of ecological complexity.

The high insect diversity in the study area may also be influenced by the availability of food sources, environmental conditions, and habitats that support the development of various insect species. Rice agroecosystems generally provide various food sources and microhabitats that enable various insect species to live and thrive. Research by Zhang et al (2020) shows

that rice ecosystems have complex insect communities due to the presence of rice plants, weeds, and environmental conditions that support organism diversity. Based on the data in Table 2, several pest species have relatively high abundances, such as *Recilia* sp. (282 individuals) and *Nephotetix* spp. (273 individuals), *Cofana* sp. (237 individuals), and *Leptocorisa* sp. (186 individuals). These species belong to the Hemiptera order, known as plant-sap-sucking insects. Insects in this group can damage plants by sucking sap from plant tissues, thereby disrupting plant physiological processes (Lu et al., 2015).

In addition to pest groups, various natural enemies were also found that play an important role in naturally controlling pest populations. Some predators found in fairly high numbers included *Menochilus* sp. (276 individuals), *Sepedon* sp. (223 individuals), and *Tetragnatha* sp. (82 individuals). The presence of these predators indicates that the agroecosystem at the study site still supports biological control organisms. The species *Menochilus* sp. in the family Coccinellidae is an

effective predator that preys on various small insects, including aphids and insect pest eggs. According to Hodek et al (2021), Coccinellidae beetles are important predators in agricultural systems because they have a high prey consumption rate and can adapt to various environmental conditions.

In addition, spiders such as *Tetragnatha* sp. and *Oxyopes* sp. play an important role as generalist predators, preying on various insect pests in agroecosystems. Research by Priyadarshini et al (2022) shows that spiders play a significant role in suppressing insect pest populations on agricultural crops through their high predatory activity. This study also found *Encarsia* sp. parasitoids, which act as natural enemies of several insect pests. Parasitoids are organisms that develop by utilising host bodies, thereby naturally suppressing pest populations. According to Naranjo et al (2015), the presence of parasitoids in an agroecosystem is very important in supporting biological pest control and reducing dependence on chemical pesticides.

The high diversity index value in this study indicates that the rice farming ecosystem at the study site still has a fairly good ecological balance. High insect diversity can increase ecosystem stability by fostering interactions between pests and natural enemies that suppress pest population growth. Gurr et al (2017) stated that the diversity of predators and parasitoids in agroecosystems can increase the effectiveness of natural pest control, thereby supporting the implementation of integrated pest management (IPM). Thus, the presence of various insect pests and natural enemies in this study indicates that the rice cultivation ecosystem harbours a diverse insect community with the potential to support ecological balance through natural biological control mechanisms.

## Conclusion

The identification results found that the insect pests consisted of 5 orders, 12 families, and 16 species, namely *Dolycorus* sp., *Scotinophara* sp., *Stenodema* sp., *Leptocoris* sp., *Paraecosmetus* sp., *Cofana* sp., *Recilia* sp., *Nephotetix* sp., *Oxya* sp., *Anacridium* sp., *Chilo* sp., *Parnara* sp., *Cnaphalocrocis* sp., *Scirchopagasp.*, *Chlorops* sp., and *Phyllostreta* sp. Meanwhile, natural enemies consist of 3 orders, 9 families, and 9 species, namely *Cyrtohinus* sp., *Agryophylax* sp., *Sepedon* sp., *Encarsia* sp., *Menochilus* sp., *Ophionea* sp., *Paederus* sp., *Sceliphron* sp., and *Agricnemis* sp.

The results of the Shannon and Wiever diversity analysis are  $H' = 3.04$ , or a high diversity index, richness index  $R = 4.67$  or a high criterion value, evenness index  $E = 0.52$  or a moderate and unstable

evenness index, and dominance index  $C = 0.377$  or low dominance.

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## Author Contributions

M.L.: Developing ideas, analyzing, writing, reviewing, responding to reviewers' comments; N.N.W., M.H.B.P.: 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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