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Monitoring Insect Diversity with a Variety of Traps in Rice Plantations Supports Food Security

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Abstract The objectives of this study in Serbajadi Village, Sunggal District, Northern Sumatera were: 1) Map the diversity and functional role of local insects in paddy agroecosystems; 2) Determine the environmental variables in the rice field that form ecosystem services; and 3) Provide recommendations for the suitability of local insect agrobiodiversity habitats that form ecosystem services, especially those capable of supporting food security. Insects caught at each trap sample point were determined diagonally with a size of 20 x 20 m in 3 plots, each plot using 5 traps (Sweep Net=SN with 10 swings, Color Pan Trap=CPT with 4 repetitions, Core Sampler= CR with 4 repetitions, and Yellow Sticky Trap=YST with 5 repetitions and Light Trap=LT with 1 repetition in the middle of the rice plant) with sampling 8 times at weekly intervals. The study's results indicated that YST traps captured the highest number of individuals and the greatest diversity of insect species, with 47 species and 479 individuals. LT traps collected 14 species with 288 individuals, and SN traps caught 236 individuals from 36 species. In contrast, the CPT tool had the lowest count of identified individuals, with 14 species and 66 individuals. Furthermore, the overall population is mainly comprised of six pest species, with *Chironomus* sp being the most abundant at 421 individuals, followed by *Anopheles* sp. (129 individuals), *Tetragnatha* sp. (94 individuals), *Leptocorisa oratorius* (73 individuals), *Chilo suppressalis* (42 individuals), and *Nilaparvata lugens* (39 individuals). Conversely, the smallest six species include *Euscyrtus concinnus, Hesperia* sp., *Gryllotalpa orientalis*, *Panstenon* sp., *Temelucha philippmensis,* and *Thomisius* sp. The main predators identified are *Agriocnemis femina, Ischnura senegalensis, Orthetrum sabina, Pantala flavescens, Paederus* sp., *Ophionea* sp., *Conocephalus* sp., *Spheidea* sp., while *Ichneumonida* sp., *Tachnida* sp. act as parasitoids in rice cultivation. The calculation of the Biological index consists of the Richness index (R1=2.78-3.29), the Evenness index (E=0.57-0.82), the Diversity index (H'=2.12-2.5) and the Dominance index (D=0.60-0.84). Based on the proportion distribution of abundance of each functional role in each habitat, a tendency was obtained for the proportion of abundance of roles with high evenness in the rice field habitat.

Keywords Agro Biodiversity, Insects, Ecosystem Services, Sustainable Agriculture, Food Security

1. Introduction

Insects are one of the most taxonomically and functionally diverse groups of organisms and are a major component of ecosystem function. Insects are also able to provide ecosystem services in all categories in the Millennium Ecosystem Assessment (MEA), namely regulation, support, provision and cultural services; as well as in the Concept of Nature's Contribution to

Humans proposed by the Inter-governmental Science, Platform of Policy on Biodiversity and Services Ecosystem (IGSPBSE) [1]. Insects contribute to the management of ecosystem functions (regulatory services), with their most prominent contributions to humanity being in the form of pollination, pest management, and the scattering of seeds [2, 3]. According to Losey & Vaughan [2] and Farji & Werenkraut [4], insects also play a role in providing fundamental support services, related to ecosystem processes necessary to produce all other services, such as soil formation, nutrient cycling, and decomposition.

Food security, especially in relation to biodiversity, can be linked through several steps, particularly those linked to the four aspects of food security, which include: the presence of food, its affordability, its utilization, and its consistency. The availability of produced and sufficient food sources, the availability and accessibility of sustainable food ingredients, as well as their use to support community health and nutrition, are important dimensions of food security [5]. The contribution of biodiversity to food security is often identified through the presence, or availability, of many different species and genetically diverse populations within a species.

Sonico [6] states Agricultural areas are very important habitats for animal life, especially insects. Agricultural ecosystem stability can be achieved through the abundance and diversity of insects in agricultural locations. Wiling [7] unveiled the connection between the diversity of airborne insects and organic rice crops in relation to ecosystem stability by not only assessing the diversity of community structure but also characterizing the components and the relationships among these ecosystem elements. Based on Wiling [7], rice is the main food for most Indonesian people. Rice pests and diseases are organisms that cause unstable rice production. Paramitha [8] states Pests are one of the factors that influence rice production because they can cause low production both in terms of quality and quantity, one of these pests is airborne insects. Air insects are insects that live on land and have wings that can be used to fly. Vinolia [9] said some air insects are insect pests that cause low rice yields.

The aim of the research is to monitor insect diversity by using various traps on rice plants to support food security in North Sumatera. Research using the Indonesia Collaborative Research (ICR) scheme is in parallel, and the research topics conducted encompass the following: 1). Investigating insect diversity in diverse environments through the utilization of the Rapid Assessment (Quadrat Protocol) approach, as well as through direct insect collection techniques involving sweep net, yellow sticky trap, core sampler, and core sampler; 2). Researching the variety of insects and how it is linked to environmental elements; 3). Ecological investigation or study functions of various insect taxa; and 4). Research on insect diversity as Agents of Ecosystem Services.

2. Materials and Methods

This study took place in Serbajadi Village, Sunggal District, North Sumatera, focusing on rice cultivation. The research spanned from May 2022 to August 2022. The materials and equipment employed in this investigation included Inpari 32 rice variety, insect adhesive, detergent, tissue, 70% alcohol, and aquadest. The equipment utilized includes Sweep Net (SN), Color Pan Trap/CPT (plastic basins in yellow, red, blue and white), Core Sampler/CS (a 25 kg white plastic bucket), Yellow Sticky Trap/YST (in yellow, red, blue, and white), Light Trap/LT, camera, a trash sieve, container, sample bottle, microscope, specimen box, small hoe, small shovel, surgical instruments, tweezers, nails, plastic rope, wood, and a notebook.

At every designated trap sample location, four sets of insect plots measuring 20 x 20 meters diagonally were established. Each of these plots was equipped with four traps (Sweep Net, Yellow Sticky Trap, and Core Sampler) for a total of eight observations conducted at weekly intervals. The Light Trap, on the other hand, was placed in a single plot located at the center of the rice fields.

The Sweep Net (depicted in Figure 1) is constructed from lightweight and sturdy mesh, allowing for easy handling to ensure that captured insects are visible. Ten swings of the net are performed at every sampling location. Insect collection takes place in the morning, between 08:00 and 10:00am. The insects captured are subsequently gathered and placed in sample bottles for the purpose of identification and the calculation of their population and biological indices.

Figure 1. Sweep Net (SN) (Personal documentation, 2022)

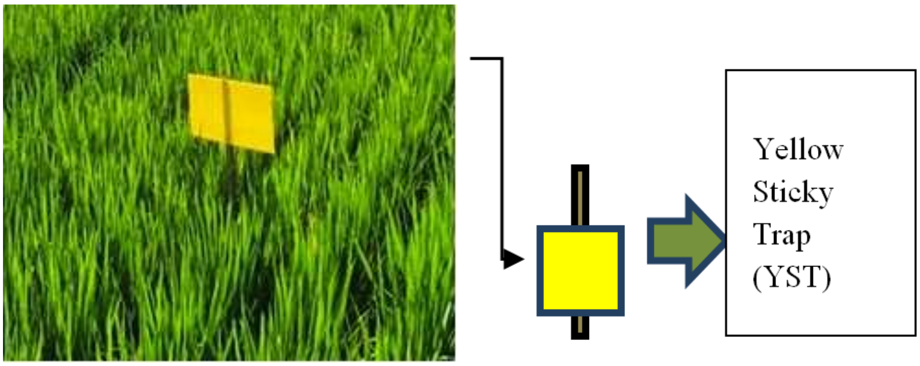

Figure 2. Yellow Sticky Trap (YST) (Personal documentation, 2022)

In contrast, the Yellow Sticky Trap (YST) shown in Figure 2 consists of yellow paper covered with sticky glue to capture insects, measuring into sizes of 25 cm x 20 cm (as depicted in Figure 2). It is set up in the morning, from 08.00 to 09.00 am, with weekly monitoring intervals and a total of 8 observations throughout the rice planting period. The insects caught are gathered in sample containers, examined in a laboratory setting, and tallied for the purpose of data analysis.

Figure 3. Core sampler (CS) (Personal documentation, 2022).

Subsequently, the Core Sampler (CS) trap (as illustrated in Figure 3) was fashioned from a white plastic paint bucket with a capacity of 25 kg, featuring a height of 46 cm and a diameter of 27 cm. Holes were created both at the top and bottom of the bucket. The Core Sampler (CS) is then positioned on the ground, allowing half of its surface to be submerged in the soil up to ground level (as shown in Figure 3). Then Siregar [10] states it is employed to capture eggs, larvae, and aquatic insects that dwell on rice plants. According to Siregar [11], the use of the CS tool takes place between 09.30am and 10.30am, and collections are conducted once a week. The mud collected is subsequently passed through a filtering sieve with a diameter of 10 cm and a mesh size of 20, effectively separating the mud and its constituent particles. Insect larvae are inspected using a soft brush, and the collected insects are then placed in sample containers.

The Color Pan Trap (CPT), as seen in Figure 4, is a plastic tray measuring 20-30 cm in width, and 12-15 mm in depth, and comes in yellow, white, red, and blue colors. It's crafted from a plastic container with a base measuring 15 cm x 25 cm and a height of 5 cm (as shown in Figure 4). The white, yellow, and red trays are positioned at a single point in the middle of the observation area along the diagonal line. To facilitate the mixing of insect soil and natural enemies (samples) in the tray, a water and detergent solution is initially added to reduce surface tension, allowing incoming samples to sink and perish. The tray is left in the field for 12 hours, specifically between 06:00 am and 06:00 pm. Observations with the tray trap are conducted once a week, amounting to a total of 8 observations.

The positioning of the traps is verified through the utilization of a Hygro-thermometer. Air temperature readings are obtained by activating the Hygro-thermometer for approximately 5 seconds and reading the scale. Additionally, the pH level is gauged with a digital pH device. Simultaneously, the light intensity, influenced by the duration of photosynthetic exposure, significantly influences the growth and reproductive processes of plants in tropical areas. A light trap is a device employed to capture or attract insects and serves the purpose of determining the presence or population count of insects in agricultural fields. The captured insects are measured in terms of light intensity using a Lux meter. Generally, wind conditions significantly impact the optimal weather elements, particularly temperature, for plant growth and productivity. Wind speed is assessed through the use of an anemometer.

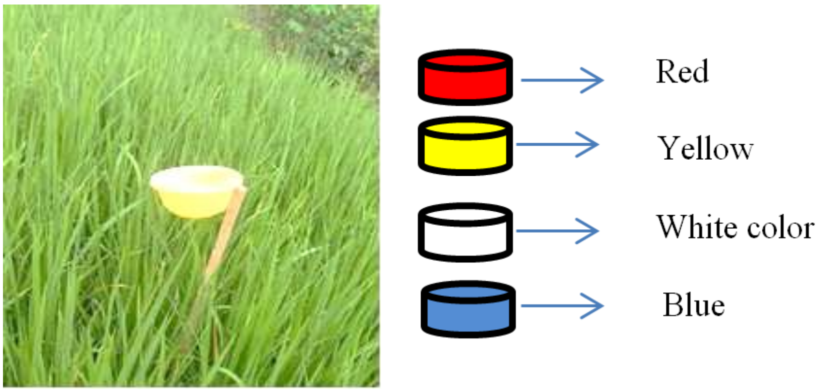

Figure 4. Color Pan Trap (CPT) (Personal documentation, 2022).

Subsequently, the Biological Index is derived by computing the value based on species richness, R1, as presented in Table 1. This computation aids in determining the abundance of individual species in each community. The evenness index calculation (Evenness Index) is used to assess the consistency in the distribution of each species within these communities. Lastly, the Dominance Index (D), as detailed in Table 2, is calculated, then Table 3 shows a range of Shannon-Wiener Diversity index.

Table 1. Margalef Index Wealth Criteria Score (R1)

Margalef Index Score	Category
< 2.5	Lower diversity
2.5 – 4	Middle diversity
>4	Higher diversity

Table 2. Odum Dominance Criteria Score

Score Dominance Index	Category
0-0.5	Lower diversity
0.5-0.75	Middle diversity
0.75-1	Higher diversity

Table 3. Shannon-Wiener Diversity Index Criteria

Shannon-Wiener Index Score	Category
<1	Lower diversity
1-3	Middle diversity
>3	Higher diversity

Data to be collected includes quantity and quality of agricultural yields, as well as the factors impacting environmental factors within the rice field. This data will undergo analysis and contribute to publications associated with agriculture, Preservation and oversight of biological resources. Furthermore, the research selves into the application of appropriate technology in agricultural systems concerning the use of predatory agents, with an aim to establish sustainable agricultural practices. The research conducted by the USU researchers team had its primary emphasis placed on monitoring biodiversity and its resulting impacts, including services and products in agricultural production systems, particularly within rice farming communities.

3. Results and Discussion

The plantations surrounding the rice fields include a variety of crops such as "banana (*Musa paradisiaca*), papaya (*Carica papaya*), coconut (*Cocos nucifera*), corn (*Zea mays*), as well as several types of weeds, including Tuton (*Leptochloa chinensis*), Teki (*Cyperus rotundus*), Javanese betteng/sari (*Echinochloa crusgalli*), gunda (*Sphenoclea zeylanica*), water saw (*Ludwigia octovalvis*), water hyacinth (*Monochoria* spp), fennel (*Fimbristylis* sp), and sunduk welut (*Cyperus iria*).

Table 4 presents a detailed summary of the inventory of insects found in rice plantations using five different tools: CPT, YST, SN, CS, and LT. While various diseases have also been identified within the rice fields, including broken neck disease (*Pyricularia oryzae*), stem rot (*Rhizoctonia solani*), and leaf spot (*Helmintosporium* sp). The results indicate that the YST trap captured the highest number of individuals and exhibited the greatest insect diversity, with 479 individuals representing 47 species. This was followed by the LT trap, which collected 288 individuals from 14 species, and the SN trap, which caught 236 individuals from 36 species. In contrast, the lowest numbers were obtained from the CPT tool, with 66 individuals from 14 species, and the Core Sampler, which yielded 233 individuals from 22 species.

Additionally, six pest types dominated the observations, consisting of *Chironomus* sp (421 individuals), followed by *Anopheles* sp (129 individuals), *Tetragnatha* sp (94 individuals), *Leptocorisa oratorius* (73 individuals), *Chilo suppressalis* (42 individuals), and *Nilaparvata lugens* (39 individuals). The research findings highlight that the various trap types used yielded varying results in terms of the number of insects collected. CPT captured the fewest insects, specifically 68 individuals, followed by the utilization of CS traps (235 individuals), SN traps (236 individuals), LT traps (288 individuals), and the highest counts were obtained from YST traps (488 individuals), predominantly represented by five species, namely *Chironomus* sp, *Anopheles* sp, *Tetragnatha* sp, *Leptocorisa oratorius*, and *Chilo suppressalis*, while the smallest species identified included *Euscyrtus concinnus, Hesperia* sp, *Gryllotalpha orientalis*, *Panstenon* sp, *Temelucha philippmensis,* and *Thomisius* sp.

The CPT is typically more convenient for capturing insects from the Hymenoptera Order. According to Mukundan [12], it was corroborated by a study which notes that the prevalence of Hymenoptera parasitoids varies with each trap type, with certain insects frequently being detected in CPT traps. In line with the findings mentioned earlier, the utilization of YST traps significantly influenced insect collections (479 individuals). According to Shimoda & Honda [13], the selection of the color yellow in YST is advantageous for attracting insects, as many insects are drawn to bright colors, including yellow trap.

Based on the identification results, there is an Order Diptera with 5 families and 7 species which constitute the Chironomidae family (160 individuals). Which states that the damage caused by the Diptera order is by sucking the flow of food on the leaves and midribs.

In addition, this study involved the capture of insects like *Tetragnatha* sp, *Leptocorisa oratorius, Atherigonia exigua, Chironomus* sp, and *Anopheles* sp using nets, specifically in the SN. This tool is proficient at capturing a wide array of insects, whether they are harmful insect pests or beneficial predators that target rice crops. According to Mulyadi's [14] opinion, the aligns with existing literature, which underscores that the Sweep Net (SN) is a physical tool suitable for trapping a broad spectrum of insects, encompassing both pests and predators.

Additionally, when employing the Core Sampler (CS), multiple insect pests are captured, primarily consisting of insect larvae that thrive in aquatic environments, such as those belonging to the Diptera Order. According to Ikemoto [15], a physical insect-catching device created from a basic paint can submerge in water, which tends to predominantly attract insects whose life cycle is associated with aquatic habitats. Accordance to Parlindungan and Siregat [16], the LT is another tool utilized for trapping insects, and it operates by utilizing light. This device proves to be quite effective in luring pest insects that are drawn to light, especially during nighttime hours, and it has proven to be particularly attractive to nocturnal insects.

Furthermore, based on insect status, several main predators and parasitoids were detected in rice fields, such as *Agriocnemis femina, Ischnura senegalensis, Orthetrum sabina, Pantala flavescens, Paederus* sp, *Ophionea* sp, *Conocephalus* sp, *Spheidea* sp, *Ichneumonidea* sp, *Tachnidea* sp which are explained in Table 4.

Table 4. Description of insects based on status in rice fields

Species Name	Information
Agriocnemis femina (Coenagrionidae, Odonata)	Its body shape is slender and has a stomach resembling a stick consisting of nine segments. The first, second, third, eighth and ninth abdominal segments are light blue. This insect has large facets. The back chest appears light blue. The limbs have feathers resembling spines, the legs are generally brownish yellow while the thigh bones are blackish brown (Figure 5). These characteristics, according to Yudiawati [17], mean that this insect belongs to the order Odonata and the family Coenagrionidae. According to Siregar [11], this insect has a length of 30 mm. The broad wings have complex venation. The life span ranges from 10-30 days and the number of eggs produced by a female are 30. Immature insects live in water and prey on small freshwater insects; while adult insects prey on small flies and mites [18].
Ischnura senegalensis (Coenagrionidae, Odonata)	*Ischnura senegalensis*is a dragonfly belonging to the Coenagrionidae family. Its habitat is in the highlands and lowlands and is usually found in open ditches, waterways, ponds, swamps and lakes. Can live in various types of habitats, both in flowing and stagnant waters. I. senegalensis has high adaptability so it can live and be found in large numbers in various types of habitats. Active from morning to afternoon by flying around aquatic plants. This dragonfly is sensitive to external disturbances so it is quite difficult to approach. I. senegalensis breeds in swamps, grass ponds and wetlands.
Orthetrum sabina (Libellulidae, Odonata)	The compound eyes are dark brown above, light green below; chest lateral stripes 6 black, light green, hair white, smooth, small; abdominal segments 1-3 rounded, segments 4-6 slender, segments 7-10 wide, segments 1-3 yellowish green, black line, segments 4-6 sideways with alternating white spots; off-white frills; wings transparent, venation black, pterostigma brown, base of back brownish yellow; short tail, white; the limbs are brownish black. Morphometry. ps 53mm x l. 80mm; chest ps 17 mm; belly 30 mm; front wing 38 mm x 9 mm, rear wing 35 mm x 11 mm. Color Pattern. Body green with black stripes; chest light green, black side stripes; pterostigma brown.

Table 4. Continued

Pantala favescens (Odonata: Libellulidae)	The morphological characteristics of the abdomen are yellowish brown or reddish orange, on the dorsal side of segments 4-10 there are black spots that widen and thicken at segments 8-9, the frills are black with a yellow base; Males with body length 42-46 mm, forewings 40-41 mm, hind wings 38-39 mm; Female with body length 50.5-53 mm, forewings 42-44.7 mm, hind wings 39-42.7 mm; The hind wings are wide, transparent with brown venation and the stigma is orange-brown, a dark brown spot at the tip of the wing outside the position of the stigma, at the base of the hind wings a small white mark near the yellow pattern towards the anus. Pantala flavescens is an ordinary dragonfly belonging to the Libellulidae family with a medium body size, also known as the twin dragonfly. This type of dragonfly has a strong flying ability, supported by the morphology of its wide hind wings. It is often found flying in groups in wide open areas. At the time of observation, it was observed that it started to perch to rest around noon in bright conditions. This dragonfly is found in almost all locations, namely in reservoir areas, incoming rivers, swamps, outgoing rivers, and rice fields.
Paederus sp.	The black head has rather large compound eyes. The antenna consists of 11 segments, 3 segments at the base are light brown and the other segments are colored. On each antenna segment there are fine hairs that resemble spines. The prothorax is brown while the meso and methatorax are black. The short elytra are black and wavy, the abdomen is elongated and wavy, the legs are black, while the vemur is brown at the base. Tarsi formula 4-4-4. This predator belongs to Phyllum Arthropoda, sub-pyllum Mandibulata, Class Insecta, Sub Pterygota, Order Coleoptera, Family Staphylinidae and Genus Paederus [Orr, 19].
*Ophionea s*p.	The slightly elongated body is brown, the head is black, the prothorax is elongated, while the meso and mesa are large. The elytra at the base and middle of the elytra are black. The antenna consists of 11 segments, 3 segments at the base are brown while the rest are black. The elytra are shorter than the hind wings so they appear to cover the entire abdomen. The middle of the elytra is brown while the base and most of the tips are black. The legs are rather long and blackish brown. Tarsus formula 4-4-4 These characteristics are as stated by Siregar [20] that body shapeThe shape of Ophionea sp is slightly elongated. Chocolate. reddish, head and thorax black, center of elytra black. The types of prey are brown planthoppers, green planthoppers, white pests, zig-zag planthoppers, white-backed planthoppers, caterpillars, sponge caterpillars and rice stem borers. found at the base of the stem or in soil without water. This predator is 8 mm long. The body is shiny, the skin is smooth, and the head and middle of the stomach are bluish black. The life cycle is 15 days and the number of eggs produced by a female is 45. 6. Conocephalus sp. The body is brownish yellow, the wings are blackish green and 16 long. The filiform antennae are longer than the size of the body; the hind legs are brownish yellow, the size is more reddish, the head and part of the chest are black, and the middle part. The head and stomach in the middle of the life cycle are black and blue for 15 days and the number of eggs produced by a female is 45.
Conocephalus sp.	Its body is brownish yellow, its wings are blackish green, and its length is 16-22. The antennae are filiform, exceeding the size of the body; The hind legs are brownish yellow and are larger and longer than the front and middle legs, the hind thigh bones are wider at the base while the tibia is long and has black spines. Tarsi formula 3-3-3. Conocephalus sp is a type of small grasshopper that acts as a predator. Its life activity as a predator mainly preys on small insects such as pests in its habitat. This group of insects is very active in the morning, they are predators of stem borer eggs and predators of brown planthoppers, green leafhoppers, zig leafhoppers and white-backed planthoppers. They have a brownish green body with a length of between 25-32 mm and have antennae that are 2-3 times as long. As their body. Its habitat is on the leaves or panicles of rice plants. The life span of this predator is 110 days and the female lays 15-30 eggs per female.
Spheidea sp.	Its body is blackish brown and measures 15. The front wings are larger than the hind wings and are brownish yellow. On the dorsal pronotum, the posterior border is straight and narrowed. In the first segment the stomach becomes smaller. The legs are blackish brown; The tibia is brownish yellow. Called brown planthopper, green planthopper, zig-zag planthopper, and white-backed planthopper. The predator's body is green and long. Predatory insects that attack the nymphs of Grylotalpa sp., aphids, ladybugs and several other species attack the larvae of the order Lepidoptera. The larvae are stung or paralyzed and then taken to the nest as food for the next generation.
Ichneumonidea sp.	Slender waist parasitoid, this insect is an insect that usually parasitizes other insects and several other invertebrate animals. By using its long ovipositor, this insect family can find out the location of its host larva even though the host larva is in plant tissue. Adult female Ichneumonidae usually lay eggs in one host or alone. Hair-like antennae with 16 segments, ovipositor measuring up to 15 mm, color and shape vary. This insect family is one of the parasitic insects on various types of pests such as rice stem borers, leaf rollers, caterpillars, and caterpillars.

Table 4. Continued

Tachinidea sp.	The Tachinidae family is a parasitic fly that provides biocontrol. Tachinid larvae are immature beetles, sawflies, earwigs, grasshoppers, butterflies, and moths. Adults are 3 and 14 mm (<1/2 inch), hairy, dark, strong, resemble houseflies, and hairs at the tip of the abdomen. The eggs produced vary greatly. Eggs are laid on leaves near the host insect, larvae will grow after hatching. The adults attach the eggs. Female tachnids have an ovipositor that pierces and inserts their eggs into the host's body. Tachinid larvae feed on their hosts and emerge from their hosts' bodies to become pupae. Pupae are generally dark brown and reddish in color.

Physical conducted on the rice cultivation site encompass the evaluation of temperature, humidity, pH levels, wind velocity, and precipitation, as outlined in Table 5.

Table 5. Measurement of physical environmental factors

Parameter	1	2	3	4	5	6
Temperature (℃)	30.3	29.5	30.3	30.3	31.3	30.8
Humidity (%)	62	63	62%	64%	63	62%
pH (ppm)	6,8	6,7	6,8	6,8	6.6	6,7
Wind velocity	15	18	17	19	17	15
Rainfall (mm/Hg)	0.5	0.7	0.9	0.7	0.6	0.8

Next, the biological index calculation is carried out by considering both the quantity and the species of insects captured, the value of the Margalef species richness index (R1), diversity index, Shannon-Weiner (H), evenness index (E), and Dominance index (D) in Table 6 below.

Table 6. Calculation of biological indices

Parameter	CS	CPT	YST	SN	LT
Richness (R1)	2.70	2.86	3.25	3.10	2.79
Evenness (E)	0.54	0.60	0.73	0.78	0.58
Diversity (H')	2.02	2.32	2.45	2.38	2.08
Dominance (D)	0.65	0.65	0.84	0.75	0.60

The species richness index is employed to ascertain the diversity of species within a community. This particular richness index is significantly affected by the individual count. From the Richness Index table, a value of 2.70 was obtained using the CS (*Core Sampler*) trap, 2.86 using the CPT (*Colour Pan Trap*), 3.25 using the YST (*Yellow Sticky Trap*) trap, 3.10 using the SN (*Sweep Net*) trap, and 2.79 for LT (*Light Trap*). This value shows that insect richness in the areas of several rice pest sampling plots is in the medium category. In accordance with the opinion of Parlindungan & Siregar [16] which states that if the R1 index is larger It's a clear signal that the diversity index will also be elevated. The species richness index generally tends to be higher in such cases. in communities with a greater number of species compared to those with fewer species. Consequently, a higher number of identified species corresponds to a greater species richness.

Then, from the evenness index data, the results obtained from using the five tools showed that the evenness index with the distribution of insect species in the region remained consistent. (E=0.54-0.78). This is supported by research of Yudiawati [17] & Tika et al., [18] which states that Inp Sungai Pinang Village, the evenness index of insects indicates a balanced distribution, signifying that insects are prevalent throughout the area. The evenness index ranges from 0 to 1, and this value is a useful metric for identifying dominant canopy-dwelling insects within a community. When a canopy-dwelling insect community exhibits an even distribution, it suggests the absence of any dominant canopy-dwelling insects within that community. However, if one specific type of canopy-dwelling insect dominates the community, the evenness index will reflect this.

Furthermore, the diversity index table obtained shows relatively moderate values (H'=2.02-2.45). The diversity index of canopy-dwelling insects holds significant importance in conveying the extent of species diversity within a community. It's closely linked to how evenly individuals are distributed among various species. Meanwhile, the dominance index was computed for insects within the medium range (D=0.65-0.84). This aligns with prior research by Maesyaroh & Jajang [19], where a low dominance index value suggests the absence of dominant individuals within the community, while a high dominance index value indicates the opposite. Consequently, we can express that the value of the dominance index for canopy-dwelling insects falls within the moderate range.

The findings of the study conducted in Serbajadi Village, Sunggal Regency, North Sumatera, have revealed that the use of agrochemical inputs, particularly pesticides and fertilizers, has led to adverse environmental and social consequences. As indicated by the research outcomes of Falahuddin [20], & Siregar, et al., [21], monitoring deceased rice insects and employing the CPT for insect collection can potentially mitigate the need for pesticides and serve as a method to assess the environmental quality in agricultural systems.

Furthermore, the rice fields are depicted in Figure 5 below. The location of the rice fields is in Serbajadi Village, Sunggal District, North Sumatera and the variety planted is the Inpari rice variety (Figure 6). Meanwhile, Figure 7 illustrates the use of CPT traps, while insects trapped in YST traps are shown in Figure 8, then Figure 9 describes the use of broom nets to catch pests in rice fields. Figure 10 shows the Core Sampler and transparent trap device. Meanwhile, Figure 11 shows the CS and LT.

Figure 5. Rice fields in Serbajadi Village

Figure 6. Research location in Serbajadi Village

Figure 7. *Color Pan Trap* (CPT) for controlling rice pests

Figure 8. Insects trapped with *Yellow Sticky Trap* (YST)

Figure 9. Use of *Sweep Nets* (SN) to catch pests in rice fields

Figure 10. *Core Sampler* and collected into plastic

Figure 11. Colour Pan Trap (CPT) and Light Trap (LT) traps.

The outcomes of the research carried out in Serbajadi Village, Sunggal District, North Sumatera, have shown that the application of agrochemical inputs, particularly pesticides and fertilizers, has resulted in adverse environmental and social effects. According to Siregar et.al., [21] and Orr [22] the findings, monitoring rice plant insects prior to planting and utilizing the CPT for insect collection can be a means to decrease pesticide usage and assess the environmental quality in the agricultural system.

Table 7 shows the dominant pest types that attack rice plants in Serbajadi Village, Sunggal District, consisting of *Cnaphalacrocis medinalis, Nymphula depunctualis, Nilaparvata lugens, Sogatella furcipoera, Scotinophara coarctata, Nephotettix virescens, Laptocorisa acuta,* and *Oxya chinensis.*

Table 7. Dominant pest types in Sei Beras Kata Village.

Order /Family	Species	Average pest population (tail)	Average pest population (heads/10 clumps	Average pest population (head)
Lepidoptera/ Crambidae	*Cnaphalocrocis medinalis*	0.14	0.16	0.03
Lepidoptera/ Crambidae	*Nymphula depunctalis*	0.16	0.19	0.1
Hemiptera/ Delphacidae	*Nilapavarta lugens*	0.35	0.37	0.23
Hemiptera/ Delphacidae	*Sogatella furcifera*	0.09	0.20	0.21
Hemiptera/ Delphacidae	*Scotinophara coarctata*	0.21	0.052	0
Hemiptera/ Cicadellidae	*Nephotettix virescens*	0	0.047	0
Hemiptera/Alydidae	*Acute leptocorrhea*	0.0	0.04	0
Orthoptera/ Acrididae	*Oxya chinensis*	0.03	0.03	0.02

Furthermore, from the insect collection carried out around the forest near the rice plants which status function of an insect inventory was carried out as shown in Table 8.

Table 8. The status and function of insects

Status function of insects	Order	Families
Herbivore	Homoptera Hemiptera Diptera Lepidoptera Coleoptera Orthoptera Psocoptera Thysanoptera	Delphacidae, Aphididae, Cicadellidae, Psyllidae Alydidae, Lygaeidae, Miridae, Pentatomidae, Tingidae Chironomidae, Chloropidae, Cecidomyiidae, Tephritidae Pyralidae, Noctuidae, Tortricidae, Notodontidae Chrysomelidae, Curculionidae, Scolytidae Gryllidae, Tettigonidae Amphipsocidae, Elipsocidae Phalaeothripidae, Thripidae
Parasitoids	Diptera Hymenoptera	Pipunculidae Eulophidae, Scelionidae, Mymaridae, Pteromalidae, Encyrtidae, Aphelinidae, Eupelmidae, Diapriidae, Tetracampidae, Braconidae Ichneumonidae, Chalcididae
Predator	Hemiptera Coleoptera Odonata Hymenoptera Dermaptera Diptera Neuroptera	Corixidae, Gerridae, Nepidae, Reduviidae Carabidae, Staphylinidae, Cicindellidae, Coenagrionidae Formicidae Carcinophoridae Coccinellidae Syrphidae, Ceratopogonidae, Dolichopodidae Chrysopidae
Destroyer	Blattaria Coleoptera Dermaptera Diptera Isoptera	Blattidae, Blattellidae Leiodidae, Scarabaeidae, Ptiliidae, Tenebrionidae Forficulidae Scathophagidae, Scatopsidae, Sphaeroceridae Termite
Other insects	Ephemeroptera Trichoptera Diptera	Baetidae, Caenidae, Oligoneuriidae Glossosomatidae, Brachycentridae, Helicopsychidae Tipulidae, Sciaridae, Stratiomyidae

Meanwhile, based on the rice planting location, 23 types of predators were detected consisting of: *A. femina, A. pygmaea, Atractomorpha lata, Coccinela septempunctata, Componatus* sp., *Crocothemis servilea, Diplocoides trivialis, Formocarfatus* sp., *Hydrophilus* sp., *Hydrobius* sp., *Leptispa* sp., *Ischnura senegalensis, Lycosa* sp., *Neurothemis terminata, N. ramburii, N.tullia, Pantala flavescens*, *Orthetrum sabina, Paederus* sp., *Pseudagrion rubriceps, Tetagrantha* sp., *Tholymis aurora, T. Tillarga*); 2 types of parasites (*Culex* sp., *Anisop* sp.), 11 categories of pests (*Atterigon* sp., *Cnaphalocrocis medinalis, Hydrellia* sp., *Leptocorisa orotarius, Nephotettix* sp., *Pomacea* sp., *Nilaparvata lugens, S.inonata, S.incertulas, Nephotettix sp Orseolia oryzae*), *Pelopide* sp., 2 types of parasitoids (*Tabanus* sp., *Aphis* sp.) and 2 types with undetectable status, namely: *Stanicophora* sp., *Battilaria* sp.).

4. Conclusions

The use of multiple traps showed differences in the composition of insect taxa and the proportion of taxa abundance. The order most commonly found in the rice field habitats is the group of flying insect taxa that are often found in vegetation (Hymenoptera and Diptera). Meanwhile, there are more mixed groups of flying insect taxa on vegetation and ground surface arthropods (Araneae and Diptera).

The study's results indicated that YST trap captured the highest number of individuals and the greatest diversity of insect species. The LT trap and SN trap collected the medium insects. In contrast, the CPT recorded the lowest count of identified individuals. Furthermore, the overall population is mainly comprised of six pest species, with *Chironomus* sp., *Anopheles* sp., *Tetragnatha* sp., *Leptocorisa oratorius*, *Chilo suppressalis,* and *Nilaparvata lugens.* Conversely, the smallest six species include *Euscyrtus concinnus, Hesperia* sp., *Gryllotalpha orientalis*, *Panstenon* sp., *Temelucha philippmensis,* and *Thomisius* sp.

The main predators identified are *Agriocnemis femina, Ischnura senegalensis, Orthetrum sabina, Pantala flavescens, Paederus* sp., *Ophionea* sp., *Conocephalus* sp., *Spheidea* sp., while *Ichneumonida* sp., *Tachnida* sp. act as parasitoids in rice cultivation. The calculation of the Biological index consists of the Richness index, the Evenness index, the diversity index and the Dominance index.

Based on the proportion distribution of abundance of each functional role in each habitat, a tendency was obtained for the proportion of abundance of roles with high evenness in the rice field habitat, supporting agrobiodiversity in the Serbajadi agroecosystem area which is proven to tend to be evenly distributed in the proportion of taxa and the proportion of functional roles in the habitat.

5. Suggestions

The existence of agrobiodiversity management by enriching plant species that have the potential to act as host plants and forage plants/nectar sources, is able to support high species richness, individual abundance, and the level of diversity of pollinators and other beneficial insects.

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