The existence of pests and its natural enemies on various embankment plants in the rice field ecosystem

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Abstract. The stability of the rice field ecosystem is not only determined by the diversity of community structures but also by the characteristics and interactions of the components. This study aims to determine the diversity of insect pests and its natural enemies in the rice field ecosystem in Marannu village, Mattirobulu district, Pinrang regency, South Sulawesi Province, from July to October 2020. The types of embankment plants were treated, namely cucumbers (Cucumis sativus), corn (Zea mays), long beans (Vigna unguicula) and zinnia flowers (Zinnia elegans). Sampling using an insect net and a pit-fall trap is then put into a plastic tick and identified. The results showed that there were three parasitoid species from the same order and ten predatory species from six different orders. The dominant parasitoid species was Trichogramma sp., while the largest predator was Lasius niger. In addition, 18 species of pests from six orders were found.

1. Introduction
One of the main foods of Indonesian society is rice (oryza sativa). Along with the increase in population every year, the amount of food needed also demand increases. The government, which has been aggressively seeking to increase post-harvest yields, has yielded significant results in recent years. This can be seen from the amount of rice production from year to year which has increased. From 2015 to 2016 the increase in crop yields was very significant due to the cooperation between the community and the government. To increase the yield of rice production is to develop good and sustainable cultivation techniques, as well as innovation in control and maintenance of cultivation and the natural environment.

In theory, the rice field ecosystem is unstable. The diversity of community structures is not only the basis for the stability of the rice field ecosystem but also must be viewed from the characteristics of several components and the interactions between ecosystem components. The results of the research on the diversity of ecosystems show that no less than 700 insects including parasitoids and predators were found in the rice field habitat in the absence of pests. According to [1], ecosystem stability can be maintained if the interaction between components is managed properly. Thus, it is hoped that the agricultural ecosystem can create a stable condition, and the concept of pest control that is applied can run well so that chemical pesticides are the last alternative and their use is very selective. In rice fields, natural enemies are clearly functioning so that ecosystem and biological balance is created.
From the perspective of agribusiness, insects are generally divided into several groups into insect pests, useful insects and neutral insects. Useful insects fight as natural enemies of both predators and parasitoids, pollinating insects and as decomposers. Meanwhile, neutral insects usually fall prey to predators, so they have a very big battle in maintaining the balance of the rice field ecosystem. However, most farmers in the field view insects as pests and must be controlled. In fact, the diversity of insect species plays an important role in the rice field ecosystem [2].

The quantity and quality produced by farming are strongly influenced by the biodiversity of insects. In the natural ecosystem, there is a stability between the population of pests and natural enemies so that the presence of insect pests on plants is not harmful. This fact should be developed so that it can reduce the amount of pesticide use to control pest attacks, especially in types of plants that have high value or export value [2].

The refugia cropping system can increase the diversity of natural enemies in the rice field ecosystem. Refugia is vegetation for predators and parasitoids to breed which is planted around cultivated plants. Refugia has a function as a plant that repels pests and attracts natural enemies, traps pests and reproduces in the area. In addition, refugia can serve as a temporary shelter for predators and parasitoids, providing alternative hosts and nectar for parasitoid imago when the environment is not suitable and benefits the biotic interactions of the ecosystem [3]. The negative impact caused by the use of pesticides requires reducing the use of synthetic chemical pesticides and implementing Integrated Pest Management (IPM) by utilizing biological agents [4]. Providers of biological agents can take advantage of a variety of refugia plants such as paper flowers (Zinnia Lugenensis), long beans (Vignia Sinensis), cucumbers (Cucumis sativus) and maize (Zea mays) as natural habitats for these biological agents. Based on the description above, this research will be abundance to determine the abundance of natural enemies and pests in different refugia plants found in the rice field ecosystem.

2. Materials and methods
This research was conducted in Punia Hamlet, Marannu Village, Mattirobulu Sub-District, Pinrang District, South Sulawesi Province in July to dry growing season 2020. The land used is 79 m x 60 m square, divided by nine rice fields. Then made bunds 50 cm x 30 cm. Previously, the land was cleared of stones, weeds, straw remains and plant roots by tilling the land using a tractor. In this study, four types of riparian plants were used as treatments (figure 1), namely: Treatment 1 = Corn and Zinnia Flowers (MZF), Treatment 2 = Long Soybean and Zinnia Flowers (LBZF), Treatment 3 = Cucumbers and Zinnia Flowers (CZF), Treatment 4 = Control.

![Figure 1. Research plan.](image-url)
2.1. Direct observation
Direct observation can be done by looking at insects in the refugia plant or using a camera. The insects that are caught and trapped are then put in a plastic tick that already contains detergent that has been thawed.

2.2. Indirect observation
Indirect sampling of insects using swing nets with a diameter of 40 cm, carried out in the morning using the zigzag method for three to five swings then put into a plastic tick containing detergent that has been melted using water. Pit fall traps are modified using plastic containers measuring 10oz then given detergent that has been melted using water. Traps are used for insects that are active during the day and at night that live above ground. Installation of this tool is done at 07.00 in the morning and left for 24 hours. Sampling using pitfall traps that are installed three vertically and horizontally on each dike lane with an interval of seven days (figure 2) Each treatment uses six traps with a distance of 5 meters and 3 meters respectively [5]

![Figure 2. Observation layout.](image)

2.3. Diversity index
To compare the high and low diversity of insect species, namely the diversity of insect pests and natural enemies, the Shannon Weiner index (H) is used with the equation:

\[ H' = - \sum_{i=1}^{s} P_i \ln P_i \]  

Information:
H ‘= Shannon-Wiener Diversity Index
P_i = ni / N
P_i = number of individuals of a species / total number of all species
ni = number of individuals of the ith species
N = total number of individuals

The total measure of the Shannon-Wiener diversity index as listed in table 1.
### Tabel 1. Diversity index measurement value.

| Benchmark values | Information                                                                 |
|------------------|-----------------------------------------------------------------------------|
| $H' < 1.0$       | Low diversity, poor, very low productivity as an indication of heavy pressure and a stable ecosystem |
| $1.0 < H' < 3.3$ | Moderate diversity, sufficient productivity, fairly balanced ecosystem conditions, moderate ecological pressure |
| $H' > 3.3$       | High diversity, stable ecosystem stability, high productivity, resistance to ecological stresses. |

3. Results and discussion

3.1. Quantity and types of insects caught

Based on the results of observations made in paddy fields, 5211 arthropods were found which can be classified based on the type of order and the species can be seen in table 2.

| Ordo             | Spesies                        | Quantity |
|------------------|-------------------------------|----------|
| Coleoptera       | Paederus littoralis           | 280      |
|                  | Carabus                       | 120      |
|                  | Coccinella                    | 441      |
|                  | Aulacophora Femorali          | 90       |
|                  | Sitophilus Oryzae             | 6        |
|                  | Cerambicidae                  | 162      |
| Lepidoptera      | scirrophaga innotata          | 58       |
|                  | S. liruta                     | 70       |
|                  | Agritis ipsilon               | 21       |
|                  | O. Furncalis                  | 12       |
|                  | L. indica                     | 50       |
| Heminoptera      | Tricogramma                   | 185      |
|                  | Lasius niger                  | 1353     |
|                  | Selenopsis invicta            | 784      |
|                  | Telenomus rowani              | 39       |
|                  | Tetrastichus schoenobi        | 21       |
|                  | Megadominidae                 | 0        |
| Diptera          | Aedes                         | 59       |
|                  | Batrocera dorsalis            | 9        |
|                  | Musca dometisca               | 2        |
|                  | Dacus cucurbitae Coq          | 48       |
|                  | siphanta acuta                | 62       |
|                  | Palomena Prasina              | 2        |
|                  | N. lugens                     | 65       |
|                  | Leptocorisa oratirius         | 73       |
| Hemyptera        | Aphis fabae                   | 95       |
|                  | Riptortus linearis            | 54       |
|                  | aphids gosypii                | 168      |
| Ortoptera        | Grylluss Asimili              | 9        |
|                  | Gryllotalpidae                |          |
| Odonata          | Ischnura senegalensis         | 100      |
| Araneae          | Chryso scintillans            | 771      |
The types of insects found in the paddy fields were mostly found in the order hemiptera with a total of 2382 which are divided into six species, all of which are fighting as natural enemies and the least in the Odonata order which only consists of 100 consisting of only one species and also at war as a natural enemy or predator. this is caused by several natural factors that can lead to the growth of natural enemy population. This is in accordance with the statement [6] which states that nectar as a source of energy for parasitoids and predators can be obtained from various types of refugia plants, both cultivated and wild. The various colors of flower petals can attract the attention of natural enemy arthropods.

3.2. Classification of insect function status
Of the total insects found in the experiments carried out on the bund can be classified as follows in table 3.

| Table 3. Classifications of insect function predators, parasitoids, pests and neutral insects |
|---|---|---|---|---|
| Ordo | Species | Status as an insect |
| | | Predator | Parasitoid | Pest | Neutral |
| Coleoptera | *Paederus littoralis* | | √ | | |
| | *Carabus* | | √ | | |
| | *Coccinella* | | √ | | |
| | *Aulacophora femoralis* | | | | √ |
| | *Sitophilus oryzae* | | | | √ |
| | *Cerambycidae* | | | | √ |
| Lepidoptera | *Scirpophaga innotata* | | | √ |
| | *S. litura* | | | √ |
| | *Agrotis ipsilon* | | | √ |
| | *O. furnecalis* | | | √ |
| | *L. indicata* | | | √ |
| Hymenoptera | *Tricogramma* | | | | √ |
| | *Lasius niger* | | | √ |
| | *Selenopsis invicta* | | | √ |
| | *Telenomus rowani* | | | | √ |
| | *Tetrastichus schoenobii* | | | | √ |
| | *Meganomiidae* | | | | √ |
| Diptera | *Aedes* | | | | √ |
| | *Batrocera dorsalis* | | | | √ |
| | *Musca domestica* | | | | √ |
| | *Dacus cucurbitae Coq* | | | | √ |
| Hemiptera | *Nephotettix virescens* | | | | √ |
| | *Palomena prasina* | | | | √ |
| | *N. lugens* | | | | √ |
| | *Leptocorisa oratirius* | | | | √ |
| | *Aphis fabae* | | | | √ |
| | *Riptortus linearis* | | | | √ |
| | *Aphids gosypii* | | | | √ |
| Orthoptera | *Gryllus asimili* | | | | √ |
| | *Gryllotalpidae* | | | | √ |
| Odonata | *Ischnura senegalensis* | | | | √ |
| Araneae | *Chryso scintillans* | | | | √ |
Three parasitoid species from the same order and ten predatory species from six different orders were found. The dominant type of parasitoid is *Trichogramma* sp., while the largest predator is *Lasius niger*. In addition, eighteen pest species from six different orders were found.

Most insects that appear in the embankment area are insects with a pest status, this is due to the monoculture cropping system in the main rice fields causing the number of pests to increase. This is explained by [7] which states that in a limited natural ecosystem, insects and natural enemies play an active role as environmental barriers, resulting in low insect populations. We recommend that in the rice field ecosystem, especially in monoculture plantations, insect food is relatively unlimited so that the population increases quickly and is not balanced by its natural enemies so that it can cause economic losses.

3.3. Diversity index
The average value of the H 'diversity index for arthropod species in the treatment of fly nets, pit fall traps and direct observation can be seen in figure 2.

![Figure 3. Mean Shannon-Wiener diversity index.](image)

The highest number of arthropod diversity indexes was found in zinnia and long bean stalks with an average number of 2.11 and zinnia flowers and the least in the control treatment of 1.96. In the treatment of zinnia and corn flowers, the average number obtained was 2.00 and zinnia and cucumber flowers were 1.97, which was almost not much different from the control treatment.

Diversity index values ranged from 1-3, thus indicating moderate diversity values and fairly balanced ecosystem conditions. Up to high (figure 3), this shows the high stability of the agro-ecosystem environment so that the interactions between species that occur tend to be high. High species diversity is one indicator of the stability of a growth environment.

Flowering plants in addition to providing shelter for natural enemies, this indicates that flowering plants contain nectar and pollen as a food source [8] stated that plants are a direct source of food for natural enemy organisms by providing nectar and pollen and indirectly providing prey and hosts for natural enemies.

Physiological and morphological characters of flowers that attract insects, both in shape, color, size or aroma released during the vegetative and generative periods of flowering plants and the content of nectar and pollen produced from these flowers. The existence of flowering plants is very important in preserving natural enemy populations in an agricultural ecosystem [9].

4. Conclusion
The number of insects found was 5,211 from three parasitoid species, with the same order and ten predatory species from six different orders. The dominant type of parasitoid is *Trichogramma* sp. Most predatory species is *Lasius niger*. In addition, 18 species of pests from six different orders were found. The highest arthropod diversity index was found in zinnia and long bean stalks with an average number of 2.11, then zinna and the least in the control treatment with an average of 1.96. This shows that the level of diversity is moderate, where the presence of pests and natural enemies is in balance.
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