ARTHROPODA DIVERSITY IN PADDY FIELD WITH REFUGIA PLANTS

line 1: 1st Hasriyanty
line 2: *agriculture faculty*
line 3: *tadulako university)*
line 4: central Sulawesi
line 5: hasriyanty.amran@gmail.com

line 1: 2nd Mohammad yunus
line 2: *agriculture faculty*
line 3: *tadulako university)*
line 4: central Sulawesi
line 5: mohyunus125@gmail.com

line 1: 3rd Rosmini
line 2: *agriculture faculty*
line 3: *tadulako university)*
line 4: central Sulawesi
line 5: rosmini.ismal@gmail.com

line 1: 4rd Adelia
line 2: *agriculture faculty*
line 3: *tadulako university)*
line 4: central Sulawesi
line 5: adeliajhutek06@gmail.com

line 1: 3rd Suriani
line 2: *agriculture faculty*
line 3: *tadulako university)*
line 4: central Sulawesi
line 5: surisuriani008@gmail.com

Refugia is a place or area that is overgrown by several types of flowering plants planted around agricultural land areas that can provide shelter, food sources or other resources for natural enemies such as predators and parasitoids so that refugia is expected to reduce rice pest populations and increase the number of natural enemies. This study aims to determine the diversity and abundance of insect pests and natural enemies in rice with refugia plant treatment. The refugia used were Cosmos caudatus and Tagetes erecta. The research consisted of field research conducted on rice plantations in Sigi regency, Central Sulawesi, Indonesia, and laboratory research at the Plant Pests and Diseases Laboratory, Faculty of Agriculture, Tadulako University. Sampling was conducted using yellow pan trap, sweep net and direct observation on 3 plots of rice plants, namely plots with C. caudatus refugia, plots with T. erecta refugia and plots without refugia. The results showed that the diversity of arthropods found in the study about 79 species belonging to 9 orders, 43 families and from 2 major groups namely Arachnids and Insecta with a total of 1,464 individuals. Refugia increases the diversity of natural enemies and reduces the population of insect pests **(***Abstract***)**

refugia, diversity, pests, arthropods ***(****key words****)***

INTRODUCTION

Rice cultivation is generally carried out with a monoculture cropping system, but this system makes rice plants very vulnerable to attacks by plant pest organisms. Monoculture planting also cause limited other living things including arthropods to be able to live and develop, even though the existence of arthropods is important because it maintains the balance of the ecosystem [1], especially because arthropods play many roles as providers of ecosystem services such as pollinators, predators and parasitoids [2].

To increase the number and species of arthropods in rice fields, habitat manipulation can be done by planting various other plants around rice fields called refugia [3]. Refugia is defined as a microhabitat that provides spatial and/or temporal shelter for natural enemies of pests, such as predators and parasitoids, and supports biotic interaction components in the ecosystem, such as pollinators or pollinating insects [4].

Refugia can be in the form of flowering plants, food plants or weeds (Thei, 2022). Refugia can be a shelter and a place to find food and various other resources for arthropods so as to increase diversity including increasing natural enemies such as predators and parasitoids [5] so that it is expected to reduce rice pest populations and increase production. The results of research [6] that with refugia treatment around the rice plant area can increase rice production var Ciherang and IR42 increased by 15.1%, and reduce stem borer pest attacks [3].

A wide variety of flowering plants, including flowering food crops, plants that only flower or flowering plants from weeds can become refugia plants if planted in cultivated crop areas, as well as broadleaf weeds, and wild plants (Thei, 2022). The function of this refugia plant is to attract various natural enemies of predators and parasitoids to come looking for food, because of the abundance of nectar and pollen from flowers [7]. The attraction of natural enemies is because flowering plants have attractive colors, with shapes, sizes, aromas that are preferred by natural enemies [3].

Some examples of flowering plants that are often used as refugia include sunflowers (Helianthus annuus), marigold flowers (Tagetes erecta), zinnia paper flowers (Zinnia elegans), water henna flowers (Impatiens balsamina Linn), kenikir flowers (Cosmos caudatus) (Thei, 2022). In addition, refugia plants are also food crops such as corn and long beans [8], even weeds and wild plants such as Cromolaena odorata, Mimosa pudica, Brachiaria and Panicum repens can also act as refugia [5].

N. Edy et al. (eds.), *Proceedings of the 2nd International Interdisciplinary Conference on Environmental Sciences and Sustainable Developments 2022 Environment and Sustainable Development (IICESSD-ESD 2022)*, Advances in Biological Sciences Research 36,
https://doi.org/10.2991/978-94-6463-334-4_7

Two types of flowering plants that are often used as refugia are Cosmos caudatus and Tagetes erecta. These two types of plants have different flower colors. C. caudatus is bright yellow while T. erecta is orange. The different flower colors are reported to determine the type of arthropods that will come.

Research on C. caudatus and T. erecta as refugia in rice agroecosystems has not been widely known about their impact on arthropod abundance and diversity. Field research generally only looks at the effect of refugia on natural enemies while the effect on overall arthropods is still rare. This study aims to analyze the impact of C. caudatus and T. erecta refugia planting on arthropod diversity in rice cultivation.

.

MATERIALS AND METHODS

Study Area

This research was conducted in rice fields in Sigy regency, Central Sulawesi Indonesia and identification of pest insect and natural enemies was carried out at the Laboratory of Pests and Plant Diseases, Faculty of Agriculture, Tadulako University, Palu.

The research was conducted using an exploratory survey method conducted on three rice planting plots, namely control plots (without refugia planting), rice plots with kenikir (Cosmos caudatus) refugia plants, and rice plots with marigold (Tagetes erecta) refugia. Refugia were planted in the bunds surrounding the rice plants with a spacing of 50 cm. Each treatment was repeated three times.

Sampling procedure

Arthtropods sampling was carried out by 3 methods, namely with insect nets, pitfall traps and direct observation. In each experimental plot, 5 pitfalls were installed in the bunds around the refugia plants with a distance of 8 m, pitfall traps were placed on the ground and samples were taken after 2 x 24 hours. Arthropod sampling with insect nets was carried out by swinging insect nets along the bunds above the refugia plant crowns and rice plant crowns. While direct observation was carried out by observing directly on 5 samples of refugia plants and 5 samples of rice plants. The last two methods were conducted in the morning at 9:00-10:00. The arthropods obtained were then put into bottles filled with alcohol and taken to the laboratory to be counted and identified to the species level (morphospecies).

Observation variables

1. Type of arthropods
2. Number of individuals in each type

Data Analysis

The data obtained were analyzed descriptively using the excel program, while the analysis of diversity, evenness and dominance was carried out using the PAST program.

RESULTS AND DISCUSSION

Diversity of arthropods

Arthropods diversity found in the study about 79 species belonging to 9 orders, 43 families and from 2 major groups namely the Arachnida class and Insecta class with a total of 1,464 individuals. The orders Diptera and Aranea had the most species with 18 species each, although when viewed from the number of individuals, the order Hymenoptera was the most common, namely 491 individuals or about 33.54% of the total individuals (Table 1).

Tabel 1. Orders, number of species, abundance of species and relative abundance

No.	Order	Number of species	Abundance of species	Relatif abundance (%)
1	Araneae	18	269	18,37
2	Coleoptera	15	292	19,95
3	Hymenoptera	7	491	33,54
4	Mantodea	2	16	1,09
5	Odonata	9	158	10,79
6	Hemiptera	5	99	6,76
7	Diptera	18	72	4,92
8	Lepidoptera	3	56	3,83
9	Orthoptera	2	11	0,75
	Total	79	1464	100

The presence of various Dipteran species in this study was due to the Diptera order generally likes the yellow and orange colors of refugia flowers. The results of research by [9] showed that in tomato plantations, Dipteran insects were found in yellow and orange refugia treatments compared to pink and white refugia. Meanwhile, spiders are always present in rice paddy fields with a large number of species. In this study only 18 species were found, while reported by [10] there were 45 spider species in rice fields.

The results also found that the presence of refugia plants in rice fields can increase the number of predatory natural enemies. Some research results also showed the same thing [10]–[13]. Of the three treatments, T. erecta refugia gave better results in the parameter of the number of individuals (Figure 1), but when viewed from the number of species, more species or types of predators were found in the C. caudatus treatment (Table 2). Reported by [12] who explained that in the T. erecta refugia treatment, 12 species were found with 74 individuals, while in the C. caudatus treatment, 16 species were found and there were only 57 individuals, and it was concluded that with T.erecta refugia, the stability of insects in the ecosystem was better while in the T. Caudatus treatment therewas a similarity of insect communities in the ecosystem.

Tabel 2. Diversity and presence of predator on refugias treatmen

No.	Order/species	Control	*Refugia plots*	
			C. caudatus	*T. erecta*
	Araneae			
1	*Pardosa milvina*	+	+	+
2	*Tigrosa annexa*		+	+
3	*Trochosa terricola*	+	+	+
4	*Trebacosa marxi*		+	
5	*Pardosa californica*	+	+	+
6	*Tegenaria domestica*	+	+	
7	*Agelenopsis aperta*	+	+	+
8	*Araneus calusa*			+
9	*Anyphaena californica*	+		+
10	*Cheiracanthium inclusum*			+
11	*Agyneta micaria*		+	
12	*Oxyopes salticus*	+	+	+
13	*Maevia inclemens*	+	+	
14	*Sassacus vitis*		+	
15	*Mecaphesa celer*			+
16	*Coriarachne runneipes*		+	
17	Tetragnatha javana	+	+	
18	Tetragnatha nitens	+	+	+
	Coleoptera			
19	*Harmonia axyridis*	+	+	+
20	*Coelophora inaequalis*		+	+
21	*Monochilus sexmaculatus*	+	+	+
22	*Coccinella transversalis*		+	
23	*Coccinella septempunctata*	+	+	
24	Bembidion sordidum	+	+	+
25	*Extensicolle agonum*	+	+	+
26	*Bisnius siegwaldii*	+	+	+
27	*Megarafonus lentus*		+	
28	*Paederus littorarius*	+	+	+
	Hymenoptera			
29	*Parathechina SP.*	+	+	+
30	*Selonopsis geminate*	+	+	+
31	*Anoplolepis gracilipes*	+	+	+
32	Braconidae	+	+	+
33	Ichmeumonidae	+	+	+
34	Scelionidae	+	+	+
35	Encyrtidae	+	+	+
	Mantodea			
36	*Stagmomantis carolina*		+	+
37	*Tenodera sinensis*		+	+
	Odonata			
38	*Ischnura verticalis*	+		+
39	Ischnura posita	+	+	+
40	*Ischnura hastata*			+
41	*Ischnura ramburii*		+	+
42	*Acisoma panorpoides*	+	+	+
43	*Erythrodiplax minuscula*		+	+
44	*Erythrodiplax umbrata*		+	+
45	*Sympetrum danae*	+		+
46	*Sympetrum striolatum*		+	
	Total predator	28	38	33

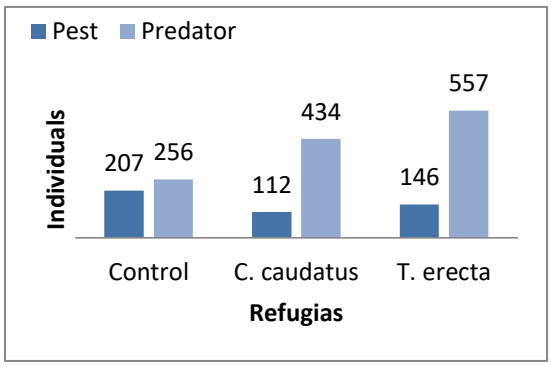
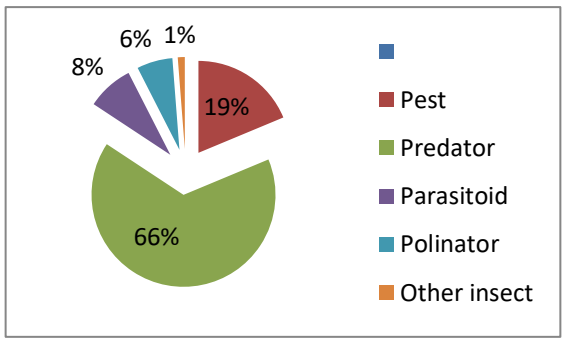


Figure 1. Number of individuals pests and predators in some refugias

When viewed from the role of insects found, generally act as predators 66%, as pests 19%, parasitoids 8%, pollinators 6% and 1% neutral insects (Figure 2).



Pigure 2. Persentage of arthropods depend of their roles

The large proportion of predators found indicates that the addition of refugia plants is an attraction for useful arthropods such as predators to come looking for shelter, find food and become a place for other resources [6], [14]. Overall arthropod diversity in rice fields tends to be higher in the treatment with refugia plants, both at the order, family and species levels. Analysis of the Shannon diversity index shows the same value between all treatments, namely diversity in the medium category, and a low dominance index indicates that no species dominates the entire treatment, as well as when viewed from the evenness index, all index values are close to one, which means that the number of individuals found in each species does not differ much between treatments (table 3).

Table 3. Number of orders, families, species and indices of diversity, evenness and dominance in various treatments

Parameters	Refugias		
	kontrol	*C. caudatus*	*T. erecta*
Number of orders	8	9	9
Number of families	41	43	43
Number of species	44	54	54
Shannon index	2.37	2,64	2,77
Dominance	0,27	0,1	0,1
Evennese	0,6	0,6	0,7

Table 3 shows even more clearly that the addition of refugia plants increases the functional diversity of the landscape. This condition attracts arthropods to come and their presence keeps the rice ecosystem stable. Similarly, it was reported by [15] that the functional diversity of landscaping in rice growing areas will increase the role of natural enemies and reduce the use of chemical pesticides that have been used by farmers. Therefore, agricultural practices such as in this study need to be applied in the field. The addition or increase of functional diversity by planting refugia plants around rice fields is expected to increase biodiversity in rice fields and increase interspecific interactions between component species in the rice ecosystem, thus creating a healthier, environmentally friendly and sustainable rice ecosystem. This concept is also part of integrated pest control [16].

CONCLUSION

This study found 79 species of arthropods belonging to 9 orders, 43 families with a total of 1,464 individuals. The orders Diptera and Aranea had the most species with 18 species each, while the order Hymenoptera had the highest number of individuals.

Arthropod diversity was higher in the refugia plant treatment with a diversity index classified as medium.

References

[1] L. Elizalde *et al.*, "The ecosystem services provided by social insects: traits, management tools and knowledge gaps," *Biol Rev*, vol. 95, no. 5, pp. 1418–1441, Oct. 2020, doi: 10.1111/brv.12616.

[2] V. Crespo-Pérez, E. Kazakou, D. W. Roubik, and R. E. Cárdenas, "The importance of insects on land and in water: a tropical view," *Current Opinion in Insect Science*, vol. 40, pp. 31–38, Aug. 2020, doi: 10.1016/j.cois.2020.05.016.

[3] N. Kurniawati, "Keragaman dan Kelimpahan Musuh Alami Hama pada Habitat Padi yang Dimanipulasi dengan Tumbuhan Berbunga," *Ilmu Pertanian (Agricultural Science)*, vol. 18, no. 1, p. 31, May 2015, doi: 10.22146/ipas.6175.

[4] G. Keppel *et al.*, "Refugia: identifying and understanding safe havens for biodiversity under climate change: Identifying and understanding refugia," *Global Ecology and Biogeography*, vol. 21, no. 4, pp. 393–404, Apr. 2012, doi: 10.1111/j.1466-8238.2011.00686.x.

[5] A. N. Allifah AF, R. Rosmawati, and Z. Jamdin, "Refugia Ditinjau Dari Konsep Gulma Pengganggu Dan Upaya Konservasi Musuh Alami," *BS*, vol. 8, no. 1, p. 82, Jun. 2019, doi: 10.33477/bs.v8i1.849.

[6] I. M. Sakir and D. Desinta, "Pemanfaatan Refugia Dalam Meningkatkan Produksi Tanaman Padi Berbasis Kearifan Lokal," *J. Lahan Suboptimal*, vol. 7, no. 1, Jan. 2019, doi: 10.33230/JLSO.7.1.2018.367.

[7] S. K. Rahayu, S. Supriyadi, S. Supriyono, R. Wijayanti, R. B. A. Putri, and R. B. A. Putri, "Keanekaragaman serangga pengunjung bunga pada tanaman tumpang sari kedelai

dengan tanaman orok-orok (Crotalaria juncea)," *J Entomol Indones*, vol. 15, no. 1, p. 23, Oct. 2018, doi: 10.5994/jei.15.1.23.

[8] Y. Setyadin, S. Hilya Abida, H. Azzamuddin, S. Fatiyatur Rahmah, and A. Setyo Leksono, "Efek Refugia Tanaman Jagung (Zea mays) dan Tanaman Kacang Panjang (Vigna cylindrica) pada Pola Kunjungan Serangga di Sawah Padi (Oryza sativa) Dusun Balong, Karanglo, Malang," *Biotropika*, vol. 5, no. 2, pp. 54–58, Jun. 2017, doi: 10.21776/ub.biotropika.2017.005.02.3.

[9] R. Adawiyah, L. Aphrodyanti, and N. Aidawati, "Pengaruh Warna Bunga Refugia Terhadap Keanekaragaman Serangga Pada Pertanaman Tomat (Solanum lycopersicum)," p. 6, 2020.

[10] I. Erdiansyah and S. U. Putri, "Optimalisasi Fungsi Bunga Refugia Sebagai Pengendali Hama Tanaman Padi (Oryza sativa L.)," p. 6, 2017.

[11] I. Erdiansyah, D. R. K. Ningrum, and F. Damanhuri, "Pemanfaatan Tanaman Bunga Marigold dan Kacang Hias Terhadap Populasi Arthropoda pada Tanaman Padi Sawah," *Agriprima*, vol. 2, no. 2, pp. 117–125, Sep. 2018, doi: 10.25047/agriprima.v2i2.91.

[12] M. Ifanalia, W. S. Harijani, and W. Windriyanti, "KEBERADAAN SERANGGA MUSUH ALAMI DAN PENYERBUK PADA PERTANAMAN JERUK PAMELO (Citrus maxima (Burm.) Merr.) MANIPULASI HABITAT DENGAN TANAMAN REFUGIA," p. 6.

[13] G. E. FIkri, B. Yanuwiadi, and A. Affandi, "The Difference of Arthropods Diversity in Semi-Organic and Conventional Citrus Orchard in Dau, Malang," p. 7.

[14] A. Z. Siregar and S. Lesnida, "PEMANFAATAN TANAMAN REFUGIA MENGENDALIKAN HAMA PADI (Oryza nivara L) DI SOPORARU TAPANULI UTARA," *AF*, vol. 20, no. 2, p. 299, Nov. 2021, doi: 10.31293/agrifor.v20i2.5744.

[15] F. G. Horgan, A. F. Ramal, C. C. Bernal, J. M. Villegas, A. M. Stuart, and M. L. P. Almazan, "Applying Ecological Engineering for Sustainable and Resilient Rice Production Systems," *Procedia Food Science*, vol. 6, pp. 7–15, 2016, doi: 10.1016/j.profoo.2016.02.002.

[16] Department of Agrotechnology, Faculty of Agriculture, Universitas Singaperbangsa Karawang, Jl. HS Ronggo Waluyo, Teluk Jambe Timur, Karawang 41361, L. Afifah, D. Sugiono, and Department of Agrotechnology, Faculty of Agriculture, Universitas Singaperbangsa Karawang, Jl. HS Ronggo Waluyo, Teluk Jambe Timur, Karawang 41361, "The Diversity of Insect in Paddy Field in Karawang, West Java with Different Pest Management Techniques," *JIPI*, vol. 25, no. 2, pp. 301–308, Apr. 2020, doi: 10.18343/jipi.25.2.301.