Akta Agrosia

Biodiversity and Arthropod Abundance in Semi Organic Rice in a Swamp Lowland of Palangka Raya City

Melhanah, Rahmawati Budi Mulyani, and Mario Satrio
Faculty of Agriculture University of Palangka Raya, Jl. Yos Sudarso, Tel / Fax 0536 3221722
Palangka Raya 73111, Indonesia

Doi: 10.31186/aa.24.2.39-44

ARTICLE INFO

Keywords:
Arthropods
Biodiversity
Rice
swamp lowland

Article history:
Received: July 28, 2020
Accepted: December 26, 2021
Published: December 30, 2021

*Corresponding author:
E-mail: melhanah@yahoo.co.id

ABSTRACT

Palangka Raya has the potential for swamp lowland to be used for rice farming. For this purpose, knowledge of arthropod biodiversity is required. The study aims to determine the biodiversity and abundance of arthropods and arthropods dominant in semi-organic rice plantations in swamp lowlands. The study was conducted from September to November 2019 in Palangka Raya City. The study was carried out on 1.148m^2 farmer's paddy fields. The land is divided into three trial plots, each measuring 28x13 m2. Observations were made at the age of 8-15 WAP. Samples were taken using a net trap (Sweep net). Arthropod biodiversity was analyzed using the Shannon-Weaver diversity index (H'). The results showed that in the semi-organic rice ecosystem were obtained 10 orders, 58 families with a total of 8973 individuals, consisting of pests 92.61%, predators 6.59%, parasitoids 0.28%, pollinators 0.06%, Detrivore 0.35%, and 0.07% neutral insects. Diversity index (H') is low to moderate (0.10-2.19), dominance index (C) is in the low to high (0.18-0.97); Evenness index shows that the community is depressed until unstable (0.04-0.67); and The abundance index on the criteria of less to very much (8.96-25.03). The dominant arthropods are dominated by the Rice bug *(Leptocorisa acuta).*

INTRODUCTION

Central Kalimantan has a potential of 3,576,800 ha area of swamp lowland and tidal swamp that can be utilized for rice farming (BPTP Kalimantan Tengah, 2012). The swamp lowland has been cultivated by traditional Banjar farmers in Palangka Raya when the dry season comes. One major problem in increasing rice production is the attack of pests.

Pests that commonly attack rice plants were rice bug (*Leptocarisa acuta*), Rice Field Rat (*Rattus argentiventer*), Brown Plant Hopper (*Nilaparvata lugens*), Yellow Rice Borer (*Scirpophaga incertulas)*, Rice Leafroller (*Cnaphalocrocis medinalis*), Rice Cotton Cutworm *(Spodoptera litura)*, and bird pest (*Lonchula spp)* (Syam & Wurjandri, 2011). The occurrence of these pests is determined by plant phenology, climatic conditions, and the unwise use of insecticides. The continuous use of insecticides by farmers resulted in the death of natural enemies of pests in the field, so that the pest population increased (Widiarta *et al.,* 2006).

The use of chemical insecticides to control pests can affect the structure of the arthropods

ISSN: 1410-3354 / e-ISSN:2615-7136

Cited this as: Melhanah., R.B. Mulyani., M. Satrio. 2021. Biodiversity and arthropod abundance in semi organic rice in a swamp lowland of Palangka Raya City. Akta Agrosia 24(2):39–44. doi: 10.31186/aa.24.2.39-44

community and result in the death of natural enemies (Croft,1989; Morgan and Kerr, 1980;). In addition, arthropods also acted as prey for other small predators, so they maintained the continuity of other arthropods (Turnbe *et al.*, 2010).

Knowledge about the structure of agroecosystems, such as the type of plant and arthropod biodiversity at the canopy and their interaction with each other, need to be known for successful natural pest control (Odum, 1996). Research results in Melhanah's *et al.* (2015a) found more arthropods in sweet corn plants and long beans that are not applied to synthetic insecticides, and the diversity and abundance of arthropods relatively high on the agroecosystem of sweet corn, long beans and mustard greens (Melhanah *et al.*, 2015b).

Based on literature searches, arthropod diversity has never been reported in the swamp lowland rice fields in Palangka Raya. Therefore, it is necessary to study Biodiversity and Arthropod Abundance in Semi Organic Rice in Swamp Lowland in Palangka Raya to know the existence of the components of the community and the role of the organism to the environment. Agroecosystems need to be managed so that natural enemies can be preserved and utilized.

MATERIALS AND METHODS

Field research was carried out in Palangka Raya, while Laboratory research was conducted at Department Agronomy Faculty Agriculture, Central Kalimantan, from September to November 2019. This research divided into field studies and laboratory experiments. In the field study, rice was planted on 1.148 m^2 land, divided into three plots, where each plot's area is 364 m^2 (28 m x 13 m).

Each plot was planted with semi-organic rice, using Certain varieties, Urea fertilizer 70 kg/ha, TSP 40 kg/ha, and chicken manure of 150 kg/ha. Pest and disease control using mechanically, bionematicide, bio fungicide, and rodenticide. The researcher uses a Sweep Net to catch active insects during the day. Caught arthropods were managed as a dry and wet collection. The arthropods identification was made based on identification books of Borror, *et al.* (1991); Reissig, W.H. *et al.* (1986) and Kalshoven (1981) through the family morphologically.

The data analysis consists of 1) composition of arthropods (pests, parasitoids, predators, etc.), diversity index (H'), dominance Index (C), 4) evenness (E), and 5) total abundance of families in the sample (N1). The diversity index and arthropod abundance were analyzed by Shannon-Wiener Index (Zar, 1984). The dominance and evenness of the number of individuals in each family are calculated by the evenness index (Odum, 1971) as follows:

1). Diversity index (H'); calculated using the following formula :

$$H' = -\sum \left[\left(\frac{ni}{N} \right) \ln \left(\frac{ni}{N} \right) \right]$$

Description:
H '= Shannon - Wiener diversity index;
ni = Number of individual species
ln = natural logarithm
N = Total number of individuals from the sample
Criteria: H '<1 (low diversity); 1 <H'≤3 (moderate diversity), and H'> 3 (high diversity).

2). The following equation can be used to measure the value of dominance.

$$D = \sum_{i=1}^{s} (Pi)^2$$

Where:
D = dominance index
Pi = comparison of the i-th proportion
S = number of families
Criteria: 0 <D ≤ 0.5 (low dominance), 0.5 <D ≤ 0.75 (moderate dominance), 0.75 <D ≤ 1 (high dominance)

3). Evenness index, calculated by formula :

$$E = H'/\ln S$$

Where:
E = Evenness index
H '= diversity index
ln = natural logarithm
S = number of species (in this case family)
Criteria for environmental communities:
0.00 <E ≤ 0.50 (depressed community),
0.50 <E ≤ 0.75 (unstable community),
0.75 <E ≤ 1.00 (stable community)

4). Abundance index, calculated by formula:

N1= exp (H')

Where:
N1 = Abundance index
H '= diversity index
Criteria for species abundance: 0 (none), 1-10 (less), 11-20 (enough), N1≥ 20: very much.

RESULTS AND DISCUSSION

The composition of arthropods

The results from the study of eight periods of observation, caught arthropods were obtained ten orders consisting of 58 families with a population of 8975 individuals (Table 1).

Table 1. Number of Order, Family, Population and Ecological Role of Arthropods in Rice Crops Caught with Sweep net

Class and Order	Family	Number of individual	Role
Insecta			
Hemiptera	Alydidae, Fulgoridae, Pentatomidae, Gelastocoridae Delphaidae, Cicadellidae, Acanaloniidae	7650	Pest
Orthoptera	Tettigoniidae, Acrididae	383	Pest
Lepidoptera	Noctuidae, Pyralidae, Arctiidae, Crambidae, Geometri-dae	152	Pest
Coleoptera	Chrysomelidae, Galerucidae, Buprestidae,Halticidae	86	Pest
Homoptera	Cicidellidae	20	Pest
Diptera	Agromyzidae,Drosophilidae Cloropidae,	19	Pest
	Number of families = 22	8310	
Insecta			
Coleoptera	Coccinellidae, Lampyridae,Staphylinidae Ostomatidae, Scarabacidae	430	Predator
Hemiptera	Lygaidae, Geridae, Miridae, Reduviidae,Veliidae	57	Predator
Odonata	Coenagrionidae, Libellulidae, Gomphidae	35	Predator
Hymenoptera	Formicidae, Vespidae,Apidae	17	Predator
Diptera	Dolichopodidae	10	Predator
Orthoptera	Mantidae,Gryllidae	6	Predator
Arachnida			
Araneida	Lycosidae, Tetragnathidaei	37	Predator
	Number of families = 21	592	
Insecta			
Diptera	Stratiomyidae, Bibionidae	21	Detrivore
Coleoptera	Curculionidae	5	Detrivore
Orthoptera	Blattidae	3	Detrivore
Isoptera	Termitidae	3	Detrivore
	Number of families =32	5	
Insecta			
Hymenoptera	Drynidae, Ichneumonidae Scelionidae, Evaniidae	19	Parasitoid
Diptera	Pipunculidae,Tabanidae	7	Parasitoid
	Number of families =6	26	
Hymenoptera	Spehecidae	3	Pollinator
Diptera	Bombyllidae	2	Pollinator
Lepidoptera	Sphingidae	1	Pollinator
	Number of families =6	6	
Insecta			
Diptera	Muscidae	**7**	Neutral
	Number of families= 1		
Total Orders=10	Total families = 58	Total Individual = 8973	

The Order Hemiptera and Coleoptera are the most caught Arthropods, Were obtained from 7543 individuals from family Alydidae and 299 individuals from Coccinellidae. Rice bug *(Leptocorisa acuta*) (Hemiptera: Alydidae) as a pest is vastly found in the canopy of the reproductive phase of rice, which is the flowering and filling phases of rice grains (11 WAP). Rice bug attacks rice grains by sucking fluid in the reproductive phase. The dominant fluctuation of stink bugs in the net trap is shown in (Figure 1). Food availability causes a high population of rice bugs in the flowering phase. According to Reji and Chander (2007) and Qomaruddin (2006), most stink bugs are found in the flowering phase because of the availability of sufficient food to increase their development

At the age of 12 to 14 week after planting (WAP), the population of rice bugs decreased. The population declined due to the population increase of natural enemies of Coccinellidae, i.e. 299 individuals (Figure 1). Insects of the order Coleoptera family Coccinellidae have an essential role in the ecosystem of rice cultivation, play a role as predators of soft-bodied insects such as nymphs, rice bugs, aphids and so on. Predators are the most important group of arthropods as life controllers of organisms in rice plants; each predator will eat prey plentifully throughout their life. Ladybird beetles eat, kill, or prey on insect pests on plants. Predators can prey on all levels of prey's development ranging from eggs, larvae, nymphs, pupae and imago and these predators are always present in rice fields throughout the year (Fitriani, 2018; Laba, 2001).

Interaction between Groups (Guilds)

Naturally, the presence of arthropods among phytophagous guilds (pests), natural enemies, insect pollinators and detritivores occurred in interactions. The observations show that a dominant group is a group of pests when viewed from the number of individuals (92.61%), but when viewed from the number of families, the dominant arthropods are natural enemy groups (predators, parasitoids) and beneficial insects (pollinators, detritivores and neutral insects) that is equal to (62.07%) (Table 2).

Three dominant groups of pests come from 3 families, namely (Hemiptera: Alydidae) and (Orthoptera: Tettigoniidae and Acrididae). The most widely found population is the Rice bug (Alydidae) of these three families. The high

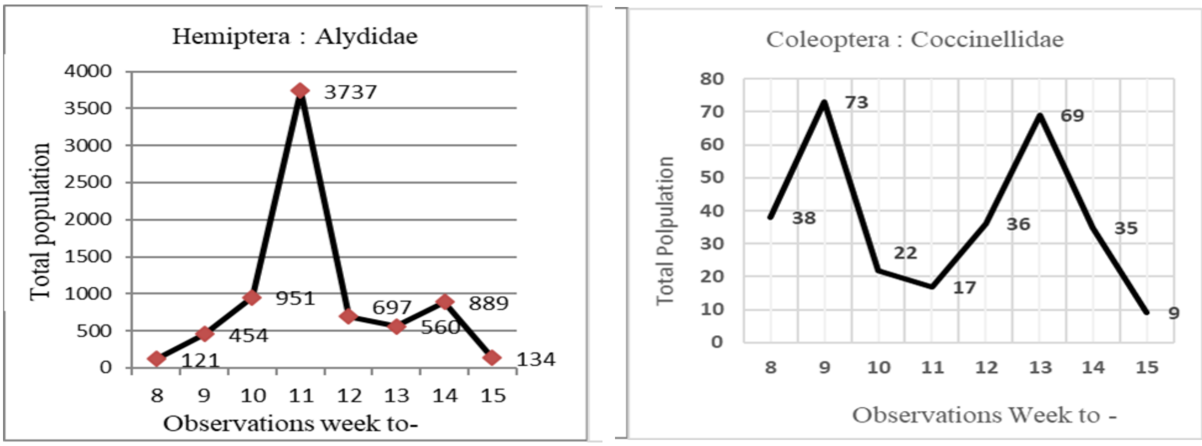

Figure 1. Population Fluctuations of Hemiptera (Alydidae) (Left) and Coleoptera

Table 2. Grouping and percentage of abundance of arthropod individuals by ecology role according to the number of individuals and the number of families caught in sweep net

No	Role	∑ Individuals	%	∑ Families	%
1.	Pest	8310	92,61	22	37,93
2.	Predator	592	6,59	21	36,20
3.	Parasitoid	26	0,28	6	10,34
4.	Pollinator	6	0,06	3	5,17
5.	Detrivore	32	0,35	5	8,62
6.	Neutral	7	0,07	1	1,72
Total		8973	100	58	100

population of rice bugs and attacking rice plants in the ripening phase will also migrate to other host plants. The host of pests is widespread in all grass families (Poaceae). This is consistent with Schaefer and Panizzi (2001) opinion that these rice bugs are usually seen on graminaceous crops and can be found on many crop plants in the family Poaceae (grasses). Plant vegetation that found growing around the area of swamp lowland rice fields were including kumpai babulu grass/bamboo grass (*Hymenachine amplexicaulis*), water hyacinth (*Eichhornia crassipes*), elephant grass (*Pennisetum purpureum*), giant salvinia (*Salvinia molesta*), and wiregrass (*Eleusine indica* L).

Diversity index

The results of the diversity index analysis (H ') is in the header range between 0-2. The highest value was obtained at age 8 MST observations. The highest dominance index (C) value is 0.97 at the age of observation of 11 WAP, the highest evenness index value (E) is 0.67 at the age of 11WAP. In contrast, the arthropod abundance index value is high, ranging from 8-25. (Table 3).

Table 3. Diversity Index (H '), Dominance Index (C), Evenness Index (E) and Abundance Index (N1) Arthropods of Rice Crops caught with a Sweep Net.

Plant age (WAP)	Canopy			
	H'	C	E	N1
8	2,19	0,18	0,67	8,96
9	0,86	0,60	0,37	10,94
10	0,68	0,77	0,21	23,70
11	0,10	0,97	0,04	10,10
12	1,14	0,56	0,39	19,22
13	1,16	0,56	0,38	20,74
14	1,16	0,56	0,37	24,23
15	1,85	0,29	0,59	25,03

WAP: Week After Planting

The high and low values of H are strongly influenced by the number of families and arthropod populations captured, and no family population dominates. Based on Table 3, the highest diversity index (H) of arthropods captured in the crop canopy in the 8-WAP swamp rice plantations was 2.19 and categorized as moderate diversity (1 <H'≤3). According to Fitriani (2018), diversity in the population was said to be moderate when productivity is sufficient, ecosystem conditions are sufficiently balanced, and ecological pressure is moderate.

The highest value of dominance index (C) obtained at the age of plant 11 WAP was 0.97. This value is classified as a high dominance criterion (0.75 <C ≤ 1). The high value of the dominance index is due to the large population of rice bugs (Hemiptera: Alydidae). The high value of the dominance index is usually followed by the low value of the evenness index (E.). Observations at the same age obtained an E value of 0.04, which indicates the criteria for depressed communities. According to Effendi *et al.* (2019), the smaller the value (E) or close to zero, the more uneven distribution of organisms in the community that family dominates.

The family abundance value (N1) arthropods at the age of observation 10, 13, 14, and 15 WAP are classified as very abundant and stable criteria; this is because the number of families caught plenty amount of 21-23 families. This is consistent with the opinion of Effendi *et al*. (2019) that if the abundance value is more than 20, it means that the abundance level of arthropod families in rice plantations is relatively stable.

CONCLUSION

The results showed that in the semi-organic rice ecosystem were obtained 10 orders, 58 families with a total of 8973 individuals, consisting of pests 92.61%, predators 6.59%, parasitoids 0.28%, pollinators 0.06%, Detrivore 0.35% and 0.07% neutral insects. Diversity index (H') is low to moderate (0.10-2.19), dominance index (C) is in the low to high (0.18-0.97); Evenness index showed that the community was depressed until unstable (0.04-0.67); and The abundance index on the criteria of less to very much (8.96-25.03). The dominant arthropods are dominated by Rice bug (*Leptocorisa acuta*).

ACKNOWLEDGMENT

Thanks and appreciation to Mr. Yani as Head of the farmer group "Rukun Bersama" Tanjung Pinang Village in Palangka Raya for land facilities for this research.

REFERENCES

BPTP Kalimantan Tengah. 2012. Teknologi Budidaya Padi IP 300 di Lahan Pasang Surut. Palangka Raya, Kalimantan Tengah.

Borror D.J, D.M. De Long and C.A. Triplehorn. 1991. An Introduction to The Study of Insects. Saunders College Publishing, Philadelphia.

Croft, B.A., 1989. Arthropoda Biological Control Agent And Pestisides. *In* John Wiley and Sons. New York. Chichester. Brisbone. Toronto. Singapore.

Effendi, S.N., E. Liestiany and D. Fitriyanti. 2019. Keanekaragaman serangga yang berasosiasi pada tanaman cabai merah besar (*Capsicum annum* L.) di Kelurahan Loktabat Utara Banjarbaru. Jurnal Proteksi Tanaman Tropika, 2(1):1– 3.

Fitriani. 2018. Identifikasi predator tanaman padi (*Oryza sativa* L.) pada lahan yang diaplikasikan dengan hamaisida sintetik. Jurnal Agrovital, 3(02):67-68.

Kalshoven. L.G.E. 1981. The Pest of Crops In Indonesia. Revised and translated by P.A. Van Der Laan. P.T. Ichtiar Baru Van Hoeve, Jakarta.

Laba, I .W. 2001. Keanekaragaman Hayati Artropoda dan Peranan Musuh Alami Hama Utama Padi pada Ekosistem Sawah. Post graduate program. Institut Pertanian Bogor. http://rudyct.com/PPS702-ipb/03112/iwlaba. htm. accessible 02 June 2010.

Melhanah, D. Saraswati and L. Supriati. 2015[a]. Diversitas dan Kemelimpahan Arthropoda Pada Agroekosistem Jagung Manis, Kacang panjang dan Sawi di lahan Gambut. Makalah dalam Seminar Nasional Bidang Ilmu Pertanian BKS-PTN Wilayah Barat. Palangka Raya, 20-21 Agustus 2015.

Melhanah., D. Saraswati dan L. Supriati. 2015[b]. Komunitas arthropoda pada agroekosistem jagung manis dan kacang panjang dengan dan tanpa perlakuan insektisida di lahan gambut. J. Agripeat. 16(1):36-44.

Morgan, F. D. and A. Kerr. 1980. Strategies in Control of Pests and Pathogens: General Concepts. In, A Course Manual in Plant Protection. Australian Vice Cancellors Committee, Melbourne. pp. 3170325.

Odum, E.P. 1996. Dasar-dasar Ekologi; Edisi Ketiga. Gadjah Mada University Press, Penerjemah Samingan, Tjahjono. Yogyakarta.

Qomaruddin. 2006. Pengendalian Walang Sangit (*Leptocorisa Ora* Torius F.) Ramah Lingkungan di Tingkat Petani di Lahan Rawa Lebak. Balai Penelitian Pertanian Lahan Rawa, Loktabat Banjarbaru, Kalimantan Selatan.

Reissig, W.H, E.A. Heinrichs, J.A. Litsinger, K. Moody, L. Fiedler, T. W. Mew and A.T Barrion. 1986. Illustrated Guide to Integrated Pest Management in Rice in Tropical Asia. International Rice Research Institute Los Banos Lguna Philippines, Manila.

Reji, G. and S. Chander. 2007. A degree-day simulation model for the population dynamics of the rice bug, *Leptocorisa acuta* (Thunb.). Journal of Applied Entomology, 132: 646-653.

Schaefer, C.W. and A.R. Panizzi. 2001. Heteroptera of Economic Importance. CRC Press. pp. 321- 336.

Syam and Wurjandri. 2011. Masalah Lapang Hama, Penyakit,dan Hara pada Padi. Puslitbantan, Bogor.

Turnbe, A., A. Toni, P. Benito, P. Lavelle, N. Ruiz, W.H. Van der Putten, E. Labouze and S. Mudgal. 2010. Soil Biodiversity: Functions Threats and Tools for Policy Makers. Bio Intelligence Service, IRD, and NIOO, Report for European Commission.

Widiarta, I.N., T. Surjana, and D. Kusdiaman. 2006. Famili Anggota Komunitas pada Berbagai Habitat Lahan Sawah Bera dan Usaha Konservasi Musuh Alami pada Padi Tanam Serentak. pp.185-192. Prosiding Simposium Keanekaragaman Hayati Arthropoda pada Sistem Produksi Pertanian, Cipayung, 16-18 Oktober. 2001. Perhimpunan Entomologi Indonesia dan Keanekaragaman Hayati Indonesia.

Zar, J.H. 1984. Biostastical Analysis: Second Edition. Prentice Hall Inc. Englewood Cliffs, New Jersey.