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DIVERSITY OF ARTHROPOD PREDATOR IN SWAMP RICE FIELDS IN SOUTH SUMATERA

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ABSTRACT

Diversity of arthropod predator in swamp rice fields in South Sumatera. The abundance and diversity of arthropod in agro ecosystem depend on the level of synthetic pesticide contamination. This study aimed to explore, identify and analyze the diversity and abundance of predatory arthropods in swamp rice fields treated with pesticide application (in Pemulutan) and without pesticide application (in Musi 2). The swamp rice fields in Pemulutan are bordered by village, river and forest. The methods were survey and direct observation on 3 ha and 2 ha of swamp rice fields in Pemulutan and Musi 2, Palembang. Sampling of predatory arthropods were conducted at 20, 50, 80 and 110 days after rice planting using pitfall trap. Identification of predatory arthropods was conducted at Laboratory of Entomology showing that the arthropod collected consisted of 17 species of insects and 9 species of Arachnida. In Pemulutan Ogan Ilir were found 19 species (10 species of insect and 9 species of Arachnida) at the village area. In the area that was bordered by river were found 8 species (7 insect and 1 Arachnida). In the area bordered by forest were found 22 species (10 species of insects and 12 species of Arachnida). The diversity level, number of species, and arthropod specimen in the field without pesticide application at Musi 2 were higher than those in the fields with pesticide application in Pemulutan.

Key words: arthropod, abundance, bio-indicator, diversity, predatory

ABSTRAK

Keanekaragaman artropoda predator sebagai bioindikator kesehatan tanah di sawah lebak di Sumatera Selatan. Kelimpahan dan keanekaragaman artropoda di agroekosistem sangat dipengaruhi oleh cemaran insektisida sintetik. Penelitian ini bertujuan untuk mengeksplorasi, mengidentifikasi dan menganalisis keanekaragaman dan kelimpahan Artropoda predator di pematang sawah lebak yang diaplikasikan pestisida (di Pemulutan) berbatasan dengan perkampungan, sungai dan hutan, serta pematang sawah lebak tanpa aplikasi pestisida (di Musi 2). Metode penelitian adalah survei pada pematang sawah lebak di Pemulutan Ogan Ilir seluas 3 ha dan Musi 2 Kota Palembang seluas 2 ha. Pengambilan sampel Artropoda predator dilakukan pada saat tanaman padi berumur 20, 50, 80 dan 110 hari setelah tanam (hst) dengan menggunakan pitfall trap. Identifikasi Artropoda predator dilakukan di Laboratorium Entomologi, Balai Karantina Kelas I Palembang. Pada lokasi Musi 2 ditemukan 26 spesies Artropoda predator di pematang sawah, terdiri dari 17 spesies dari kelas Insekta dan 9 spesies dari kelas Arachnida. Di lokasi penelitian Pemulutan Ogan Ilir, yaitu lahan yang berbatasan dengan perkampungan ditemukan sebanyak 19 spesies (10 spesies dari kelas Insekta dan 9 spesies dari kelas Arachnida). Lahan yang berbatasan dengan sungai ditemukan sebanyak 8 spesies (7 spesies dari kelas Insekta dan 1 spesies dari kelas Arachnida). Di lahan sawah yang berbatasan dengan hutan ditemukan sebanyak 22 spesies (10 spesies dari kelas Insekta dan 12 spesies dari kelas Arachnida). Tingkat keanekaragaman, jumlah spesies dan spesimen Artropoda predator yang ditemukan di pematang sawah pada lahan tanpa aplikasi pestisida (Musi 2) lebih tinggi, jika dibandingkan dengan ketiga lahan penelitian di Pemulutan yang secara intensif diaplikasikan pestisida sintetis.

Kata kunci: artropoda, bioindikator, keanekaragaman, kelimpahan, predator

INTRODUCTION

Increasing use of synthetic insecticides has a negative impact on agro ecosystems (Meidalima, 2014), such as soil and water pollution in lowland rice fields. In addition, the use of synthetic fertilizers and pesticides has an impact on arthropods around the ecosystem resulting in a frequent explosion of pest populations

(Herlinda *et al*., 2008; Khodijah *et al*., 2012a). This explosion of pest populations shows natural enemy helplessness (Wissinger, 1997).

Unhealthy agro ecosystems caused by synthetic insecticides lead to low abundance and diversity of arthropods (Meidalima & Meihana, 2013) especially parasitoid and predators (Wanger *et al*., 2010; Herlina *et al*., 2011). Several types of soil surface arthropods can be used as indicators of soil health, including appropriate land management, abundance and diversity of the arthropods, network structure, and community stability (Suheriyanto, 2012). Herlinda *et al*. (2008) mention that healthy agro ecosystems are not pest-dominated.

In the ecosystem of rice fields, predatory arthropods are natural enemies that have very important role in suppressing pest populations, especially brown plant hopper and stem borer (Thalib *et al*., 2002; Khodijah *et al*., 2012b). It is because predators have high adaptability in the ephemeral ecosystem (Herlinda *et al*., 2004). The results of research conducted by Rizali *et al*. (2002), in the forest edge of the embankment in Halimun was found Carabidae which is a bio indicator of agricultural land management (Kromp & Steinberger, 1992) and Formicidae as indicators of agro ecosystem conditions in an area (Peck *et al*., 1998). Research on abundance and diversity, as well as species of predatory arthropods in paddy fields with pesticides application bordered by villages, rivers and forests and in paddy fields without application of pesticides in South Sumatra have not been carried out. This study aimed to identify and analyze the species diversity and abundance of predatory arthropods inhabiting swamp rice fields in South Sumatra treated with pesticides bordered by villages, rivers and forests and without application of synthetic pesticides.

MATERIALS AND METHODS

Research Site. The research was carried out in swamp rice fields covering 3 ha of area in Pemulutan Ogan Ilir Regency and 2 ha of area in Musi 2, Palembang City from March to June 2017. Laboratory observations were carried out at the Entomology Laboratory Class I Quarantine Hall, Palembang.

Collecting Predatory Arthropods Samples on Swampy Rice Fields. The selection of research locations in Pemulutan was based on the criteria in which the local farmers apply synthetic insecticides regularly. Observations were conducted on rice fields bordered by villages, rivers and forests, each covering 1 ha. Meanwhile, the selection of research loacations in Musi 2 Palembang City was based on the criteria in which the local farmers do not apply synthetic insecticides. Weeding is done by farmers in Pemulutan, at least 2 times during the planting season using herbicides. Meanwhile, weeding by farmers in Musi 2 is done manually before rice planting. The distance between the two locations (Pemulutan and Musi 2) is around 15 Km, with slight similarity in biological and topographic conditions.

Sampling of predatory arthropods was carried out at 20, 50, 80 and 110 days after planting (dap). Predatory arthropods in both study locations were collected using pitfall traps such as Price & Shepard (1980), Whitcomb (1980), and McEwen (1997). The trap hole was made of plastic glass with a diameter of 50 mm and a depth of 100 mm. The trap hole was then filled with 4% formalin solution in one-third the height of the glass.

The trap hole was installed on the surface of the paddy field and the surface was flat with the surrounding surface. The trap hole that had been installed, then given a shade made of plastic supported with a 15 cm tall pole. This shade aimed to avoid the pitfall trap filled with rain water. For the installation of trap holes, each of the rice fields observed was divided into 4 sub-fields, thus there were16 pitfall traps installed. The position of the trap hole was spread evenly with a distance of 25 m on each side of the subspace. In Pemulutan, the installation of trap holes was done 2 x 24 hours after the local farmer applied synthetic insecticides. It is expected so that arthropods are trapped in large quantities. Predatory arthropods trapped in a trap pit were filtered with a 20 cm diameter tea filter. Then, cleaned by rinsing them with running water. Next, they were put in vial bottles containing 70% alcohol to be identified in the laboratory. The vial bottle was labeled explaining the date, time and location of sampling.

Identification of Predatory Arthropods in Swamp Rice Fields. The identification of predatory arthropods was based on their morphological characteristics, carried out at Entomology Laboratory Class I Quarantine Hall, Palembang. The identification was doine using the reference book by deGunst (1957), Kalshoven (1981), Hadlington & Johnston (1987), Barrion & Litsinger (1994), and Lawrence & Britton (1994).

Observation of The Abundance of Predatory Arthropods in Swamp Rice Fields. After all predatory arthropod species were trapped in trap holes, they were identified, then grouped and calculated. Predatory arthropod species grouping was based on location and plot observation criteria.

Data analysis. Predatory arthropod insect species found in the research sites were analyzed descriptively and displayed in the form of images. Data on species composition and number of predatory arthropods were used to analyze species abundance and diversity. The size of the diversity used is the Shannon species diversity index value, the Berger-Parker Species Domination index and the Pielou species evenness index (Fachrul, 2007).

RESULTS AND DISCUSSION

Based on the data obtained, predominant arthropods in Musi (without pesticide application) were found as many as 25 species consisting of 17 species from insect class and 8 species from arachnida class. Meanwhile, in Ogan Ilir, Pemulutan (rice field with pesticide application bordered by village) were found 19 species (10 species from insect class and 9 species from arachnida class). In rice field with pesticide application bordered by river were found 8 species (7 species from insect class and 1 species from arachnida class). In ricefield bordered by forest were found 21 species (10 species from insect class and 11 species from arachnida class). The number of families and species of predatory arthropods found in in Musi 2 (without pesticide application) was greater compared to the other three rice fields bordered by villages, rivers and forests with intensive synthetic pesticides application (Table 1). The number of families and species of predatory arthropods found in wild plant canopy was also higher around rice fields without the application of pesticides (Musi 2) compared to around rice fields with pesticides application (Meidalima *et al*., 2017). The data show that in general, the presence of predatory arthropods is higher in field without the application of synthetic pesticides. This condition proves that synthetic pesticides affect the abundance of predatory arthropods.

The application of pesticides has a direct effect on the existence of natural enemies (Hall & Nguyen, 2010). In ecosystems in which insecticides are not applied, the abundance of predatory arthropods, such as Carabidae (Purwanta *et al*., 1997) and spiders is much higher than in ecosystems in which pesticides are applied (Tulung, 1999). The use of pesticides is a major cause of the low diversity and abundance of macro invertebrate communities (such as: Ephemeroptera, Plecopter, and Trichoptera) on wetlands (Uwimana, 2011; Bambaradeniya *et al*., 2004).

The diversity index of predatory arthropods in ricefields without the application of pesticides (Musi 2) was higher compared to the other three rice fields with the application of pesticides in Pemulutan (Table 2). The Berger-Parker index value (the predominance of predatory arthropods) was higher and the Pielou index value (evenness) was lower in rice fields intensively treated with pesticides application (Table 2). The Shannon index value (diversity of predatory arthropods) in Musi 2 was higher because pesticides were not applied in the rice field. According to Herlinda *et al.* (2008) exposure to insecticide chemicals in rice fields can reduce the number of individuals in the population. The decline in the number of individuals in the population resulted in a decrease in the diversity of arthropod species in the field (Widiarta *et al*. 2006; Herlinda *et al*., 2008). This condition can be an indication that the agro ecosystem is not healthy. The high level of predatory arthropods in the field treated with pesticides shows a population imbalance between species. This indicates a very high dominance by certain species compared to other species (Meidalima & Meihana, 2013).

The results of the analysis show that the lowest Shannon index value (H‘ = 1.826) and the highest dominance index (D = 0.266) were found in the research location bordered by river. The least number of species and specimens was also found in this location, i.e. 8 species with 79 specimens. This is suspected to be caused by the accumulation of pesticide residues along the upstream and downstream of the river. According to the innformation from several farmers along the river in Pemulutan, they applied insecticides and herbicides regularly and intensively. In one rice planting season, insecticeds and herbiceds were applied at least 4 times and 2 times, respectively. In addition, people in Pemulutan utilize river flow for daily needs, such as bathing and washing. The detergent solution wastes greatly influence the presence of organisms in the river (Sopiah & Chaerunisah, 2006).

Some research results proved the negative effects of pesticides on natural enemies, as reported by Carmo *et al*. (2010) mentioning that pesticides, herbicides and fungicides are very dangerous for the *Telenomus remus* Nixon parasitoid. The use of broad spectrum pesticides can also kill other beneficial insects (Amirhusin, 2004; Kartohardjono, 2011).

The number of predatory arthropod species found in the study area near the forest (22 species consisting of 157 specimens) and the Shannon index value (H‘ = 2.512) were almost the same as the number of predatory arthropod species found in Musi (26 species consisting

Table 1. Species of pest arthropod predators in paddy fields treated with and without pesticides application

Class	Species	Number of species in the rice fields			
		Without pesticide Musi 2	With pesticide		
			near village	near river	forest
Insect	*Anapolepis longipes*	7	-	-	4
	Crematogaster difformis	5	12	11	3
	Dolicoderes bituberculatus	24	-	-	9
	Oecophylla smaragdina	43	-	21	37
	Odontoponera transversa	37	-	7	28
	Pheropshopus javanus	29	-	-	3
	Mantis religiosa	3	4	-	1
	Cicindela campestris	7	-	-	16
	Paederus fuscipes	19	-	14	17
	Chlaenius acroxanthus	11	-	-	5
	Amauromorpha acepta	2	-	-	-
	Drosophila sp. A	8	-	-	-
	Bembidion tetracolum	13	-	-	-
	Egadroma quinquespustalata	4	-	-	-
	Coccinella septempunctata	16	-	6	-
	Coccinella transversalis	13	17	4	-
	Harmonia axyridis	22	-	9	-
	Verania liniata	-	11	-	-
Arachnida	*Cyclosa malmeinensis*	-	-	-	4
	Pardosa sacayi	-	8	-	3
	Pardosa pseudoannulata	22	-	-	1
	Pardosa apostoli	-	9	-	3
	Pardosa caliraya	1	-	-	-
	Pardosa sumatrana	9	-	-	3
	Schizocosa cotabatoana	-	-	-	4
	Bathyphantes tagalogensis	-	9	7	3
	Wendligarda liliwensis	-	-	-	1
	Simaetha damomapalaya	-	-	-	4
	Hogna rizali	5	-	-	2
	Lycosa chaperi	17	-	-	4
	Hyllus maskaranus	9	-	-	-
	Diaea tadtadtinika	12	-	-	-
	Lynipidae mikro	21	-	-	-
	Tetragnatha javana	54	-	-	3
	Tetragnatha havaca	-	6	-	-
	Peucetia myanmarensis	-	11	-	-
	Theridion otsospotum	-	7	-	-
Number of specimen		412	94	79	157

of 412 specimen with the H‘ = 2.697). This condition occurs, because there are still many wild plants near the forest, allowing predatory arthropods to survive. When conditions are not appropriate, wild plants around the plantations have function as shelter for natural enemies (Van Emden, 1990). Wild plants can also provide alternative hosts or prey which act as “natural enemy bridges” that connect the two growing seasons and can also act as sinks of natural enemies originating from newly harvested rice plants. Besides, wild plants can be a source of natural enemies in the next planting season (Herlinda & Irsan, 2011).

Meanwhile, predatory arthropod species found in the study location near village were as many as 10 species consisting of 94 specimens. Shannon index value (H ‘= 2.043) was higher than the Shannon index value in the study location near river and lower than in Musi 2 and in study location near forest. This is presumably because in addition to the intensive use of synthetic pesticides, there was also an effect of the chemical contamination from daily household activities. Based on the observations at the research site near village, local farmers usually dispose the remaining detergent of washing and bathing in their paddy fields affecting the health of the soil and rice fields. The detergent solution waste can interfere with the life of organisms in soil and water (Sitorus, 1997; Sopiah & Chaerunisah, 2006).

The number of predatory arthropod species found at each time of observation was different. However, it shows the same tendency. The number of predatory arthropods observed was low at 20 days after planting (DAP), then it began to increase and reached the highest peak at 50 DAP. At 80 DAP, the number of predatory arthropod species found began to decline, and the lowest number was reached at the end of the observation, which was at 110 DAP (Figure 1). This situation is closely related to the generative phase of rice plants which occurs at 50-60 days after planting. In this phase, the presence of predatory arthropods is very abundant. This is in line with what was conveyed by Herlinda *et al*. (2008), that in the generative phase, phytophage insects and pollinators are abundant in rice plants. Phytophage insects and pollinators are prey for predatory arthropods (Ishijima *et al.*, 2006). Frequent and intensive use of synthetic pesticides can cause agro-ecosystems to become unhealthy, thus disrupting the existence of

Table 2. Characteristic Community characteristics of arthropod predatory arthropods atin paddyswamp rice fields

Community characteristics	Musi 2	Village	River	Forest
Number of species	26	10	8	22
Index Shannon	2.697	2.043	1.826	2.512
Index Berger-Parker	0.131	0.245	0.266	0.236
Index Pielou	0.838	0.887	0.878	0.825

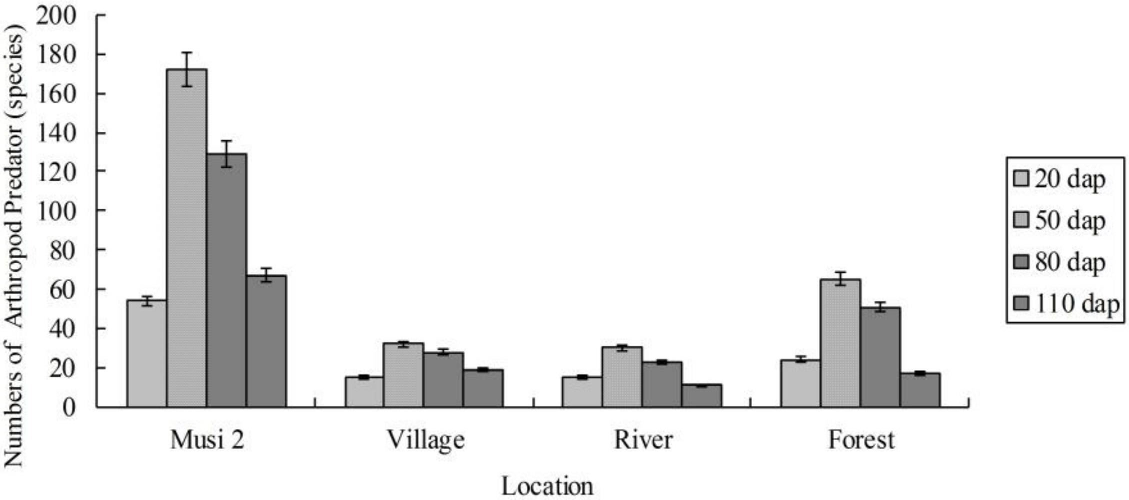

Figure 1. Proportion of predatory arthropods species at each observation time.

predatory arthropods (Waage, 1989). As a result, there is a decrease in the diversity value of arthropod species in the field.

CONCLUSION

Frequent and intensive use of synthetic pesticides influenced the presence of predatory arthropods in swamp rice fields. The diversity, abundance, number of species and specimens of predatory arthropods found in the swamp rice fields without the application of pesticides (Musi 2) was higher compared to the other three swamp rice fields in Pemulutan intensively treated with synthetic pesticides application.

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