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Predators and Parasitoids on Ricefield of Back Swamp and Tidal SwampLands in South Kalimantan

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Abstract: ***The objective of this study was to find out the species richness and the dominance of natural enemies (predators and parasitoids) on backswamp and tidal swamp lands in South Kalimantan in two cropping systems, using a survey method. The survey took place from April to September 2012.The equipment used to sample the predators and parasitoids was insect net, yellow trap and light trap. Species richness (R) and dominance index (C) from each cropping system was counted. Twenty two species of predators were found, which were included in family of Formicidae, Staphylinidae, Coccinellidae, Coenagrionidae, Lycosidae, Araneidae, Tetragnathidae, Thomisidae, Oxyopidae, Microphysidae, Miridae, Gerydae, Gryllidae, Tettigoniidae and 14 species of parasitoids included in family of Chalcidoidea, Bethylidae, Braconidae, Ichneumonidae, Eulopidae, Vespidae, Diapriidaae, Pteromalidae, Platygastroidea, Pipunculidae, Lygaeidae. Species richness (R) of predators and parasitoids on local cropping system tended to be higher than on conventional ones in all stages and types of swamplands (back swamp and tidal swamp lands). Dominance index (C) of predators on back swamp land was included in the low category and on tidal swamp land in the medium category, for both cropping systems. Dominance index (C) of parasitoids on back swamp land in local cropping system was included in the low category and in conventional in the medium category. The dominance values of both cropping systems on tidal swamp land were high, dominated by Telenomusrowani (local) and Goniozus nr. Triangulifer (conventional).***

Keywords: predator, parasitoid, backswamp, tidal swamp, cropping system

1. Introduction

Swamplands (back swamp and tidal swamp) are agro-ecosystems that are unique and unstable, and one of the alternative lands that can be utilized for various activities of agricultural production. In Indonesia, there are swamplands covering an area of 33.40- 39.40 million hectares (Subagjo and Widjaja, 1998), whereas according to Ardi*et al*., (2006) the area was estimated about 33.40 million hectares consisting of tidal swamp(24.20 million hectares) and back swamp(13.27 million hectares), which were generally located in Sumatera, Kalimantan, and Papua of 5.70,3.40,and 5.20 million hectares, respectively(Swamp Land Agricultural Research Center, 2005).In South Kalimantan, a small part of back swamp land has been utilized by local farmers for cultivating rice and a few types of vegetables. Although there are many obstacles in order to make these lands productive, the use of these lands has provided a meaningful contribution to the national food security system. Agro-ecosystem management to overcome various problems requires treatments which should be specific in location, including the management of pests that attack rice crops. The biological pest control using natural enemies is the right solution. However, the application of these technologies should be integrated with agro-ecosystem of swamplands as the key principle of integrated pest management.

According to Laba (2001), the presence of natural enemies such as parasitoids and predators in fields will benefit in reducing pest populations at each plant stage. Given the role of parasitoids and predators in suppressing pest populations naturally is quite important, it is necessary to optimize their roles as natural control agents, such as by conducting the conservation of natural enemies in the field so that the existence of these natural enemies can be utilized in a sustainable manner. Similarly, the tillage to weed the weeds produced heaps of weed used as green manure. The condition of richness in organic matter is an alternative food resource for the population of neutral insects that could become the prey for predators, and it would make the balance between pests and their natural enemies. Besides, the heaps of weed can also be a temporary shelter or hiding place for predators, such as nymph spiders and adult spiders from cannibalism. The objective of this study was to find out the species richness and the dominance of natural enemies (predators and parasitoids) on back swamp and tidal swamp fields in South Kalimantan in two cropping systems (local and conventional).

2. Materials and Methods

The study lasted from April to September, 2012. The survey of major pests and the collection of the natural enemies were conducted on back swamplands (Banua Rantau Village of Banua Lawas District of Tabalong Regency) and on tidal swamp lands (Gudang Hirang Village of Sungai Tabuk District of Banjar Regency, and Kolam Kiri DalamVillage of Barambai District of Barito Kuala Regency) in South Kalimantan. The identification of the natural enemies was carried out at Biological Control Laboratory of Plant Pest and Disease Department of Agricultural Faculty, Lambung Mangkurat University.

2.1 Survey of Major Pests

The survey of the major rice pests was conducted in local and conventional cropping systems. The local cropping

system is the cropping method applied by local farmers with traditional tillage, whereas conventional system is a common way of cropping practiced by farmers with synthetic chemical inputs (fertilizers and pesticides). The pest intensity was calculated by taking the plant samples from each area diagonally as much as ten clusters, using Abbot's1925formula (in Hamed*et al*, 2012). For the pest species with non systemic attacks, it was calculated using Townsend and Heuberger's formula 1943 (in Adria, 2010).

2.2 Planting Preparation

The study was conducted on backswamp lands with two cropping systems; the lands were cultivated with conventional and local systems. Both lands were located separately at a distance of 500 m. The rice variety used for the conventional cropping system was superior rice variety Ciherang, and for the local Siam Unus, which was the common rice variety grown by local farmers. The local rice cropping followed the custom of the local farmers, using the method of moving the seedlings three times. The planting with local cropping system began with *Teradak* (nursery). This plant stage was carried out on high land section. The seedlings were then transferred to rather lower land (called *Lacak*). The land tillage was carried out while waiting for the rice seedlings to become rather high and strong. The weeds were trimmed using a trowel, a type of sickle applied in water. The trimmed weeds were then gathered and put on the top of the embankment. They were left to rot, and then chopped (cut into small pieces) and applied on land. Then the seedlings from *lacak* stage were ready to be planted on the land (*Planting on land*). The conventional cropping system had the same stages of planting as the local cropping system, teradak, lacak, and planting n field, except for the tillage method, using herbicides.

2.3 Collection and Identification of Predators and Parasitoids

The natural enemies were collected in three planting stages, taradak, lacak, and when the rice seedlings were planted in the field, for each cropping system. They were collected using insect net, yellow trap and light trap. The insects trapped were stored in a collection bottle that had been filled with a solution of 70% alcohol for the identifying purpose later in laboratory. The identification was conducted to the level of family, based on Borror*et al* (1992), and the number was also calculated. The observations of the diversity and abundance of parasitoid and predator species were carried out every two weeks, started from nursery (teradak) until the seedlings were planted in the field during generative phase (16 weeks after planting).

3. Observations and Data Analysis

This study used a descriptive method, which was a direct observation of the study objects, namely the species of insect predators and parasitoids. Furthermore, the species richness (R) and dominance index (C) from each cropping system were calculated.

The index of species richness (R) was calculated using Margalef's formula in Ludwig and Reynolds (1988):

$R = S\text{-}1 / \ln N$

Specification:
S = whole species
N =total number of species

The index of dominance (C) was calculated using Simpson's formula (1949) in Odum (1983), and the categories of dominance index can be seen in Table 1.

$$C = \sum \left(\frac{ni}{N}\right)^2$$

Specification:
ni = number of individuals of each species
N = number of individuals of all species

Table 1: The categories of dominance index

Dominance (C)	*Category*
$0,00 < D \leq 0,50$	Low
$0,50 < D \leq 0,75$	Medium
$0,75 < D \leq 1,00$	High

4. Results

The results of the survey indicated that the major rice pests on backswamp land were brown plant hoppers with the attack intensity of 42.5% (medium category), and on tidal swampland stem borers with the attack intensity of 8.9% (low category).The natural enemies (predators and parasitoids) found in backswamp and tidal swamp lands were 22 species of predators that belong to the family of *Formicidae*, *Staphylinidae*, *Coccinellidae*, *Coenagrionidae*, *Lycosidae*, *Araneidae*, *Tetragnathidae*, *Thomisidae*, *Oxyopidae*, *Microphysidae*, *Miridae*, *Gerydae*, *Gryllidae*, *Tettigoniidae* and 14 species of parasitoids that belong to the family of *Chalcidoidea*, *Bethylidae*, *Braconidae*, *Ichneumonidae*, *Eulopidae*, *Vespidae*, *Diapriidaae*,*Pteromalidae*,*Platygastroidea*,*Pipunculidae*,*Lygaeidae*. The species of predators and parasitoids can be seen in Tables 2,3,4 and 5.

Table 2: The speciesof predatorsfound in back swamp land

No.	*Species*	*Ordo*	*Family*
1	*Polyrachis nigra*	Hymenoptera	Formicidae
2	*Paederus litoralis*	Coleoptera	Staphylinidae
3	*Agriocnemis femina femina*	Odonata	Coenagrionidae
4	*Pardosa psuedoannulata*	Araneae	Lycosidae
5	*Araneus irustus*	Araneae	Araneidae
6	*Tetragnatha maxillosa*	Araneae	Tetragnathidae
7	*Lycosa pseudoannulata*	Araneae	Lycosidae
8	*Cyrtorhinus lividipennis*	Heteroptera	Microphysidae
9	*Micraspis* sp.	Coleoptera	Coccinellidae
10	*Menochilus sexmaculatus*	Coleoptera	Coccinellidae
11	*Oxyopes javanus*	Araneae	Oxyopidae
12	*Atheta coriaria*	Coleoptera	Staphylinidae
13	*Paederus fuscipes*	Coleoptera	Staphylinidae
14	*Anaxipha longipennis*	Orthoptera	Gryllidae
15	*Conocephalus longipennis*	Orthoptera	Tettigoniidae
16	*Deraecoris vittatus*	Hemiptera	Miridae
17	*Misumenops sp*	Araneae	Thomisidae

Table 3: The species of parasitoidsfound in back swamp land

No.	*Species*	*Ordo*	*Family*
1	*Elasmus* sp.	Hymenoptera	Chalcidoidea
2	*Goniozus nr. triangulifer*	Hymenoptera	Bethylidae
3	*Coelinidae oryzicola*	Hymenoptera	Ichneumonidae
4	*Trichomma cnaphalocrosis*	Hymenoptera	Ichneumonidae
5	*Tetrastichus* sp.	Hymenoptera	Eulophidae
6	*Rompalidia marginata sundaica*	Hymenoptera	Vespidae
7	*Spathiushelle*	Hymenoptera	Braconidae
8	*Coptera hispanica*	Hymenoptera	Diapriidae
9	*Panstenon nr. collaris*	Hymenoptera	Pteromalidae
10	*Platygaster oryzae*	Hymenoptera	Platygastroidea
11	*Pipunculus javanensis*	Diptera	Pipunculidae
12	*Tomosvaryella oryzaetora*	Diptera	Pipunculidae
13	*Rogas narangae*	Hemiptera	Lygaeidae

Table 4: The speciesof predatorsfound in tidal swamp land

No	*Species*	*Ordo*	*Family*
1	*Paederus fuscipes*	Coleoptera	Staphylinidae
2	*Gerris remigis*	Hemiptera	Geriidae
3	*Conocephalus longipennis*	Orthoptera	Tettigoniidae
4	*Conocephalus dorsalis*	Orthoptera	Tettigoniidae
5	*Agriocnemis femina femina*	Odonata	Coenagrionidae
6	*Agriocnemis pygmea*	Odonata	Coenagrionidae
7	*Pardosa psuedoannulata*	Araneae	Lycosidae
8	*Araneus irustus*	Araneida	Araneidae
9	*Tetragnatha maxillosa*	Araneae	Tetragnathidae
10	*Lycosa pseudoannulata*	Araneae	Lycosidae
11	*Oxyopes javanus*	Araneae	Oxyopidae
12	*Menochilus sexmaculatus*	Coleoptera	Coccinellidae
13	*Gryllus assimilis*	Orthoptera	Gryllidae
14	*Polyrachis nigra*	Hymenoptera	Formicidae
15	*Ophionia nigrofasciata*	Coleoptera	Staphylinidae
16	*Micraspis* sp.	Coleoptera	Coccinellidae

Table 5: The speciesof parasitoidsfound in tidal swamp land

No.	*Species*	*Ordo*	*Family*
1	*Telenomus rowani*	Hymenoptera	Braconidae
2	*Tetrastichus* sp.	Hymenoptera	Eulophidae
3	*Coptera hispanica*	Hymenoptera	Diapriidae
4	*Goniozus nr. triangulifer*	Hymenoptera	Bethylidae
5	*Pipunculus javanensis*	Diptera	Pipunculidae

Species richness (R) and dominance index (C) of Predators and Parasitoids

The values of species richness (R) and dominance index (C) of predators and parasitoids at each stage of planting and cropping system on backswamp land are shown respectively in Tables 6 and 7.

Table 6: Species richness (R) and dominance index (C)of predators on local and conventional croppingsystem of back swamp land

Stage of planting	Species richness index (R) on cropping system		Dominance index (C) on cropping system	
	conventional	local	conventional	local
Taradak	1,559	1,573	0,254	0,469
Lacak	1,737	2,275	0,219	0,185
Tanam	3,069	3,119	0,125	0,171

Table 7: Species richness (R) and dominance index (C)of parasitoids on local and conventional croppingsystem of back swamp land

Stage of planting	Species richness index (R) on cropping system		Dominance index (C) on cropping system	
	conventional	local	conventional	local
Taradak	0,736	2,232	0,709	0,222
Lacak	1,674	2,569	0,278	0,184
Tanam	2,552	2,597	0,300	0,124

The values of species richness (R) and dominance index (C) of predators and parasitoids at each stage of planting and cropping system on tidal swamp land are shown in Tables 8 and 9.

Table 8: Species richness (R) and dominance index (C)of predators on local and conventional croppingsystem of tidal swamp land

Stage of planting	Species richness index (R) on cropping system		Dominance index (C) on cropping system	
	conventional	local	conventional	local
Semai	0,558	1,188	0,556	0,294
Taradak		1,276		0,331
Lacak		0,334		0,58
Tanam	1,924	1,616	0,173	0,272

Table 9: Species richness (R) and dominance index (C)of parasitoids on local and conventional croppingsystem of tidal swamp land

Stage of planting	Species richness index (R) on cropping system		Dominance index (C) on cropping system	
	conventional	local	conventional	local
Semai	0	0	0	0
Taradak		0		1
Lacak		0		0
Tanam	0,261	0,738	0,957	0,76

5. Discussion

The diversity of predator and parasitoid species on rice crops made the values of species richness (R) and dominance index (C) varied at each planting stage and cropping system.

The species richness of predator/parasitoid is an indicator of the number of predator/parasitoidspecies in an ecosystem. The species richness of predators and parasitoids on local cropping system tended to be higher than on the conventional for all stages of planting and types of swamplands (back swamp and tidal swamp). That higher species richness on local cropping system was probably caused by the tillage method using a trowel to clear the weeds when the water was stagnant producing weed heaps for green manure. The richness in organic matter was an alternative food source for neutral insect population that could become the prey for predators. Besides, weed heaps could also be a temporary shelter or hiding place for pests that would make them as the prey for predators/parasitoids remain available, and also a hiding place for the predators from their natural enemies or the cannibalism by their own species. The habitat around the agricultural land is the shelter for many insect predators and parasitoids when there are no crops available, and also the habitat for prey or the alternative host for natural enemies as well as the providers

of additional food such as nectar and pollen (Sosromarsono & Untung, 2000).

The tillage in conventional cropping system generally used herbicides. Each stage of planting in local cropping system required a longer time than in conventional, allowing the natural enemies to be able to associate with the ecosystems longer on rice plants. It showed that the condition of the habitat surrounding the rice fields affect the diversity of insects including the natural enemies in it (Settle *et al.*, 1996 and Herlina*et al*., 2011). The habitat conditions surrounding the land may affect the food network between parasitoid with its host (Tylianakis*et al*., 2007; Laliberté &Tylianakis, 2010)

Species richness of predators/parasitoids generally increased with the increasing age of the rice crop (taradak, lacak, planting). The age differences of rice crops caused the presence of pests and natural enemies may also be different for each stage of crop ages. This was similar to the results of the previous studies which stated that in supporting habitat condition, the parasitoid diversity would follow the different diversity of the host in every phase of rice growth (Heinrichs*et al*., 1994).

Most of predators and parasitoids on rice crops, *Cyrtorhinuslividipennis, Micraspissp Agriocnemis femina femina, Goniozus*nr. *triangulifer, Pipunculusjavanensis*, and *Telenomusrowani*, were the predators and parasitoids of rice pests (including brown plant hoppers and stem borers),so as the presence of predators and parasitoids suppressed the attack of rice pests including the major pests, brown plant hopper (on the backswamp land) and stem borer (on the tidal swamp land).

The dominance index of predators/parasitoids described the species of predators/parasitoids dominating a community in each habitat. The dominance index of predators in local cropping system of backswamp land ranged from 0.171 to 0.469 and in conventional cropping system from 0.125 to 0.254. According toOdum (1983), the criteria of dominance values in both cropping systems were low because they were in the range of below 0.5. It indicated that each species may have had the same number, and there was no predator species more dominant than the others in the habitat.

The dominance index of parasitoids in local cropping system of backswamp land ranged from 0.124 to 0.222 and in conventional from 0.278 to 0.709. The criteria of dominance values in local cropping system were low whereas in conventional were categorized medium because they were in the range of 0.5-0.75. It indicated that there was one species that was more dominant than the others, namely *G.nr.triangulifer*.

The dominance index of predators in local cropping system of tidal swampland ranged from 0.272 to 0.58, and in the conventional from 0.173 to 0.556. According to Odum (1983), the criteria of dominance values in both cropping systems were categorized medium in the range of 0.5 to 0.75. It showed that there was one species more dominant over the others, but still in medium category (indicating that the difference in the number of dominating individuals of a species was not too extreme).

The dominance index of parasitoids in local cropping system of tidal swamp land ranged from 0 to 1 and in conventional from 0 to 0.957. The criteria of dominance values in both cropping systems were included in high category, which were in the range of 0.75-1. This indicated that there was one very dominant species (the difference in the number of individuals of a species that dominated and did not was very extreme), namely *T. rowani* (parasitoids of eggs) in the local faming system, and *G.nr.triangulifer* (parasitoids of larvae) in the conventional cropping system. This high number of dominating individuals of a species may have been caused by the environmental conditions, either micro-climate or the host availability, that were favorable for their development. Both the dominating species were also classified as parasitoids considerable potential in controlling rice pests, especially stem borers and leafhoppers (Shepard *et al*., 1987).

The index of species richness (R) and dominance (D) in an ecosystem can describe the condition of the ecosystem. The species richness of predators and parasitoids in local cropping system tended to be higher with low dominance index compared to conventional cropping system. It can be said that the ecosystem was in a relatively stable condition, that the number of individuals of each species were relatively the same.

In general it suggested that the presence of natural enemies, both predators and parasitoids, in these swamplands was significantly potential in pest management in rice crop ecosystems. According to Altieri (1999), the presence of natural enemies, namely predators and parasitoids, in agricultural ecosystems have a very important role, especially in controlling the population of insect pests. The values of species richness and dominance index indicated that the local cropping system was capable of conserving natural enemies in rice crop ecosystem on swamplands (tidal swamp and backswamp).

6. Conclusion

Based on the results of the study, it can be concluded that the species richness of predators and parasitoids in local cropping system tended to be higher than in conventional system for all stages of planting and types of swamplands (tidal swamp and back swamp). The dominance index of predators on backswamp land was categorized low and on tidal swamp land medium, for both cropping systems. The dominance index of parasitoids on back swamp land showed that in local cropping system it was categorized low and in conventional system medium while the dominance index on tidal swamp landin both cropping systems had relatively high values, dominated by *Telenomusrowani* (local) and *Goniozus nr. triangulifer* (conventional). The values of species richness and dominance index indicated that the local cropping system capable of conserving natural enemies in rice crop ecosystems on swamplands (backswampand tidal swamp land). In the future, we need to conduct further studies on the potential *Telenomusrowani* and *Goniozus nr. Triangulifer* in controlling stem borers and leafhoppers.

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