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OVERVIEW OF PREDATORS IN SHALLOTS PLANTATION IN PEATLAND, LANDASAN ULIN SOUTH BORNEO

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ABSTRACT

Species abundance and diversity of predatory arthropods are important information for developing biological pest control strategies. A study that aims to determine the abundance of predators (Coccinellidae and Araneae) in peatlands planted with shallots in Tegal Arum Village, Landasan Ulin District, Banjarbaru City, South Borneo has been carried out. The method used is purposive sampling method. Selecting plots with uniform growth and plant height of shallots in one plot or beds measuring 3 x 20 m and six plots were observed using three methods: direct sampling, swing nets, and pitfall traps. Observations on species abundance of spiders and predatory coccinellids were carried out to describe the number of species and the abundance of insects in shallot cultivation on peatlands. Predators from the order Coleoptera of the Coccinellidae family observed belong to (*Menochilus sexmaculatus*, *Micrapsis* sp, *Coccinella novemnotata* and *Scymnus* sp. with 143 individuals and the highest population was found by *Micrapsis* sp (128 individuals). Meanwhile, there were 6 species of spiders (Araneae) from 5 different families (Oxyopidae, Tetragnatidae, Lyniphiidae, Thomisidae, and Lycosidae) with the most individuals being Oxyopes variabilis (Araneidae: Oxyopidae). The distribution index of species diversity (E) shows E> 0.6, indicating that the evenness of species on the land is uneven

Key words: Abundance, araneae, coccinellidae, coleoptera, diversity, families, peatland, predator, shallots, species

Plant pest population management is carried out by paying attention to the agro-ecosystem. Especially the biotic factors which consist of insect pests, natural enemies, both predators, and parasitoids (Chakravarthy et al., 2016). The approach to studying the structure of the agroecosystem is to study the biodiversity of the cultivated land, in this research the land used is peatland for shallot cultivation in South Kalimantan. Coleoptera predators are biological control agents that are found in various types of agricultural land. This insect has a large number of species with a cosmopolitan distribution (Efendi et al*.,* 2016). These Coccinellidae is a well-known beetle family, consist of seven families, i.e. Epilachninae, Coccinellidae, Chilocorinae, Coccidulinae, Ortaliinae, Scymninae, and Sticholotidinae (Pope, 1988). Except for the mycophagous Coccinellinae (Halyziini and Tythaspis) and the phytophagous Epilachninae, all remaining coccinellids are predators of hemipteran insects from the suborder Sternorrhyncha (e.g. aphids, scales, psyllids and whiteflies), mites eventually other insect larvae and insect eggs (Amir, 2002; Dixon, 2000; Damayanthi, 2016). Fiaboe et al., (2007) stated that as many as 5200 species of predatory Coccinellidae have been identified. Foltz (2002) estimates that there are 5000 species of predatory Coccinellidae worldwide, while according to Vandenberg (2009); Kundoo and Khan (2017) predatory Coccinellidae is 6000 species and are found in mountainous areas, agricultural areas, coastal areas to urban areas and 90% predatory. Coccinellidae has fairly high diversity, it is estimated that there are 5000 species worldwide, while in Indonesia it is estimated that more than 300 species are widespread (Nelly et al., 2015). Many types of predatory Coccinellidae in Indonesia have great potential in controlling the population of various types of plant pests (Aprila et al*.,* 2019). The Coleoptera represent one of the most abundant animal groups (Sushko, 2018) and important natural enemies of many insect pests in terrestrial ecosystems such as peatlands. They are important members of food webs, providing protein for species at higher trophic levels (Sushko 2012; Sushko 2017). In Soraya's research (2016), nine species of predatory Coccinellidae were found in eggplant plantations, i.e. *Epilachna vigintioctopunctata, E. borealis, Illeis flava, Harmonia consformis* and *H. testudinaria*. Meanwhile, Efendi et al. (2016) found ten predatory Coccinellidae viz., *Chilocorus melanophthalmus*, *Coelophora maculata*, *C. inaequalis*, *C. reniplagiata*, *C. bisellata*, *Ropaloneda decussate*, *Verania discolor*. In eggplant and chili three species were found *Coccinella transversalis*, *Menochilus sexmaculatus*, and *Verania lineata*. This study explores abundance of Coccinellidae predators and spiders as natural enemies.

MATERIALS AND METHODS

This research was conducted in Tegal Arum Village (-3°25'44 ", 11°44'69", 10.8 m, 284°), Landasan Ulin District, Banjarbaru City, South Borneo, Indonesia. The research was conducted from August to October 2020. Species diversity was analyzed using the Shannon-Wiener index (H '), the Simpson Domination Index (D), and Evenness (E) using the Magurran handbook (Magurran 1988). If the value of H '<1 then the community is less stable, if the value of H' is between 1-2 then the community is stable, and if the value of H '> 2 is said to be very stable (Kent and Paddy, 1992). The criteria for the level diversity based on this index are high if the value of H '> 3.5, moderate if H' = 1.5 - 3.5, and low if H '<1.5. Odum (1993) stated that the criteria for dominance if the C value approaches 0 (<0.5), then no species dominate and If the C value approaches 1 (≥ 0.5), then there is a dominant species. Observations of Predator. Using purposive sampling method, by selecting plots with uniform growth and plant height of shallots in one plot or beds measuring 3 x 20 m. The observed 6 plots. Observations were made using three methods: direct sampling, sweeping nets, and pitfall traps. The determination of the point for trapping is done deliberately. 3 traps were placed in the front, middle and back of the plot with a distance of 5 meters between the traps, placed in the center of the plot. Observations were made at the age of 0, 28, 42, 56 dd. Installation of pitfall traps for 24 hrs, at the same time as other observations. Sampling was done by direct collection. Hand picking on the sample plots. Sweeping net. Insect sweeping nets were used with 10 double swings across the plot area vertically and three captures were made for each observation. Pitfall trap were used to observe ground-level arthropods made of plastic cups with a diameter of 50 mm and a depth of 100 mm. This trap was filled with a solution of water and four drops of liquid detergent (10:1). This trap is filled with a solution of water and four drops of liquid detergent (10:1), the solution being filled with only one third of the total volume. Then placed in a hole that has been provided according to the size of the plastic cup, placed for 24 hours on the ground. The traps are cleaned and bottled for identification. Predator identification was carried out by observing insect specimens, especially the Coccinellidae, Coleoptera and spiders (Family Araneidae, Araneae). Predatory Coccinellidae specimens obtained in the field were identified to species level by matching the specimens with pictures and descriptions from the identification key book. Identification of specimens using morphological characteristics of the wings, antennae, and thorax. Predatory Coccinellidae specimens obtained in the field were identified to species level using the identification key of Khan et al. (2006), Stephens and Losey (2004), Kalshoven (1981), McAlpine, et al. (1987), and Barrion and Litsinger (1995). To identify spiders using Wegner, (2009), Jocqué and Anna (2007), and Heisswolf, S., et al. (2010). Species composition data and the number of individual predators of Coccinellidae and spiders were used to analyze abundance and evenness. The measure of abundance used is the value of the Shannon-Wienner species diversity index (H') and Eveness (E) using Magurran's (1988) book.

RESULTS AND DISCUSSION

The land for shallot cultivation in the Tegal Arum is a peatland that has just been cleared and is starting to be planted with Citrus, sugar cane, chilies, and shallots. Based on the results of observations that have been made, 217 individual predators were collected. The results showed that the predators of the order Coleoptera family Coccinellidae were 4 species with 143 individuals and the highest population was found by *Micrapsis* sp (128). Meanwhile, there were 6 species of spiders with the most individuals being *Oxyopes variabilis* (22) Araneidae: Oxyopidae and the lowest was *Lycosidae* sp (Araneidae: Lycosidae) with 4 individuals (Table 1).

Predators from coccinelidae have more individuals than Aranaea but the number of Aranaea taxa are Coccinellids function in complex food webs as predators, as non-prey food consumers, and as prey or host of natural enemies. In the life stage of the coccinellids, the eggs are particularly susceptible to predation, and the coccinellids are behaviorally adapted to reduce egg predation from heterospecific predators (Weber and Jonathan, 2009).

Several papers have discussed the positive and negative effects of these two predators in new environments (Camacho-Cervantes et al., 2017; Kenis et al., 2017; Koch and Costamagna, 2017; Riddick, 2017). The second interaction affects community structure and predator-prey dynamics in various ecosystems, including agroecosystems. Thus, the expansion of the range of these predatory species has both negative and

Table 1. Diversity and abundance of predators in shallot peatland agroecosystems (Tegal Arum Village, Landasan Ulin District, Banjarbaru City)

No.	Taxon	Ordo	Family	Number of insects caught				Total
				Plant age				
				0	28	42	56	
1	*Menochilus sexmaculatus*	Coleoptera	Coccinellidae	8	1	0	0	9
2	*Micrapsis* sp	Coleoptera	Coccinellidae	43	45	30	10	128
3	*Coccinella novemnotata*	Coleoptera	Coccinellidae	2	1	0	0	3
4	*Scymnus* sp	Coleoptera	Coccinellidae	1	1	1	0	3
								143
1	*Oxyopes variabilis*	Araneidae	Oxyopidae	4	9	4	5	22
2	*Oxyopes* sp	Araneidae	Oxyopidae	3	2	0	0	5
3	*Tetragnatha* sp	Araneidae	Tetragnathidae	4	2	4	1	11
4	*Linyphiidae* sp	Araneidae	Lyniphiidae	10	6	2	0	18
5	*Vitia misumena*	Araneidae	Thomisidae	5	6	1	2	14
6	*Lycosidae* sp	Araneidae	Lycosidae	0	2	2	0	4
								74
Number of taxa				9	10	7	4	10
Total				80	75	44	18	217

positive ecological effects on biodiversity and levels of biological control. Although many studies examine the spatial and temporal patterns among predatory coccinellidae and predatory aranaea. However, the mechanisms involved in the coexistence of this species are still limited (Hongran et al., 2021). *Micraspis* sp had the highest individual among the others. It is suspected that this species is a species whose natural habitat is in peatlands. This is supported by research by Soedijo et al. (2012) and Samharinto et al. (2011). Micrapsis sp was found in large numbers from three research sites on peatland planted with rice in South Kalimantan. When viewed from the length of the life cycle, *Micrapsis* sp were higher than the males in longevity and predation rate. Longer than other species, which ranged from 1-2 weeks to develop from eggs to adults. Chaudhary et al. (2015) in their research stated that female *Menochilus sexmaculatus* (Fabricius) consumed higher than other Coccinellidae. However, Hllaing et al. (2017) stated otherwise, the predation rate of 1st instar grub was 37.5± 4.6 and 4th instar grub was 51.7± 9.8. The male predation rate (51.1± 16.1) and female predation rate (57.8± 16.4) were observed under the same conditions. It is possible that this is the basis for this species to dominate in onion fields. In observations this type is found in grasses, shrubs. Meanwhile, *Menochilus sexmaculatus*, *Coccinella novemnotata* and *Scymnus* sp were not found. According to Puspasari et al. (2016), *Menochilus sexmaculatus* is more commonly found in peanuts, soybeans, beans, corn, eggplant and vegetables. *Coccinella novemnotata* in chili plants attacked by *Bemisia tabaci* and *Scymnus* sp was more commonly found in plants infected with mealybugs (*Paracoccus marginatus*) (Tairas et al., 2015). In the research area, eggplant, chili were planted, while banjar siam oranges and guava were attacked by mealybugs. It is possible that the three predators apart from this *Micrapsis* sp, have already gotten their food from these plants, so they are rarely found in shallot plantations.

Spiders are common predators that can eat a wide variety of prey (Foelix, 2011) and are very effective in managing pests and reducing crop damage. Spiders are very abundant in agriculture and if conserved and the population is plentiful, they can control insect pests (Basnet and Mukhopadhyay, 2014). At the initial observation, in the uncultivated land found various types of leafhoppers and grasshoppers. It is suspected that this is a supporting factor why many types of spiders are found. The ability of spiders to prey on the main insect pests of brown planthoppers, their ability to prey on nymphs and imago ranges from 5-15 tails/day and can also become cannibals for fellow species or different species (Soedijo and Indar, 2015). It is also suspected that the clearing of land for shallot plantations causes spiders to lose their habitat so that their population also decreases and food decreases. Each spider species has a different active time and prey species, so it is very important to manage the diversity of spider species in an area (Wayan and Hery, 2013). So that the time of observation in the field also affects the number of individual spiders caught in the observation.

The highest individual in Araneae is *Oxyopes* sp. ratter (lynx spider) and *Lycosidae* sp. (wolf spider) was the lowest among the Araneae. Lynx spiders are roving hunters commonly associated with the shrubby and grassy understory and are small and slender. This is in contrast to the larger wolf spiders and fast-moving ground hunters. The research of Memah et al. (2018) states, the preying ability of *Oxypes* sp. on imago is the highest compared to others. The families Agelenidae, Araneidae, Tetragnathidae, and Thomisidae are spiders that are nocturnal or nocturnal. On the other hand, Lyniphiidae is a family of spiders that are active during the day or diurnal. Costello and Daane (2005) also found that most members of the Araneidae and Lycosidae are nocturnal, while all Salticidae are diurnal. Oxyopidae is more in the field because this species was active during the day and night or 24 hrs.

There is a tendency for the predatory population of Coccinellidae and Araneidae to decrease with the increasing age of shallot plants. Successively, at 0 days to 56 days after planting the population was 80, 75, 44, 18 predators. There was a decrease in species diversity and the number of individuals along with the age of the shallot plants. The land used in this study is peatland, where this land is formed from organic materials, such as leaves, stems, branches, and plant roots. Likewise, according to Sugiyarto (2007), organic matter which is difficult to decompose will function as a ground cover so that it can be used as a good source of energy for the insect community. Therefore, trophic composition of predator assemblage can play an important role in determining the nature of the relationship between predator diversity and ecosystem fuction (Finke and Denno, 2005). Organic matter has an important role to support plants and soil organisms so that if the soil organic matter content decreases, the soil's ability to support the productivity of plants and soil organisms also decreases. Naturally, the number of insects in this study predators Coccinellidae and spiders is more at the beginning of the observation.

The population of pest predators at the beginning of planting (0 days) was more diverse and the numbers were more numerous plus there were still weeds and bushes. On the land, grasses, shrubs and shrubs were found such as *Leersia hexadra, Hymenachne acutigulma, Brachiaria* sp. *Pennisetum purpureum*, *Panicum* sp, *Paspalum* sp. *Stenochlaena palustris*, *Chromolaena odorata*, *Xyris indica* and *Melastoma malabathricum*. Wild plants or weeds are important agro-ecosystem components because they can positively influence the biology and dynamics of natural enemies (Altieri and Nicholls, 2004; Puspasari et al., 2016). This plant is an alternative host, a place to hide if predators or natural enemies experience bad environmental conditions (Van Emdem, 1991; Altieri and Nicholls, 2004). The cropping pattern used also affects the diversity and population of insects in a land. This study used a shallot monoculture pattern. According to Semiun and Stefanus (2016) and Melhanon and Dewi (2020), the diversity and abundance of monoculture farming systems of arthropods are lower than that of polyculture systems.

Besides, the growth phase of the shallot also affects the abundance of these two predators. This is supported by Kaleb et al. (2015) which states that the height and low level of individual insects as natural enemies of the crown and soil surface indicate that the availability of available food sources is closely related, i.e. conformity to the growth phase of plants that provide a source of food for the growth and development of natural enemy insects, the reduction of pests that have the potential to serve as a food source for natural enemy insects.

At the beginning of soil cultivation or 0 days, the diversity index showed a moderate and stable category (1.57), along with land cultivation and cleaning of weeds and planting into monocultures (shallots), the diversity index decreased to a low (<1.5) (Table 2). This is thought to be due to land clearing and weed clearing, loss of housing for various types of insects, both pests and predators. Many types of planthoppers (zig-zag planthoppers, white-backed planthoppers, brown leafhoppers, green leafhoppers, leafhoppers, white and yellow rice stem borers and grasshoppers were found before land clearing. All these are food for spiders and coccinelid beetles. Changes occur in the food web or trophic transfer. Yang et al. (2018) observed the effects of predator diversity on prey biomass and

Table 2. Diversity index, evenness index of predatory (Coccinellidae and Araneida species) in shallot crop ecosystems on peatlands in South Kalimantan

Observation (days)	Index value	
	Diversity (H ')	Evenness (E)
0	1.57	0.71
28	1.43	0.62
42	1.15	0.59
56	1.09	0.78

trophic transfer efficiency (using the predator/prey biomass ratio). Higher prey diversity increases predator diversity and biomass, as well as trophic transfer efficiency, which may result from a more balanced diet and/or increased niche complementarity due to higher prey diversity. This effect of prey diversity affects predator-prey interactions in natural ecosystems. Weber and Jonathan (2009) and Wilby et al. (2005) stated that the effects of species diversity appear in natural enemy assemblages depending on the context; they depend not only on the characteristics of the predatory species but on the identity of the species they prey on. This effect of prey diversity affects predator-prey interactions in natural ecosystems.

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AUTHOR CONTRIBUTION STATEMENT

Salamiah and Helda conceived and designed research. Samharinto and Muhammad conducted experiments. Pramudi and Lyswiana contributed analyzed data. All authors read and approved the manuscript.

CONFLICT OF INTEREST

No conflict of interest.

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