Community Characteristics of Brown Planthopper (Nilaparvata lugens Stal) Predator Arthropoda Community in Agroforestry-Based Rice Fields

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Abstract: *This study aims to explore the potential of agroforestry ecosystems in maintaining the balance of the rice field ecosystem. Two rice fields around agroforestry with different types of agroforestry were selected, namely rice fields adjacent to simple agroforestry and complex agroforestry in Gunungcupu Village, Sindangkasih District, Ciamis Regency, West Java. Arthropod species data were obtained using a mask and suctioning was carried out with an aspirator. There are 40 sample plots at each Location. Plots were placed systematically in rice fields adjacent to agroforestry with a distance between plots of 10 m and a distance between plots of 10 m. Observations were made since the beginning of the first planting period, September 20 2018, continued during the planting interval and ended in the last week of the second planting period on June 14 2019. Based on the analysis results, it was found that the even distribution of predatory arthropod species in the rice fields was not affected by the planting period. The planting interval also did not affect the diversity and even distribution of insect predatory arthropod species. This condition indicates that agroforestry areas have the potential to support the diversity of arthropod species in paddy fields.*
Keywords: *Agroforestry; paddy fields; predatory arthropods; species diversity; planting gap*

I. Introduction

Agriculture has the potential to cause ecological problems. The problems found are mainly related to the imbalance of the system chain in the land, which is indicated by the emergence of pests in abundance at certain times. According to Ferdy in Hasibuan (2019), in the world of agriculture and in the sub sciences of plant breeding in particular there is something called the castration. Agricultural land is increasingly narrow due to the shifting of the function of agricultural land into industrial areas, so that hydroponic cultivation is considered appropriate to utilize available land because this cultivation system does not require soil media (Zailani, 2019). These findings are strengthened after intensive farming with the use of synthetic fertilizers and poisons. Planthoppers in rice fields, for example, has long been an important pest in Japan and other tropical Asian countries (Hattori, 2001). The rice planthopper is endemic to the mainland tropics, but its habitat has temporarily spread to Japan and Korea in a massive long-distance migration (Sogawa, 1982). The increasing influence of the brown planthopper (Nilaparvata lugens Stal), has occurred since 1970 as a pest that destroys rice harvests in Indonesia, especially in Java, North Sumatra and Bali (Kalshoven, 1981; Anonymous, 2005; Untung, 2006). In 1976-1977 the area of rice fields attacked by brown planthoppers reached 347,000 ha, thus disrupting the national rice supply. The brown planthopper attack in waves from time to time is influenced by its physiological properties that are able to create new biotypes to break rice resistance in varieties grown in the field (Hattori, 2001; Zuraida, 2004; Baehaki, 2005). Green leafhoppers (Niphottetix virescens) are also widely reported to be the cause of crop failure (Widiarta, 2005) mainly because of their ability to transmit the tungro virus which is very damaging to rice crops. This problem is of course closely related to the surrounding environmental conditions.

An ecological approach can overcome pest attacks on agricultural land. The approach taken is to present natural enemies of pests on the land (Pranadji and Saptana, 2005; Untung, 2006; Susilo, 2007). The ecological principle emphasizes that pests and natural enemies must be in a balanced condition. Pests do not cause crop-damaging effects because ecosystems provide natural mechanisms through numerical responses and functional responses. The mechanism is formed through the diet eaten between predators/parasitoids and prey/hosts.

Arthropods have an essential role in the ecosystem. In relation to the agricultural ecosystem, there are arthropods that play a neutral role, act as pests and some act as natural enemies of the pests concerned (Tarumingkeng, 2001; Untung, 2006; Susilo, 2007). Mahrub (1998) conducted a study on the community structure of arthropods in lowland rice in the rainy and dry seasons without the application of insecticides. An important finding from this research is that in the lowland rice ecosystem, the diversity and abundance of arthropods are known to be quite high. The pest population is lower than predators. This condition has encouraged negative feedback interactions and can increase the potential for natural enemies so that the natural pest control process runs well without the use of insecticides. Increasing the diversity of habitats in agricultural landscapes can increase the variety of insect pests and beneficial insects (natural enemies) and often reduce crop damage by pests (Yaherwandi and Syam, 2007). The creation of these balance conditions poses the next challenge, namely the application of the most suitable strategy in the cultivation area. Consideration to create the suitable habitat for natural enemies is now essential.

Agroforestry can be an alternative habitat for natural enemies. Agroforestry has the main function that emphasizes meeting the needs of life in the form of agricultural production (improvement of welfare) and ecosystem sustainability from a practical point of view. The ability of agroforestry to maintain and maintain natural resources has an impact on several things, namely: 1) maintaining physical properties and soil sustainability, 2) maintaining the hydrological function of the area, 3) maintaining carbon stocks, 4) reducing greenhouse gas emissions and 5) maintaining diversity. biodiversity (Hairiah et al., 2003; Sardjono et al., 2003; Widianto et al., 2003). Agroforestry makes beneficial contributions both economically and ecologically (Widianto et al., 2003). Agroforestry ecosystems can also be a habitat for useful animals such as pollinators and predators of agricultural pests. This is an important value in agroforestry areas related to the condition of the rice field ecosystem. Agroforestry that functions as a forest area is a buffering force for ecosystems that must be maintained for its sustainability. Of conceptual relevance between agroforestry and forests, Pranadji and Saptana (2005) view forests as important controllers of natural insect diversity. Consideration of forest as a balancer for lowland rice farming ecosystems because rice fields have a fragile ecosystem. The system link in the rice field ecosystem has been modified to be simpler and lamer (Laba, 2001; Untung, 2006). The agroforestry system approach to provide carrying capacity for lowland rice cultivation is very important. Agroforestry systems are considered to have high biodiversity. Thus, it is important to know more specifically the role of agroforestry areas around rice fields.

This picture is interesting to be studied further, especially with regard to the functioning of the agroforestry ecosystem in providing resources for the predatory arthropods of leafhoppers in the rice field ecosystem. The findings of this study are useful for various aspects, both scientific and applied. Practitioners in the field also received new information about the potential of agroforestry as a supporter of the rice field ecosystem.

II. Research Method

This research is in the form of field exploration studies in farmers' fields. The rice fields chosen as the research location are those in the vicinity bordering the agroforestry area. The study location is in Gunungcupu Village, Sindangkasih District, Ciamis Regency, West Java

Province Ciamis District. The research location was determined in two rice fields that have different types of agroforestry areas, namely simple agroforestry and complex agroforestry. The rice fields were chosen by cooperative farmers who grow rice conventionally, namely rice cultivation by applying inorganic fertilizers and the use of pesticides for pest control. Data collection in the field was carried out for two uninterrupted planting seasons starting on September 20, 2018, until June 14, 2019.

The tools needed for transect activities are a plastic mine measuring 200 m long, a lid with a diameter of 55 cm2 (Mahrub, 1998; Schoenly et al., 2003), a tape meter, and red bamboo poles with a length of 1 m which are used as markers. Permanent sample plot.

The main tools for observing arthropods are the mask and aspirator. The lid is made of a frame made of an iron plate covered with mica plastic in the form of a tube with a bottom surface diameter of 55 cm and a height of 80 cm. The aspirator is made from a modified mini vacuum cleaner with an energy supply from a 1000-watt mini generator. Another tool needed is a cloth bag to hold the sample in the aspirator. Species identification is carried out in the laboratory, the equipment needed in the field is a drum, sasag, newsprint, soft-bristled brush, plastic bag clip, small styrofoam cubes, label paper, species recapitulation form, and stationery.

This research is a quantitative exploratory study. The research variables included the diversity of plant species in the agroforestry area, the diversity and abundance of predatory arthropod species in the agroforestry and paddy fields. The diversity of plant species in the agroforestry area is used as the basis for the comparison of agroforestry types in the research location. Abiotic environmental conditions were also taken as complementary data including temperature, humidity and daily rainfall.

Table 1. Observation Phase at the Research Site

September 24 – December 31 2018	January 7 – February 25 2019	March 4 – June 17 2019
First planting time (15 weeks of observation)	Planting break (8 weeks o observation)	Second planting time (15 weeks of observation)

III. Discussion

Plant samples were taken using stratified plots. Observations of plant diversity were carried out in two different locations, namely Location A and Location B. The number of samples taken at each Location took into account the broad representation of each agroforestry. Based on the results of measurements in the field, it is known that the area of Location A is 31,095.21 m2 and the area of Location B is 47,684.34 m2.

The characteristics of Location A are rice fields side by side with simple agroforestry. This agroforestry is dominated by mahogany (Swietenia mahagoni). Other plants found with rare frequency were coconut (Cocos nucifera), albasiah (Albizia falcataria) and banana (Musa sp.) while those found very rarely were teak (Tectona grandis). The grass plants in the middle of the forest are not too dense because S. mahagoni as the main plant making up the forest vegetation has a fairly high level of area cover so that the grass plants do not have the opportunity to grow freely. Grass plants that are denser are found on the outskirts of agroforestry bordering the rice field ecosystem. The grasses that grow there are Laersia sp., Paspalum conjugatum, Imperata cylindrica, Ageratum conyzoides, Phylanthus niruri. This grass looks very tight, especially during the rainy season. The cropping pattern on this land does not follow certain rules. S. mahagoni as the main constituent of vegetation grows without certain rules. Ripe seeds that fall around the forest floor then grow naturally so that this plant has a complete strata starting from the new seedling level, saplings, poles to the shape of an adult tree with a trunk diameter varying between 1-27 cm. These forest characteristics are categorized as simple agroforestry.

The characteristics of Location B are rice fields adjacent to complex agroforestry. Agroforestry at Location B has a much more diverse vegetation. The agroforestry land in this Location is managed by the owner by deliberately planting various types of plants without setting certain rows or rows. Similar plants are planted anywhere on land that allows them to be planted. The distances and rows/rows are not well defined so that a regular crop pattern does not appear. Plants consist of seasonal plants, namely kencur (Kaempferia galangal), taro (*Colocasia esculenta*), cayenne pepper (Capsicum frutescens), turmeric (Curcuma longa) and cassava (Manihot uttilissima). The fruit plants found consisted of banana (Mussa sp.), jackfruit (Arthocarpus integra), rambutan (Nephelium lappaceum), salak (Zalacca edule), randu (Bombax malabaricum), clove (Eugenia aromatic), coconut (C. nucifera).), mango (Mangifera indica) and jatropha (Jatropha curcas). Timber plants consist of teak (T. grandis), albasia (A. falcataria), tissuek / mountain waru (Hibiscus macrophyllus) and African wood (Maesopsis eminii). Land owners use land with any useful plants to meet short, medium and long term needs. Grass plants are allowed to grow to compete with seasonal plants that are deliberately planted. These forest characteristics are categorized into complex agroforestry groups.

Diversity and Evenness of Arthropod Species by Location and Season

Based on the results of the analysis, it is known that the rice fields around which there is a simple type of agroforestry (Location A) have a lower total number of individual arthropod species predators of rice planthoppers than the rice field where there is a complex type of agroforestry around them (Location B). But in terms of species diversity, research sites with simple type agroforestry have a higher species diversity index than those in complex type agroforestry research sites.

The type of agroforestry is related to the number of predatory species in the rice fields. Based on the observations, rice fields surrounding complex type agroforestry have more arthropod species than rice fields surrounding simple type agroforestry. Table 1 presents the number of predatory arthropods species of rice planthopper by location and observation phase. The number of predatory arthropod species in rice fields where there is agroforestry is 26 while the number of species in fields where complex agroforestry is located is 29. The planting period, on the other hand, does not seem to be related to the presence of species in the land because the data obtained inconsistent information between one observation location to another. For example, at Location A, 25 predatory arthropod species were found in the first planting period and at the second planting period, more species were found (26). The findings at Location B were the opposite, because the number of species found in the first planting period was actually more (29 species) than the second planting period (27 species).

The number of predatory arthropod species during the planting interval is less. The data at Location A and Location B showed that during the planting interval the number of predatory arthropod species was much less than the number of species at the planting period, but during the planting interval the number of species in Location A became more (22 species) than Location B (21 species).

The total number of predatory arthropod individuals during the observation was 5,178. The number by Location during observation, individuals at Location B (2,966) was more than Location A (2,122). Thus, the predatory arthropods of rice planthoppers in rice fields around which there are complex type agroforestry ecosystems have 34% more than other locations in this study. The number of individual predatory arthropods during the planting interval at Location B was also much higher (632) than the number at Location A (440), although the number of species showed the opposite (21 and 22 species, respectively). As the description of the number of species, it turns out that the number of individuals found in each research location also does not show the same conditions in the two growing seasons. The highest number of individuals at Location A (1,027) was found during the second planting season, while at Location B the highest number of individuals (1,586) was found during the first planting season. The determining factor for this condition is probably related to the condition of the paddy fields. It is known, in the second planting period where rainfall has decreased quite sharply causing the condition of the paddy fields to become drier, but specifically at Location A the condition of the paddy fields during the second planting period continues to end so that it has higher humidity around the planting. This condition probably caused the predatory arthropod community to be more abundant than the rice fields in Location B.

Table 2. Population Characteristics of Rice Planthopper Predatory Arthropods by Location and Observation Phase

No	Community characteristics	Location A			Location B		
		MT I	Plantin Break Time	MT II	MT I	Planting Break Time	MT II
1	Number of species	25	22	26	29	21	27
2	Total number of individuals	745	440	1.027	1.586	632	748
3	Species diversity index	2,09	2,38	2,40	2,02	2,14	2,33
4	Species evenness index	0,65	0,77	0,74	0,60	0,70	0,71

Information:

MT I : first planting season, 24 Sept – 31 Dec 2018 (15 x observations) Planting break: 7 Jan – 25 Feb 2019 (8 x observations)

MT II : second planting season, March 4 – June 17, 2019 (15 x observations)

The species diversity index has increased over time. The data in Table 1 shows the fact that the diversity of predatory arthropods in paddy fields is thought to be unaffected by the planting period because although the paddy fields experience a fairly long planting gap (two months), it does not decrease the species diversity index.

Figure 1 shows two interesting facts regarding the growing season. The first fact is that the index increases over time without being affected by the interval between the two planting periods, both at Location A and at Location B. This illustration shows that the interval between plantings does not cause a decrease in the index of diversity of arthropod species in the paddy field ecosystem. Although the number of species during the planting interval decreased, it was offset by a decrease in the number of individuals so that the species diversity index showed an increase compared to the first planting period. Thus, it can also be stated that during the planting interval, the ecosystem conditions in paddy fields are maintained at a moderate level of balance.

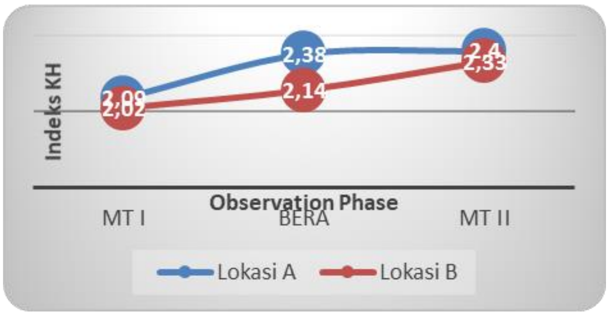

Figure 1. *Diversity Index of Predatory Arthropod Species by Observation Phase*

The second fact is that the index at Location A is higher than that of Location B. The diversity of predatory arthropod species at Location A shows a higher index than Location B, whereas in terms of total individuals and species of predatory arthropods at Location B, it is higher than Location A. Species diversity is a a function of the species and the number of individuals per species. Theoretically, the abundance of certain species which is higher than other species will disproportionately lower the value of the species diversity index. This condition is in accordance with the observed facts.

The evenness index description is almost the same as the diversity index. Table 1. states that there is an increasing trend of evenness index from time to time without being influenced by the planting interval, both at Location A and at Location B. Even at Location B, evenness during the planting interval has the highest index compared to all planting phases. . Figure 2 can also illustrate that at each observation phase the evenness of species at Location A is higher than evenness at Location B.

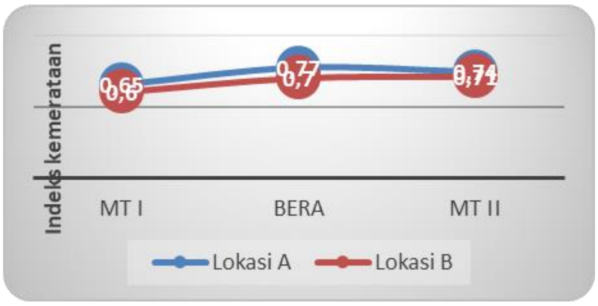

Figure 2. *Evenness Index of Predatory Arthropod Species by Observation Phase*

Agroforestry has the potential to support the diversity of arthropod species in rice fields. The results of the analysis on the diversity of predatory arthropod species data based on observations during the two growing seasons (three phases of observation) illustrate that agroforestry ecosystems around rice fields are able to provide support for the diversity and even distribution of predatory arthropod species in paddy fields. Descriptive analysis of three observation phases (first planting period, planting interval and second planting period) showed that between the two planting periods interspersed with a fairly long planting interval did not reduce the diversity of predatory arthropod species in the rice field ecosystem. The structure of vegetation in agroforestry, the presence of grass in the rice fields and in agroforestry, the intentional distribution of straw in paddy fields and rice *singgang* that are left as they are make the rice field ecosystem able to provide better survival for the biotic elements in the rice field ecosystem, including species. -Arthropod species predatory rice planthopper.

Migration of several insect species from rice field ecosystems to agroforestry ecosystems occurs during the planting interval. The most preferred place for these arthropod species is the forest floor, which is mostly covered with grass, Paspalum vaginalum species, Leersia sp. and Imperata cylindrica. The presence of grass which is the choice of several rice pests as a migration destination will at the same time attract natural enemies to the same destination due to the availability of prey sources. Agroforestry in this case is an alternative habitat for arthropods that live in rice fields.

Agroforestry is a land management system that maintains three environmental elements. The social, economic and ecological elements in agroforestry land management have been unconscious for a long time, making this land management system superior and not found in other land management systems. Farmers get economic benefits in layers from the land they own. Agroforestry at the study site can be an example of this. Short-term needs are met from the forest by means of planting land with plant species for daily needs such as kencur, laja and cayenne pepper. Medium-term needs are represented by fruit species, namely cloves, rambutan, mango, salak and coconut. The long-term needs obtained by farmers from woody plants are teak, albasiah, mahogany or fruit plants that are quite old and unproductive to produce fruit. Farmers developing cropping patterns on their land cannot be separated from the cultural elements inherent in their social environment so that between one area and another will have differences.

Local wisdom in farming communities was born from hereditary experiences. Cultivation carried out by farmers in West Java is also related to the local wisdom of the surrounding community. An example that can be observed is placing cattle pens around the forest so that there is a mutually beneficial relationship between the forest and livestock. Farmers get their source of animal feed from the forest environment and the forest benefits because fertilizer is available sustainably from the barn. Farmers also deliberately allow grass to grow on the forest floor because at certain times it becomes an easy and cheap source of animal feed. This condition will at the same time build a stronger ecosystem because the balance of ecological elements can be maintained by itself.

West Java farmers in many places place rice fields side by side with agroforestry. This situation is related to pragmatic reasons and environmental conditions itself. Farmers view that rice fields adjacent to an agroforestry environment can provide benefits, for example manure from livestock or forage from forests can be applied as fertilizer for rice plants in the fields. They can also do two main things efficiently at the same time, namely work in the garden and in the fields that are not far apart. The reason related to environmental conditions is because topographically the West Java region has a unique topography so that the villages are in a hilly condition. Because rice fields and gardens are the main source of livelihood for the village community, the existence of rice fields and agroforestry side by side is a sight in many places in West Java.

The important value of this research is the exploration of ecological value and scientific intervention for practical value. This study tries to explore the conditions that develop in West Java farming communities where they place rice fields side by side with agroforestry. There have been many studies related to rice fields and agroforestry, but very few studies have attempted to link the ecological value of forests to the interest of lowland rice cultivation. Farmers so far have been cultivating lowland rice side by side with agroforestry, not considering the scientific side in the form of ecosystem support for one another. The ecological point of view states that these two ecosystems allow for mutual support, although in a very simple context. These considerations underlie the conduct of this study so that it can provide information from a scientific point of view.

The scientific intervention for practical cultivation activities is to create an agroforestry area around the rice fields. The diversity of plants found in agroforestry is significant for the diversity of predatory arthropods in paddy fields. While theoretically, rice fields are an unequal ecosystem because the biotic and abiotic elements in it tend to be fragmented. Inequality of rice field ecosystem elements will be recovered by creating complementary ecosystems in the form of agroforestry in the vicinity. In this case, the agroforestry ecosystem becomes a complementary factor for the rice field ecosystem.

IV. Conclusion

The study found that agroforestry was able to support the existence of predatory arthropods in rice fields. The existence of agroforestry around rice fields provides support in the form of a sustainable diversity of predatory arthropod species, both in simple agroforestry and in complex agroforestry. The diversity and evenness of arthropod species are not even affected by the season and planting intervals carried out by farmers in the fields. The results of this study, therefore, can reveal the ecological value of agroforestry for paddy fields, in relation to the sustainability of the diversity of predatory arthropod species in paddy fields.

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