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The Diversity of Insects on Durian Plants

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Abstract. Durian is a fruit that has very high economic prospects and is one of the state assets that can increase non-oil and gas sector income. This research aims to obtain data related to insect diversity on durian plants in the durian fruit plantations in the Bawen area. Determining the research location for durian plants used purposive sampling which took two fields where 25 and 20 tree samples were taken from each field. The sampling method uses the observative method and the relative method. The observational method is taking insects directly and getting samples at that time, namely by using a sweep net, while the relative method is taking insect samples using traps, namely yellow traps and pitfall traps. The results of the analysis of species diversity data calculations show an index value of 1.5, which includes moderate diversity. Moderate diversity means that the number of individuals per species is distributed moderately and there is moderate community stability. The insect species evenness index shows a figure of 0.5 with the criteria for a medium evenness index. The results of calculating the dominance index, the resulting number is 0.25. The index value shows that the environmental and ecosystem conditions are in good (moderate) condition. Good conditions are also described as stable ecosystem conditions where there is stable interaction between insect populations and their natural enemies.

Key words: Insect diversity, durian plants

INTRODUCTION

Indonesia is a country with a very wide natural landscape, so it is called an agricultural country, where Indonesia's nature plays an important role in the development of the agricultural and plantation sectors. One fruit that can reproduce well in Indonesia is durian fruit. Durian (*durio zibethinus*) is a fruit plant that is quite popular with local and foreign people. In Indonesia, precisely on the island of Kalimantan, around 18 of the 27 global durian species are found, 16 of which are classified as endemic species, nine of which are edible, namely *Durio zibethinus*, *Durio kutejensis*, *Durio dulcis*, *Durio excelsus*, *Durio lowianus*, *Durio oxleyanus*, *Durio grandiflorus*, *Durio graveolens* and *Durio testudinarium* (Mursyidin, 2022). Many areas in Indonesia are places where durian is cultivated so that the results are exported to various countries in the world, for example in Banten Province, Lebak Regency and Pandeglang Regency, which contribute to the annual production of durian fruit by 44.6% (Yursak *et al*., 2020) So, it can be said that durian fruit is a state asset that can be a source of income in the non-oil and gas sector.

In 2020, durian fruit production in Indonesia experienced a decline (Rizaty, 2021). To maintain stable durian fruit production, it is necessary to prevent problems, especially preventing insect pest attacks. To know the correct way to prevent and control insect pests, it is necessary to obtain data regarding the diversity of insects in durian plantations. This aims to ensure that the control carried out is in accordance with environmental conditions, can maintain the quality of the durian fruit while minimizing the damage caused to the surrounding ecosystem. As one of the areas where there are quite a variety of durian plantations, the Bawen area, Semarang Regency, was the location chosen because there has been no research on insect diversity in this area.

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Observations that have been made show that there are symptoms of insect pest attacks, most of which attack the leaves. If this is left unchecked, it will cause the durian plants to be damaged and cause losses. Currently, this is an obstacle faced by these plantation farmers. The lack of knowledge about the diversity of insect species found on durian plantations means that insect pests are still controlled using insecticides which have the potential to have a negative impact on the environment if used continuously. In research by García & Argüelles, (2021), it is also stated that the use of insecticides (pesticides) must be very careful, if the use of insecticides is carried out carelessly it can result in the death of various fauna that can be beneficial as well as damage to the ecosystem and impact on human health.

RESEARCH METHODS

Research Location and Time

This research was carried out on durian fruit plantations in the Bawen area, Semarang Regency during July-August 2023. This research is an exploratory type of research with data collection using the survey method, namely direct observation and sampling at the research location. In this research, the population that will be used is an insect species. Meanwhile, the samples used in this research were insects caught in yellow traps, pitfall traps and sweep nets. Samples taken were 45 durian trees with a distance between the plants about 7-10 m x 7-10 m.

Insect Sampling

Data collection uses samples from the population and uses interview questionnaires to obtain data. The tools used in the sampling method are yellow traps, sweep nets, tweezers, thermohygrometers, soil testers and luxmeters, labels, cameras for documentation, writing tools, identification books. Pitfall trap traps consist of plastic clips, plastic cups or cans, plastic covers, small wooden sticks, ribbons or other objects to mark the place where the pitfall trap is installed, while yellow traps use the basic color of the trap to be yellow and are placed on fruit-bearing durian plants and/ or flowering. Yellow is a color that can attract insects effectively for catching insects, especially when the sun is hot (Zhang *et al*., 2020). Interviews with durian plantation farmers were also carried out to obtain additional data regarding insect control carried out.

Insect Identification

Insect identification activities were carried out in the Biology Laboratory, FMIPA, Semarang State University using a stereo microscope and assisted by a camera for documentation. As a reference for determining insect species, the book Borror and various accredited books and journal articles were used.

Data Analysis

Insect diversity data can be calculated using the Shannon-Wiener species diversity index formula, the Shannon Weiner Index (H') is a quantitative measure that reflects how many different species there are in a data set with the following formula (Adelusi *et al*., 2018):

$$H' = - \sum \frac{ni}{N} log \frac{ni}{N}$$

where: ni is the number of individuals in one type and N is the total number of individuals of species that have been discovered. Determining the criteria for the Shannon-Wiener species diversity index is (Reflinaldon & Hamid, 2023):

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Diversity Index (H')	Community Structure Conditions	Category
H' ≥ 2.41	Very stable	Excellent
1,8 ≤ H'< 2.41	More Stable	Good
1,21≤ H'< 1.8	Stable	Medium
0,61≤ H'< 1.21	Stable Enough	Bad
H'< 0.6	Unstable	Very Bad

Evenness index. The evenness index functions to measure the abundance of individual species in a community at a certain place and time, with the following formula and criteria (Adelusi *et al*., 2018):

$$E = \frac{H'}{H\ max\ or\ InS}$$

E is the evenness index (range 0–1), H' is the observed species diversity, H max is the maximum species diversity

The criteria for determining the evenness index are:

Eveness Index (E)	Distribution Condition of Type Community Structure	Category
E ≥ 0.81	Very stable	Excellent
0,61 ≤ E < 0.80	More Stable	Good
0,41 ≤ E < 0.61	Stable	Medium
0,21 ≤ E < 0.41	Stable Enough	Bad
E ≤ 0.21	Unstable	Very Bad

Simpson Dominance Index. The Dominance Index is a measure of diversity (number of species per sample) and evenness (abundance of different species that form the diversity of an area) (Adelusi *et al*., 2018), with the following formula (Hutasuhut *et al*., 2021):

$$C = \sum (ni / N)^2$$

C is the Dominance Index, ni is the number of individuals of the i-th species, and N is the number of individuals of all species with the criteria are:

Dominance Index (C)	Category
≤ 0.50	non-dominant type
≥ 0.50 - ≤ 75	sub dominant types
≥ 0.75 - 1	high dominant type

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RESULTS AND DISCUSSION

The results of insect identification on durian plants found in the durian plantations of Bawen District are presented in Table 1.

Table 1. Observation Results of Insect Species

Order	Species	Role	Total
Hymenoptera	*Apis* sp.	Pollinator	16
	Dorymimex sp.	Predator	15
	Eustenogester sp.	Predator	1
	Polistes carolina Linnaeus	Predator	3
	Trigona sp.	Pollinator	2
	Dolichoderus sp.	Herbivor	23
	Cotesia sp.	Parasitoid	88
Lepidoptera	*Papilio Memnon*	Pollinator	1
	Bycyclus anynana	Pollinator	1
	Artaxa sp.	Pollinator	2
	Nyctemera baulus	Pollinator	1
Coleoptera	*Lilioceris lilii*	Herbivor	2
	Epilachna sp.	Herbivor	3
Diptera	*Hemiphentes* sp.	Pollinator	5
	Bactroctera sp.	Herbivor	249
Hemiptera	*Pseudococcus* sp	Herbivor	248
	Aulacaspis tubercularis	Herbivor	375
Orthoptera	*Dichromorpha* sp.	Herbivor	3
		Total	1038

The calculation results of the Shannon – Wiener diversity index, evenness index, and Simpson dominance index are presented in Table 2.

Table 2. Calculation Results of Diversity Index, Evenness Index, and Dominance Index

No	Index	Value	Category
1	Diversity (H')	1.6	Medium
2	Evenness (E)	0.5	Medium

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3	Dominance (C)	0.25	Non-dominant type

The total of 18 insect species were found at the observation location from 14 families and 6 orders with a total of 1038 individuals. The results of the analysis of species diversity data calculations showed a diversity index (H') value of 1.6, which includes moderate diversity. Medium diversity means that the number of individuals per species is moderately distributed and there is moderate community stability. This shows that the ecosystem conditions in the plantation are quite balanced, with moderate ecological pressure or stability. The results on the evenness of insect species show a figure of 0.5 with medium evenness index criteria. If the evennes index values approaching zero indicated uneven distribution of insects in ecosystem, and conversely (Abuzar *et al*., 2021).
Based on the results of calculating the dominance index, the resulting number is 0.26, which means it falls within the criteria of no dominant genus. The smaller the dominance index (C) value, the more widespread the species dominance pattern will be.

The order with the most insect species found is the order Hymenoptera where there are 7 insect species found. These species are *Apis mellifera*, *Dorymimex* sp., *Eustenogester* sp., *Polistes carolina* sp., *Trigona* sp., *Dolichoderus* sp., and *Cotesia* sp. After that, followed by the order Lepidoptera with the species *Papillio memnon*, *Bycyclus anynana*, *Artaxa* sp., and *Nyctemera baulus*. Apart from that, there is the order Coleoptera with the species *Lilioceris lilii* and *Epilachna* sp. Order Diptera with 2 species, namely *Hemiphentes* sp. and *Bactroctera* sp. Order Hemiptera with 2 species, namely *Pseudococcus* sp., and *Aulacaspis tubercularis*. Finally there is the Orthoptera order with 1 species, namely *Dichromorpha* sp.

The Hymenoptera order is one of the insect orders that is most beneficial to humans, for example as flower pollinators, pollinators and honey producers (Trianto & Salsabillah, 2021). Insects are pollinators that are very important for agricultural production and biodiversity throughout the world (Parichehreh *et al*., 2020). The Hymenoptera order contains parasitoid insects which are very potential biological agents in nature and can be used as natural enemies in agriculture to control pests that damage agricultural commodities. The use of parasitoid insects as natural enemies has several advantages compared to other methods, namely that parasitoid insects can prevent specific problems and their populations are large in the field (Trianto & Salsabillah, 2021). The species from the Hymenoptera order that was most frequently found from observations was *Cotesia* sp. *Cotesia* sp. is the most diverse genus in the subfamily Microgastrinae with almost 300 species having been described (Kaiser *et al*., 2017). *Cotesia* sp. is a parasitoid wasp that uses its host to continue its offspring. When Cotesia sp. The female lays eggs into the host (larva), simultaneously injecting toxins and a virus called polydnavirus. This virus prevents the host's immune system from attacking and killing Cotesia eggs which will develop through encapsulation. So it can be concluded that *Cotesia* sp. has an important role in controlling plant pests as well as reducing the use of pesticides which can damage the environment.

The Diptera order consists of three suborders, namely Nematocera, Brachycera, and Cyclorrhapha. Members of Diptera perform many roles, such as phytophages, entomophages (parasitoids), and saprophages. Flies (Diptera) have a pair of front wings, one set and many (compound) eyes. The fly's hind wings also change, producing a dumbbell-shaped structure that helps maintain balance on the back. Flies have mouth parts that can pierce and suck. In general, female flies have a larger body size than male flies. These fly larvae can develop only in certain environmental substrates, such as decaying substances or decaying materials (Savdurin *et al*., 2023). The species from the Diptera order that was most frequently found during observations was the *Bactrocera* sp. species. The large number of these species was because near the durian plantations there were orange plantations which were at the time of flowering and fruit harvest, so many *Bactrocera* sp. were invited. to attack the citrus plants. The symptoms caused are destructive to plants, especially plants that produce fruit. Early detection and appropriate pest management strategies are essential to reduce the damage caused by these insects (Vargas *et al*., 2015).

The order Lepidoptera is the second largest order in the insect class consisting of around 150.000 species. The total of 17.820 from Lepidoptera are butterfly species (Bibi *et al*., 2022). Butterflies serve as significant ecological indicators and play an important role in the environment. Butterflies has function as bioindicators to

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identify environmental damage and disturbance and play an important role in maintaining natural balance in an ecosystem and as pollinators during the flower pollination process, which helps plants naturally reproduce (Savdurin *et al*., 2023). Geographical expansion of human settlements has led to a wide range of environmental disruptions that impact biodiversity, include the butterflies. Case studies documenting local extinctions resulting from urbanization, emphasizing the associated causes (Ramírez-Restrepo & MacGregor-Fors, 2017).

The order Hemiptera is mostly herbivorous insects. Some members of the hemiptera, such as the stink bug, can live on plants by sucking their juices, and sucking ladybugs can also live on plants by eating small animals. Hemiptera can be found anywhere except in cold areas. Its needle-shaped mouth structure is the main characteristic of the Order Hemiptera. Insects use their mouthparts to pierce the tissue of their food and then suck the fluid contained therein. However, there's a species from Hemiptera as biological control agent, as an example is *Xylocoris sordidus* as a biological control agent for *Enneothrips enigmaticus* (de Oliveira *et al*., 2024).

Coleoptera there is The order Coleoptera can be used to control insect pests which is guaranteed to be safe and recommended. The 277.000 types of insects estimated to comprise the insect class, the order Coleoptera has the largest number of types in the world. Among the most extensive insect families, Curculionidae from Coleoptera (snout and bark beetles) consists of about 50,000 identified species, categorized into over 4,600 genera (Catafesta *et al*., 2023). Also, 40% of all types of insects are beetles. In the research, the insects of the order Coleoptera found were *Epilachna* sp. The ecological importance of beetles is increasingly greater because of the various roles they play with plants and fungi, such as helping with reproduction and decomposition and consuming plant tissue and fungi directly. In fact, almost every non-marine habitat has beetles as part of its food web (Iskandaria, 2023).

CONCLUSION

The level of insect diversity in durian plantations in Bawen District (H') has a value of 1.5, where this value includes medium diversity. The evenness index value shows a value of 0.5 in the medium category and the dominance index value shows 0.25 in the no one dominates category. The index value shows that the environmental and ecosystem conditions are in good (moderate) condition. Good conditions are also described as stable ecosystem conditions where there is stable interaction between insect populations and their natural enemies.

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