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Abundance of Ordo Lepidoptera in The Land Conversion of Ciwidey Pine Forest

Sabella Friska Safitri Mulyono[1*], Suhara[2], Iwan Setia Kurniawan[3]

[1,2] Department of Biology Education, Pasundan University
[3] Department of Biology Education, Indonesia University of Education

Abstract

The pine forest in Ciwidey is a forest that is still beautiful and cool. This is indicated by the preservation of the ecosystem. But lately, the number of visitors has affected the balance of the CIwidey pine forest area. One way to see that the ecosystem of the pine forest is still maintained is by monitoring the weakening of the Lepidoptera Order. The aim is to obtain information about protecting insects or Lepidoptera and the influence of climatic factors on the competition. The research method used is descriptive method, the research design is a belt transect, and the sampling techniques used are pitfall traps, hand sorting, beat trays, and insect nets. There are 6 stations with 5 quadrants each. The results of this study obtained 37 individuals from 10 species, 10 genera, and 6 families. Abundance at station one was worth 2 individuals/m^2, paintings at station two were valued at 4 individuals/m^2, paintings at station three were valued at 6 individuals/m^2, announcements at station four were valued at 6 individuals/m^2, announcements at station five were valued at 2 individuals/m^2, stop at station six worth 10 head/m^2. It can be gathered that the nest of the order of Lepidoptera is in the medium category. So it is necessary to maintain the pine forest ecosystem in order to stay awake and sustainable.

Keywords: lepidoptera; pine forest; ciwidey; insect; transect.

Introduction

Indonesia is well-known as an archipelago country and megabiodiversity. This nickname was given because Indonesia has flora and fauna with the highest diversity in the world. The high diversity of flora and fauna can be proven by the large number of forests in Indonesia.

Forests are ecosystems where there are biotic and abiotic factors that interact continuously in a balanced way with each other (Cartono, 2008, pp. 28-29). Biotic factors include all living creatures, such as microorganisms, plants, animals, and humans, while abiotic factors include non-living factors such as temperature, light intensity, soil, and water.

Ideally, to achieve a balanced ecosystem, the inter-factors have a balanced reciprocal relationship as well. However, it does not rule out the possibility of an unbalanced interaction between the two factors. One of the causes of the imbalance between these two factors is the increasing human need to survive which will have an impact on the environment. One of the impacts is the conversion of forest land to meet human needs.

Forests are one of several ecosystems that can be managed by humans because

**Corresponding Author: Sabella Friska Safitri Mulyono, Department of Biology Education, Pasundan University*

they have very high natural resources. Utilization is a form that humans do to meet their needs. For example, from pine forests, humans can use the wood from pine tree stems as the basic material for furniture because it is durable and the price is cheaper than other wood. Humans can also hunt animals that settle or pass through the forests.

It is often found that environmental damages in surroundings are caused by humans who use the environment excessively and arbitrarily without considering regulations or the availability of nature for a long term in order to obtain maximum benefits. This is also known as a form of exploitation.

One of the activities that has potential to have a destructive impact is land conversion. Land conversion is defined as an area that has changed its function from its natural function either partially or completely from the area so that there is a change in land potential in the ecosystem itself.

Most of the land conversion is carried out for humans' benefits, such as pine forest land which is then partially converted into coffee plantations, so that according to Awaludin, et al. (2019, p. 2) can have an impact on ecosystem diversity transformation as niches for insects, including their abundance. One of them is the abundance of insects in the pine forest conversion area in Ciwidey, Bandung District.

There are two factors that affect the abundance of insects. The first is innate factors (internal factors) and environmental factors (external factors). This was stated by Hadi, et al. (2009, p. 152) by saying that these two factors are the reasons for changes in the number of insects that live and they can explain the reasons for differences in abundance in each habitat and changes in the abundance in the same habitat over a certain period of time.

Pine forest land which is one of the original habitats for insects can potentially change the number of insects that live in it when a conversion of land to coffee plantations occurs. The abundance of insects has the potential to increase or decrease in the face of ecosystem changes due to their sensitivity to the environment.

Lepidoptera is a type of insect that has scaly wings, like butterflies and moths. According to Dewi in Nuraini et al. (2019, p. 158), butterflies like the area that feels fresh and not dirty, free from the use of insecticides, smoke, and unpleasant smells, so the more values of butterfly species abundance, the better the area in a certain place. Therefore, Lepidoptera has the ability to be a determinant of the quality of a particular ecosystem because of its sensitivity towards changes that take place in the environment it is in. On this basis, Lepidoptera is used as a bioindicator to determine the level of forest damage.

One of the forests located in West Java is Jayagiri Pine Forest in Lembang. Based on Agesti et al. (2018, p. xi) research, the diversity of insects in the Jayagiri pine forest in Lembang was in the moderate category. This can be estimated because the interactions between the components of the ecosystem in it are still in balance. However, when an imbalance between ecosystem components occurs, it will have an impact on changes in the ecosystem, which will change the diversity and the abundance, especially insects.

Based on the explanation of the background, the importance of the role of Lepidoptera in an ecosystem and the lack of information related to the abundance of

insects of the ordo Lepidoptera, it is necessary to conduct a study entitled "Abundance of Ordo Lepidoptera in The Land Conversion of Ciwidey Pine Forest".

Research Methods

The research occurred using descriptive research method through survey conducted. This method was chosen because the descriptive research method is used to find out the facts that exist to describe the object and subject studied through direct field observations in an effort to collect information contained at a certain time.

Design Used

The research design that was used in sampling the Lepidoptera sample data was the belt transect.

The belt transect that was made as a research design was located on an area of 300 x 100 m^2 which was divided into six stations. The distance between stations was 50 meters. Each station consists of five quadrants which had a size of 2 x 10 m^2. The distance between each quadrant was 10 meters. Each quadrant consists five pitfall traps; there were 2 meters apart between every pitfall traps. The overall size of this research design could represent 30% of the research area in the Ciwidey pine forest land conversion area, Bandung District.

Population and Sample Selection

The population of this study are species of the ordo Lepidoptera which are taken in the area of land conversion of Ciwidey pine forest, Bandung District. Meanwhile, the sample of this study were all species of the ordo Lepidoptera which were sampled in each quadrant in the area of land conversion of Ciwidey pine forest, Bandung District.

Data Collection Techniques

The main data, which are data from the identification of individuals or species of the ordo Lepidoptera and the abundance of the ordo Lepidoptera, which were sampled from each quadrant that has been made in the area of land conversion of the Ciwidey pine forest, were taken with various methods to obtain corresponding data. The sampling methods consist of pitfall trap, hand sorting, beating tray, and insect net method.

Pitfall Trap Method

Pitfall traps are used to pick up insects that are on the ground and accidentally fall into the trap. The trap contains a solution which is a mixture of formalin solution and detergent. This trap is kept in a hole made inside the ground until the rim of the glass touches the surface of the ground.

Hand Sorting Method

The hand sorting method is done by sorting the insect samples data in the quadrants directly by hand (without using tools) according to the required sample, which is the ordo Lepidoptera.

Beating Tray Method

This beating tray method is used to catch insects that inhabit leaves or twigs with a height of 1.5 to 2 meters, by shaking the tree and storing the tray under the tree to catch insects that fall from the tree.

Insect Net Method

Insect net method is the sample data collecting in the form of insects of the ordo Lepidoptera by using insect catching nets at the belt transect station.

Meanwhile the supporting data which are the results of measurements of climatic

factors at the research site in the area of conversion of pine forest land was measured by lux meter for light intensity, hygrometer for air humidity, and thermometer for air temperature.

Temperature Measurement

The tool that is used to measure air temperature is a thermometer. The way to use the thermometer is by hanging it on a tree branch, then taking a look at the line in the middle and the numbers next to it 15 minutes later. After getting the air temperature, take a note of it. Measurement of data is done for 3 times to take the average.

Air Humidity Measurement

The hygrometer is hung on a tree branch and let it stand for 15 minutes then pay attention to the numbers on the wet and dry sections. In order to get the humidity number: deduct the number in the dry section by the number in the wet section, the number obtained from the subtraction becomes the reference for the line of the humidity table in the middle, then pay attention to the number in the dry section, and draw a line according to the number in the dry section until it is aligned with the reference result number from the deduction between wet and dry, the number obtained is the humidity of the air at the measurement site. Measurement of data was done 3 times to take the average.

Light Intensity Measurement

The tool used in light intensity measurement is a lux meter. The way to use the lux meter is by opening the sensor cover first, then pressing the on button and directing the light sensor at the quadrants to be measured. If the number on the sensor is stable, press the hold button and record the number. The measurement data was done 3 times to take the average.

Data Analysis Techniques

The supporting data which are the result of measurement climatic factors such as light intensity, air temperature, and air humidity, needs to be analyzed using multiple linear regression with the SPSS v.26 program (statistical product and service solution version 26) to see the correlation between the main data and the supporting data

Research Results and Discussion

Research Result

The main data of this study is the acquisition of data on insects of the ordo Lepidoptera in the area of land conversion of Ciwidey pine forest, Bandung District, by direct observation in the field using a belt transect. Determination data obtained through the process of insect net, beating tray, hand sorting, and pitfall trap techniques are successfully identified as many as 37 individuals from two sub ordos, six families, and 10 species.

Two subordos, namely Rhopalocera (Butterfly) and Heterocera (Moth), including identified families with 10 species of Lepidoptera came out as the result of determination of the species of the ordo Lepidoptera that have been identified. The 10 Lepidoptera species sampled were *Arctornis sp*., Agrotis ipsilon, Delias belisama, *Ypthima nigricans*, *Pieris rapae, Plutella xylostella, Trichoplusia ni, Hypospidia talaca*, *Araschnia levana,* and *Lymantria marginata*. Meanwhile each family with the most species are Lymantriidae, Noctuidae, Pieriidae, and Nymphalidae has two species

Table 1
Determination of Ordo Lepidoptera that Have Been Identified

No.	Species	Station (Ind/m²)						Total
		1	2	3	4	5	6	
1.	*Arctornis sp.*	0	0	1	0	0	0	1
2.	*Lymantria marginata*	0	1	0	0	0	1	2
3.	*Agrotis ipsilon*	0	0	0	1	1	0	2
4.	*Trichoplusia ni*	0	1	0	0	0	0	1
5.	*Delias beliasama*	2	0	0	0	1	1	4
6.	*Pieris rapae*	0	0	0	2	0	7	9
7.	*Ypthima nigricans*	0	0	4	1	0	8	13
8.	*Araschnia levana*	0	1	0	0	0	0	1
9.	*Plutella xylostella*	0	0	1	2	0	0	3
10.	*Hyposidra talaca*	0	1	0	0	0	0	1
The Number of Species by Station		**2**	**4**	**6**	**6**	**2**	**17**	**37**

Table 2
Climatic Factors Measurement

No	Station	Light Intensity (Lux)	Air Humidity (%)	Air Temperature (°C)
1.	I	5560	71	24
2.	II	5259	84	23
3.	III	5204	84	23
4.	IV	5624	75	25
5.	V	6115	79	27
6.	VI	6537	64	29
Average		5716.5	76.2	25.2

On Table 2, measurement of climatic factors based on sampling stations from station one to station four along with the average of each parameter measured has been presented. The average light intensity was recorded at 5716.5 light intensity, air humidity was 76.2%, and air temperature was 25.2°. To process the data of abundance from the amount of species that were identified in the pine forest land conversion area, Ciwidey, Bandung District, the abundance formula was used according to Michael (1984, p. 57):

$$Abundance: \frac{Amount\ of\ the\ identified\ species}{Amount\ of\ the\ quadrant\ that\ contains\ the\ species}$$

Using that formula, the result turned out to be a data acquisition of ordo Lepidoptera in the pine forest land conversion area, Ciwidey, Bandung District, which has been processed in table 3

Table 3
Amount of Abundance

Famili	Species	Station						Amount of Abundance Per-Species
		1	2	3	4	5	6	
Lymantriidae	*Arctornis sp.*	0	0	1	0	0	0	1
	Lymantria marginata	0	1	0	0	0	1	2
Noctuiidae	*Agrotis ipsilon*	0	0	0	1	1	0	2
	Trichoplusia ni	0	1	0	0	0	0	1
Pieriidae	*Delias beliasama*	2	0	0	0	1	1	4
	Pieris rapae	0	0	0	2	0	4	6
Nymphalidae	*Ypthima nigricans*	0	0	4	1	0	4	9
	Araschnia levana	0	1	0	0	0	0	1
Plutellidae	*Plutella xylostella*	0	0	1	2	0	0	3
Geometridae	*Hyposidra talaca*	0	1	0	0	0	0	1
Amount of Abundance Per-Station		2	4	6	6	2	10	**30**

The type of Lepidoptera that has the highest value of abundance is *Ypthima nigricans* with 9 individuals/m^2. Meanwhile, the Lepidoptera with the lowest value of abundance species are *Arctornis sp., Trichoplusia ni, Araschnia levana,* and *Hyposidra talaca*, which each of them has 1 individual/m*2.*

In order to determine the correlation of climatic factors that affect species of ordo Lepidoptera in the Ciwidey pine forest land conversion area, Bandung District, climatic data must interact with species of the ordo Lepidoptera and analyzed by the IBM SPSS Statistic software version 20 with linear regression analysis settings

Table 4
Calculation Result of SPSS Coefficient

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig
		B	Std. Error	Beta		
1	(Constant)	50.505	39.795		1.269	.332
	Light Intensity (X1)	-0.045	.024	-7.742	-1.87	.202
	Air Humidity (X2)	-0.333	.245	-.861	-1.36	.306
	Air Temperature (X3)	9.516	4.938	7.534	1.927	.194

Based on Table 4, the results of the SPSS Coefficient describe the linear regression equation Y = 50.505 + (-0.045) X1 + (-0.333) X2 + 9.516 X3 + e. Where Y represents the abundance of species of the ordo Lepidoptera, X1 represents light intensity, X2 represents air humidity, and X3 represents air temperature and e represents confounding variables

The results of the SPSS Coefficient calculation also describe the positive load value of 50.505, it refers to the positive influence on the ordo Lepidoptera. When the independent variable (light intensity, air humidity, and air temperature) increases, the dependent variable (abundance of the ordo Lepidoptera) will also increase.

The linear regression coefficient of light intensity (X1) is -0.045 with a negative load, this indicates that if the light intensity increases by one unit, the abundance of the ordo Lepidoptera will decrease by 0.045. The linear regression coefficient of air humidity (X2) is -0.333 with a negative load, this shows that if the air humidity increases, the abundance will decrease by 0.333. The linear regression coefficient of air temperature (X3) is 9.516 with a positive load, this shows that if the air temperature increases, the abundance will increase by 9.516.

Using that formula, the result turned out to be a data acquisition of ordo Lepidoptera in the pine forest land conversion area, Ciwidey, Bandung District, which has been processed in table 5.

Table 5
Calculation Result of Summary SPSS

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.853 a	.728	.319	2.50234

Based on Table 5, regarding the result of the summary SPSS calculation analysis, the determination value of R Square is 0.728. It means that the dependent variable or climatic factors, including light intensity, air humidity, and air temperature, have an effect of 72.8% on the abundance of the ordo Lepidoptera in the area of land conversion of Ciwidey pine forest, Bandung District. This means that other factors that are not measured, such as predators, food availability, human activities on Lepidoptera, have an effect of 18.2% on the abundance of the ordo Lepidoptera.

Conclusion

The research, which was conducted on March 29, 2022, was located in the Ciwidey pine land conversion area, Bandung District, precisely on Jl. Raya Ciwidey – Patengan, Lebakmuncang, Ciwidey Sub-District, Bandung District. As previously described, the research was located at six (6) stations on a pine forest conversion area. This means that the research area was 300 m x 100 m which is divided into 6 stations and each station was further divided into 5 quadrants to collect research data in the form of species from the ordo Lepidoptera.

The first station, the outermost station, was located closest to the main road, compared to other stations, where the larger the order of stations, the deeper the location into the area of pine forest conversion area. This station plant density is fairly moderate. In addition, this location is also frequented by coffee farmers whom work there, so many paths are made for pedestrians and motorized vehicles to pass by.

The second station, 50 meters from the first station, entering further into the location of land conversion. The density between plants can be said to be fairly dense because there are many coffee plantation activities in this location. There are many coffee plants. In addition to coffee plants, there are also several banana trees near the station.

The third station, located more further away from the edge of the forest which is

marked by a large road that is actively traversed by motorcyclists, has a vegetation environment that tends to be similar to the second station, namely the density of plants is fairly dense with coffee plants.

The fourth station has a medium density of coffee plants. Banana trees were found in several locations, but not with pine trees which were not found.

The fifth station is an area where coffee plants are rarely found, but the vegetation can be said to be more diverse than the previous station. There are several pine trees and there are leeks.

The sixth station, located at the farthest point from the edge of the forest and road. The vegetation was found to be very diverse, so it can be said that this location has the highest vegetation. This location was planted with cabbages, mustard greens, round eggplants, coffees, mulberries, and some old pine trees. This location is next to a wide river that separates the research area from other areas.

The species found in accordance with the previous description, consisted of 37 individuals/m^2 of Lepidoptera consisting of 6 families and 10 species. The most commonly encountered famili is Nymphalidae. Based on Koneri et al (2016, p. 3277) and Nuraini et al (2020, p. 160), Nymphalidae is the most frequently encountered famili due to its widespread presence in various types of vegetation. This is a strong reason why Nymphalidae are often found, another reason is because as stated by Sari et al. 2013, Sarma et al., 2012, Lamatoa et al. 2013 in Koneri et al (2016, p. 3280) that Nymphalidae are polyphagous which can meet their needs not only from host plants, but also rotten fruit and urine of other animals.

One of the Lepidoptera species encountered during the research was *Ypthima nigricans*. This butterfly comes from the famili Nymphalidae with an individual gain of 13 individuals/m^2, the highest among other Lepidoptera species. *Ypthima nigricans* was most commonly found at station six, as many as 8 individuals/m^2, with an abundance of 4 individuals/m^2. Looking back at how the vegetation and the location of station six have the highest plant diversity, as well as the location closest to the river, this is equivalent with the statement of Andrianto and Ginoga (2020, p. 70), where the habitats that *Ypthima nigricans* often encounter are forests, areas plantations and on the riverside.

Apart from its good adaptability because it is polyphagous, which can survive more than one host and a suitable habitat for its type, the determination of the existence of *Ypthima nigricans* is strongly influenced by climatic factors. Lepidoptera is known as a good environmental bioindicator because it is sensitive to changes in the surrounding environment (Sreekumar and Balarishnan, 2001, in Kamaludin, et al, pp. 18, 2013).

Temperature strongly affects the activity of Lepidoptera because these animals are classified as polyothermic or cold-blooded animals and their body metabolism will depend on the temperature of their environment, such as requiring warm temperatures to be able to flap their wings and keeping a pair of wings dry and light to fly (Millah, 2020, p. 34). Temperature undoubtedly will have an effect on air humidity, where temperature is inversely proportional to air humidity, so the higher the temperature, the lower the air humidity. According to Florida (2015, in Millah, 2020, p. 94), the suitable range temperature for Lepidoptera activities is from 15°C to 45°C with an optimal temperature of 25°C, while according to (Nuraini, 2020, p. 161), optimal

air humidity is in the range of 60% to 75%. This is in accordance with the results of the temperature climatic factor at the research site which has an average temperature of around 25.2°C and the station where *Ypthima nigricans* is mostly commonly found has 64% air humidity, which is the reason for the discovery of the ordo Lepidoptera, especially the type *Ypthima nigricans* at the research location which is an area of conversion of pine forest land into coffee plantations.

The pine forest which gradually becomes a coffee plantation is a sign of human activities in the Lepidoptera habitat, in the form of land conversion activities. Based on interviews that were conducted at the same time as the field research, coffee farmers whom work at the location admitted that they did not use pesticides or commercial fertilizers that were traded to reduce insects that could potentially become pests. Another way for coffee farmers to control the presence of insects in the field is by physical means, namely burning the remains of leaves to repel insects including Lepidoptera in the area. Even though fire has been carried out to repel insects that have the potential to become pests, Lepidoptera can still be found, although it is possible that the total number of Lepidoptera individual abundances can change if coffee is not planted and / or is not treated with insect repellent.

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