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Diversity of Order Lepidoptera at Different Levels of Canopy Covers Around Panten Camping Ground, Mount Ciremai National Park

Keanekaragaman Ordo Lepidoptera pada Berbagai Tingkat Tutupan Tajuk di Sekitar Bumi Perkemahan Panten, Taman Nasional Gunung Ciremai

Ria Raudhatul Fariha[1], Laila Ramadhania[1], Putri Dewi Fahmawati[1], Supriyadi[1], & Malihatun Nufus[1*]

[1]Departement of Forest Management, Faculty of Agriculture, Sebelas Maret University, Kentingan Jalan Ir. Sutami No. 36, Jebres, 57126, Surakarta, Indonesia
*Email: malihatunufus@staff.uns.ac.id

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ABSTRACT

Mount National Ciremai Park has abundant biodiversity, including the insect order Lepidoptera. Therefore, this research aimed to determine the diversity of order Lepidoptera based on different levels of canopy cover around Panten Camping Ground, Mount Ciremai National Park. This research used an exploration survey using a 100 m transect line and three observation transect lines with different levels of canopy cover. Based on the result of observation, 225 individual Lepidoptera were identified from 26 species and 8 families. The diversity of Lepidoptera showed that 4, 5, and 7 families were at the open, moderate, and closed canopy covers, respectively. Open canopy areas had the most significant number of species, namely 18. In addition, the most commonly found species was *Bradina diagonalis,* with 82 individuals. The diversity index value (H') of the order Lepidoptera around Panten Camping Ground was recorded at 1.62, 2.14, and 2.08 in open, medium, and closed canopy areas, respectively. The diversity index results showed that the levels of canopy cover did not affect insect diversity, while temperature, humidity, plant species, and springs had a significant influence.

KATA KUNCI
keanekaragaman,
ordo Lepidoptera,
tutupan tajuk

INTISARI

Taman Nasional Gunung Ciremai memiliki keanekaragaman hayati yang melimpah, salah satunya serangga ordo Lepidoptera. Penelitian ini bertujuan untuk mengetahui keanekaragaman ordo Lepidoptera berdasarkan tingkat tutupan tajuk di sekitar Bumi Perkemahan Panten Taman Nasional Gunung Ciremai. Metode yang digunakan adalah survei eksplorasi dengan mengikuti garis transek sepanjang 100 m dan tiga transek pengamatan dengan tingkat tutupan tajuk yang berbeda. Berdasarkan hasil pengamatan, total ordo Lepidoptera yang ditemukan sebanyak 225 individu dari 26 spesies dan 8 famili. Keanekaragaman serangga berdasarkan famili pada tutupan tajuk tinggi, sedang, dan rendah, yaitu 4 famili, 5 famili, dan 7 famili. Jenis ordo Lepidoptera ditemukan paling banyak pada tutupan tajuk rendah sebanyak 18 jenis. Ordo Lepidoptera yang mendominasi adalah Bradina diagonalis *dengan jumlah 82 individu. Nilai indeks keanekaragaman (H') ordo Lepidoptera di sekitar Bumi Perkemahan Panten yaitu pada tutupan tajuk tinggi sebesar 1,62, tutupan tajuk sedang sebesar 2,14, dan tutupan tajuk rendah sebesar 2,08. Hasil indeks keanekaragaman menunjukkan tutupan tajuk tidak berpengaruh terhadap keanekaragaman serangga. Keanekaragaman jenis serangga dapat dipengaruhi oleh suhu, kelembaban, jenis tumbuhan, dan sumber air.*

Introduction

Mount Ciremai National Park is a nature conservation area in Kuningan and Majalengka regencies, West Java. This area has a rich biodiversity of plant and animal species, such as insects. Previous research has shown that insects play various roles in the ecosystem, such as pollinators, decomposers, predators (biological controllers), parasitoids, and bioindicators (Meilin & Nasamsir 2016). A total of 235 insect species from 11 families have been identified in the Mount Ciremai National Park area, with the majority belonging to the order Lepidoptera, including 160 species from five butterfly families, namely Hesperiidae, Lycaenidae, Nymphalidae, Papilionidae, and Pieridae (Lucyanti et al. 2017). Research at a chili plantation bordering the forest of Mount Ciremai National Park found four families of order Lepidoptera, namely Nymphalidae, Hesperiidae, Crambidae, and Tortricidae (Firmansah et al. 2023).

Lepidoptera is one of the insect orders with the most significant number of species, around 160.000 species spread worldwide except Antarctica. In addition, Lepidoptera comes from the Greek words *lepis* (scales) and *ptera* (wings), which means scaly wings (Rosnita et al. 2015). Order Lepidoptera is grouped into butterflies and moths. Butterflies are active during the day (diurnal), while moths are active at night (nocturnal), but several moth species are active in the morning and afternoon (Krismawanti et al. 2022).

The presence of the order Lepidoptera indicated a good ecosystem condition of the Mount Ciremai National Park. This order is an indicator of environmental change because it has a role as a pollinator and a pest, which is sensitive to changes in both biotic and abiotic components (Wakano & Moniharapon 2019). The existence and abundance of this insect are important in the ecosystem. Hence, research to determine the species diversity of order Lepidoptera is needed. Biotic components such as plant species and composition can affect the existence of the order Lepidoptera. Diverse vegetation can also increase biodiversity by creating suitable habitats and food resources for some species, such as insects (Liarian et al. 2023).

Research related to insect species diversity has been carried out in Mount National Ciremai Park but was limited to one species of butterfly (Haryanto et al. 2020) and one family (Mukaromah et al. 2019). There is also still a lack of information regarding moths and their diversity. Therefore, this research aims to determine the diversity of order Lepidoptera based on canopy cover around Panten Camping Ground, Mount Ciremai National Park. The results are important because determining biodiversity can be helpful in maintaining the genetic basis, better use of biological resources, and identifying the ecosystem that needs rehabilitation due to degradation (Siboro 2019).

Methods

Research Area

This research occurred at Panten Camping Ground, Utilization Resort, National Park Management Section (SPTN) Region II Majalengka, Mount Ciremai National Park (49 S 208006 – E 9236668), with an altitude of 1,248 masl. The total area of Panten Camping Ground was 1000 m^2, while the air temperature and humidity in the research area were 22-24 °C and 63-89%, respectively. This mountain was at an altitude of 3,078 masl, the highest mountain in West Java. According to Schmidt and Ferguson, the climate of this location was a type B and C with an average rainfall of 2000 to 4000 mm/year at 18 to 24 °C monthly. Mount Ciremai National Park has protected life support systems and hydrological functions such as water catchment areas and springs (Lucyanti et al. 2017).

Methods

This research was carried out at three levels of canopy cover, namely closed, moderate, and open (Figure 1). The closed canopy area had a high cover, the moderate canopy area had an abundance of undergrowth and was directly adjacent to agricultural land containing tomatoes, pumpkins, and celery, and the open canopy area was near the flow of springs.

Data was collected following a 100 m line transect along three observation paths, marked using Avenza Maps (Figure 2). This observation included three transects, each consisting of five plots, measuring 15 m

Figure 1. Observation site: (a) closed canopy area, (b) moderate canopy area, and (c) open canopy area

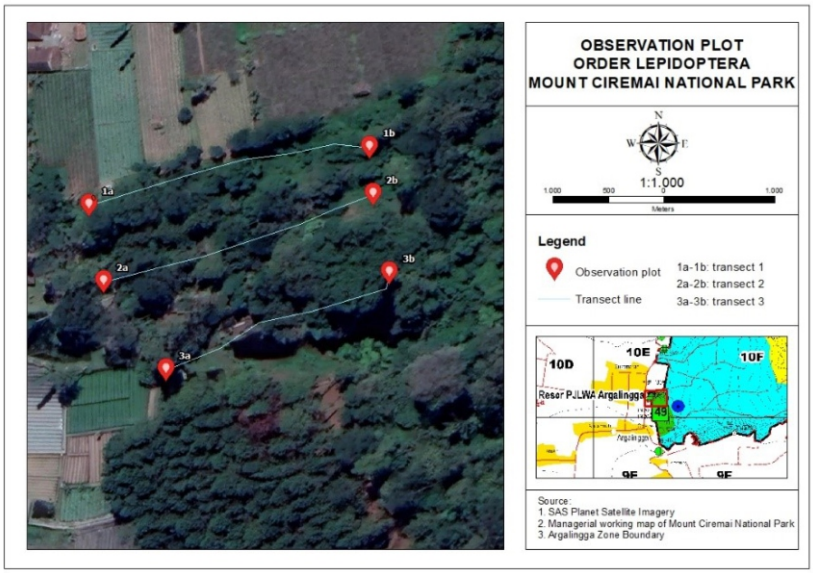

Figure 2. Observation transects at the research site

x 15 m with a distance of 5 m between each plot. The canopy assessment was conducted through on-screen visual classification using high-resolution satellite imagery from the SAS Planet application. This method allowed for observing and identifying changes in canopy cover distribution (Malda et al. 2022). Field data collection involved recording the coordinates of each transect, which were subsequently transferred to ArcGIS software for further analysis.

The method used was an exploratory survey method with observers exploring and observing insects found (Aji et al. 2018). Insects were collected using insect nets. The observation was carried out by performing five double swings in each plot. The net was swung while walking around the plot, with one swing to the left and one to the right. During each swing, the net was rotated to invert and secure the opening, minimizing the risk of insect escape (Oktarima 2015). This research was conducted at 09.00-11.00 WIB for three days with a different transect order each day. Temperature and humidity measurements were taken using a thermohygrometer at 09:00 WIB for five minutes at each transect. This timing was based on the active time of flying insects, such as butterflies and several moth families, to pollinate (Keshya et al. 2022). A smartphone camera under natural lighting conditions without optimal instruments was used to photograph Lepidoptera specimens found during the observation. Magnification helped compare the image size to the actual size using a ruler. Consistent distance and lighting were maintained to minimize discrepancies. The air temperature, humidity, and plant species were observed to determine their effect on the species diversity of the order Lepidoptera and were identified with identification books or articles related to the order, such as the *Identification Guide for Butterflies of West Java* (Schulze 2010), *Keanekaragaman Kupu-Kupu* (Ruslan et al. 2022), and *The Butterflies of the Malay Peninsula* (Corbet & Pendlebury 1992).

Data Analysis

The species diversity was determined using the Shannon-Wiener diversity index formula (Shannon & Weaver 1948).

$$H' = \Sigma \, Pi \, Ln \, Pi$$

with Pi = ni/N; Remarks: ni = number of individual species; N = total number of individuals of all species; H'= Shannon-Wiener index formula; Pi = proportion of individual species.

Result and Discussion

Species Diversity of Order Lepidoptera at Different Levels of Canopy Cover

This research identified a total of 225 individuals, 26 species, and 8 families of order Lepidoptera at Panten Camping Ground with different levels of canopy cover (Table 1). The families were Papilionidae (6 individuals), Nymphalidae (73 individuals), Pieridae (5 individuals), Lycaenidae (4 individuals), Hesperiidae (3 individuals), Erebidae (37 individuals), Crambidae (94 individuals), and Geometridae (3 individuals). Crambidae and Nymphalidae were the families most found on the site.

The highest number of individuals of order Lepidoptera was observed in the moderate canopy cover area (98) and the lowest in the closed canopy area. Meanwhile, the number of species was highest in the open canopy area, showing that insects were commonly found in open areas. The open canopy area had more species (18) than the closed and moderate canopy area (11). Order Lepidoptera preferred environments with good light intensity, close to water sources, appropriate temperature, and diverse vegetation (Ruslan et al. 2022).

Canopy cover was closely related to the environmental parameters affecting the number of individuals (Table 2). Order Lepidoptera insects had different characteristics. Butterflies preferred places with abundant feed and host plants and were close to water sources (Mukaromah et al. 2019), while moths preferred habitats with high humidity (Keshya et al. 2022). The temperature at the research site was 20 to 40 °C, which was optimal for butterflies (Fasa 2023). Canopy cover influenced the amount of light intensity, temperature, and relative humidity. An open canopy increases the light intensity and temperature and decreases relative humidity (Jayanthi & Arico 2017). However, dense canopy cover caused a decrease in

Table 1. Number of individual and species of order Lepidoptera in Panten Camping Ground

No.	Species	Family	Canopy cover		
			Closed	Moderate	Open
1	*Graphium sarpedon*	Papilionidae	0	0	3
2	*Papilio memnon*	Papilionidae	0	0	1
3	*Papilio helenus*	Papilionidae	0	0	2
4	*Libythea myrrha*	Nymphalidae	0	0	2
5	*Melanitis leda*	Nymphalidae	4	4	0
6	*Mycalesis moorei*	Nymphalidae	4	4	4
7	*Mycalesis sudra*	Nymphalidae	1	0	0
8	*Neptis hylas*	Nymphalidae	0	0	2
9	*Rohana parisatis*	Nymphalidae	0	0	1
10	*Symbrenthia hypselis*	Nymphalidae	2	1	2
11	*Ypthima pandocus*	Nymphalidae	5	17	20
12	*Delias* sp.	Pieridae	0	0	1
13	*Eurema hecabe*	Pieridae	0	0	4
14	*Heliophorus epicles*	Lycaenidae	0	1	3
15	*Mooreana trichoneura*	Hesperiidae	1	0	1
16	*Potanthus* sp.	Hesperiidae	0	0	1
17	*Egnasia* sp.	Erebidae	1	20	21
18	*Erebus ephesperis*	Erebidae	0	1	0
19	*Herminiinae-genera* spp.	Erebidae	1	2	0
20	*Rivula* sp.	Erebidae	9	0	4
21	*Bradina diagonalis*	Crambidae	3	44	35
22	*Herminia tarsicrinalis*	Crambidae	0	0	2
23	*Spilomelinae* sp.	Crambidae	5	0	0
24	*Spoladea recurvalis*	Crambidae	0	1	1
25	*Ostrinia* sp.	Crambidae	0	0	2
26	*Idaea biselata*	Geometridae	0	3	0
Number of individuals			36	98	91
Number of species			11	11	18

temperature and an increase in moisture (Indrawati et al. 2020).

Abiotic factors such as temperature, humidity, light intensity, and water sources influenced the number of individual insects (Taradipha et al. 2019). This research showed that the number of order Lepidoptera was higher in moderate and open-canopy areas (98 and 91) than in closed-canopy areas (36). The relative humidity in moderate and open canopy areas was 78% and 73%, respectively. Moreover, both places were near water sources. These findings were similar to research by Ashari et al. (2021) in Taman Wisata Aik Bukak, which had a humidity of 69%-81% and was suitable for the survival of order Lepidoptera.

The most significant number of Lepidoptera individuals was found in the moderate canopy cover area. In addition to suitable temperature and humidity, this area had more hosts and food plants of Lepidoptera. The availability of food plants was indicated by the number of plants and species that butterflies and moths preferred. Table 3 showed that the number of order Lepidoptera in moderate and open canopy cover was almost the same, and species of plants were present. In contrast, the closed canopy area had a smaller number. The higher diversity of food plants and host species could affect the number and species of insects (Triyogo et al. 2017). According to research on butterfly diversity on land cover types and active time in Mount Leuser National Park, there was a relationship between the number of host and food plants and the number of butterflies. The number of butterflies found in the settlement habitat types and river borders was higher than in the forest habitat (Irni et al. 2016).

Plant species in each canopy cover area had different roles (Figure 3). The host plants in the closed canopy were ti plant (*Dracaena fragrans*) and trees spikes (*Cyathea spinulosa*), while the food plants were *Rosa* sp. and *Heliconia rostrata*. In the moderate canopy cover, there were 11 plant species, including host plants, such as basket grass (*Oplismenus hirtellus*), billygoat-weed (*Ageratum conyzoides*), *Sphagneticola trilobata*; and food plants, namely *Calliandra tetragona*, jackfruit (*Artocarpus heterophyllus*), *Lantana camara*, and *Eupatorium riparium*. The *E. riparium* was an insect food plant essential in the understory community and could adapt to environmental conditions (Purnomo et al. 2018). In the open canopy area, there were 8 plant species, including host plants such as *Ficus* sp.; food plants namely *A. conyzoides, Sagittaria cuneata,* and *Impatiens walleriana*; and plants that played a second role as jackfruit (*A. heterophyllus*). The Ageratums plants from the Asteraceae family were preferred by the family Pieridae. Kaliandra (*C. tetragona*) had a considerable number and was usually used as a food

Table 2. Environmental parameters in different levels of canopy cover in Panten Camping Ground

Environmental Parameters	Canopy cover		
	Closed	Moderate	Open
Temperature (°C)	22.6	22.3	23.7
Humidity (%)	81	78	73
Water source	Intermediate	Far	Near
Number of individuals	36	98	91

Table 3. Plant species in different levels of canopy cover in Panten Camping Ground

No.	Closed	Moderate	Open	Category (Host/food)
1	*Dracaena fragrans*	*Eupatorium riparium*	*Dracaena fragrans*	Host[1]
2	*Cyathea spinulosa*	*Sphagneticola trilobata*	*Cordyline fruticosa*	Host[1]
3	*Pinus merkusii*	*Pinus merkusii*	*Pinus merkusii*	Host[1]
4		*Oplismenus hirtellus*	*Ficus* sp.	Host[2]
5	*Heliconia rostrata*	*Ageratum conyzoides*	*Ageratum conyzoides*	Food[3]
6	*Rosa* sp.	*Calliandra tetragona*	*Calliandra tetragona*	Food[4]
7		*Artocarpus heterophyllus*	*Artocarpus heterophyllus*	Host and food plant[3]
8		*Lantana camara*	*Impatiens walleriana*	Food[3]
9		*Asystasia gangetica*	*Sagittaria cuneata*	Food[5]
10		*Mikania micrantha*	*Datura fastuosa*	Food[6]
11		*Galinsoga parviflora*		Food[6]

Reference: [1]Kurniawan (2012); [2]Irni et al. (2016); [3]Ashari et al. (2021); [4]Rohman et al. (2019); [5]Saputra et al. (2024); [6]Saud et al. (2024)

plant for the Pieridae and Lycaenidae families (Ashari et al. 2021).

Diversity Index of the Order Lepidoptera

The diversity index describes the state of the population systematically to facilitate the analysis of the number of individuals or species in a community. The diversity index (H') in the closed canopy area was 1.622, while in the moderate and open canopy areas 2.149 and 2.081, respectively. These results showed that order Lepidoptera preferred the open canopy area than the closed canopy area. The findings indicated that the complexity level of the site was still suitable for being a habitat for insects.

These were similar to research in Mount Ciremai National Park about butterfly species at various age levels of post-burn land with a moderate diversity index in three blocks with an H' value range of 2.17-2.87 (Putri et al. 2019). In addition, butterflies with colorful or unique wings were more often found in the open canopy area, while in the closed canopy area, they tended to be less opaque to brown (Harmonis 2021). The diversity index of the order Lepidoptera was smaller than in the buffer area of Mount Leuser National Park (Jayanthi & Arico 2017). In the morning observation, the diversity index of order Lepidoptera in the forest habitat, settlement, and river border was 2.59, 3.36, and 3.38, respectively. The highest index was found in settlement habitat types because it contained understory plants that butterflies infested (Irni et al. 2016).

Diversity of Order Lepidoptera Based on Family

The results of observations around the Panten Camping Ground area showed 225 individuals covering 26 species and eight families, including five families of butterflies and three families of moths. As presented in Figure 4, the diversity of insects based on family had different percentages. The most abundant family found was the Crambidae (42%), while the least abundant were the Geometridae (1%) and the Hesperiidae (1%). This percentage showed the tolerance or adaptability of Lepidoptera to biotic or abiotic environmental conditions (Taradipha et al. 2019).

Family Crambidae (42%) and family Nymphalidae

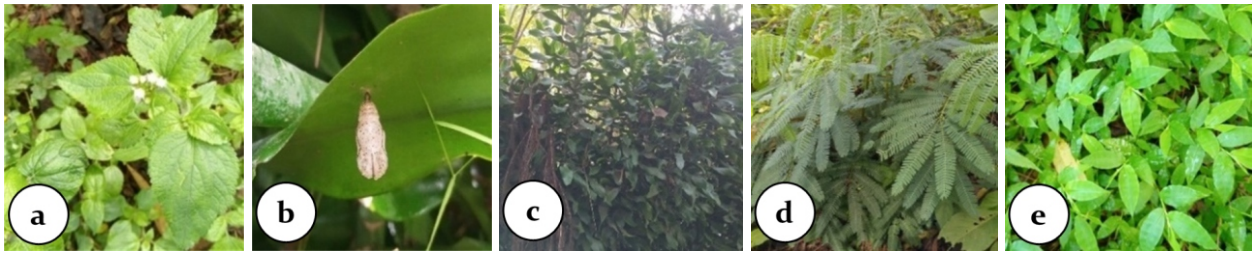

Figure 3. Several plant species in the order Lepidoptera observation transect: (a) *Ageratum conyzoides,* (b) Cocoon on *Dracaena fragrans,* (c) *Dracaena fragrans*, (d) *Calliandra tetragona,* (e) *Oplismenus hirtellus.*

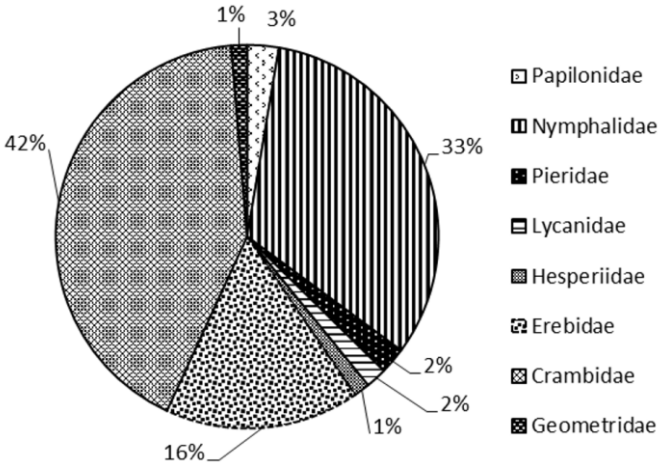

Figure 4. Percentage of insect diversity by family

(33%) became the most observed concerning the food source of this family and species (Figure 5). *Bradina diagonalis* (Crambidae) preferred Myrtaceae, Leguminosae/Fabaceae, Graminae, and Pedaliaceae plants as food sources (Wulandary 2022). *Calliandra tetragona* (Fabaceae) was the most abundant plant in the research site. The abundance of *Ypthima pandocus* (Nymphalidae) in this site had similarities with research in Ujung Batu Village, Pelaihari District, because it had a wet grassy and low-flying habitat not far from the ground surface, such as basket grass (*Oplismenus hirtellus)* (Hamid & Maulana 2021).

The fewest families were the Geometridae family (1%) and the Hesperiidae family (1%) (See Figure 6). Insects had different tolerance and adaptability to environmental conditions in their habitat (Taradipha et al. 2019). The Geometridae family was only found in moderate canopy areas because it had abundant pine tree vegetation. Meanwhile, *Heliophorus epicles of* the Lycaenidae family were found in medium and open canopy areas. These butterflies are usually found on sunny days and in open places (Rohman et al. 2019).

The observation results showed that the more open the canopy, the more the Lepidoptera were found (Figure 7). The closed, moderate, and open canopy areas had 4, 5, and 7 families, respectively.

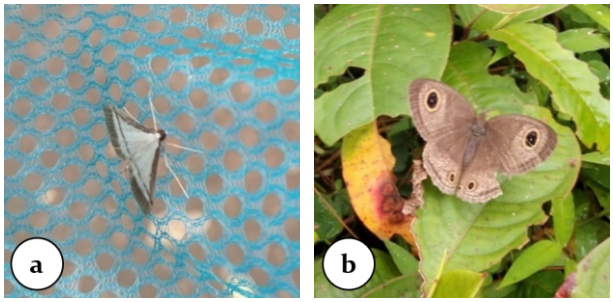

Figure 5. Order Lepidoptera family Crambidae with one magnification: (a) *Bradina diagonalis*; and family Nymphalidae: (b) *Ypthima pandocus.* The manual calculation used magnification by comparing the object size in the image with its actual size using a standard measurement tool without additional optional instruments.

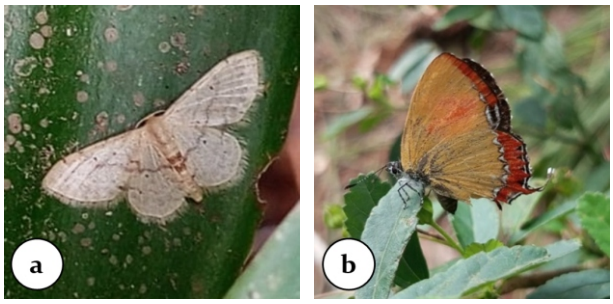

Figure 6. Order Lepidoptera family Geometridae with 2x magnification: (a) *Idaea biselata*; and family Lycaenidae: (b) *Heliophorus epicles.* The manual calculation used magnification by comparing the object size in the image with its actual size using a standard measurement tool without additional optional instruments.

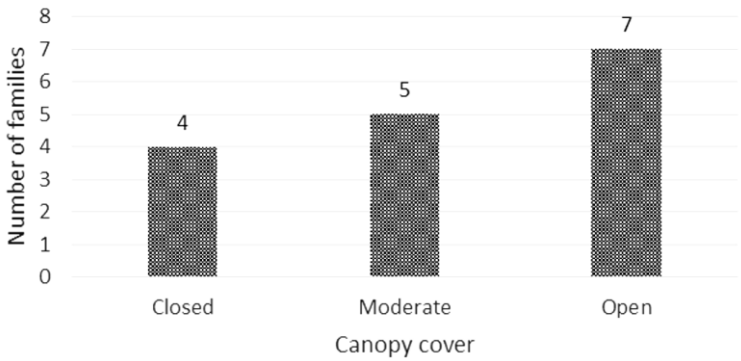

Figure 7. Comparison of the number of families found on the canopy cover

Based on the families found, it indicated that canopy cover could affect insect diversity. The open canopy area found more families of order Lepidoptera because it preferred open land for light intensity and had appropriate water flow (Mukaromah et al. 2019). In the closed canopy area dominated by the Nymphalidae family, this family was highly tolerant to environmental conditions due to easy and abundant food plants such as rotten fruit, dirt, exudate, and animal decomposition (Wicaksono et al. 2023). More moths were found in the moderate canopy area because this transect had more understory, such as basket grass (*Oplismenus hirtellus)* and *Bradina diagonalis.*

Conclusion

In conclusion, the diversity of the order Lepidoptera in Panten Camping Ground Mount Ciremai National Park was 225 individuals from 26 species and eight families, namely Papilionidae, Nymphalidae, Pieridae, Lycaenidae, Hesperiidae, Crambidae, Erebidae, and Geometridae. The highest diversity was in the Crambidae family (42%) of *Bradina diagonalis* and the Nymphalidae family (33%) of *Ypthima pandocus.* Meanwhile, The diversity index value (H') of the order Lepidoptera around Panten Camping Ground was recorded at 1.62, 2.14, and 2.08 in open, medium, and closed canopy areas, respectively. Based on this observation, canopy cover did not affect the diversity of insects in the order Lepidoptera insects but affected the number of families and species observed. Order Lepidoptera preferred open canopy to get more light intensity and water sources.

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