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Diversity of Insect Species in Generative Phase Maize Plant in Caturharjo, Sleman

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ABSTRACT

The presence and diversity of these insects are influenced by insect activity. This study aimed to analyze the diversity and dominance of insect species in the generative phase of maize fields in Caturharjo Village, Sleman, Yogyakarta. The research was conducted from March to August 2025, on a 1000 m^2 maize field. The maize field was then divided into three plots, each measuring 10 × 15 m. One light trap was set at the center of each plot. Insects were collected every three days. Insect species diversity was calculated using the Shannon–Wiener Index, and species dominance was calculated using the Simpson Index. Data on the abundance of individuals and abiotic factors were then analyzed using a correlation test. The results obtained 60 species of insects in the maize generative phase in Caturharjo Village. The highest number of insect individuals found was Paederus fuscipes (1272 individuals), which had the highest role of insects as predators (31.67%). The index value of species diversity obtained in this study fell into the medium category (H' = 1.1484), and there were no dominant species of insects at the research site (D = 0.1093). The conclusion of this study is that there are 60 species of insects at the study site, with a moderate level of diversity and no dominant species in the study site.

Keywords: ***Anoplolepis gracillipes*, insect, maize, *Paederus fuscipes,* predator**

INTRODUCTION

The existence and diversity of insects in agricultural ecosystems can affect various aspects of the ecosystem, both biotic and abiotic (Ramadhan *et al.* 2023). The existence and diversity of these insects are influenced by insect activity. The majority of insects that are active at night have a role as pests, while insects that are active during the day have a majority role as pollinators or natural enemies.

Information about insect pests in crop cultivation activities is very important, both in terms of taxonomy, biology, and activity, including in maize cultivation (Nurmaisah & Purwati, 2021; Naftaly *et al.* 2024). Insect pests that cause absolute damage to maize plants are pests that attack the generative phase of maize plants in the form of male flowers or cobs. These pests include *Helicoverpa armigera, H. assulta, Spodoptera frugiperda, S. litura, Ostrinia furnacalis, and Mythimna loreyi*. All of these insects are highly active at night, commonly referred to as nocturnal insects.

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Losses due to nocturnal insect pests in the generative phase of maize include damage to cobs and flowers, which reduces the yield. Pest infestations also reduce the quality of developing maize kernels and produce feces that contaminate the product, reducing its market value. Information on the types of insects available at various stages of maize growth, especially the generative phase, is expected to increase maize production in maize-growing areas.

Research on insect diversity in maize plants has been conducted previously. Research conducted by Purnomo *et al*. (2023) in South Lampung and Pesawaran Districts, Lampung Province, 19 species of insects were found on corn plants, some of which were nocturnal. Another study by Purnomo *et al*. (2023) in Teluk Bogam Village, Pakalan Bun, Central Kalimantan Province obtained the results of 9 species of insects in corn crops that move at night. However, research on the diversity of nocturnal insect species on corn plants, especially in Caturharjo Village, Sleman District, has never been conducted.

Research on insect species diversity that has been conducted in this area has focused on invasive pests in corn plants (*S. frugiperda*) associated with 15 parasitoid species by Nurkomar *et al*. (2024). Another study by Nurkomar *et al*. (2021) examined only the population and distribution of *S. frugiperda* in the Sleman Regency. Consequently, information on the diversity of nocturnal insects associated with maize in the generative phase in this area remains limited, constraining the development of ecologically based and sustainable pest management strategies. Therefore, this study aimed to analyze the diversity and dominance indices of insect species in maize fields in Caturharjo Village, Sleman, Yogyakarta. These findings provide baseline information on insect communities during the generative phase of maize, which may support the development of sustainable and environmentally friendly pest management programs.

METHODS

Materials

The materials used in this study were insects caught in light traps, 70% alcohol, 32 × 64 mm label paper (Phoenix), and liquid detergent (Rinso).

Method

Determination of Sampling Location

Sampling was conducted in Caturharjo Village, Sleman District, Sleman Regency, and Yogyakarta. The land used a minimum area of 1000 m^2. The land will then be divided into three plots with an area of 10 x 15 m for each plot.

Insect Sampling

Insect samples were indirectly collected using light traps. One light trap was installed 1 light trap in the center of each plot (Figure 1), making a total of 3 light traps installed in the sampling area.

The light traps were set up in the morning and left to charge during the day, so that the lights on the traps would switch on at night. The bottom of the lamp was filled with a tray of soapy water (1:1) to kill any insects that were caught. The traps were set during the generative phase of maize, and the insects in the trays were collected every three days. The trapped insects were collected in the afternoon at 4.00 pm while refilling the soap water in the trays. The insects in the trays were then transferred to plastic bottles for identification at the species level in the laboratory.

The abiotic data measured in this study were wind speed, using an anemometer, and air temperature and humidity, using a thermohygrometer. Abiotic data measurements were carried out 3 (three) times at each sampling location, with repetitions spaced every 7 minutes (Nurkomar *et al.* 2024; Putra *et al.* 2024).

Insect Identification

Insects obtained from the field were then brought to the Ecology and Systematics Laboratory, Ahmad Dahlan University, to be identified at the species level. Insects were identified up to the species level by paying attention to their morphological characteristics, namely, wings, head, body style, body shape, antenna segments, leg segments, and body color. Insect identification was performed using the keys provided by Dewi *et al*. (2023). In addition to books, identification also uses identification journals from Nurmaisah and Purwati (2021) and Permana *et al.* (2024).

Measurement of Insect Diversity Index

One of the parameters measured in this study was the diversity index (H'). According to Utami and Putra (2021), H' is calculated using the following formula:

$$H' = -\sum_{i=1}^{s} p_i \ln p_i \quad (1)$$

Where:

H' = Shannon-Wiener Diversity Index

pi = Proportion of the number of i-th individuals to the total number of individuals

The criteria for the Shannon-Wiener diversity index value according to Utami and Putra (2021) are as follows:

According to Utami and Putra (2021), the criteria of the Shannon-Wiener Diversity of Index value are as follows: (1) if H' < 1, then species diversity is low; (2) if 1 < H'< 3, then species diversity is moderate; and (3) if H' > 3, then species dominance is high.

Dominance Index

The dominance index was calculated using Simpson's dominance index formula (Utami & Putra 2021):

$$D = \sum (Pi)^2 \quad (2)$$

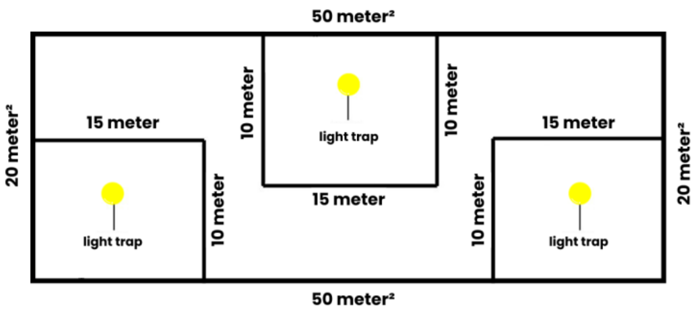

Figure 1 Layout of the research area showing the sampling plots and the locations of the light traps.

Where:
D = Dominance index
pi = Proportion of the number of i-th individuals to the total number of individuals

According to Utami and Putra (2021), the range of dominance index values is as follows: (1) if 0.00 < D < 0.50, then species dominance is low; (2) if 0.50 < D < 0.75, then species dominance is moderate; and (3) if 0.75 < D < 1.00, then species dominance is high.

Data Analysis

Data will be analyzed using the correlation test to determine the relationship between abiotic factors and insect abundance.

RESULTS AND DISCUSSION

Abundance of insect species in generative maize fields

Seven orders of insects were identified, namely Coleoptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera, Neuroptera, and Orthoptera (Figure 2). The number of insect families found in this study was 33 families with insect families with the highest number of species, namely Carabidae (6 species), while the least was the Orthoptera order with 1 species.The highest number of individuals of insect species found was *Paederus fuscipes* (1272), followed by *Anoplolepis gracillipes* (1147), *Culicoides* sp. (1002), *Stenolophus* sp. (437), and *Lasius niger* (372) were recorded.

Coleoptera was the most commonly found order in this study. This is in accordance with the research by Naftaly *et al*. (2024), who found that most insects were from the order Coleoptera. According to Prihatin *et al*. (2023), the Coleoptera order was found in this study because it is a common insect that can live well in various types of habitats. The insect family with the most species found in this study was Carabidae (six species). Carabidae became the family with the most number of species found because according to Surgandi *et al*. (2024), this family is a family that is easy to find in various habitats, under leaves, under rocks, under plant stems, in the soil, litter and organic material that has weathered and decomposed. This family was caught in the light trap because members of the Carabidae family are usually active at night (nocturnal), so that the lights from the light trap attracted the insects come and get caught. According to Ramadhan *et al*. (2023), all nocturnal insects are strongly attracted to light.

Contrary to the Coleoptera Order, the Orthoptera Order had the least number of families and species found in this study. According to Arma and Sari (2021), Orthoptera was least abundant in the generative phase of corn plants. This is because the condition of the mature corn plant is less favored by species of Orthoptera, especially the leaves of corn plants that are hard, dry, and have little water content. The results of this study found 5 species of insects with an abundant number of individuals in the generative phase of maize plants at the research site (Figure 2). The insect species with the highest number of individuals were *P. fuscipes* (1272 individuals) and *A. gracillipes* (1147 individuals), both of which act as predators (Figure 3).

According to Herlinda *et al*. (2014), the movement of predatory insects follows the presence of their prey. This is why *P. fuscipes* was found in maize fields, as it follows the presence of its prey on maize plants. The prey of *P. fuscipes* found in maize fields includes *H. armigera* larvae, aphids (*Aphis* sp.), and *Nezara viridula*. *P. fuscipes* also preys on the larvae of *H. armigera* and aphids. In addition, according to research

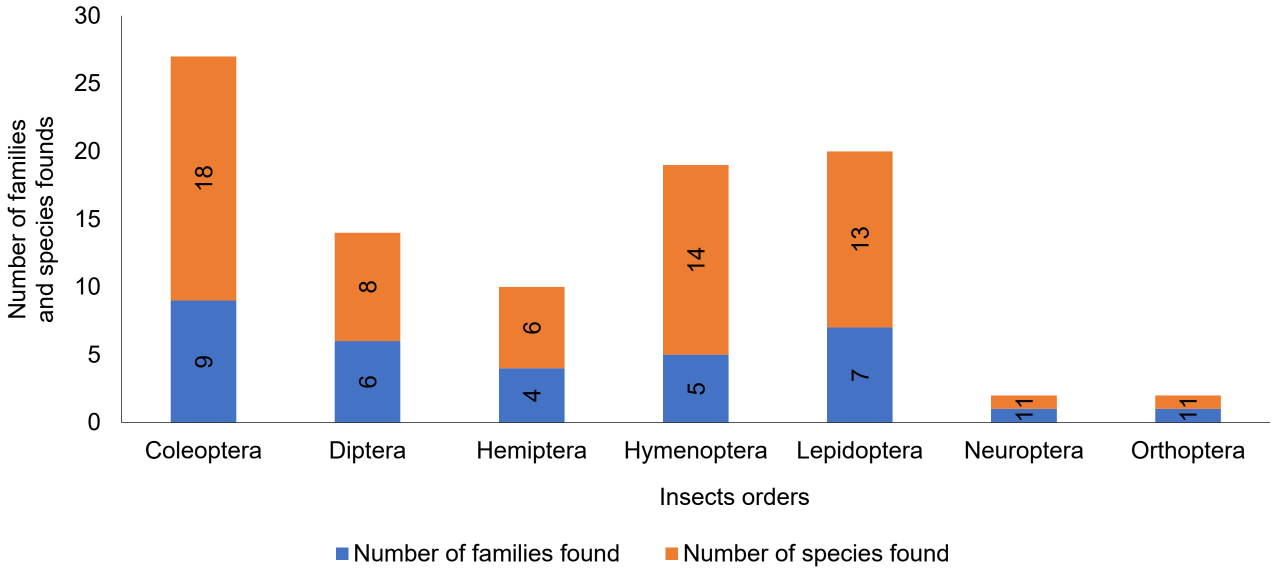

Figure 2 Insects found on generative phase maize plants in Caturharjo Village.

from Suastika *et al*. (2005), *P. fuscipes* also preys on the aphids (*A. glycines* Mats.) (Hemiptera: Aphididae), eggs of *N. viridula* (Hemiptera: Pentatomidae) and *Piezodorus huebneri* (Gmel.) (Hemiptera: Pentatomidae), eggs of *Etiella zinckenella* Tr. (Lepidoptera: Pyralidae) and Spodoptera *litura* F. (Lepidoptera: Noctuidae).

In addition to *P. fuscipes*, the other insect found in high numbers in this study was *A. gracillipes*. *A. gracilipes* is an ant that acts as a predator in maize fields (Latumahina *et al*. 2014). *A. gracilipes* can prey on a variety of insects, including beetles (Order Coleoptera) and stem borers (*Scirpophaga* sp.) (Adhi *et al*. 2017). The discovery of prey of this species at the research site is a factor in the abundance of individuals of this species obtained in this study. According to Perfecto and Vandermeer (2002) in Romarta *et al*. (2020) *A. gracilipes* acts as a predator of herbivorous insects, such as caterpillars and grasshoppers, which are potential maize pests, thereby contributing to pest suppression. Its high abundance is supported by prey availability and a wide foraging range that includes litter and plant canopy. s (Latumahina *et al.* 2014). According to Haneda and Larasati (2021), agricultural land with sufficient litter and relatively uniform soil composition provides a suitable habitat for these ants to forage and survive. Although other ant species were present, their lower abundance reflects the high adaptability of *A. gracilipes* to human-modified environments. However, as an invasive species with aggressive foraging behavior, its dominance may negatively affect other ants and local arthropod communities and should, therefore, be interpreted cautiously.

In addition to determining the type and number of insect individuals in the generative phase of corn plants, this study also determined the role of insects on corn plants. Of the insects found, 31.67% were predators, herbivores (21.67%), maize pests (18.33%), visitors (11.67%), detritivores and pollinators (6.67% each), and parasitoids (3.33%) (Figure 4).

The results of this study are in line with the statement of Naftaly *et al*. (2024), who stated that insects in maize fields are generally dominated by predatory insects. According to Melhanah *et al*. (2020), predatory insects are usually polyphagous, meaning they can eat various types of prey; therefore, they do not depend on just one type of prey to survive. Predatory insects often actively search for prey during the day, but there are predatory insects some are active at night. Reduced visual efficiency at night limits the ability of herbivorous insects to forage and avoid

(A) (B)

Figure 3 The most abundance insects found on generative maize plants at Caturharjo Village, (A) *P. fuscipes* and (B) *A. gracillipes*.

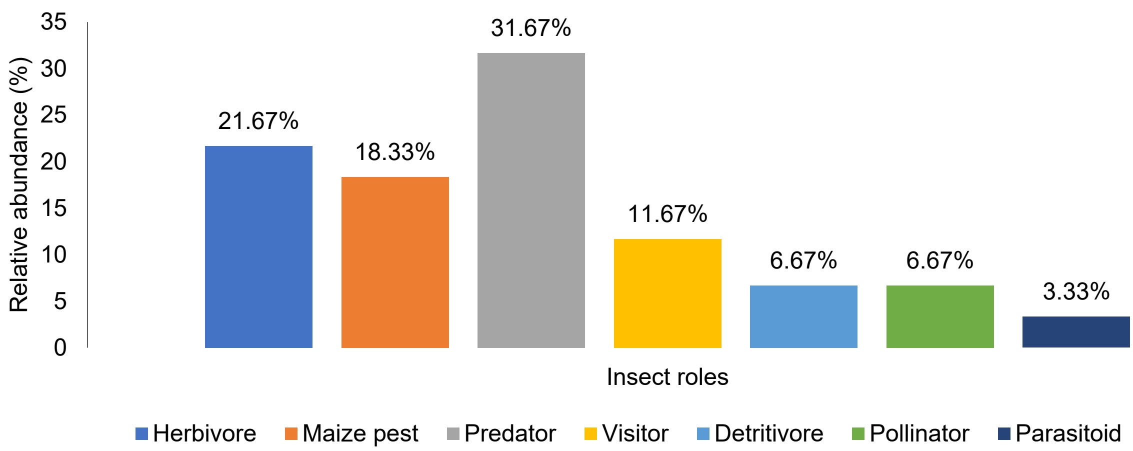

Figure 4 The role of insects found at Caturharjo Village, Sleman.

predators, causing them to remain inactive or hidden, which in turn facilitates prey capture by predators. The availability of prey greatly affects the predation ability of predators; the more prey available, the higher the predator's predation ability (Hidayat *et al*. 2021).

The second most important role of insects in this study was as herbivores. Herbivorous insects associated with maize plants can come from various orders, such as Lepidoptera, Coleoptera, Diptera, Hemiptera, and Orthoptera. The high percentage of insect pests is generally influenced by the structure of the plant community in a field and the host plant. Maize belongs to the Poaceae Family, which is known as the main host of herbivorous insect groups, most of which act as pests (Nurmaisah & Purwati 2021). Herbivores that have the status of corn pests can attack all parts of the plant, from roots, stems, and leaves to corn cobs; however, not all herbivores act as harmful pests.

The least role of insects found in this study was that of parasitoids. Parasitoids were found to be the least prevalent in this study because most of the pests that attack the generative phase of maize tend to hide in the cobs, such as *S. frugiperda* and *H. armigera*. This makes it difficult for parasitoids to find and identify their hosts. According to Hrcek *et al*. (2013), parasitoids prefer semi-hidden hosts in plant parts because they are easier to parasitize than hosts that are not hidden and fully hidden in plant parts, one of which is on the cob. Therefore, the role of insects as parasitoids was found to be minimal in this study.

The presence of insects in an environment is influenced by various biotic and abiotic environmental factors. Abiotic factors include elements such as soil, water, temperature, light and atmospheric conditions. Biotic factors include the presence of other organisms that live together in the habitat (Hartini *et al.* 2019). The abiotic factors measured in this study included air temperature, humidity, and wind speed (Table 1).

Insects can live at temperatures ranging from 15–45°C, with the ideal temperature for their survival being around 25°C. Air humidity influences insect growth and development by regulating body water content, which is generally maintained within the range of 50–90%. Low humidity inhibits metabolism and slows insect development (Rizky *et al.* 2023). Wind speed also affects insect abundance, as variations in wind conditions influence insect activity and their environmental responses.

The environmental conditions showed a temperature of 27.4°C. The temperature is still within the range for insects to develop well. According to Irni *et al*. (2021), the effective temperature range for living and developing well is a minimum temperature of 15°C, an optimum temperature of 25°C, and a maximum temperature of 45°C. The humidity at the location was 78.1%. The humidity measurement was still within the range of good humidity. In line with Irni *et al*. (2021), the measure of humidity is still in a normal size, namely in the range of 50–90%, which can still be tolerated by insects to live and breed in that place. The wind speed was 1.2 m/s. This is in line with Weschler and Tronstad (2024), who reported that insects usually fly at low wind speeds.

The results of the abiotic factor measurements were further tested with the number of insect individuals found during the study. The test carried out using the correlation test was used to determine whether there was a relationship between abiotic factors and the number of individuals found at the research site. The results of the correlation test are presented in Table 2.

Based on the correlation test results, no significant relationship was found between abiotic factors and the abundance of insects at the study site ($p > 0.05$), indicating that changes in abiotic conditions were not followed by consistent changes in the abundance of insects. According to Potts *et al*. (2020), biotic factors such as interactions between species (predation and competition) can also significantly affect insect distribution and abundance. This is in line with the results of this study, as insects with a predatory role are most commonly found in maize fields during the generative phase. The increase in the number of

Table 1 Average of abiotic factors that measured at sampling sites in Caturharjo Village, Sleman

Sampling number	Air temperature (C)	Air humidity (%)	Wind speed (m/s)
1	28	76	0.8
2	30	75	1.1
3	25	74	1.6
4	30	75	2.0
5	27	80	1.1
6	29	75	1.9
7	29	70	1.2
8	26	88	1.1
9	26	75	1.1
10	29	83	1.1
11	25	86	1.1
12	25	77	1.0
13	28	80	1.3
Average	27.4	78.1	1.2

predators in the generative phase is likely due to the abundance of potential prey, such as herbivores, which attract the presence of predatory insects.

Diversity and dominance of insect species found in generative maize fields at Caturharjo Village

The diversity index value of insect species obtained at the research site was H' = 1.1484, which is in the medium category (1 < H'<3) (Table 3). The dominance index value of insect species in this study was D = 0.1093. Therefore, it is said to be low, or there are no insects that dominate the ecosystem.

According to Elisabeth *et al*. (2021), a moderate diversity index indicates a relatively balanced ecosystem that supports functional food webs. The results of this study are in accordance with the research of Kurnia *et al*. (2020), who also obtained moderate results for the value of the insect diversity index in maize crops on rainfed land in the Pati district of Central Java. Insect abundance in a habitat is influenced by the availability of resources, such as water and food, and interactions among species, including predation and competition (Baderan *et al*. 2021; Rizky *et al.* 2023). High ecosystem stability

Table 2 Correlation analysis test of the number of insect individuals with abiotic factors in Caturharjo Village, Sleman

			Insect_abundace	Air_temperature	Air_humidity	Wind_speed
Spearman's rho	Insect_abundace	Correlation Coefficient	1.000	.329	.245	-.061
		Sig. (2-tailed)	.	.272	.419	.844
		N	13	13	13	13
	Air_temperature	Correlation Coefficient	.329	1.000	-.317	.359
		Sig. (2-tailed)	.272	.	.291	.228
		N	13	13	13	13
	Air_humidity	Correlation Coefficient	.245	-.317	1.000	-.445
		Sig. (2-tailed)	.419	.291	.	.128
		N	13	13	13	13
	Wind_speed	Correlation Coefficient	-.061	.359	-.445	1.000
		Sig. (2-tailed)	.844	.228	.128	.
		N	13	13	13	13

Table 3 Diversity and dominance of insect species at generative maize fields in Caturharjo Village, Sleman

Species	Insect abundance (Individual)	pi	Log pi	pi log pi	Dominance
Agonum marginatum	1	0,0	-3,8	0,0	0,0
Chlaenius sp.	6	0,0	-3,0	0,0	0,0
Clivina sp.	208	0,0	-1,5	0,0	0,0
Licinus punctatulus	6	0,0	-3,0	0,0	0,0
Pheropsophus aequinoctialis	10	0,0	-2,8	0,0	0,0
Stenolophus sp.	437	0,1	-1,2	-0,1	0,0
Chrysolina graminis	1	0,0	-3,8	0,0	0,0
Aulacophora nigripennis	1	0,0	-3,8	0,0	0,0
Coccinella transversalis	2	0,0	-3,5	0,0	0,0
Glyphonyx sp.	2	0,0	-3,5	0,0	0,0
Protaetia fusca	2	0,0	-3,5	0,0	0,0
Onthophagus venoi	191	0,0	-1,5	0,0	0,0
Cylas formicarius	19	0,0	-2,5	0,0	0,0
Ostrinia furnacalis	3	0,0	-3,3	0,0	0,0
Helicoverpa armigera	1	0,0	-3,8	0,0	0,0
Pyralidae sp.	306	0,0	-1,3	-0,1	0,0
Pyralidae sp.1	7	0,0	-3,0	0,0	0,0
Scirpophaga sp.	90	0,0	-1,9	0,0	0,0
Scirpophaga sp.1	1	0,0	-3,8	0,0	0,0
Utethesia ornatix	15	0,0	-2,6	0,0	0,0
Creatonotos gangis	7	0,0	-3,0	0,0	0,0
Creatonotos transiens	1	0,0	-3,8	0,0	0,0
Paracles sp.	3	0,0	-3,3	0,0	0,0
Acraea trepiscore	8	0,0	-2,9	0,0	0,0
Leptosia nina	109	0,0	-1,8	0,0	0,0
Chrysopa sp.	184	0,0	-1,6	0,0	0,0
Gryllotalpha hexadactyla	1	0,0	-3,8	0,0	0,0
Average	6532	1	-164,2	H' = 1.1	0.1

reflects a high level of complexity arising from strong interactions among insects within the ecosystem (Nuraida *et al.* 2022). Although light traps primarily target insects, they may also capture predatory and parasitoid insects owing to light disturbance and species interactions; therefore, the results should be interpreted cautiously because of potential differences in capture probability among insect groups.

In addition to calculating the diversity index, this study calculated the dominance index of insects at the research site. The dominance index is the ratio between the number of individuals of one morphospecies and the number of individuals of all morphospecies in an ecosystem (Nisa *et al.* 2024). The absence of dominant insects can be caused by several factors, such as biodiversity and competition between insects.

According to Permana *et al.* (2024). A low dominance value indicates that the ecosystem is stable, with no single insect species dominating the community. This aligns with the findings of Elisabeth *et al*. (2021), who reported that insect dominance can be influenced by abiotic factors, such as physical and chemical environmental conditions, and other factors that affect the competition between insects. Other factors have also been suspected. Although chemical pesticides were not directly applied at the research site, their use in adjacent lands may still affect insect diversity and abundance, particularly in species, as pesticide particles can be carried by the wind and settle on corn plants. The combined effects of abiotic and biotic factors help explain the observed low dominance while highlighting the ongoing role of insects in maintaining ecosystem stability. According to Aveludoni (2021), the occurrence of insects is influenced by abiotic factors, particularly temperature, relative humidity, wind speed, light intensity, and rainfall.

CONCLUSION

The insects found came from 7 insect orders with 33 families. Insect family with the highest number of species is Carabidae (6 species). There was no correlation between insect abundance and the abiotic factors measured at the sampling sites. The species diversity index (H') value of this research was H' = 1.1484, which is categorized as a moderate diversity index, suggesting a relatively balanced community structure. The dominance index of insect species value in this study was D = 0.1093, showing that no species dominated the community, indicating a stable insect community that can maintain its role in the ecosystem.

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