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Insect Community Structure in Corn Plantations and the B.J. Habibie Forest Park (Tahura)

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.***Abstract***: The conversion of forest land into cornfields in the Bontula Village Buffer Forest, Tahura BJ Habibie, has caused changes in vegetation and environmental conditions that have impacted insect diversity. This study aims to analyze the structure of insect communities in the buffer forest habitat and the corn fields in Bontula Village. The study employed a quantitative descriptive method with a comparative approach. Sampling was conducted using purposive sampling with a combination of pitfall traps and light traps. The collected insects were identified to the species level and then analyzed using the Shannon-Wiener diversity index (H'), abundance (Di), evenness (E), species richness (R), and dominance (D). The results showed that 1,460 insect individuals belonging to 24 species and 21 families were found. The diversity index value for the buffer forest (H' = 1.376) was higher than that for the corn plantation (H' = 1.091), but both fell into the moderate category. The species with the highest abundance was Novomessor cockerelli, with a Di value of 0.415% in the buffer forest and 0.588% in the corn plantation. The evenness index was moderate, with a value of E = 0.508 in the buffer forest and E = 0.439 in the corn plantation. The species richness indices were R = 2.031 and R = 1.784, respectively, while the dominance indices were D = 0.302 and D = 0.441. In general, the insect community structure in both habitats was relatively stable, with a fairly good ecological balance.

Keywords: insect diversity, community structure, buffer forests, corn plantations, BJ Habibie National Park.

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Introduction

Sulawesi is one of the regions in Indonesia with a high level of biodiversity, including insect species. The wide variety of habitats in this region ranging from natural forests to agricultural land supports the presence of various insect species with diverse ecological functions. According to Moleong et al. (2023), habitat diversity in Sulawesi contributes to high biodiversity and plays a crucial role in maintaining ecosystem balance.

Insects play a vital role in various ecological processes, such as pollination, the decomposition of organic matter, biological control, and soil formation. Groups of insects such as predators, parasitoids, pollinators, and soil-forming organisms contribute to maintaining ecosystem sustainability through biological control, increased pollination success, and improved soil quality (Jarpla et al., 2024).

Although they play an important ecological role, insect communities are greatly influenced by their habitat conditions. Changes in land use, particularly the conversion of natural habitats into agricultural land, can lead to a decline in population size and species diversity due to a reduction in the resources needed to sustain their lives. Ruslan et al. (2024) state that the conversion of natural habitats into agricultural land can affect insect populations through changes in food sources, shelter, and environmental conditions.

Land-use changes can also affect community composition, the dominance of certain species, and the ecological relationships that form within an ecosystem. Nisa et al. (2025) explain that the conversion of natural ecosystems into agricultural landscapes has the potential to alter the structure of insect communities and reduce species diversity. Therefore, the structure of insect communities can be used as a biological indicator to assess environmental conditions and the impacts of land-use changes.

One area facing pressure due to land-use changes is the BJ Habibie Community Forest Park (TAHURA) in Boalemo Regency, Gorontalo Province. Covering an area of approximately 6,208 ha, this park serves as a vital conservation area for preserving biodiversity. Surrounding it is the buffer forest of Bontula Village, which acts as a transition zone between the conservation area and community activities, while also serving as a habitat for various insect species.

The growing demand for agricultural land, particularly for corn cultivation, has driven changes in land cover around the area. Data from the Gorontalo Central Statistics Agency (BPS) (2025) show that the area under corn cultivation in 2024 reached 128,230 ha, with a production of 625,970 metric tons. In Bontula Village alone, the area of corn plantations is approximately 700 ha. The conversion of natural vegetation into agricultural land dominated by corn crops has the potential to affect habitat conditions and the presence of insect communities.

Various studies have reported that habitat changes resulting from land conversion can affect insect community structure (Moleong et al., 2023; Ruslan et al., 2024; Nisa et al., 2025). However, information regarding the structure of insect communities in buffer forests directly bordering corn plantations remains limited, particularly in Bontula Village near the BJ Habibie National Park (TAHURA BJ Habibie). Therefore, this study was conducted to analyze the structure of insect communities in buffer forests and corn plantations to determine the influence of differing habitat characteristics on insect communities in these two habitat types. The results of this study are expected to provide a scientific basis for supporting sustainable agricultural management and biodiversity conservation efforts.

Materials and Methods

The study was conducted in Bontula Village, Asparaga Subdistrict, Gorontalo Regency, Gorontalo Province, in June 2025. Insect specimen collection for this study was carried out at two research sites: Site 1, a buffer forest area located at 0°48'58.41“N 122°26'38.31”E, and Site 2, a corn plantation area located at 0°48'54.27“N 122°26'46.45”E.

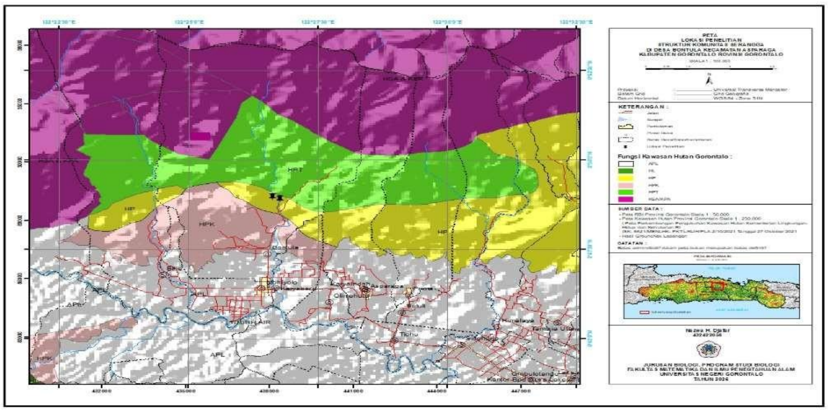

Figure 1. Research location map

The subject of this study is the insects found in the cornfields and buffer forests of Bontula Village, BJ Habibie Community Forest Park (Tahura). The study employed a quantitative descriptive method with a comparative approach to compare the structure of insect communities in these two habitats.

Research sites were selected using purposive sampling based on differences in habitat type, vegetation conditions, and the potential presence of insects. Insect sampling was conducted using pitfall traps and light traps in the morning and evening throughout the study period. All collected specimens were preserved in a NaCl solution and identified to the species level using various insect identification guides as well as the Picture Insect and Seek by Naturalist apps.

Measurements of environmental parameters included air temperature, light intensity, and soil quality. Equipment used included pitfall traps, light traps, thermometers, lux meters, soil testers, specimen storage containers, millimeter blocks, writing utensils, GPS devices, cameras, and insect identification guides. Research materials included insect specimens, NaCl solution, as well as label paper and permanent markers for sample labeling.

Data analysis was conducted using quantitative descriptive methods by calculating the following ecological indices:

1. Shannon-Wiener Diversity Index (H') $H' = -\sum \left(\frac{ni}{\mathrm{N}} \ln \frac{ni}{\mathrm{N}}\right)$
   H′ = Shannon-Wiener diversity index
   pi = ni/N
   ni = Number of individuals of species i
   N = Total number of individuals
   Ln = Natural logarithm
   Assessment criteria based on the diversity index:
   H′ > 3 = High diversity
   H′ 1–3 = Moderate diversity
   H′ < 1 = Low diversity
2. Abundance Index (Di) $Di \frac{ni}{N} x\ 100\%$
   Di : Abundance Index
   ni : Number of individuals of the i-th species
   N : Total number of individuals of all species
   Assessment criteria based on the abundance index:
   Di : > 5% = Dominant
   Di : 2–5% = Subdominant
   Di : < 2% = Non-dominant
3. Evenness Index E$\frac{H\prime}{ln\ S}$
   E : Species evenness index
   H′ : Shannon-Winner diversity index
   S : Total number of species at each location
   Assessment criteria based on the evenness index:
   E > 0.6 = high evenness
   0.4 < E < 0.6 = moderate evenness

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E < 0.4 = low evennes

4. Richness Index $R\frac{S-1}{\ln N}$

R : Richness index

S : Total number of species at each location

N : Total number of individuals across all species

Assessment criteria based on the richness index:

R > 5.0 = high richness

R > 3.5 < 5.0 = moderate richness

R < 3.5 = low richness

5. Dominance Index $D = \sum\left(\frac{ni}{N}\right)^2$

D : species dominance index

ni : number of individuals of each species

N : total number of individuals across all species

Assessment criteria based on the dominance index:

D < 1.00 = High dominance

D > 0.50 < 0.75 = Moderate dominance

D < 0.50 = Low dominance

Results and Discussion

Identification of Insects in Corn Fields and Buffer Forests in Bontula Village

A study conducted at a corn plantation and buffer forest site in Bontula Village, Asparaga Subdistrict, Gorontalo Regency, Gorontalo Province, resulted in the discovery of 1,460 insect specimens, which have been identified as shown in Table 1.

Family	Genus	Spesies	Number of Individuals		Total Individuals
			Buffer Forest	Corn Field	
Formicidae	Messor	Messor cephalotes	53	27	80
	Nocomessor	Novomessor cockerelli	408	280	688
Pterophoridae	Adaina	Adaina bipunctatus	0	144	144
Dytiscidae	Agabus	Agabus bipustulatus	1	0	1
Sphingidae	Agrius	Agrius convolvuli	0	3	3
Coccinellidae	Coccinella	Coccinella septempunctata	1	0	1
Erebidae	Pseudopharus	Pseudopharus hades	3	0	3
	Asota	Asota caricae	3	0	3

Cicadidae	Cystopsaltria	Cystopsaltria immaculata	0	6	6
Crambidae	Desmia	Desmia funeralis	3	0	3
Gryllotalpidae	Gryllotalpa	Gryllotalpa africana	1	0	1
Tettigoniidae	Hexacentrus	Hexacentrus japonicus	0	6	6
Mantidae	Hierodula	Hierodula unimaculata	0	1	1
Pyralidae	Lamoria	Lamoria imbella	2	0	2
Geometridae	Melanchroia	Melanchroia chephise	3	0	3
Mycetophilidae	Mycetophila	Mycetophila magnicauda	251	0	251
Blattidae	Periplaneta	Periplaneta fuliginosa	1	0	1
Cossidae	Phragmataecia	Phragmataecia castaneae	2	0	2
Reduviidae	Rhiginia	Rhiginia cruciata	0	1	1
Halictidae	Sphecodes	Sphecodes albilabris	0	1	1
Acrididae	Stenocatantops	Stenocatantops vitripennis	0	1	1
	Valanga	Valanga nigricornis	0	1	1
Tenebrionidae	Tenebrio	Tenebrio molitor	245	0	245
Gryllidae	Xenogryllus	Xenogryllus marmoratus	7	5	12
TOTAL		24	984	476	1.460

Table 1. Insect Species in the Buffer Forest and Cornfield Area of Bontula Village, Asparaga Subdistrict

Table 1 shows that the insects found at the Bontula site in Asparaga Subdistrict comprise 21 families, 24 genus, and 24 species. The total number of individuals was 1,460, covering two study sites, with 984 individuals at site 1 (buffer forest) and 476 individuals at site 2 (cornfield). These included the families Formicidae, Erebidae, Acrididae, Pterophoridae, Dytiscidae, Sphingidae, Coccinellidae, Cicadidae, Crambidae, Gryllotalpidae, Tettigoniidae, Mantidae, Pyralidae, Geometridae, Mycetophilidae, Blattidae, Cossidae, Reduviidae, Halictidae, Tenebrionidae, and Gryllidae.

The insect species successfully identified include *Messor cephalotes, Adaina bipunctatus, Agabus bipustulatus, Agrius convolvuli, Asota caricae, Coccinella septempunctata, Cystopsaltria immaculata, Desmia funeralis, Gryllotalpa africana, Hexacentrus japonicus, Hierodula unimaculata, Lamoria imbella, Melanchroia chephise, Mycetophila magnicauda, Novomessor cockerelli, Periplaneta fuliginosa, Phragmataecia castaneae, Pseudopharus hades, Rhiginia cruciata, Sphecodes albilabris, Stenocatantops vitripennis, Tenebrio molitor, Valanga nigricornis, and Xenogryllus marmoratus.*

The number of insect individuals found in the buffer forest area was higher than in the corn plantation area. This is due to the greater vegetation diversity, which provides better habitats and food sources for insects. Rahim et al. (2023) explain that diversity is influenced by host plant diversity, ecosystem balance, competition, and seasonal factors.

The number of insect species and individuals found at each study site showed fairly distinct differences. Some species were found only at Site 1 (buffer forest), some were found only at Site 2 (corn plantation), and others were found at both locations. These differences in species composition indicate variations in habitat conditions that influence the presence of insects at each study site. According to Ardianto et al. (2023), the diversity index is influenced by the number of species, the distribution of individuals, and the vegetation conditions present in the habitat.

Insect Community Structure at a Corn Farm and Buffer Forest in Bontula Village

a. Diversity Index (H')

Figure 2. Graph of the Insect Diversity Index at the Corn Farm and Buffer Forest Site in Bontula Village

The insect diversity index (H') at both study sites fell into the moderate category. The diversity index value in the buffer forest area was H' = 1.376, while in the corn plantation area it was H' = 1.091. The higher value in the buffer forest area indicates that the habitat there is more conducive to the presence and distribution of various insect species compared to the corn plantation area, which has more homogeneous vegetation. Aveludoni (2021) states that the high diversity values in the buffer forest area are influenced by vegetation complexity, the availability of food sources, and more stable environmental conditions, which provide a more suitable habitat for various insect species.

The high level of biodiversity in buffer forest areas is related to the complexity of the vegetation and more diverse microhabitat conditions. Buffer forests have denser vegetation cover, creating a more stable environmental condition. Measurements show that the temperature in the area is 25.8°C. According to Taradipha (2019), habitats with high vegetation density generally maintain better humidity levels and have lower temperatures compared to open habitats. These microclimatic conditions create a more stable environment, thereby increasing both the diversity and abundance of insects.

b. Abundance Index

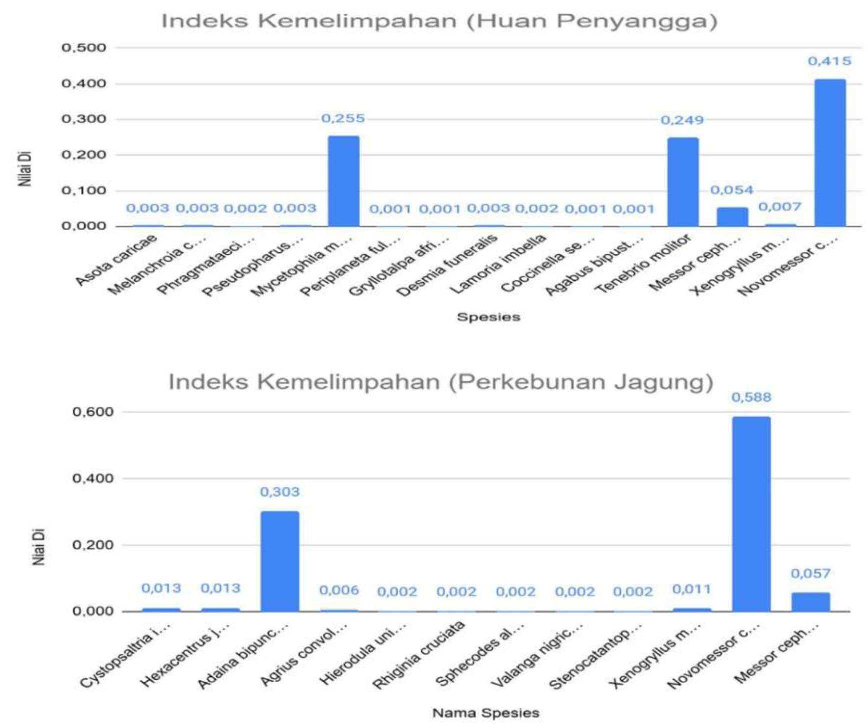

Figure 3. Graph of the Insect Abundance Index at the corn plantation and buffer forest sites in Bontula Village.

The abundance index graph in Figure 3 shows that each species has a different abundance value. The highest abundance at point 1 (buffer forest) was 0.415%, and at point 2 (cornfield) it was 0.588%, both of which fall into the “non-dominant” category. The species with the highest abundance at both point 1 and point 2 was Novomessor cockerelli.

Novomessor cockerelli had the highest abundance index (Di) at both locations. The abundance value for this species reached Di = 0.415% in the buffer forest area and Di = 0.588% in the corn plantation area. This species has the highest abundance value because the family Formicidae is known as a group of eusocial insects that live in large colonies with a very high number of individuals and a high ability to adapt to various environmental conditions, as stated by Kocher and Kingwell (2024); the ecological success of ants is supported by their eusocial nature, which enables colonies to function as superorganisms with a high level of efficiency in utilizing resources. Andersen (2019) explains that ants play a crucial role in ecosystems because of their strong adaptability to environmental disturbances and flexibility in resource utilization, which often allows them to dominate insect communities.

C. Equity Index (E)

Figure 4. Graph of the Insect Evenness Index at the corn plantation and buffer forest sites in Bontula Village.

The Evenness Index (E) graph in Figure 4. shows that Point 1, which is a buffer forest area, has an evenness value of E = 0.508, which falls into the moderate evenness category, while Point 2, which is a plantation area, has an evenness value of E = 0.439, which also falls into the moderate evenness category.

The abundance index value is directly proportional to the evenness index value (E). Uneven abundance of each species results in low species evenness, and vice versa (Nikmah et al., 2021). The results of the evenness index calculations in this study are consistent with this statement. The insect evenness index in the buffer forest area was E = 0.508, while in the corn plantation area it was E = 0.439. Based on the species evenness criteria, the evenness indices at both sampling locations indicate

d. Wealth Index (R)

Figure 5. Graph of the Insect Abundance Index at the Corn Farm and Buffer Forest Site in Bontula Village

Referring to Figure 5, it can be seen that the highest Wealth Index value was obtained at point 1, with an R value of 2.031, which falls into the moderate wealth category, while point 2 has an R value of 1.784, which falls into the low wealth category.

The species richness index in the buffer forest area was R = 2.031, while in the corn plantation area it was R = 1.784. Both values indicate a relatively low level of species richness, although the buffer forest area had a higher value than the corn plantation area. This difference suggests that buffer forest habitats provide more favorable conditions for the presence of various insect species due to their more complex vegetation structure and more diverse microhabitat conditions. According to Seibold et al. (2019), species richness is strongly influenced by habitat heterogeneity, resource availability, and low levels of environmental disturbance. The more complex a habitat is, the higher the likelihood of a species-rich insect community forming.

Monoculture systems in cornfields result in habitat homogeneity, which can reduce the diversity and richness of insect communities due to limited resources and high levels of environmental disturbance. These conditions indicate that intensively farmed land is less capable of supporting the stability of insect communities compared to natural habitats. This aligns with the findings of Wagner et al. (2021), who noted that natural habitats with diverse vegetation are able to maintain higher species richness than intensively farmed land.

e. Dominance Index (D)

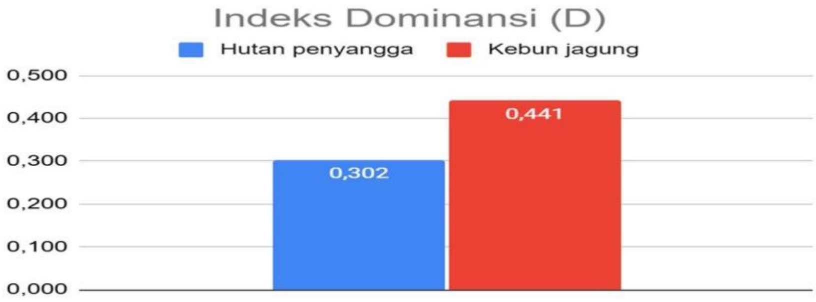

Figure 6 Graph of the Insect Dominance Index at the Corn Farm and Buffer Forest Site in Bontula Village

Figure 4.3.5 shows the dominance index values for point 1 (D = 0.302), which falls into the moderate dominance category, and point 2 (D = 0.441), which also falls into the moderate dominance category.

The dominance index (D) in the buffer forest area was D = 0.302, while in the corn plantation area it was D = 0.441. Based on dominance criteria, both locations fall into the moderate dominance category. A moderate dominance value indicates that there are several species with higher numbers of individuals than other species, but no single species absolutely dominates the community. This suggests that the insect communities in both habitats still exhibit fairly good species diversity. According to Nikmah et al. (2021), species dominance can be influenced by resource availability and habitat conditions that support the development of certain species.

Simpler habitats (monocultures) tend to increase the likelihood of dominance by a few highly adaptable species. However, the dominance values obtained in this study indicate that both habitats are still capable of supporting a variety of insect species, so no single species was found to dominate. This is consistent with the findings of Ardianto et al. (2023), who stated that a moderate Dominance Index indicates the absence of dominance concentration in any particular species within a community.

Conclusion

Based on the analysis of insect community structure in corn plantations and buffer forests in Bontula Village, Tahura BJ Habibie, it can be concluded that the buffer forest supports a more diverse and stable insect community than the corn plantation. This is indicated by higher diversity, evenness, and species richness values in the buffer forest. Although dominance levels in both habitats were moderate, dominance was higher in the corn plantation. Novomessor cockerelli was the most abundant species in both habitats, without strongly dominating the community.

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