Diversity of Butterflies on Different Ecosystems and Seasons

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Abstract. Indonesia is a tropical country that has two seasons, dry and wet. These climate conditions make Indonesia have mega biodiversity. The organism that has high diversity is an insect. Butterflies are exotic insects for diversity. This research aims to calculate and compare the abundance, diversity, richness, evenness, and similarity of butterfly species in several different ecosystems and seasons, and analyze the effect of seasonal differences on their abundance. The sampling method used the time search method on primary forest, secondary forest, plantation, and paddy field on the border of South Sulawesi (Pinrang Regency) and West Sulawesi (Mamasa Regency). The results showed that in the dry season, there were 156 species from 25 families of butterflies, while in the wet season, 74 species from 10 families of butterflies were found. Three species of butterflies are protected and nine endemic species.

1. Introduction
Indonesia is a tropical country that only has two seasons, namely the dry and wet seasons. These climatic conditions make Indonesia has a high biodiversity. Warm temperatures and sufficient humidity make plants and animals develop well, making natural resources in Indonesia more diverse. One type of animal that has a high diversity in Indonesia is insects [1].

Insects are organisms that found and various types in Indonesia, but there are still not many species studied to study their role further. Insects are still very little use as a bio-indicator of environmental assessment [2]. Butterflies are one type of insect that is interesting to study its diversity. Butterflies are insects that have attractive shapes and colors that easily recognized in nature. Butterflies act as pollinators and as a bioindicator of environmental damage [3]. Changes in the dry and wet seasons cause changes in the microclimate, which affect populations of several species of butterflies. Seasonal changes result in differences in rainfall and average temperatures. According to Handini [4], insect diversity is different in each season.

The purpose of this research is to calculate and compare the abundance, diversity, richness, evenness, and similarity of butterflies species in different ecosystems and seasons, and analyze the influence of seasonal differences on butterfly abundance. Measurement of habitat characteristics aims to determine the effect of habitat characteristics on butterfly diversity. This research is expected to provide information and be a reference for the diversity of butterflies at each observation station and different seasons so that it can be used as a reference for conservation.
2. Method

2.1. Time and Place
The research conducted in August 2018 and January 2019. The location of insect data collection was carried out at the border of South Sulawesi (Pinrang Regency) and West Sulawesi (Mamasa Regency), which divided into four ecosystems, namely primary forest, secondary forest, plantation, and rice field. Identification of insect species and data processing were carried out at the Forest Entomology Laboratory, Department of Silviculture, Faculty of Forestry, IPB University.

2.2. Procedure
The research consisted of several stages, namely sampling, identification of samples, and measurement of habitat characteristics.

2.3. Sampling
Sampling is carried out using the time search method, which is a modification of the line transect method where the observation plot not limited by a specific area but limited by time. Each observation plot is limited for 15 minutes, starting with the discovery of the first individual captured. The plot ends until the specified deadline. The next plot begins with the discovery of the first individual at a different point [5]. Sampling is carried out using hand-net. Banana trap installation follows a plot that has been made using the time search method.

2.4. Measurement of habitat characteristics
The habitat characteristics measured are air temperature, humidity, and canopy density. All habitat characteristics measured in each ecosystem.

2.5. Data Analysis
Data analysis was carried out by calculating the diversity of butterflies. The diversity observed in this research included species abundance, species richness, species diversity, species evenness, and species similarity [6]. This research also analyzed the correlation between butterfly abundance and habitat characteristics and analyzed the influence of seasons on butterfly abundance.

3. Result and discussion

![Figure 1](image_url)

**Figure 1.** The abundance of butterflies in four ecosystems in different seasons.
Based on Figure 1, the number of butterflies in the dry season is more than the wet season. The number of butterflies in the dry season is 399 butterflies consisting of 27 butterflies in primary forests, 216 butterflies in secondary forests, 73 butterflies in plantations, and 83 butterflies in rice fields. The number of butterflies in the wet season is 211 butterflies consisting of 39 butterflies in primary forests, 79 butterflies in secondary forests, ten butterflies in plantations, and 83 butterflies in rice fields. Butterflies in the dry season are most commonly found in secondary forest ecosystems while in the wet season most commonly found in the rice field ecosystem. The Butterflies found in secondary forests when dry season because of the wide-crowned host tree as a place to perch or forage [7]. Rice field ecosystems have the highest number of individuals in the wet season. This is presumably because it bordered by rivers and secondary forests that have a high abundance of butterflies.

The Butterflies found in both seasons change. There are several families found in the dry season but not found again in the wet season, namely butterflies from the family Artiidae, Callidulidae, Drepanidae, Ericaceae, Ethmiidae, Hepialidae, Incurvariidae, Lasiocampidae, Limacodidae, Noctuidae, Nolidae, Pyralidae, Sphingidae, Tortricidae, Uraniiidae dan Zygaenidae. New butterflies also found in the wet season, which not found in the dry season, namely the butterflies of the Cossidae family. The change in the number of butterflies is caused by flight periods and stops at certain season periods [8]. The dominant family in the two seasons is the butterfly of the Nymphalidae family. The Nymphalidae family butterfly is the butterfly with the largest member and the most widespread distribution compared to other families [9].

The value of species richness is used to determine species diversity based on the number of species in an ecosystem. The index used is the Margalef Wealth Index (Dmg) [10]. If the Dmg value is less than 3.5, the species richness classified as low if the Dmg value ranges from 3.5 to 5, the species richness classified as moderate, and if the Dmg value is more than 5, the species richness is high. Based on Figure 2, the value of species richness in all four ecosystems in the dry season classified as high. Secondary forests have the highest species richness in the dry season, with a value of 17.67. The wet season has a variety of species richness values. Plantation ecosystems have low species richness (2.61), primary forest ecosystems have medium species richness (4.37), secondary forest ecosystems have high species richness (9.15), and rice field ecosystems have the highest species richness (9.51).

**Figure 2.** Richness index of butterflies in four ecosystems at different seasons
The species diversity index calculation is carried out using the Shannon-Wiener Index [6]. Figure 3 shows that in the dry season in primary forests, plantations, rice fields, the value of species diversity is classified as moderate with successive values of 3.17, 3.28, and 3.49. Secondary forests have the highest species diversity value (4.24) in the dry season. The value is relatively high. This is because secondary forests have diverse vegetation conditions and areas that are slightly open. The slightly open forest has room for light to enter, so it attracts several species of butterflies that come into secondary forests compared to primary forests [11]. The wet season has diverse values of species diversity. The value of species diversity is in plantations 1.83, primary forests 2.58, secondary forests 3.4, and rice fields 3.58. The species diversity of butterflies in secondary forests and rice fields is considered high due to the large number of host plants such as the families of Rutaceae, Annonaceae, and Aristolochiaceae around rice fields bordering rivers and secondary forests. Some types of butterflies have great flying distances to find a host. Host plants are where the larvae obtain their food from the larval stage to the imago [12]. Butterflies have a special food source that is often endemic in an area. This is due to the nature of the host plant, which is usually endemic in an area. Some species of butterflies have specific host plant needs as a place to lay eggs and as larval feed.

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**Figure 3.** The diversity index of butterflies in four ecosystems at different seasons

**Figure 4.** Evenness index of butterflies in four ecosystems at different seasons
The Pielou Evenness Index is a value that explains individual dominance in a place. Evenness value range from 0 to 1. If the value near to 0, then there is a butterfly that dominates in a certain place; otherwise, if the value near to 1, then the number of individuals per species are evenly distributed [10]. Evenness values in the four ecosystems in the dry and wet season are high, meaning that no type of butterfly dominates in an ecosystem.

| Ecosystem | PF  | SF  | P   | PFd |
|-----------|-----|-----|-----|-----|
| PF        | 1.00|     |     |     |
| SF        | 0.19| 1.00|     |     |
| P         | 0.20| 0.34| 1.00|     |
| PFd       | 0.21| 0.41| 0.21| 1.00|

PF= Primary Forest, SF= Secondary Forest, P= Plantations dan PFd= Paddy Field

The similarity index is a value that shows the level of similarity between locations based on individuals found in each ecosystem. The similarity index in the dry season and wet season can be seen in Tables 1 and 2. The higher the value is, the higher the similarity between the two ecosystems, which means that the different types between the two ecosystems are getting smaller [13]. Table 1 shows the value of the similarity index type in the dry season. A comparison of secondary forests and paddy fields has the highest similarity in the dry season. This is because the distance between the two ecosystems is not too far away, and the butterflies found are also many. Table 2 shows the value of the type similarity index in the wet season. A comparison of the primary forest and the plantation forest is the highest similarity in the wet season. This is because butterflies in the primary forest ecosystem and the plantations in the wet season have a small abundance.

The results of the Pearson correlation analysis showed that air temperature, air humidity, canopy density in this study did not significantly correlate with the abundance of butterflies in the dry and wet seasons. The T-test was conducted to find out the average abundance of butterflies in both seasons, having the same or no average value with the level used at 5%. The results of the T-test showed that there was a significant difference in the 95% significance level with a significance value of 0.047 between the abundance of butterflies and the difference in season, meaning that the difference in seasons had a significant effect on the abundance of butterflies. This was allegedly due to differences in environmental conditions and vegetation at each observation location. Plantations and rice fields have different flowering and harvesting periods so that the availability of feed is always available in every season.

### 4. Conclusion
The diversity of butterflies varies in primary forest ecosystems, secondary forests, plantations, rice fields in each different season. The highest abundance, richness, and diversity of butterflies in the dry season found in secondary forest ecosystems with following values 216, 17.67, and 4.24 while in the wet season in paddy ecosystems with following values 83, 9.51 and 3.58. There are no butterflies that dominate in a certain place. This influenced by environmental factors of the ecosystem.
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