Entomology

Study ecology of dragonfly (odonata) in North Sumatera, Indonesia

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Abstract

This research aims to determine the diversity, abundance, dominance, and evenness of dragonflies (Odonata) as well as environmental factors in two different habitats, namely rice fields and riverbanks. Sampling was conducted purposively using insect nets. Seven species of dragonflies were identified, with *Orthetrum sabina* being the most abundant species. The diversity index in rice fields (H′ = 1.34) is slightly lower compared to riverbanks (H′ = 1.38). The values of abundance, dominance, and evenness show small differences between habitats. Environmental factors such as temperature, humidity, and wind speed influence the distribution of dragonflies, with riverbanks having more optimal microclimate conditions. These results affirm that both habitats support dragonfly diversity and are important to maintain as indicators of ecosystem health.

Keywords: Dragonfly, Odonata, Diversity, Abundance, Environmental factors

1. Introduction

Indonesia is one of the countries that has the nickname "Mega Biodiversity", ranking third after Brazil and Madagascar (Hartika *et al*., 2017) [3]. It is estimated that about 25% of all species on earth are found in Indonesia. Insects are the most abundant group of animals in the world, amounting to about 80% of the total animal species. According to Sonia *et al*., (2022) [11], insects that have a relatively high diversity and play a beneficial role for the environment are dragonflies.

Dragonflies are insects that play an important role in an ecosystem, both as biological controllers. In the role of biological control, dragonflies function as natural enemies that help to control pest populations on crops in rice fields (Hermawan, 2015). On the other hand, research also states that the diversity and abundance of dragonflies in an ecosystem can serve as indicators of ecosystem balance. Besides being biological controllers, dragonflies can also be used as bioindicators of environmental quality (Susanto & Bahri, 2021) [13].

Scientifically, the order Odonata is divided into three suborders, but in Indonesia, there are only 2 suborders, namely Anisoptera and Zygoptera. These two suborders have quite noticeable differences in terms of eye shape, wings, body, and flying behavior. Anisoptera dragonflies have large, fused eyes, a body that is larger than Zygoptera dragonflies, and larger front wings than hind wings. When at rest, their wings remain open. These dragonflies can fly quickly and cover large areas. Meanwhile, Zygoptera dragonflies have separated eyes, a smaller body, and front and hind wings of the same size. When resting, their wings are folded above the body. Their flying ability tends to be weaker with a limited range (Pamungkas, 2015) [7].

2. Research methods

This research was conducted in Sei Semayang Village, Sunggal District, Deli Serdang Regency, North Sumatra Province, Indonesia, and the Biology Laboratory of Medan State University from March to May 2025. Samples were taken from rice fields and riverbanks in Sei Semayang Village, Sunggal District, Deli Serdang Regency, North Sumatra Province, Indonesia. The tools used in this study include an insect net for catching dragonflies, a killing bottle for euthanizing the dragonflies, paper towels for storing dead samples, and various other items such as pens and paper. The research material is 70% alcohol. The research procedure is divided into two main stages:

a) Collection of dragonfly samples

The steps to collect dragonfly samples are as follows:

- If there are dragonflies active in the rice field and riverbank areas, capture them using an insect net.
- Swing the insect net freely or without a pattern for about 15 minutes at 2 observation stations, namely in the rice field and on the riverbank.
- The captured dragonflies are placed into a killing bottle containing cotton and 70% alcohol, then wrapped in a paper envelope and stored in a plastic clip, with a label that contains location information and others.
- Sampling is done during high dragonfly activity, specifically in the morning from 08:00 to 11:00 AM and in the afternoon from 15:00 to 17:00 PM.

b) Identification of dragonfly samples

The steps to identify a dragonfly are as follows:

- The dragonfly samples were then identified at the Biology Laboratory of the Faculty of Mathematics and Natural Sciences, State University of Medan.

- After that, the identification of dragonfly samples was carried out using a stereo microscope to observe body parts such as the thorax, abdomen, and wings.
- Then, the identification of adult dragonfly specimens refers to Baskoro *et al.* (2018) and Murwitaningsih *et al*. (2019).

3. Data analysis techniques

a) Diversity index

The dragonfly diversity index in this study can be determined using the Shanon-Wienner index formula (H') as referenced in Manurung (2020) [6]. Using the following formula-

$$H' = -\sum_{r=t}^{s} pi\,(\ln pi)\,; pi = \frac{ni}{N}$$

Description-

H' = Shanon Wiener diversity index
S = Number of species
ni = Number of individuals of one type
N = Number of individuals of all types
ln = Natural logarithm
Pi = The proportion of the number of individuals of each species to the total number of individuals.

b) Abundance index

The type of abundance index used is the Margalef method, which according to Sari *et a*l. (2022) [10] states that the formula is as follows:

$$Dmg = \frac{S-1}{\ln N}$$

Description-

Dmg = Margalef abundance index
S = The number of species observed
In = Natural logarithm
N = The number of individuals of all species Indeks dominansi

c) Dominance index

The dominance index to determine the level of dragonfly dominance. According to Manurung, 2020 [6], to determine the amount of dominance, it can be calculated using the following formula:

$$C = \sum(\frac{ni}{N})2$$

Description-

C = Dominance index
ni = Number of individuals of one species
N = Number of individuals of all species Indeks kemerataan

d) Evenness index

The evenness index indicates whether the distribution of species is even or not. According to Manurung (2020) [6], it can be determined using the following formula:

$$E = \frac{H'}{In\ S}$$

Description-

E = Evenness Index
H' = Species Diversity Index
In = Natural logarithm
S = Number of species found

e) Test t

Test t is used to test whether the diversity of dragonflies in the rice field and riverbank area in Sei Semayang Village is significantly different or not. The formula used is the t-test proposed by Hutcheson (1970 in Zar, 2010) [18] as follows:

$$t_{count} = \frac{H_1 - H_2}{S_{H1-H2}}$$

Where,

$$S_{H1-H2} = \sqrt{S^2H'1 + S^2H'2}$$

The variance of H' can be estimated through the following equation:

$$S^2H' = \frac{\sum n_i(\log^2 n_i) - (\sum n_i \log n_i)^2/N}{N^2}$$

Meanwhile, the magnitude of the degrees of freedom (df) used is estimated through the following equation:

$$df = \frac{(S^2H'1 + S^2H'2)^2}{\frac{(S^2H'1)^2}{N_1} + \frac{(S^2H'2)^2}{N_2}}$$

Description-

H_1 = Diversity index Station I (rice field)
H_2 = Diversity index station II (riverbank)
S_{H1-H2} = Variations of diversity from station I and station II
$S^2H'1$= Sample variations of station I (rice field)
$S^2H'2$ = Sample variation of station II (riverbank)
N_1 = total number of individuals at station I
N_2 = total number of individuals at station II
df = Degrees of freedom

4. Results and discussions

A. Types and number of dragonflies in Sei Semayang Village, Sunggal District, Deli Serdang Regency

The types and number of dragonflies found in Sei Semayang Village, Sunggal District, Deli Serdang Regency from March to May 2025 amounted to 257 individuals consisting of 7 species that belong to 2 families. The types of dragonflies found are shown in Figure 1, so the number of individuals and species of dragonflies found at each station in the Sei Semayang Village area is presented in Table 4.1.

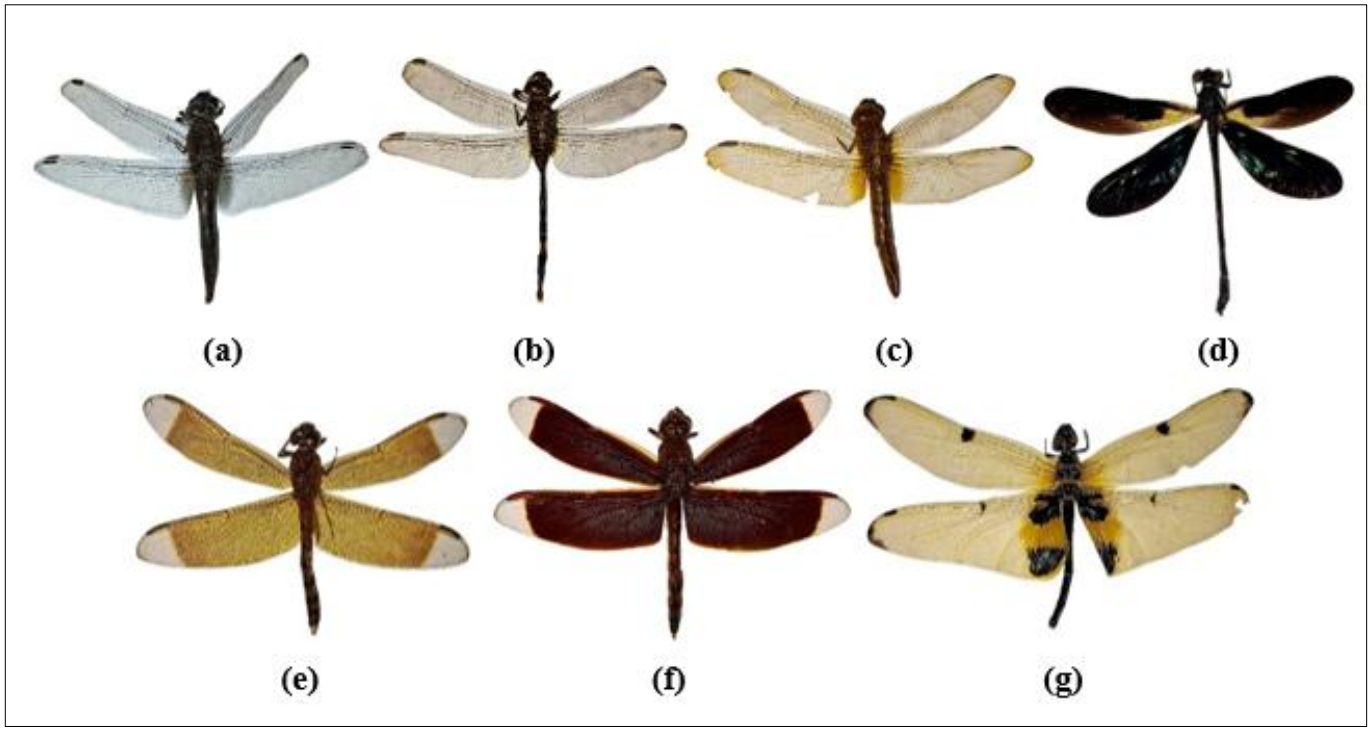

Fig 1(a): *Orthetrum testaceum,* (b) = *Orthetrum sabina,* (c) = *Pantala flavescens,* (d) = *Euphaea variegate*, (e) = *Brachythemis contaminate,* (f) = *Neurothemis fluctuans,* (g) = *Rhyothemis phylis*

Tabel 4.1. Types and numbers of dragonflies found at each station

No	Type	Station	
		I (rice field)	II (riverbank)
1.	*Orthetrum testaceum*	42	25
2.	*Orthetrum sabina*	55	44
3.	*Pantala flavescens*	32	33
4.	*Brachythemis contaminate*	5	-
5.	*Neurothemis fluctuans*	7	-
6.	*Rhyothemis phylis*	-	11
7.	*Euphaea variegata*	-	3
Total		141	116

Based on Table 4.1, it is known that the types of species found at the two stations indicate that the Libellulidae family dominates with 6 species (254 individuals), such as *Orthetrum testaceum*, *Pantala flavescens*, and *Neurothemis fluctuans*. The high dominance of Libellulidae is suspected to be due to their long-distance migratory abilities (Rahadi, 2013) [9], aggressive predatory behavior (Triyanti *et al*., 2021) [15], and their ability to adapt to various habitat types, including rice field areas and riverbanks. Meanwhile, the Euphaeidae family consists of only one species, namely *Euphaea variegata* (3 individuals), which tends to be found in clean and calm flowing waters. Its presence serves as an indicator of an unpolluted aquatic ecosystem (Hamid *et al*., 2021) [2]. Although the numbers are small, the presence of Euphaeidae reflects the fairly good environmental quality at the research site.

B. Abundance index

The results of the abundance index calculation of dragonflies based on the Margalef method are presented in Table 4.2.

Tabel 4.2: The abundance index value of dragonfly uniformity at each station

No	Station	Abundance index
1.	Rice field	0.81
2.	Riverbanks	0.84

Based on Table 4.2, it is known that the dragonfly abundance index value using the Margalef method shows a figure of 0.81 at Station I (rice fields) and 0.84 at Station II (riverbanks). This small difference indicates that species richness in both habitats is relatively similar, although the riverbank is slightly higher. These findings are in line with Pelealu *et al.* (2022) [8] who reported higher species richness in secondary forests compared to plantations or settlements, as well as Kurnia *et al*. (2023) [4] which showed that stable water flow and diverse vegetation in the Katulampa Dam contribute to the high diversity of dragonflies. Thus, although the differences are not significant, both habitats have proven to support rich species communities of dragonflies. The preservation of rice field habitats and riverbanks remains important to maintain the sustainability of dragonfly biodiversity in this area.

C. Diversity index

The results of the calculations regarding the diversity index values of dragonflies found at each station are presented in Table 4.3.

Tabel 4.3: The diversity index value of dragonflies at each station

No	Station	Diversity index
1.	Rice field	1.34
2.	Riverbanks	1.38

Based on the calculation of the Shannon-Wiener diversity index (H'), the diversity of dragonflies in Sei Semayang Village is classified as moderate, with values of 1.34 at Station I (rice field) and 1.38 at Station II (riverbank). These results are in line with the findings of Pelealu *et al*. (2022) [8], which reported that the diversity index value correlates with habitat conditions, being higher in secondary forests and lower in settlement areas. The research by Wakhid et al. (2020) [16] also supports this finding, with the highest index in rice field habitats (2,11) dominated by generalist species. Additionally, Waryati and Triatmanto (2022) [17] found an index value of 1.88 in the natural area of Curug Cipendok, which is also classified as moderate.

Thus, the diversity of dragonflies at the research location indicates a relatively good habitat quality, despite the presence of dominant species. Further monitoring of the dragonfly community is important to be carried out as an ecological indicator to assess the sustainability of local ecosystem conditions

D. Dominance index

The results of the dominance index calculations of the dragonflies found at each station are presented in Table 4.4.

Tabel 4.4: The dominance index value of dragonfly uniformity at each station

No	Station	Dominance index
1.	Rice field	0.29
2.	Riverbanks	0.28

Based on Table 4.4, the dragonfly dominance index value at Station I (rice field) is 0.29 and at Station II (riverbank) is 0.28, both of which are classified as low. This indicates that no species dominantly prevails, allowing for a fairly even distribution of individuals among species. These findings are in line with Artika *et al*. (2024) [1] who reported a low dominance value (0.4) in Lake Tangkas, Jambi, as an indicator of a stable dragonfly community. Additionally, Wakhid *et al*. (2020) [16] also noted that rice field habitats in Lumajang have a high diversity index supported by generalist species. Thus, the low dominance index at both research stations indicates that these habitats support a balanced dragonfly community, which is essential for the preservation of the local ecosystem.

E. Evenness index

The results of the calculation of the dragonfly evenness index found at each station are presented in Table 4.5.

Tabel 4.5: The evenness index value of dragonfly uniformity at each station

No	Stastion	Evenness index
1.	Rice field	0.83
2.	Riverbanks	0.85

Based on Table 4.5, it is known that the evenness index value of dragonflies in Sei Semayang Village is 0.83 (rice fields) and 0.85 (riverbanks), indicating a relatively even distribution of individuals among species, with the community on the riverbank being slightly more balanced. This reflects a stable community structure with minimal dominance of specific species. This result is consistent with Artika *et al*. (2024) [1], which states that an evenness value close to 1 reflects a healthy aquatic insect community. Pelealu *et al*. (2022) [8] also show that habitats with high evenness indicate good environmental conditions and support the balanced existence of species. Thus, both habitats in Sei Semayang Village are considered ecologically stable enough and are important to maintain in order to preserve the balance of dragonfly populations and the sustainability of the local aquatic ecosystem.

F. Differences in diversity and abundance of dragonflies at station i (rice field) and station ii (riverbank)

Data on the number of dragonfly individuals at Station 1 (rice field) and Station 2 (riverbank) were collected over five repeated observations. The Shannon-Wiener diversity index (H′) was calculated for each repetition at both stations. The average diversity index (H′) at Station 1 is 1.248 with a standard deviation (SD) of 0.241, while at Station 2 it is 1.218 with an SD of 0.186 as shown in Table 4.6.

Tabel 4.6: Results of the t-test on the dragonfly diversity and abundance in sei Semayang village

Test statistic	Value
H' Station I	1.34
H' Station II	1.38
Standard Deviation (SD) Station I	0,04
Standard Deviation (SD) Station II	0,05
Value t count	0,56
Degrees of freedom (df)	253
t table value (α)	1,97
Decision	no significant (t hitung < t table)

The index of dragonfly diversity at Station I (rice fields) is 1.34, and at Station II (riverbanks) is 1.38, with a t-test result ($t = 0.56$; $p>0.05$) indicating no significant difference. This indicates that both habitats have similar dragonfly diversity and support a relatively homogeneous community. These findings are consistent with Lino *et al*. (2019) [5] in Kali River, Minahasa, and Prayoga (2024) in Booro River, Jombang, which reported moderate dragonfly diversity in aquatic habitats. The similarity in index values is suspected to be influenced by the structure of vegetation and the level of disturbance that is relatively equal at both locations. These results emphasize the importance of conserving both rice field and riverbank habitats in maintaining the stability of Odonata communities.

G. Environmental factor

Environmental factor data is used to describe the environmental conditions at the time dragonflies were found. The dragonflies encountered during this study were obtained under environmental conditions, and the measured environmental factor data is presented in Table 4.7.

Tabel 4.7: Data from the measurement of environmental factors

No	Parameter	Station I	Station II
1.	Temperature (°C)	30-34 °C	28-32 °C
2.	Humidity	60-80 %	75-95%
3.	Wind speed	1-3 m/s	0.5-2 m/s

Based on Table 4.7, there are differences in environmental factors between Station I (rice field) and Station II (riverbank) that affect the microclimate conditions and the presence of dragonflies. The air temperature in the rice field is higher (30–34 °C) compared to the riverbank (28–32 °C), due to sunlight exposure in the open area. Meanwhile, humidity is higher at the riverbank (75–95%) than in the rice field (60–80%) because of the presence of flowing water and shade-providing vegetation, creating a more ideal environment for dragonflies sensitive to drought (Susanti *et al*., 2019) [12]. Wind speed also differs, with the rice field having stronger winds (1–3 m/s) compared to the riverbank (0.5–2 m/s). Overall, these differences create habitat variation: rice fields support species tolerant of extreme conditions, while riverbanks support species that require humid and stable environments. Understanding the influence of these abiotic factors is important in the efforts to conserve dragonflies and monitor the health of aquatic ecosystems.

5. Conclusion

Research conducted in Sei Semayang Village recorded 257 individuals of dragonflies from 7 species within two families, with the dominance of Libellulidae. The Shannon-Wiener diversity index shows a moderate value (1.34–1.38), accompanied by relatively high species richness and evenness, as well as low dominance. This reflects a stable and diverse dragonfly community. Abiotic factors such as temperature, humidity, and wind also influence the distribution of dragonflies. Riverbanks have a more optimal microclimate compared to rice fields, supporting species that are sensitive to environmental changes. Overall, both habitats support dragonfly diversity, and these results emphasize the importance of habitat conservation as an indicator of aquatic ecosystem health.

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