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Population Dynamics of Dragonflies at The Paddy Field Ecosystem, Sidorejo, Central Bengkulu

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Abstract

The rice fields of Sidorejo Village have the potential for dragonfly diversity. This study aims to analyze fluctuations in the diversity and abundance of dragonflies in three ecosystem conditions of rice fields in Sidorejo Village, Bengkulu Tengah. Sampling using purposive sampling with the cruising method. Data analysis was carried out descriptively through the identification of characteristics to obtain the name of the species. After the species name was obtained, the relative abundance, Shannon Wienner diversity index, and species evenness index were calculated. The results of the study found that the harvest ecosystem had the highest diversity and abundance of dragonflies (13 species and 45 individuals). The species that were consistently found in three types of ecosystems were *Orthetrum sabina, O. testaceum,* and *Pantala flavescens*. The species with the highest relative abundance was O. sabina with 32%. The diversity index ranged from 1.32 (post-harvest) to 2.25 (harvest). The highest evenness index was in the post-harvest ecosystem at 0.95, and the lowest was in the harvest ecosystem at 0.87. The results of this study are expected to show that the diversity and abundance of dragonflies fluctuate depending on seasonal ecosystem conditions in the rice fields.

Keywords: rice field ecosystem, dragonflies, dynamics

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INTRODUCTION

Rice fields are man-made ecosystems with dry and wet conditions depending on the availability of water. Rice fields play a role as a source of wealth for farmers, rice producers, and as habitat for various types of organisms. In the paddy field ecosystem there are various communities that interact with each other [1]. The community The paddy field ecosystem is an ecosystem that fluctuates greatly depending on the stages of rice growth. In general, the paddy field ecosystem is divided into pre-harvest, harvest, and post-harvest stages. In general, rice growth shrinks into three phases, namely vegetative, reproductive, and maturation [2]. The vegetative phase starts from budding until any time before the formation of flowers, the reproductive phase occurs in the formation of panicles into grains, and the maturation phase occurs when the panicles develop into mature grains. These three stages are generally included in the pre-harvest category. Harvesting is the stage when it is ready to be harvested by collecting ripe rice grains, while post-harvest is experiencing rice milling and leaving rice fall marks [3]. This difference in conditions is expected to cause differences in community structure in the paddy field ecosystem, especially in the dragonfly community structure.

Dragonflies are insects with their main habitat around water areas such as rice fields, rivers, or lakes [4]. Dragonflies have a head, thorax, abdomen, and a pair of wings. Dragonflies have a nymphal phase in the water and are very sensitive to changes in air conditions [5]. After the tandem and mating processes, the female dragonfly will lay her eggs on plants near the water. The eggs then hatch into nymphs, which live in the waters. Nymphs experience several changes in the skin process, and in favourable environmental conditions, nymphs will become internal individuals [6]. The internal individual is a dragonfly that has just emerged with a pale colour and will make the first flight movement. Dragonfly nymphs generally cannot live in polluted waters. Therefore, dragonflies can act as bioindicators of water pollution. The more dragonflies in the rice fields indicate the better water quality.

This study aims to analyze fluctuations in the diversity and abundance of dragonflies in three rice field ecosystem conditions (pre-harvest, harvest, and post-harvest) in Sidorejo Village, Central Bengkulu. Paddy fields in Sidorejo Village were chosen as the sampling location because was carried out in the morning from 07.00 to 09.00, and in the afternoon from 15.00 until 17.00. At that time dragonflies were active in looking for food, so it was easier to catch them [7]. Sampling structure of the paddy field ecosystem consists of rice as a producer; bugs, brown planthoppers, rice borers, and rats as consumers 1; dragonflies and snakes as consumers 2, and eagles as top consumers. The biotic factors that affect this ecosystem are plants and animals, while the abiotic factors are temperature, light intensity, rainfall, and humidity [1].

they are easily accessible. The rice fields in this location use a rainfed pattern with a planting season only once a year. Therefore, the water quality in this location is strongly influenced by the microclimate. The Paddy Field Area of Sidorejo Village has an area of around 10 ha. This research is expected to add to our knowledge about the diversity and abundance of dragonflies in Indonesia.

METHODS

Time and Place of Research

This research was conducted from January to April 2022. Sampling was carried out in the Paddy Field area of Sidorejo Village, Central Bengkulu Regency, while sample identification was carried out at the JPMIPA FKIP Learning Laboratory, Bengkulu University.

Research Tools and Materials

The tools used in the research were insect nets, luxmeters, digital hygrometers, cameras, dragonfly identification books, and stationery. The material used is 70% alcohol.

Method of collecting data

Sampling was done by purposive sampling. Purposive sampling is a sampling technique based on the researcher's goal of getting as many samples as possible using the roaming method. The area of Sidorejo Village's rice fields is 10 hectares, while the area explored is 10% (1 hectare) of the total rice field area.

Dragonfly sampling was carried out 3 times with an interval of 2 weeks between periods. The sampling period for the pre-harvest ecosystem took place on February 7-11, 2022, the harvest ecosystem on February 21-25, 2022 and the post-harvest ecosystem on March 7-11, 2022. Sampling

was carried out by two catchers with two insect nets. Sampling was carried out on three types of ecosystems, namely: pre-harvest paddy ecosystems, harvested paddy ecosystems and

post-harvest paddy ecosystems. The distance travelled in the pre-harvest, harvest, and post-harvest ecosystems was recorded using the GPS application (Figure 1). The dragonflies obtained were then characterized and identified based on their morphological characteristics. The characterization carried out includes colour, wing length, and body size.

Simultaneously with sampling, measurements of abiotic factors were also carried out in the Paddy Fields of Sidorejo Village. This measurement was carried out in the morning at 07.00 and in the afternoon at 15.00. The abiotic factors measured include: light intensity, temperature, and humidity. Measurements were made 3 times per sampling period.

Data analysis

Data analysis was carried out descriptively through a description of the characteristics to obtain the name of the species. After the species name was obtained, the relative abundance, Shannon Wienner diversity index, and species evenness index were calculated.

1. Relative Abundance

$$KR=\frac{Ki}{\Sigma K} \times 100\%$$

Information:
KR = relative abundance
Ki = Number of individuals in each species

ΣK = Number of individuals of all species [8].

2. Species diversity index

The diversity of dragonflies was determined using the Shannon-Wienner index with the formula:

$$H' = -\Sigma p_i * \ln(p_i)$$

information:
H' = Diversity index
ni =Number of individuals of the i-th species
pi = Proportion of S made up of all species [8].

3. Species Evenness Index

The evenness index is calculated using [8]:

$$E=\frac{H'}{LnS} \times 100\%$$

Information:
E = Evenness Index
H'= Diversity index
S = Number of types

RESULTS AND DISCUSSION

There are significant differences in the number of species and individual dragonflies between pre-harvest, harvest, and post-harvest ecosystems. Harvest ecosystems have a greater number of species and individuals than pre- and post-harvest ecosystems. The types that consistently appear in the three types of ecosystems are *Orthetrum sabina*, *Orthetrum testaceum*, and *Pantala flavescens*. The species with the highest relative abundance is *Orthetrum sabina*. Species that are only found in one type of ecosystem are *Brachydiplax chalybea, Neurothemis rambutii, Potamarcha congener.* and *Tholymis tillarga*. The species with the lowest relative abundance were *Brachydiplax chalybea* and *Tholymis tillarga* (Table 1).

The diversity index (H') generally ranges from 1.32 to 2.25. The highest H' was found in the harvest ecosystem type, while the lowest H' was found in the post-harvest ecosystem type. The highest evenness index was found in the post-harvest ecosystem type, while the lowest evenness index was found in the pre-harvest ecosystem type. The number of species and individuals is higher in the harvested ecosystem than pre- and post-harvest. In Assam, India it was also found that the harvest ecosystem had more species and individuals [9]. The growth phase of rice in the paddy field ecosystem is thought to influence the type and number of individual dragonflies that are more numerous during the harvest. The higher number of species and individuals in the harvested ecosystem is thought to be due to the availability of more rice-eating insects/pests, which are dragonfllies feed on. Food sources for dragonflies come from pests such as rice bugs (*Leptocorisa acuta*), brown planthopper (*Nilaparvata lugens*), and rice stem borer (*Chilo* sp.)[10]. The large number of dragonflies at harvest is also related to the dry season based on abiotic factors with a temperature of 30.2°C. The air temperature range of 29-31°C is the optimal temperature range for dragonflies.

The three consistent types of dragonflies in the three ecosystems are *Orthetrum sabina, Orthetrum testaceum*, and *Pantala flavescens*. These three species belong to the Libellulidae family, which can adapt to the paddy field ecosystem even though the environmental conditions are different.

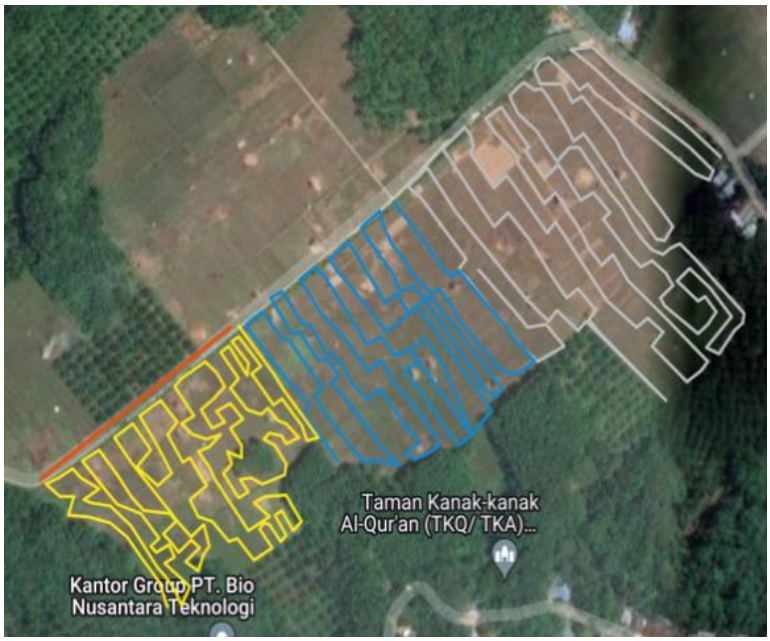

Figure 1. Map of Research Locations
Information:
White colour = Pre-harvest ecosystem
Blue colour = Harvest ecosystem
Yellow colour = Post-harvest ecosystem

Table 1. Types of dragonflies found in 3 rice field ecosystems

No	Species name	Number of Individuals				KR (%)
		Pre-Harvest	Harvest	Post-harvest	Total	
1	*Agriocnemis pygmaea*	1	3	-	4	0.05
2	*Pseudagrion microcephalum*	1	2	-	3	0.04
3	*Brachydiplax chalybea*	-	1	-	1	0.01
4	*Brachythemis contaminata*	-	2	-	2	0.02
5	*Macrodiplax cora*	-	3	2	5	0.06
6	*Neurothemis ramburii*	-	3	-	3	0.04
7	*Neurothemis terminata*	1	2	-	3	0.04
8	*Orthetrum sabina*	8	12	4	24	0.32
9	*Orthetrum testaceum*	4	9	4	17	0.22
10	*Pantala flavescens*	2	3	2	7	0.09
11	*Potamarcha congener*	-	2	-	2	0.02
12	*Tholymis tillarga*	-	1	-	1	0.01
13	*Trithemis aurora*	1	2	-	3	0.04
Total species (individuals)		7 (18)	13 (45)	4 (12)	13 (75)	
Diversity Index (H')		1.58	2.25	1.32	2.08	
Evenness Index (E)		0.81	0.87	0.95	0.81	

It [11] stated that the feed for the Libellulidae family is dominated by rice plant pest organisms. The number of dragonfly species in the Libellulidae family dominates due to the availability of pests as food. *Orthetrum sabina* can be adaptive to waters that are not good and prey on insects including cannibals with fellow dragonflies [12]. *Orthetrum testaceum* is a dragonfly species that is quite sensitive to environmental changes and is only found in clean rivers. This species was found to have perched behavior near trees above the river [13]. *Pantala flavescens* is a common species of dragonfly that can be found in various places. This is closely related to good adaptability in the rainy season and dry season [14].

The type of dragonfly with the highest number of individuals is *Orthetrum Sabina* with 24 individuals. The body colour of this dragonfly is a combination of green and black, so it is easy to camouflage with aquatic habitats, plants, and the bottom of the waters. It also stated [15] that *Orthetrum Sabina* is a species that is often found solitary (alone) around us. This dragonfly can be found in countries other than Indonesia, namely India, China, Vietnam, Malaysia, and Singapore.

The results of identifying the diversity of dragonflies in the rice fields of Sidorejo Village, Central Bengkulu Regency found 13 species of dragonflies consisting of the Coenagrionidae family and the Libellulidae family. The number of types of dragonflies found is not much different from the results of Depi's research (2020) in the Pekik Nyaring Rice Fields, Central Bengkulu Regency, which found as many as 12 species of dragonflies. In addition, researcher [13] also found 14 species of dragonflies in the Paddy Fields of Sri Kuncoro Village, Central Bengkulu Regency. The difference in the number of dragonfly species found was influenced by the wide area of the area explored, food resources from the paddy field ecosystem, habitat, and environmental conditions of dragonflies [16]

The diversity index of the three ecosystems ranges from 1.32-2.25. This shows moderate species diversity because 1>H'>3. The evenness index ranges from 0.81 to 0.95 which is very high and indicates a stable ecosystem condition. According to [17] the value of high evenness. A high species evenness index value in an ecosystem indicates that the habitat is in stable condition.

The results of abiotic factor measurements show that environmental conditions are almost the same between ecosystems. The difference in temperature is only in the range of 1.6^{o}C, the difference in humidity is in the range of 4%, and the difference in light intensity is in the range of 374 lux (Table 2).

Table 2. Abiotic Factors of Paddy Fields in Sidorejo Village, Central Bengkulu

No	Abiotic Factors	Ecosystem Type		
		Pre - Harvest	Harvest	Post - Harvest
1	Air Temperature (^{o}C)	29.5	30.2	31.1
2	Air humidity (%)	75	79	76
3	Light intensity (lux)	1083	1457	1267

CONCLUSION

The harvest ecosystem is the ecosystem with the highest diversity and abundance of dragonflies, namely 13 species and 45 individuals. The types that were consistently found in three types of ecosystems were *Orthetrum sabina, Orthetrum testaceum*, and *Pantala flavescens*. The species with the highest relative abundance was *Orthetrum sabina* with 32%. The diversity index ranged from 1.32 to 2.25. The highest diversity index was found in harvested ecosystems and the lowest in post-harvest ecosystems. The evenness index ranges from 0.81 to 0.95 with the highest index in the post-harvest ecosystem and the lowest in the harvested ecosystem.

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