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Dragonfly (Odonata) Species Diversity in the Sigolo-Golo Tourism Area, Jombang, East Java

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ABSTRACT

The *sigolo*-golo area is a tourist area with waterfalls and rivers. It is located in a secondary forest far enough from settlements, so it has the potential to be a habitat for dragonfly diversity. This study aims to analyze the composition and diversity of dragonflies in the Sigolo-golo tourist area. Data collection was carried out using the Visual Encounter Survey (VES) method. The results of research conducted in three locations showed that there were 12 species from five families, namely Libellulidae, Euphaeidae, Calopterygidae, Chlorocyphidae, and Platicnemididae, with a total of 319 individuals. The species with the highest relative abundance value in this study was *Pantala flavescens* with a value of 77.40%. The value of species diversity at this location is H' = 0.984, which indicates that the diversity index value is low.

Keanekaragaman Spesies Capung (Odonata) Di Kawasan Wisata Sigolo-Golo, Jombang, Jawa Timur

***ABSTRAK**: Kawasan Sigolo-golo merupakan area wisata dengan terdapat air terjun dan sungai, yang terletak di dalam hutan sekunder yang cukup jauh dari pemukiman, sehingga berpotensi sebagai habitat bagi keanekaragaman capung. Penelitian ini bertujuan untuk menganalisis komposisi, dan keanekaragaman capung di kawasan wisata Sigolo-golo. Pengumpulan data dilakukan dengan menggunakan metode Visual Encounter Survey (VES). Hasil penelitian yang dilakukan di tiga lokasi menunjukkan bahwa terdapat 12 spesies dari lima famili, yaitu Libellulidae, Euphaeidae, Calopterygidae, Chlorocyphidae, Platicnemididae dengan total 319 individu. Nilai kelimpahan relatif yang tinggi pada penelitian ini yaitu Pantala flavescens dengan nilai sebesar 77.40%. Nilai keanekaragaman jenis pada lokasi ini adalah H' = 0.984, yang menunjukkan bahwa nilai indeks keanekaragaman tergolong rendah.*

INTRODUCTION

Dragonflies are insects that undergo incomplete metamorphosis. Dragonflies live aquatically in the egg and nymph phases (Koneri et al., 2020) while in the adult phase, dragonflies live terrestrially (Liao et al., 2023);(Setyawati & Triatmanto, 2022);(Susanto & Arianti, 2021). Since dragonflies live aquatically during the egg and nymph phases, freshwater ecosystems are a very important factor regarding the

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presence of dragonflies (Akhtar et al., 2021);(Pelealu et al., 2022) Dragonflies can be found in various freshwater ecosystems, such as rivers, lakes, ponds, waterfalls, and springs (Amrullah et al., 2023); (Citraningrum et al., 2022).

Dragonflies are predatory insects in all phases of their lives (Mega & Sari, 2021). Dragonflies act as food chain controllers in the ecosystem, feeding on small insects such as Diptera and Orthoptera (Thongprem et al., 2021). Dragonflies also act as predators of disease-vector insects, predating on mosquitoes (Maharani et al., 2023). In addition, dragonfly species diversity and composition can also be bioindicators of environmental quality in an ecosystem (Turnhout & Halffman, 2023). This is because some dragonfly species are sensitive to environmental changes. Dragonfly diversity can decline due to habitat destruction and urbanization.

The Sigolo-golo area is a tourist area with waterfalls and rivers, located in a secondary forest quite far from settlements. The Sigolo-golo area is administratively located in the Wonosalam sub-district, Jombang Regency. This area has various habitat types with a variety of vegetation, making it a potential habitat for dragonflies. Research on dragonfly diversity in the Sigolo-golo area has never been conducted. This study aims to analyze the composition and diversity of dragonflies (Odonata) in the Sigolo-golo tourist area.

METHOD

This research was conducted in February 2023. Observations were carried out during the active hours of dragonflies, namely in the morning from 08.00 to 14.00 WIB. This research was conducted in the Sigolo-golo area located in the Wonosalam sub-district, Jombang Regency. The research was conducted in three locations: a plantation area, a secondary forest, and a river (Figure 1). At the location of the plantation area, there is a canopy of riparian shrubs around the path. In the secondary forest location, there is a canopy of trees, and there are springs. At the location of the river, there are riparian shrubs open from the canopy and many rocks around the river.

Data collection was conducted using the Visual Encounter Survey (VES) method. Data collection was carried out by recording the diversity of dragonfly species and the number of individuals at each predetermined location. The determination of the research path was carried out using the transect line method, which is an observation method, by following a 100-meter straight line.

Data collection was done by capturing dragonflies using a sweeping net, and then every part of the dragonfly's body was documented in detail using a camera. Each individual that has been collected is then identified at the species level. Identification of dragonfly species was carried out based on morphological keys, including body color, wing pattern, abdominal color pattern, and umbilical shape. Identification activities are carried out using a guidebook (Pamungkas et al., 2016; Setiyono et al., 2017).

Dragonflies found during the study were analyzed using relative abundance, diversity index, dominance index and evenness index. The following is the formula according to (Koneri et al., 2020).

Relative Abudance (RA)

$$RA = \frac{ni}{N} \times 100\ \%$$

Description:
RA = Relative Abudance
ni = Number of individuals belonging to the first species
N = Number of individuals in the population

Diversity Index

$$H' = \sum(pi \ln pi)$$

Description:
H' = Diversity index Shannon-Wiener
pi = ni/N
ni = Number of individuals belonging to the first species
N = Number of individuals in the population.

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Figure 1. Documentation of research site (A) Plantation, (B) Secodary Forest, and (C) River

RESULTS AND DISCUSSION

Based on observations made in the Sigolo-golo tourist area, 12 dragonfly species were found, for a total of 319 individuals. All dragonfly species found are included in five families, namely Libellulidae, Euphaeidae, Calopterygidae, Chlorocyphidae, and Platycnemididae (Table 1). The family with the highest number of species found in this study is Libellulidae, with eight species. The Libellulidae family has a high survival rate. According to (Nafisah & Soesilohadi, 2021), the Libellulidae family is a very adaptive dragonfly species that can live in an environment far from water. The family that has the least number of species is Platycnemididae with one species. The Platycnemididae family is found in quiet streams, Susanto et al. (2023) reported that the Platycnemididae family likes habitats that are overgrown with plants on the banks of rivers. overgrown habitats on the banks of streams that have a fairly closed canopy with slow-flowing waters.

Based on the results of the relative abundance analysis, it shows that the species that has the highest value is *Pantala flavescens* with a value of 77.40% (Table 1). The species that have the lowest relative abundance value are *Crocothemis servilia, Neurothemis terminata, Rhodothemis rufa*, and *Copera marginipes* with a value of 0.30% (Table 1). *Pantala flavescens* (Figure 2) is the species with the highest relative abundance value because this location has an open-water habitat, and there are several trees that are natural habitats for *Pantala flavescens* species. This dragonfly is found flying in groups in open areas and is not much affected by the presence of vegetation because it has a very high migratory ability (Astuti et al., 2022). This is supported by Susanto & Zulaikha (2021), who stated that *Pantala flavescens* has a habit of flying in groups in open areas such as rivers or plantations, and this dragonfly has the power to fly far enough and live in groups.

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Table 1. List of species and Relative Abundance Values of dragonflies in Sigolo-golo Area

Subordo & Family	Species	Relative Abundance (%)			
		Plantation	Secondary forest	River	Total
Anisoptera					
Libellulidae	*Crocothemis servilia*	0.00	0.00	0.40	0.30
	Neurothemis ramburii	13.3	0.00	0.00	1.30
	Neurothemis terminata	3.30	0.00	0.00	0.30
	Orthetrum glaucum	0.00	56.00	0.80	5.00
	Orthetrum Sabina	16.70	2.00	0.80	3.80
	Pantala flavescens	66.70	0.00	86.00	77.40
	Rhodothemis rufa	0.00	0.00	0.40	0.30
	Trithemis festiva	0.00	0.00	1.10	0.90
Zygoptera					
Euphaeidae	*Euphaea variegata*	0.00	16.00	2.70	3.40
Calopterigidae	*Vestalis luctuosa*	0.00	8.00	5.30	5.00
Chlorocyphidae	*Heliocypha fenestrata*	0.00	0.00	2.30	1.90
Platycnemididae	*Copera marginipes*	0.00	0.00	0.40	0.30

Figure 2. Species of *Pantala flavescens* (Photo: M. Azmi Dwi Susanto, 2023)

The results of the diversity index analysis show that the Sigolo- golo area has a diversity index value of H' = 0.984, which indicates that the diversity index value is low. This is in accordance with Grether et al. (2023), who reported that the Shannon-Wienner diversity index value of 1 < H is low. The diversity index value is caused by species interactions that occur in one community (Suaskara & Joni, 2020). The value of the dragonfly diversity index at a location can be influenced by vegetation, water quality, differences in habitat types, and abiotic factors from the environment, such as temperature, humidity, light intensity, and food availability (Dalzochio et al., 2020).

Vegetation conditions can be a factor affecting dragonfly diversity and abundance (Strobl et al., 2020). Vegetation is the main factor that provides a natural habitat for small insects that are potentially the main food for dragonflies (Hykel et al., 2020). Vegetation in the water can be used by adult dragonflies to lay eggs. Dragonfly nymphs use aquatic vegetation to protect themselves from predators (Perron et al., 2021). Vegetation on the riverbank is used for resting and basking. Trees are needed by

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some dragonfly species to protect them from high sunlight intensity (O'Malley et al., 2020).

Water quality is one of the important factors affecting the dragonfly life cycle. Dragonflies spend most of their lives in aquatic habitats; any changes in water quality will affect dragonfly survival (Deacon & Samways, 2021). Most dragonfly species require good water quality to thrive and survive (Askew, 2021). Dragonflies are considered to be an indicator of the habitat quality of aquatic ecosystems (Bowles & Kleinsasser, 2022). Adult dragonflies are sensitive to the conditions at aquatic sites. However, many dragonfly species have a high tolerance to pollution and can colonize in a variety of extreme environments (Guimarães et al., 2021).

Abiotic factors such as temperature, humidity, and light intensity are very influential on dragonfly species diversity. Temperature and humidity can affect the availability of dragonfly food in the form of small insects (Marcellino, 2023). In addition, temperature and humidity affect dragonfly activities to find prey, rest, and carry out the life cycle. The light intensity can potentially affect dragonfly activity. Dragonflies are active when the intensity of sunlight causes them to bask and look for prey (Castillo-Pérez et al., 2022).

The availability of dragonfly food at a site is also one of the factors that provide natural habitat for insects in an ecosystem. In the larval phase, dragonflies inhabit aquatic systems for months or even years with relatively limited dispersal abilities (Harabiš & Hronková, 2020). Therefore, dragonfly larvae and adult damselfly are highly dependent on food availability. Adult damselfly have low flying ability, while adult Anisoptera dragonflies have the ability to move far to find food, Anisoptera dragonflies are found in open areas such as grasslands to catch insects to eat.

In the Sigolo-golo tourist area, there are waterfalls and rivers that are used as tourist attractions. Sigolo-golo tourist area has the potential to become a natural habitat for various types of dragonflies. This is due to the aquatic ecosystem used by dragonflies to carry out their life cycle by laying eggs and becoming larvae in the water (Minot, 2021). This is in accordance with (Olsen et al., 2022), who reported that the egg and nymph phases of dragonflies live in water. Therefore, adult dragonflies are generally found near water. The Sigolo-golo area is located in a forest that is quite far from settlements. This area has various habitat types with a variety of canopy cover. The Sigolo-golo area was divided into three observation sites consisting of plantations, secondary forests, and rivers. Each observation location has a different dragonfly family composition.

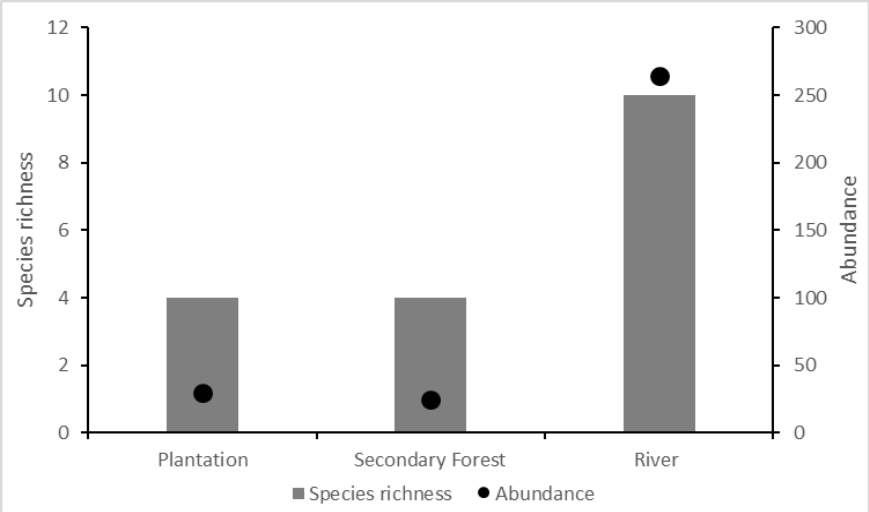

Figure 3. Species Result richness and abundance

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The highest number of species richness is found in the location of the river, with a total of 10 species (Figure 3). Whereas the plantation and secondary forest locations have a low number of species, namely 4 species (Figure 3). The river location has a variety of vegetation that can be a habitat for dragonflies to carry out their life cycle. This is due to the vegetation around the waters that can be used by dragonflies to find food, sunbathe, and rest, and some types of dragonflies lay eggs on aquatic plant vegetation. Aquatic plant vegetation is also used by dragonfly larvae to hide from predators (Kietzka et al., 2021).

The secondary forest site is a forest with dense vegetation and a closed canopy. The secondary forest location has the highest diversity index value of the three locations, namely 1.142 (Figure 4). Four species were found, and the lowest abundance was 25 individuals. The abundance value is relatively low compared to the three locations due to the lack of river in the secondary forest location. Observations found the species Orthetrum sabina, Orthetrum glaucum, Vestalis luctuosa, and Euphaea variegata. The presence of small streams in the secondary forest resulted in the presence of Vestalis luctuosa and Euphaea variegata. These dragonflies are usually found in streams that are still in good condition, with rocks and shrub vegetation. Orthethum glaucum lives solitary; male dragonflies are often found competing to defend their territory. Often found at the beginning of the rainy season, its habitat is in open places such as around waters or plantations (Chavers, Tiffany N., Schlosser, 2018).

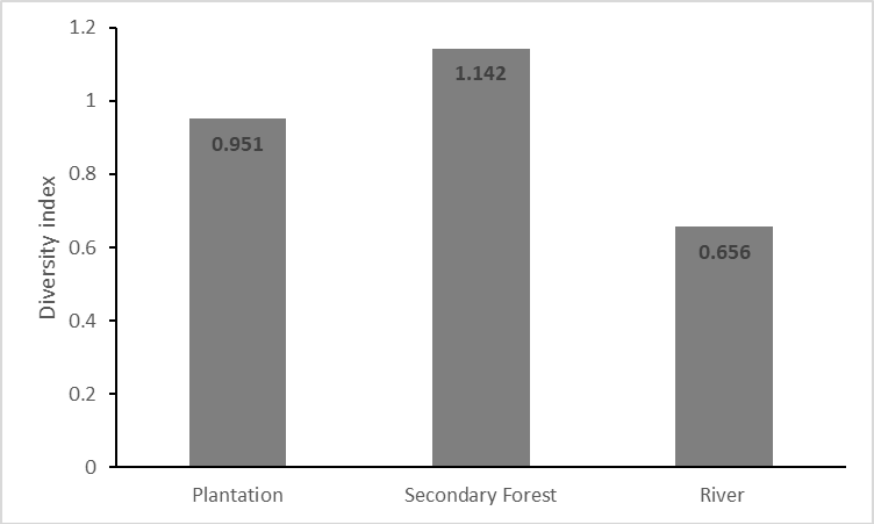

Figure 4. Diversity index resul

Secondary forest sites have a denser vegetation structure with a closed canopy composed of various types of plants, such as *Macaranga sp*. Vegetation can affect adult dragonfly activities such as basking for food, resting, and shelter. The large variety of dragonfly species in secondary forests is due to the density of vegetation compared to plantation land locations (Ancco Valdivia et al., 2020). Based on the opinion of Minot et al. (2021), forest habitat is still very dense, and there have been no disturbances or conversions of forest functions, causing the diversity value of dragonflies.

The river location has many trees and is dominated by open areas with grass vegetation and rocks in the water. The river location has the lowest diversity index value of the three locations at 0.656 (Figure 4). The river location had the highest species richness and abundance, with 10 species and 264 individuals. Observations found species of *Orthetrum sabina*, *Orthetrum glaucum*, *Pantala flavescens*, *Rhodothemis*

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rufa, Crocothemis servilia, *Trithemis festiva*, *Vestalis luctuosa*, *Euphaea variegata*, *Heliocypha fenestrata*, and *Copera marginipes*. *Pantala flavescens* is very dominant at the river site because it is an open area and can search for prey around the rivers vegetation. This dragonfly lives in groups and has the power to fly far enough to migrate (Oliveira-Junior et al., 2021). Habitats of *Heliocypha fenestrata*, *Euphaea variegata*, *Orthetrum glaucum* and *Trithemis festiva* are often found. Trithemis *festiva* is often found perching on river rocks and vegetation on riverbanks. These species are characterized by rocky substrates and shaded environments with aquatic vegetation for reproductive cycles.

CONCLUSIONS AND SUGGESTIONS

Based on the research that has been done in Sigolo-golo Tourism Area, there are 12 species from five families with a total of 319 individuals. The high relative abundance value in this study is *Pantala flavescens* with a value of 77.40%. The results of the diversity index of H'= 0.984, this shows that the value of the diversity index is low. Some factors that affect the value of dragonfly diversity index are vegetation, water quality, differences in habitat types, abiotic factors of an environment, such as temperature, humidity, light intensity, and food availability.

For further researchers, it is necessary to conduct research on dragonfly diversity outside the location that has been studied, but still in the Sigolo-golo Area and carried out in the dry season, the transition of the dry season to the rainy season and the transition of the rainy season to the dry season to complete the data on dragonfly diversity in this region.

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