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Research Article

Community Structure of Dragonfly (Anisoptera) and Damselfly (Zygoptera) at The Gunung Sigogor Nature Reserve, East Java, Indonesia

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Abstract

Gunung Sigogor Nature Reserve is a conservation forest administratively located in Ngebel District, Ponorogo Regency, East Java, Indonesia. The dragonfly and damselfly community structure, which includes diversity, abundance, evenness and dominance, can be used as an early indicator of changes in environmental conditions, especially in aquatic ecosystems. This study aimed to determine dragonfly and damselfly's community structure, diversity, evenness, dominance, and habitat preference. This study uses the Visual Encounter Survey (VES) observation and transect methods. This method is carried out by tracing all predetermined observation stations by recording the diversity of dragonfly species and counting the number of individuals. The study conducted in the Gunung Sigogor Nature Reserve area showed 15 species from 8 families consisting of 9 species of Suborder Anisoptera and six species of Suborder Zygoptera. In the results, the highest diversity index value was in the Small Stream (S3) with H'= 1.84. The evenness index, Goa Jepang Stream (S5), has the highest value with a value of E=0.9, and the dominance index of Watu Bandar Stream (S6) location has the highest value with a value of C=1.
Keywords: Community Structure, Dragonfly, Damselfly

1. Introduction

Gunung Sigogor Nature Reserve is a conservation forest administratively located in Ngebel District, Ponorogo Regency, East Java, Indonesia. Gunung Sigogor Nature Reserve is a nature reserve area under the Nature Conservation Agency (BBKSDA) East Java management under the auspices of the Ministry of Environment and Forestry (KLHK). The Gunung Sigogor nature reserve area has a tropical rain forest ecosystem with an area of 190.5 Ha with elevations ranging between 1087.5 – 1675 m asl (BBKSDA Jatim, 2020). This nature reserve is directly adjacent to the PERHUTANI plantation area and the Mount Wilis forest. One of the main roles of the Gunung Sigogor Nature Reserve is as a water catchment area and a provider of clean water for villages; this is because in this area, there are five sources of water flowing from the area that flows into the village river (BBKSDA Jatim, 2020). In addition, the Gunung Sigogor Nature Reserve area also has a major role as a biodiversity conservation area including dragonfly and damselfly.

Dragonfly and damselfly (Odonata) are a group of flying insects with diverse morphologies and have adapted to various habitats. Dragonfly and damselfly are insects that rely on aquatic ecosystems to lay their eggs and continue their life cycle (Kohli et al., 2020; Aziz & Mohamed, 2018), so dragonflies and damselfly are often found near aquatic ecosystems (Paulson, 2009). Dragonfly and damselfly community structures such as diversity, abundance, evenness, dominance can be used as indicators of environmental change, especially in aquatic ecosystems (Buczyński et al., 2020). There are several species of dragonfly and damselfly that have high sensitivity to pollution in the environment; this is because dragonflies and damselfly have olfactory sensor nerves found on the antennae that function as detectors of chemical compounds in the environment (Nugrahani et al., 2014). In addition, dragonflies and damselfly also act as predators of small insects in the ecosystem (Herlambang et al., 2016; Setiyono et al., 2017).

Each dragonfly and damselfly species have different habitat characteristics as a place to live, so the structure of the dragonfly community at each location will have the potential to have great differences in line with the environmental conditions at that location so that the habitat characteristics of dragonflies and damselfly are very important to know, to be used as information about changes in environmental conditions at a location. Information regarding the community structure and habitat preference of dragonflies and damselfly at the Gunung Sigogor Nature Reserve still lacks data. Therefore, this study provides data on dragonfly and damselfly's community structure, diversity, evenness, dominance, and habitat preference.

2. Material and Method

This research was conducted in the Nature Reserve of Gunung Sigogor, Ngebel District, Ponorogo Regency, East Java, Indonesia. The Location of the Gunung Sigogor Nature Reserve is divided into several observation locations based on the composition of vegetation, differences in habitat, the position of water flow, and ease of access. Accordingly, in this study, six observation stations were used scattered at various points in the Gunung Sigogor Nature Reserve area, namely Coffee plantation Stream (S1), Wates Stream (S2), Small Stream (S3), Large Stream (S4), Goa Jepang Stream (S5) and Watu Bandar Stream (S6). The selection of this location also considers the factor of ease of access to the location and its potential as a natural habitat for dragonflies and damselfly (Purposive Random Sampling).

This research was conducted on November 2020 and February 2021; five days of observations were carried out with observation time at 08.00-12.00 WIB. This study uses the Visual Encounter Survey (VES) observation method (Harms et al., 2014). VES observations are generally known as direct observations; this method is carried out by tracing all predetermined observation stations by recording the diversity of dragonfly species and counting the number of individuals. Observations with the VES method in this study were modified using the transect method (Oppel, 2005). The transect method is an

observation method by following a predetermined straight line. The types of dragonfly and damselfly observed were documented using a camera and identified using the identification book Orr (2005) and Setiyono et al., (2017).

This study also collected microclimate factors consisting of air temperature, Humidity, and light intensity. The air temperature and humidity factors were measured using a thermohygrometer, while the light intensity factor was measured using a light meter. In addition, observations were also made on ecosystem types, vegetation conditions and canopy cover, which were described in narrative form data. The tools used in this research are GPS, stationery, thermohygrometer, cameras, watches, insect nets and identification books (Orr, 2005; Setiyono et al., 2017).

Quantity index analysis of diversity index analysis based on the Shanon-Wiener diversity index (*H'*) formula (Metcalfe, 1989).

$$H' = \sum\left(\frac{ni}{N}\ In\ \frac{ni}{N}\right)$$

H : Shanon-Wiener diversity
ni : Number of individual types
N : Total number of individuals

The Evenness Index (E) based on Aslam (2009) can be calculated using the formula:

$$\mathrm{E} = \frac{H'}{\ln \mathrm{S}}$$

E : Evenness Index
H' : Diversity Index
S : Number of Species

The Simpson Dominance Index (C) based on Magurran (2004) can be calculated using the formula:

$$\mathrm{C} = \sum\left(\frac{ni}{\mathrm{N}}\right)^2$$

C : Simpson's Dominance Index
ni : Number of individual types
N : Total number of individuals

The Presence Frequency can be calculated using the formula:

$$\mathrm{PF} = \frac{fi}{F} x\ 100\%$$

PF = Presence Frequency
fi = Total occurrence at the observation site
F = The number at the observation location

3. Results and Discussion

3.1. Results

Based Results of the study conducted in the Gunung Sigogor Nature Reserve area showed that there were 15 species with 218 individuals from 8 families. The suborder Anisoptera consists of 9 species with 38 individuals in three families, namely Cordulidae, Gomphidae and Libellulidae. Meanwhile, the suborder Zygoptera consists of 6 species with a total of 180 individuals in five families, namely: Euphaeaidae, Calopterygidae, Clorocyphidae, Coenagrionidae and Platycnemididae, can be seen in Table 1:

Table 1. List of dragonfly and damselfly species, Amount of individuals, PF and Conservation Status

Suborder & Family	Species	Amount							PF (%)	Conservation Status
		S1	S2	S3	S4	S5	S6	Total		
Anisoptera										
Cordulidae	*Idionyx montana*	1			6			7	33	DD
Gomphidae	*Heliogomphus drescheri*			1				1	17	NE
	Nepogomphus fruhstorferi				1			1	17	NT
Libellulidae	*Orthetrum glaucum*			1	2			3	33	LC
	Orthetrum pruinosum			1				1	17	LC
	Orthetrum sabina	1		2	2			5	50	LC
	Pantala flavescens			13				13	17	LC
	Zygonyx ida		3		3			6	33	LC
	Zygonyx iris			1				1	17	LC
Zygoptera										
Euphaeaidae	*Euphaea variegata*	2	13	8	17	2		42	83	LC
Calopterygidae	*Vestalis luctuosa*	14	22	11	26	6		79	83	LC
Clorocyphidae	*Heliocypha fenestrata*				2			2	17	LC
	Rhinocypha anisoptera	2	9	1	10			22	67	LC
Coenagrionidae	*Pseudagrion pruinosum*		2					2	17	LC
Platycnemididae	*Coeliccia membranipes*	5	7	6	3	3	9	33	100	LC
	Total	25	56	45	72	11	9	218		

Note: Location: S1). Coffee Plantation Stream; S2). Wates Stream; S3). Small Stream; S4). Large Stream; S5). Goa Jepang Stream; S6). Watu Bandar Stream. Conservation status: NE (Not Evaluated), DD (Data Deficient), LC (Least Concern), and NT (Near Threatened). Source: (IUCN, 2021).

Table 2. Diversity index Results (H ')

Location	H'	Value	Category
1	1.31	1< H'<3.0	Moderate
2	1.54	1< H'<3.0	Moderate
3	1.84	1< H'<3.0	Moderate
4	1.81	1< H'<3.0	Moderate
5	1	1< H'<3.0	Moderate
6	0	H'<1.0	Low

Table 3. Evennes index results (E)

Location	E	Value	Category
1	0.73	E > 0,6	High
2	0.86	E > 0,6	High
3	0.8	E > 0,6	High
4	0.79	E > 0,6	High
5	0.9	E > 0,6	High
6	0	E < 0,4	Low

Table 4. Dominance Index Results (C)

Location	C	Value	Category
S1	0.37	0,31< C <0,60	Moderate
S2	0.25	0,10< C <0,30	Low
S3	0.2	0,10< C <0,30	Low
S4	0.21	0,10< C <0,30	Low
S5	0.4	0,31< C <0,60	Moderate
S6	1	C > 0,61	High

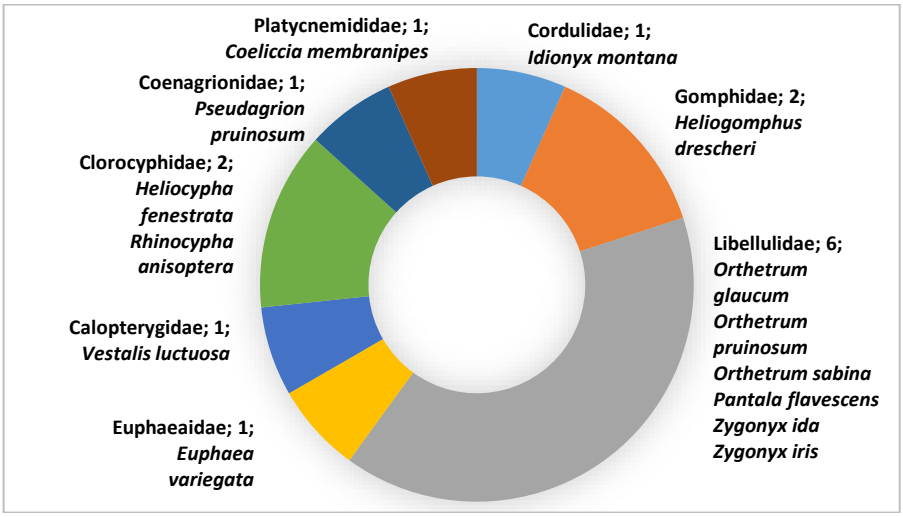

Figure 1. Compotition of Odonata

Figure 2. Documentation of damselfly species. A). *Euphaea variegata,* B). *Vestalis luctuosa,* C). *Heliocypha fenestrata,* D). *Rhinocypha anisoptera,* E). *Pseudagrion pruinosum,* F). *Coeliccia membranipes*

Figure 3. Documentation of dragonfly species. A). *Idionyx montana,* B). *Heliogomphus drescheri,* C). *Nepogomphus fruhstorferi,* D). *Orthetrum glaucum,* E). *Orthetrum pruinosum*, F). *Orthetrum sabina,* G). *Pantala flavescens,* H). *Zygonyx ida*.

3.2.Discussion

This research was conducted in the morning at 08.00-12.00 am according to the optimal time for dragonflies to carry out their activities. At 08.00 am, the intensity of sunlight has been optimal in supporting dragonfly and damselfly sunbathing activities. The habit of dragonflies and damselfly basking in the sun aims to warm their bodies and strengthen the wing muscles used for flight. In addition, at an optimal light intensity, dragonflies and damselfly will be used to find food. Meanwhile, at 12.00 am, the intensity of sunlight is very high, so the dragonfly will again look for a place to rest and shelter from the sun. This is following Corbet (1962), who reported that if the light intensity is too high, dragonflies will spend time resting and taking shelter.

The highest diversity index value is in Small Stream (S3) with H'= 1.84. Goa Jepang Stream's evenness index (S5) has the highest value. with a value of E = 0.9. and the dominance index of the Location of Watu Bandar Stream (S6) has the highest value with a value of C=1. The Community differences of dragonflies and damselfly in their natural habitat are influenced by various factors, including habitat type (Perez & Bautista, 2020), water quality (Aziz & Mohamed, 2018), vegetation conditions (Remsburg, 2008; Silva et al., 2010), canopy cover (Nugrahani et al., 2014), microclimate (Abdillah et al., 2019) and food availability (Herlambang et al., 2016).

The Small Stream (S3) is the research location with the highest Diversity index value, namely with a value of H'= 1.84. Location Small Stream is a small stream with a flow width of ± 0.7 m and a depth of ± 0.3 m. This location has an open canopy dominated by shrubs and herbs on the banks of the stream, and there are many trees. At this location, there is also a flow of water under the bamboo vegetation so that the intensity of incoming light is hampered. Microclimate measurements at this location showed Air temperature 25.2 ^{o}C, Humidity 79.0% and Light intensity 7191 lx. There are open and closed types of canopy cover at this location, making Small Stream a natural habitat for ten species in six families with 45 individuals. The species found are *Heliogomphus drescheri, Orthetrum glaucum, Orthetrum pruinosum, Orthetrum sabina, Pantala flavescens, Zygonyx iris, Euphaea variegata, Vestalis luctuosa, Rhinocypha anisoptera* and *Coeliccia membranipes.*

Goa Japan Stream (S5) is the research location with the highest evenness index value, E = 0.9. The Location of Goa Japan Stream is a stream with a flow width of ± 1.5 m with a depth of ± 0.8 m. This location has open vegetation with a closed canopy dominated by many trees on the banks of the river. Measurements of the microclimate at this location indicate the air temperature of the Watu Bandar Stream is 25.0 ^{o}C, Humidity is 86.4%, and Light Intensity is 2943 lx. At this location, we found three species in 3 families with 11 individuals. The species found were *Euphaea variegata, Vestalis luctuosa* and *Coeliccia membranipes* in equal numbers.

The Watu Bandar Stream is a research location with the highest Dominance index value, namely C= 1. This is because, at this location, only one species was found, namely Coeliccia membranipes. This location is a small stream with a flow width of ± 0.5 m and a depth of ± 0.3 m. This location has dense vegetation and a closed canopy dominated by

bush vegetation, and there are many trees on the banks of the stream. Microclimate measurements at this location show Watu Bandar Stream Air temperature 23.0 ^{o}C, Humidity 90.2% and Light intensity 1867 lx. Conditions of dense vegetation and a closed canopy make the air temperature and light intensity very low and Humidity highest. Therefore, the Location of Watu Bandar Stream shows the highest dominance index value with one species found.

The Gunung Sigogor Nature Reserve has good water quality and minimal disturbance and pollution. This is because the area is far from settlements in mountainous areas and is a conservation area protected by the government, so there are no community activities in this area. Water quality is an important factor that affects the presence and abundance of dragonflies in their natural habitat. This is because adult dragonflies will lay their eggs in the water. In addition, most of the dragonfly life cycle is spent in the larval phase in the water.

Some dragonflies lay their eggs in certain aquatic habitats, and even some species only live in clean waters. For example, at the location of this study, Zygonix ida was found, a species with high sensitivity to pollution and disturbance (Nugrahani et al., 2014). Zygonix ida species can only be found in locations that have clean waters and a protected environment. Each type of dragonfly has a tolerance limit to the different pollution for each species. Therefore, dragonflies in the environment can be a bioindicator of the waters. Changes in the population of dragonflies in an environment can be used as an early indication to mark the presence of pollution in an environment (Pamungkas and Ridwan, 2015).

Vegetation and canopy factors affect the presence and abundance of a type of dragonfly at a location. The Gunung Sigogor nature reserve area has quite dense vegetation, with most of the waters having a closed canopy. In this study, the damselfly community with individuals was much more abundant with 180 individuals than dragonflies with 38 individuals. Dragonflies have fewer individuals because Anisoptera dragonflies are often found in habitats with open canopies. This is supported by (Kalkman & Orr, 2013), who reported that Anisoptera dragonflies are commonly found in forest areas, grass fields and other habitats that have open areas.

Conclusion

The research results conducted in the Gunung Sigogor Nature Reserve area showed 15 species from 8 families consisting of 9 species of Suborder Anisoptera and six species of Suborder Zygoptera. The total individuals found were 218 individuals consisting of 38 dragonfly individuals and 180 damselfly individuals. The highest diversity index value was in the Small Stream (S3) with H'= 1.84. In the evenness index, Goa Jepang Stream (S5) has the highest value with E=0.9. The dominance index of the Location of Watu Bandar Stream (S6) has the highest value with D=1.

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