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Study on Diversity of Dragonfly (Odonata) as A Bioindicator of Water Quality in Mount Muria Area, Central Java

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Abstracts

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Water in the Mount Muria area is needed by the surrounding community to fulfill life. An indicator is needed to determine water quality. Dragonfly (Odonata) is one of the organisms as ecosystem controllers and bioindicators. This study aims to determine the diversity of dragonflies, determine water quality and describe the role of dragonflies as a bioindicator of water quality in the Mount Muria area. This type of research is descriptive quantitative research. The data collection technique used direct observation at 3 stations, namely the Colo Flower River, the Monthel Waterfall River and the River in the Rejenu Area. The results showed that there were 10 species of dragonflies consisting of 6 suborders Anisoptera and 4 suborders Zygoptera with the highest abundance value being *Euphaea variegata* (51.39%), *Enallagma signatum* (28.47%), *Trithemis festiva* (6.94%), *Orthetrum glaucum* (5.56%), *Orthetrum chrysis* (2.78%), *Orthetrum prunosum* (2.08%), *Orthetrum testaceum* (0.69%), *Orthetrum sabina* (0.69%), *Prodasineura autumnalis* (0.69%), and *Drepanosticta fontinalis* (0.69%). Based on water quality analysis and according to government regulation no. 82 of 2001, the water in the muria river belongs to category 2. According to the analysis of the family biotic index, it can be seen that the FBI value of the river in the Muria area is 5.60 which means the condition of the river is fair with moderate pollution levels.

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Keywords: Dragonfly, Bioindicator, Mount Muria Area

1. Introduction

Geographically, Indonesia is located in a strategic area, which is between the two continents of Asia and the continent of Australia, the Pacific Ocean and the Indian Ocean and is surrounded by mountains. Indonesia is a country that has many mountains, one of which is Mount Muria. Mount Muria is located in three regencies, namely Kudus, Pati and Jepara regencies. The Muria area, precisely located on the south side, is in the Dawe sub-district, Kudus district, Keling district, Jepara district on the northwest side, and Gembong sub-district, Pati district on the east side. Mount Muria has a total area of approximately 293,297,189 hectares with an altitude of 1602 meters above sea level and a temperature of 20-330 C. Muria as one of the protected forests that must be preserved by the people of Central Java. The protected forest in the muria area has richness and biodiversity (plants and animals) (Muria Studies, 2010).

In 2017, the water quality of the Muria area) was still in good condition with indicators that there were still many invertebrate animals such as stone fly larvae (Plecoptera) and bagworm larvae (Trichoptera) in forest areas, and beetle larvae (Coleoptera), dragonfly nymphs (Odonata) , snails, snails, shrimp in rural areas (UPT Graha Muria. 2017). Over time there is forest damage and environmental pollution in the Muria area that needs to be anticipated.

Dragonfly is one of the diversity of animals found in the Muria area. Dragonflies are included in the Odonata Order, because they have toothed jaws. In the labium (lower lip) there are sharp protrusions (spina) resembling teeth (Amir and Kahono, 2003). Odonata is a group of insects that are medium to large in size and often attractively colored. This insect spends most of its life flying.

In the ecosystem, dragonflies have a big role in maintaining the balance of the food chain. Dragonflies act as predators of other small insects, even cannibals of their kind. In the context of agriculture, dragonflies are able to suppress insect populations that have the potential to become agricultural pests as their

prey (Sigit et al, 2013). The presence of dragonflies in an ecosystem can be an indicator of the balance of the ecosystem.

Dragonflies have 2 habitats, namely water and air. Female odonata in oviposition chooses clear and clean water habitat, because the nymph stage is susceptible to polluted water quality (Borrer et al., 1992; John, 2001). Therefore, the presence of dragonflies in the environment can be a bioindicator of waters, that indirectly the presence of dragonflies can indicate that around the environment there is still clean water. Changes in dragonfly populations can be used as an initial step to signal pollution (a polluted environment).

Biological water quality also needs to be considered because biological life is directly affected by the pollution that occurs. Biological quality can be measured by using the method of biomonitoring (bioassessment). Biomonitoring is the biological monitoring of water quality which is carried out by observing the presence of groups of bioindicators living in the water. The group of indicator organisms that are commonly used in water quality estimation are plankton, benthos, odonata nymphs and nekton (fish). This group is used in estimating water quality because it can reflect the effect of changes in physical and chemical conditions that occur in the waters in a certain time interval (Rahayu et al., 2017).

Some areas on Mount Muria have begun to be converted into secondary agricultural land and some are used for building buildings such as hotels/inns. The land use change will certainly have an impact on the diversity of animals such as dragonflies and water quality in the Mount Muria area. Whereas Mount Muria has abundant springs such as Montel Waterfall and Tiga Rasa Water in Rejenu. This environment is an ideal habitat for dragonfly breeding. This study aims to determine the diversity and distribution of dragonflies as a bioindicator of water quality in the Mount Muria area. The results of this study are expected to be the initial data for biodiversity conservation measures in Mount Muria.

2. Experiments Procedure

This type of research is quantitative descriptive research. According to Sugiyono (2012) descriptive research, namely, research conducted to determine the value of independent variables, either one or more variables (independent) without making comparisons, or connecting with other variables.

This research was conducted in August 2018 in the Mount Muria area, Central Java. The water sample test was carried out at the Undip Laboratory. Dragonfly (Odonata) sampling was carried out on either side of the water flow that had been selected at 3 locations as research stations. The research area is limited to three different locations, namely: Water in the Air Tiga Rasa Rejenu area (station 3), Montel Waterfall (station 2), river flows in the settlements of the Muria slopes (station 1).

All Dragonfly data were taken using the visual day flying method. Data collection was carried out by recording all data on the type of dragonfly (Odonata), and the number of individuals. Data collection and samples in the field were carried out in the morning from 07.00 to 10.00 WIB. The selection of research time is based on the active time of dragonflies, so it is hoped that various types of dragonflies can be found (Suheriyanto, 2008).

Secondary data in the form of water sampling in the area of Mount Muria, with the parameters measured include physical and chemical parameters. Physical parameters include temperature, light intensity, humidity. Chemical parameters include the degree of acidity (pH), the content of Chemical oxygen demand in the waters (COD), and BOD (Biochemical Oxygen Demand) (Virgiawan et al, 2015).

Dragonfly data were identified using the Simpson, 2006 identification technique, which can be done in 5 activities, namely using identification keys, descriptions based on literature, comparison specimens, photos or pictures. Then analyzed the relative abundance value, diversity value, dominance index, and diversity/evenness value. Meanwhile, data on

water quality were analyzed based on water quality test parameters according to government regulation no 82 of 2001. Then the Family Biotic Index was calculated to determine the relationship between the presence of dragonflies and water quality in the Muria area.

3. Result and Discussion

Results and Discussion of Dragonfly Identification in the Muria Region of Central Java

The results of research conducted at 3 watershed stations in the Muria area of Central Java in August 2018 obtained 10 species of dragonflies consisting of 6 species of dragonflies suborder Anisoptera and 4 species of dragonflies suborder Zygoptera, the details are as in table 1.

The results of the analysis of the abundance of dragonflies found in the river flow of the Muria area are in table 1. In table 1 shows that the type of dragonfly that has the highest abundance value is *Euphaea variegata* (51.39%), *Enallagma signatum* (28.47%), *Trithemis festiva* (6.94%), *Orthetrum glaucum* (5.56%), *Orthetrum chrysis* (2.78%), *Orthetrum pruinosum* (2.08%), *Orthetrum testaceum* (0.69%), *Orthetrum sabina* (0.69%), *Prodasineura autumnalis* (0.69%), and *Drepanosticta fontinalis* (0.69%). These results indicate that the *Euphaea variegata* dragonfly is an abundant species, closely related to its ability to adapt to environmental changes.

Based on table 1 above, it shows that the species most frequently encountered is *Euphaea variegata*, indicated by the highest relative abundance (KR) value of 29.4%. This dragonfly lives solitary with a wide distribution (Susanti, 1998) and has a high tolerance for changes in environmental conditions, including polluted water conditions (Rahadi et al. 2013).

The results of the analysis of the dragonfly diversity index can be seen in Table 2. The results of the calculation of the Shanon-Wiener diversity index (H') obtained for each location (water source) in this study are different. The diversity index at station 1 is 0.343, station 2 is 0.366 and at station 3 is 0.367 (table 3).

Table 1. Types of species of dragonflies in the Muria River aliran

No.	Type of dragonflies	Number of individuals			Total	KR (%)
		Kembang River	Montel Waterfall	Rejenu River		
1	<i>Orthetrum pruinatum</i>	0	2	1	3	2.083333
2	<i>Orthetrum glaucum</i>	3	3	2	8	5.555556
3	<i>Orthetrum testaceum</i>	0	1	0	1	0.694444
4	<i>Orthetrum chrysis</i>	4	0	0	4	2.777778
5	<i>Orthetrum sabina</i>	0	1	0	1	0.694444
6	<i>Trithemis festiva</i>	5	3	2	10	6.944444
8	<i>Euphaea variegata</i>	19	29	26	74	51.38889
9	<i>Prodasineura autumnalis</i>	0	1	0	1	0.694444
10	<i>Enallagma signatum</i>	3	18	20	41	28.47222
11	<i>Drepanosticta fontinalis</i>	1	0	0	1	0.694444
Total					144	

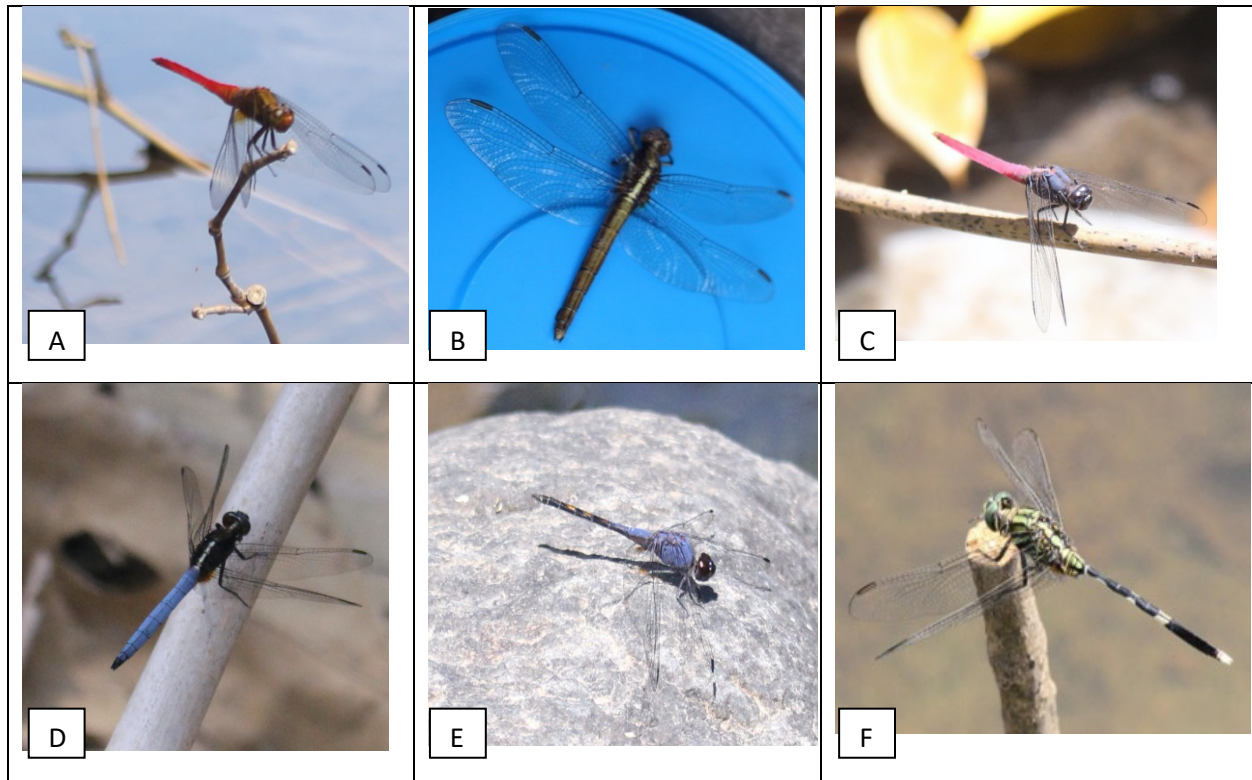


Figure 1. Dragonfly Suborder Anisoptera. (A) *Orthetrum chrysis*, (B) *Orthetrum testaceum*, (C) *Orthetrum pruinatum*, (D) *Orthetrum glaucum*, (E) *Trithemis festiva*, and (F) *Orthetrum sabina*

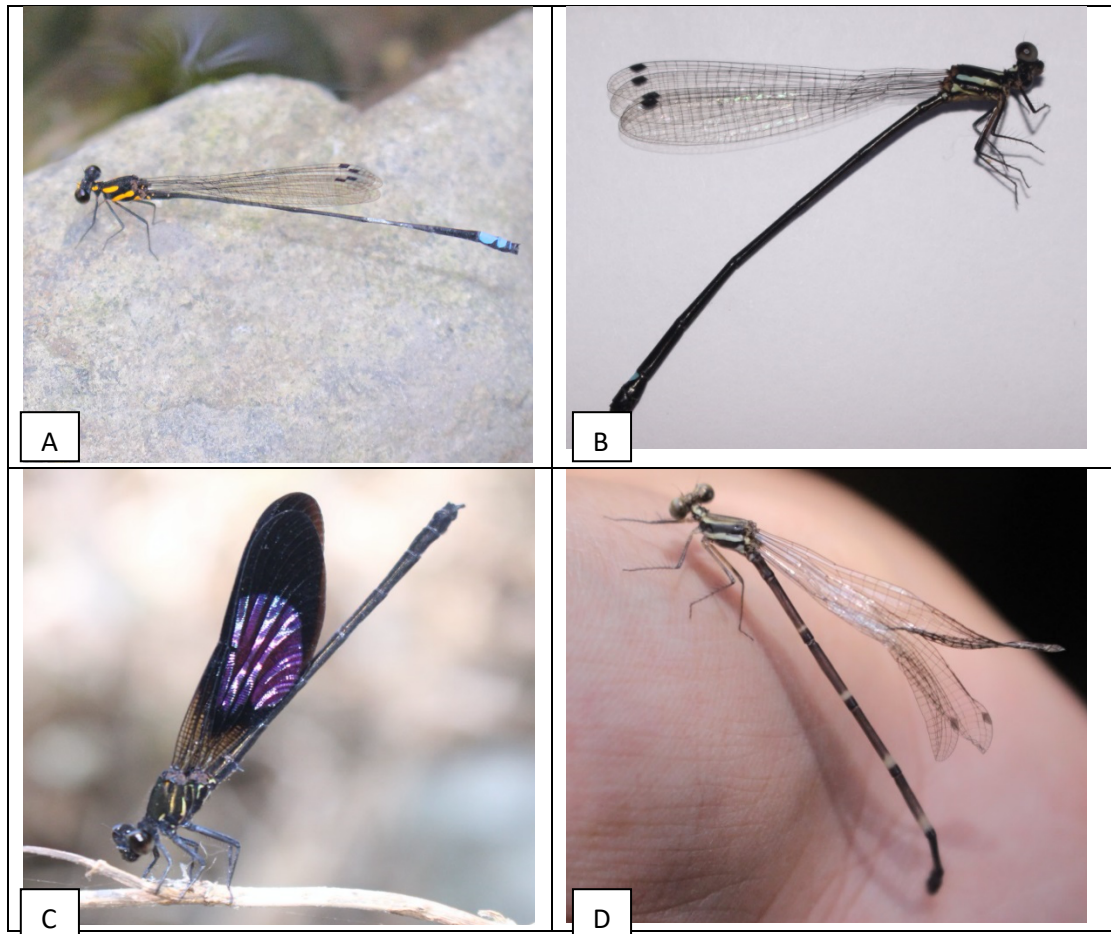


Figure 2. Dragonfly suborder Zygoptera. (A) *Enallagma signatum* , (B) *Drepanosticta fontinalis*, (C) *Euphaea variegata*, and (D) *Prodasineura autumnalis*

Table 2. Dragonfly diversity index at 3 stations in the muria area

No	Lokasi	jenis capung										analisis					
		<i>Orithetrum pruinosum</i>	<i>Orithetrum glaucum</i>	<i>Orithetrum testaceum</i>	<i>Orithetrum clypeis</i>	<i>Orithetrum sabina</i>	<i>Trithemis festiva</i>	<i>Euphaea variegata</i>	<i>Prodasineura autumnalis</i>	<i>Enallagma signatum</i>	<i>Drepanosticta fontinalis</i>	Jumlah	PI	LN PI	H'/Nilai keanekaragaman	C'/Indeks dominansi	E'/Indeks keseragaman
1	stasiun 1	0	3	0	4	0	5	19	0	3	1	35	0,243056	1,414465	0,343794	0,059076	
2	stasiun 2	2	3	1	0	1	3	29	1	18	0	58	0,402778	0,90937	0,366274	0,16223	
3	stasiun 3	1	2	0	0	0	2	26	0	20	0	51	0,354167	1,037988	0,367621	0,125434	
												144			1,077688		0,980954

Station 3 (Rejenu River) has the highest level of diversity of dragonflies (Odonata) than other sources. Station 3 (Rejenu River) is located at an altitude of 1000 meters above sea level which has clean (unpolluted) water quality, so there are several types of microhabitats, such as flowing and stagnant waters and the presence of aquatic plants (*Nasturtium officinale*, *Ipomoea*

aquatic) that are suitable for dragonfly habitats. certain (Dalzochio et al. 2011). Ecologically, the four water sources have a moderate level of dragonfly (Odonata) species diversity, this means that the ecosystem has sufficient productivity, fairly balanced ecosystem conditions and low ecological pressure (Magurran, 1988).

Table 3. Average results of water quality measurements in the muria river

Location	Measurement	Stasiun 1	Stasiun 2	Stasiun 3
Pos 1	Temperature (°C)	21.9	21.5	25.9
	Humidity (%)	59	61	44.6
	Water Salinity	0	0	0.06
	Water pH	6.4	7.2	7.46
Pos 2	Temperature (°C)	23.3	2,9	26.1
	Humidity (%)	55	54.3	46.6
	Water Salinity	0.1	0	0
	Water pH	6,6	7.24	7,5
Pos 3	Temperature (°C)	2,5	22.3	25,7
	Humidity (%)	56.3	64	50,6
	Water Salinity	0.1	0	0
	Water pH	6.9	7.4	7,5

Table 4. Test results for COD, BOD, Cl, Pb and Fe

description	Unit	COD	BOD	Cl	Pb	Fe
Stasiun 1	Mg/l	3,9	1,2	249,30	0	0
Stasiun 2	Mg/l	16,8	5,2	237,20	0,138	0
Stasiun 3	Mg/l	13,5	4,2	307,11	0	0

The results of the above calculation show that the water quality of the river at station 1 (the river in Colo village) shows a water pH of 6.6; COD levels are 3.9 mg/l where COD or Chemical Oxygen Demand is the amount of oxygen needed to break down all organic matter contained in water (Boyd, 1990). BOD level 1.2

mg/l where BOD or Biochemical Oxygen Demand is a characteristic that indicates the amount of dissolved oxygen required by microorganisms (usually bacteria) to decompose or decompose organic matter under aerobic conditions. Boyd (1990) emphasized that organic matter decomposed in BOD is

organic matter that is ready to be decomposed (readily decomposable organic matter). Mays (1996) defines BOD as a measure of the amount of oxygen used by the microbial population contained in the waters in response to the entry of biodegradable organic matter (Odum, 1993). Concentration of Cl 249.30 mg/l, Pb 0mg/l and Fe 0 mg/l. The river water quality at station 2 (the river in the montel waterfall stream) shows the pH of the water 7.3 ; COD content is 16.8 mg/l, BOD content is 5.2 mg/l, Cl is 237.20 mg/l, Pb is 0.138 mg/l and Fe is 0 mg/l. Meanwhile, the river water quality at station 3 (the river near

Rejenu) shows a water pH of 7.5; COD levels 13.5 mg/l, BOD levels 4.2 mg/l, Cl 307.11 mg/l, Pb 0mg/l and Fe 0 mg/l.

Based on government regulation standard no. 82 of 2001 concerning water quality management and water pollution control shows that the quality of the water in the Muria River belongs to category 2, namely water whose designation can be used for water recreation infrastructure/facilities, freshwater fish cultivation, animal husbandry, water for irrigating crops, and/or other designations that require the same water quality as that use.

Table 5. Family Biotic Index calculation results

Dragonfly Family	Number (xi)	Tolerance value (ti)	xi.ti
<i>Libellulidae</i>	27	9	243
<i>Euphaeidae</i>	74	3	222
<i>Protoneuridae</i>	1	9	9
<i>Coenagrionidae</i>	41	8	328
<i>Platycnemididae</i>	1	5	5
jumlah	144		807
FBI		5,604166667	

Table 6. The River condition criteria

FB Value	River Condition	Pollution level
0,00 – 3,75	Excellent	Not polluted at all
3,76 – 4,25	Very good	Very unpolluted
4,26 – 5,00	Good	Unpolluted
5,01 – 5,75	Fair	Lightly polluted
5,76 – 6,50	Fairly poor	Medium polluted
6,51 – 7,25	Foor	Heavily polluted
7,26 -10,00	Very poor	Very heavily polluted

Analysis of the Role of Dragonflies as Bioindicators of Water Quality in the Muria Area

Based on the environmental quality weighting assessment criteria, the diversity index value (H') of the odonata dragonfly in the Muria area of Central Java is 1.36, which means that the quality of the community structure is quite stable or is included in the poor category.

Meanwhile, the environmental quality weighting criteria for the evenness index (E) of the odonata dragonfly in the Muria area is 0.56. Which means that the Distribution Condition for the Type of Community Structure is stable or can be categorized as moderate.

According to the FBI table above, it can be seen that the FBI value of the river in the Muria area is 5.60, which means the condition of the river is fair with a moderate level of pollution.

There needs to be an effort to maintain water quality in the Mount Muria area because water is a natural resource that fulfills the needs of many people, so it needs to be protected so that it can continue to be useful for life and the lives of humans and other living creatures. To maintain or achieve water quality so that it can be used sustainably in accordance with the desired level of water quality, it is necessary to conserve and/or control it. Preservation of water quality is an effort to maintain the function of water so that its quality remains in its natural condition.

4. Conclusion

in the Muria area of Central Java, it can be concluded that: Dragonflies identified from 3 watershed stations in the Muria area obtained 10 species of dragonflies consisting of 6 species of dragonflies suborder Anisoptera (Orthetrum pruinosum, Orthetrum glaucum Orthetrum testaceum, Orthetrum chrysis, Trithemis festiva, and Orthetrum sabina) and 4 species of dragonflies suborder Zygoptera (Euphaea

variegata, Prodasineura autumnalis, Enallagma signatum and Drepanosticta fontinalis). The results of the analysis of the abundance of dragonflies found in the river flow of the Muria area showed that the species of dragonfly that had the highest abundance value were Euphaea variegata (51.39%), Enallagma signatum (28.47%), Trithemis festiva (6.94%), Orthetrum glaucum (5.56%), Orthetrum chrysis (2.78%), Orthetrum pruinosum (2.08%), Orthetrum testaceum (0.69%), Orthetrum sabina (0.69%), Prodasineura autumnalis (0.69 %), and Drepanosticta fontinalis (0.69%). Based on government regulation standard no. 82 of 2001 concerning water quality management and water pollution control shows that the quality of the water in the Muria River belongs to category.

Based on the environmental quality weighting assessment criteria, the diversity index value (H') of the odonata dragonfly in the Muria area of Central Java is 1.36, which means that the quality of the community structure is quite stable or is included in the poor category. Meanwhile, the environmental quality weighting criteria for the evenness index (E) of the odonata dragonfly in the Muria area is 0.56. Which means that the distribution conditions for the type of community structure are stable or can be categorized as moderate. According to the FBI analysis, it can be seen that the FBI value of the river in the Muria area is 5.60, which means that the condition of the river is fair with a moderate level of pollution.

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