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Diversity of the dragonfly (Odonata) as an indication of water quality

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ABSTRACT

Information on the diversity of dragonfly in the University area is still not much. Reduced areas that support the growth and development of dragonfly species are thought to have an impact on the decline of the population and the diversity of these species. The purpose of this study identified and analyzed the diversity of dragonfly species. Dragonfly are collected through direct capture and using sticky traps, then visual observations are made for identification. Environmental conditions in the area of Sriwijaya University Campus is still good, with the visibility of environmental parameters in the form of DO, BOD and COD still meet environmental quality standards so that dragonflies are still able to lay eggs to keep their generation. Sriwijaya University campus found 19 species of Odonata belonging to 5 families and 2 sub-ordo, with the value of species diversity index of 2.05 and moderate.

Keywords: biomonitoring, environmental conditions, Odonata

1. INTRODUCTION

Research on the Odonata or often known as a dragonfly, has never been done in the environment of Sriwijaya University campus. Dragonfly is an important component of the ecosystem of an environment (Junior *et al*. 2014 and saha *et al*. 2014). Low or high quality environment can affect the existence of dragonfly. This is evidenced by the decrease in the number of dragonflyj types seen in Suhonen *et al*. (2010) due to the decrease of environmental quality.

Research on Odonata (Harabiŝ & Dolnŷ, 2012; Willigalla & Fartmann, 2012; Jŭnior *et al*. 2014 and saha *et al*. 2014), reported that the reduction of conservation areas present in an environment makes important organisms in the region It becomes extinct. Dragonfly has many roles in nature. This group is one of the population controllers of other organisms (Paulson, 2009). Dragonfly can be functioned as a balancing of an ecosystem (Harabiŝ & Dolnŷ, 2012; Willigalla & Fartmann, 2012 and Jŭnior *et al*. 2014).

Odonata has two sub-ordo namely Anisoptera and Zygoptera. Anisoptera known as dragonfly and Zygoptera known as the damselfly. The main differences of morphology of these two sub-ordo lie in the shape of the eyes, wings, piston and abdomen. The flying behavior of Zygoptera tends to weaken and its range is not widespread, whereas Anisoptera has a rapid movement and wide range (Sigit *et al*. 2013)

In addition, the other role is to be a natural adverse insect controller as a predator (Pamungkas & Ridwan, 2015). The nymph phase of the dragonfly lives in clean and predatory waters (Setiyono *et al*., 2015 and Berquier et al., 2016). The nymphs from dragonfly will feed on insect larvae that live in water like mosquito larvae. Further Sigit *et al*. (2013), states that a nymph of dragonfly can live in waters for several months to several years and is sensitive to contaminated water conditions. In the adult phase of dragonfly has an olfactory sensory organ present in the antenna that serves to detect the condition of a waters, so as to support the life of the eggs to be laid (Setiyono et al., 2015). Therefore, the dragonfly can serve as an indicator in contaminated waters. Berquier *et al*. (2016) explains that a fresh environment can be seen from the existence of the living Odonata species in the area, because the larva phase of the dragonfly can only live in undisturbed water conditions

To see the change in environmental quality due to human ac-

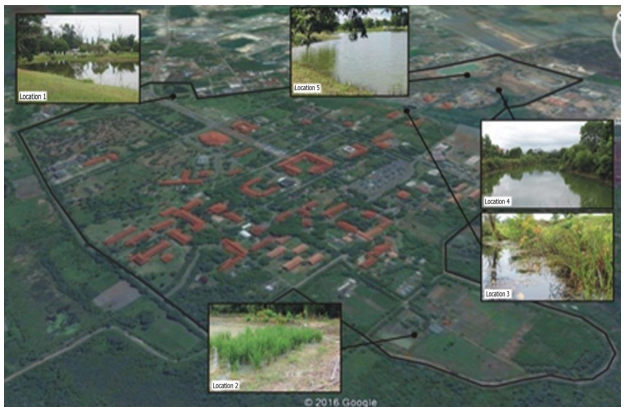

Figure 1. Map of research location on Sriwijaya University Campus, Indralaya

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tivities and as one of the steps in evaluating the environmental conditions in the campus of Sriwijaya University, the existence of dragonfly needs to be monitored. This is caused dragonfly is one of the indicator of aquatic environment that can be relied upon to see the condition of the environment and can be one of the supporting data for the environmental management effort that has been done. Simply stated, the aquatic environment will be reflected in the diversity of dragonfly in the area. Therefore, research on the diversity of dragonfly in some areas in the campus area of Sriwijaya University, Indralaya, Ogan Ilir, South Sumatra.

2. EXPERIMENTAL SECTION

The research has been conducted in the campus area of Sriwijaya University, Indralaya, Ogan Ilir, South Sumatra. The area of Sriwijaya University campus is 712 ha. In general, the area of Sriwijaya University campus consists of swamp area, arboretum area, agriculture area, oil palm plantation area, retention pond and building area. The location of the research is five points: campus gate pool (Location 1), Agro Techno Center (Location 2), swamp (Location 3), rusunawa pond (Location 4) and back gate pool of campus (Location 5) and determined by purposive sampling method. That is determined based on representative locations. The coordinates of each location can be seen in Table 1 and the map of the study sites is shown in Figure 1.

Data collection using visual observation method (Bismark, 2011), direct capture using insect webs and using sticky traps (Figure 2) placed at each location and taken every afternoon. Data collection is done once a week for three months and is conducted between 07.00 am to 10.00 am and the afternoon between 14.00 pm to 18.00 pm.

Identification of species is done by taking into account the color, shape and position of the wings, as well as the flying behavior (Sigit *et al*., 2013). Identification was done using the help of the Odonata field manual and other books supporting identification (Moore, 1997, Paulson, 2009, Setiyono *et al.* 2015, Sigit *et al*., 2013 and Theischinger & Fartmann, 2012).

Data analysis of species diversity was calculated by the Shannon formula (1) (Odum, 1998)

$$H = -\sum pi \ln pi \quad (1)$$

Where H indices of diversity, Pi is ni / N, Ni is number of individual species i and N is total number of individuals.

The dominance of the Odonata order is calculated using the Simpson formula (Indriyanto, 2010):

$$D = \sum \left(\frac{ni}{N}\right)^2 \quad (2)$$

Where D is dominant species, Ni is Number of individual species i, and N is total number of individuals

3. RESULTS AND DISCUSSION

The result of measurement of abiotic condition in Sriwijaya University Campus, Indralaya can be categorized as having clean water condition. Clean water conditions can be related to the existence of living things, especially Odonata in the area. According to Suhonen *et al.* (2010) unclean waters will remove species from Odonata. Setiyono *et al*. (2015) explains that the olfactory sensory organs present in the antenna in Odonata will detect the condition of a water that is capable of supporting the eggs to be placed, so that Odonata will move from a dirty habitat to a clean habitat. Physical parameters such as air temperature, water temperature

Table 1. Coordinates of Research sites on Sriwijaya University Campus, Indralaya

No	Location	Information	Coordinate
1	Location 1	Pond front gate Unsri campus (angsana vegetation, mahogany and palm)	3°12'40,64" LS 104°38'57,78" BT
2	Location 2	Agro Techno Center (rice area, corn area)	3°13'19,19" LS 104°38'46,12" BT
3	Location 3	Swamp (shrubs)	3°13'1,67" LS 104°39'12,03" BT
4	Location 4	Rusunawa Pool (shrubs)	3°13'6,24" LS 104°39'22,36" BT
5	Location 5	Pond back gate Unsri campus (acacia vegetation and shrubs)	3°13'0,24" LS 104°39'28,98" BT

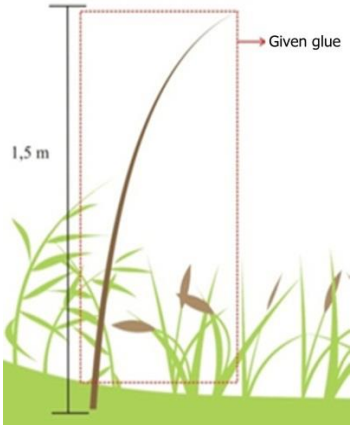

Figure 2. Sticky Trap

and humidity and chemical parameters such as Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) in this study can be seen in Table 2.

The value of DO in waters at Sriwijaya University Campus is relatively high, ranging from 6.80 to 7.39 ppm (Table 2), while BOD values obtained from small relative measurements ranged from 1.31 to 2.84 ppm (Table 2.2) . Referring to the BOD standard for the determination of water quality in the UK, a BOD value of 2 ppm can be categorized as a clean water condition. High oxygen consumption is indicated by the smaller amount of dissolved oxygen in the water, the content of the oxygen-consuming waste material is high (Kristanto, 2004)

Species that have been found based on research using visual observation methods, direct capture and sticky traps in December 2016 to February 2017 amounted to 19 species (Table 2 and Figure 2). The species are included in the three families of the Anisoptera of Aeshidae, Gomphidae, and Libellulidae, and two families from the Zygoptera of Coenagrionidae and Lestidae.

Dragonflies still found on the University of Sriwijaya Campus is a form of their success to remain able to maintain the sustainability of his generation. The availability of food sources and the presence of suitable habitats for dragonflies is a reflection of the stable ecosystem in the area of Sriwijaya University Campus.

The species were identified from the Anisoptera as many as 13 species is *Anax guttatus*, *Ictinogomphus decoratus*, *Acisoma panorphoides*, *Brachythemis contaminata*, *Diplacodes trivalis*, *Neurothemis ramburii*, *Lathrecista asiatica*, *Trithemis pallidinervis*, *Orthetrum pruinosum*, *O. sabina*,

Table 2. Abiotic conditions at Sriwijaya University Campus, Indralaya

No	Parameter	Location					Average
		1	2	3	4	5	
1	DO (mg/l)	7,31	6,80	7,39	6,71	6,95	7,03
2	BOD (mg/l)	2,84	1,31	1,48	1,50	2,54	1,93
3	COD (mg/l)	44,98	25,52	6,45	17,91	20,62	23,10
4	Air temperature (°C)	32 - 37	34 - 36	32 - 35	29 - 35	32 - 38	29-38
5	water temperature (°C)	26 - 32	26 - 38	26 - 29	26 - 32	26 - 32	26-38
6	Humidity (%)	38 - 78	46 - 54	32 - 79	46 - 79	46 - 80	32-80

Rhyothemis phyllis, Crocothemis servilia, and *Rhodothemis rufa* (Table 2). The species were identified from the Zygoptera namely *Agriocnemis femina*, *Agriocnemis pygmaena*, *Ceriagrion auranticum*, *Ischnura senegalensis*, *Pseudagrium microcephalum* and *Lestes praemorsus*

The five species that have the largest number of individuals are *B. contaminata, O. sabina, N. ramburii, R. phyllis* and *P. microcephalum* (Table 3). The five species that have the largest number of individuals can be attributed to the adaptability of each species is better when compared with other species, so the five species can live in different habitat types.

The five species that have the lowest number of individuals are *R. rufa, A. guttatus, C. auranticum, L. asiatica* and *O. pruinosum* (Table 3). The five species have the lowest number of individuals can be caused by the sensitivity of their bodies, so have a tolerance limit for very narrow environmental changes. An unsuitable environmental condition is suspected to cause the migration of these five species to another more suitable site, thus rarely finding these five species at research sites.

The first week in January 2017 was the most-discovered week of dragonfly, 242 individuals of 14 species, while December 2016 was the month least dragonfly (Table 3). The large number of individuals in January 2017 can be expected due to the number of naiads that successfully transformed into the imago phase, as evidenced by the abundance of naiad skin found in January 2017. The large number of skin naiads found means that the water conditions in the Campus of Sriwijaya University are still good, Support the life of dragonfly in the egg phase, naiad to the imago phase.

The composition and variety of species found at each study

Table 3. List of species and number of individuals from dragonfly found at each observation location at Sriwijaya University Campus from December 2016 to February 2017

No	Species	December				January				February				Total
		I	II	III	IV	I	II	III	IV	I	II	III	IV	
	Anisoptera													
	Aeshnidae													
1	*Anax guttatus*	0	0	0	0	0	2	0	0	0	0	0	0	2
	Gomphidae													
2	*Ictinogomphus decoratus*	0	2	1	0	8	9	4	3	0	2	3	8	40
	Libellulidae													
3	*Acisoma panorphoides*	0	0	0	3	6	4	5	3	3	1	0	0	25
4	*Brachythemis contaminata*	27	21	20	36	60	47	30	38	49	51	78	53	510
5	*Crocothemis servilia*	2	4	2	7	6	4	10	3	8	3	9	3	61
6	*Diplacodes trivalis*	0	1	2	2	1	3	2	2	2	1	5	2	23
7	*Lathrecista asiatica*	0	0	0	0	0	2	0	0	0	0	0	0	2
8	*Neurothemis ramburii*	13	10	13	23	25	22	31	16	8	7	18	14	200
9	*Orthetrum pruinosum*	2	0	0	0	8	0	3	0	0	0	0	0	13
10	*Orthetrum sabina*	16	17	17	20	28	25	18	10	15	12	24	21	223
11	*Rhodothemis rufa*	0	0	0	0	0	0	1	0	0	0	0	0	1
12	*Rhyothemis phyllis*	20	3	8	19	5	23	32	0	36	17	15	17	195
13	*Trithemis pallidinervis*	4	1	3	6	10	3	5	3	5	3	0	0	43
	Zygoptera													
	Coenagrionidae													
14	*Agriocnemis femina*	0	0	5	3	8	0	0	4	0	0	0	3	23
15	*Agriocnemis pygmaena*	3	0	2	2	31	0	2	3	0	0	5	5	53
16	*Ceriagrion auranticum*	0	0	0	0	0	0	1	0	0	0	1	0	2
17	*Ischnura senegalensis*	2	1	1	8	18	10	5	3	10	4	5	5	72
18	*Pseudagrium microcephalum*	2	8	5	10	23	26	5	11	15	15	13	15	148
	Lestidae													
19	*Lestes praemorsus*	0	0	0	0	5	8	0	2	5	3	6	4	33
	TOTAL	**91**	**68**	**79**	**139**	**242**	**188**	**154**	**101**	**156**	**119**	**182**	**150**	**1669**

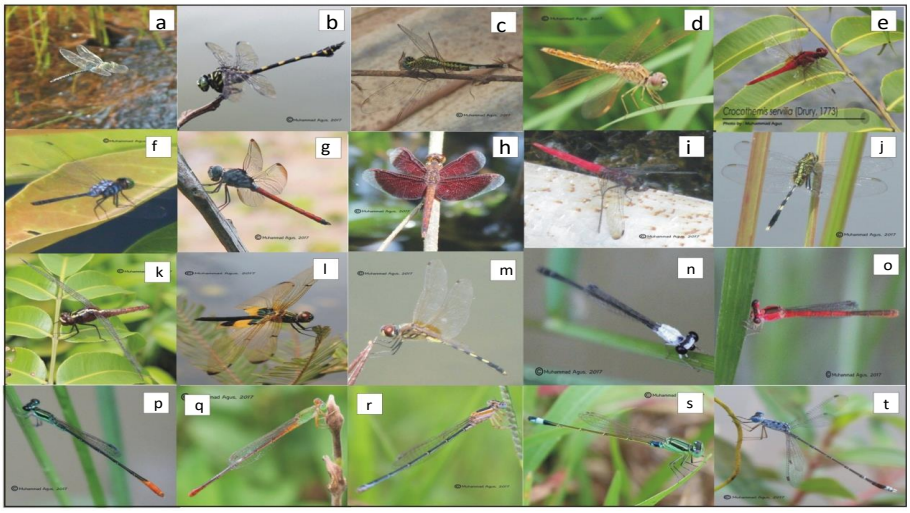

Figure 3. Dragonflies found on Sriwijaya University Campus from December 2016 to February 2017 (a) *Anax guttatus* (b) *Ictinogomphus decoratus* (c) *Acisoma panorphoides* (d) *Brachythemis contaminata* (e) *Crocothemis servilia* (f) *Diplacodes trivalis* (g) *Lathrecista asiatica* (h) *Orthetrum pruinosum* (i) *Orthetrum sabina* (j) *Rhodothemis rufa* (k) *Rhodothemis rufa* (l) *Rhyothemis phyllis* (m) *Trithemis pallidinervis* (n) (o) *Agriocnemis femina* (p) *Agriocnemis pygmaena* (q) *Ceriagrion auranticum* (r) *Ischnura senegalensis* (s) *Pseudagrium microcephalum* (t) *Lestes praemorsus*

Table 4. The value of the dominant index in each location in December 2016 to February 2017 at the Campus of Sriwijaya University, Indralaya

Location	December				January				February				Average
	I	II	III	IV	I	II	III	IV	I	II	III	IV	
1	1,00	0,50	0,52	0,32	0,21	0,28	0,52	0,28	0,35	0,24	0,24	0,24	0,39
2	0,56	0,24	0,46	0,29	0,48	0,49	0,69	0,64	0,44	0,43	0,36	0,43	0,46
3	0,39	0,28	0,59	0,18	0,14	0,13	0,21	0,17	0,23	0,17	0,17	0,17	0,24
4	0,26	0,31	0,17	0,18	0,15	0,17	0,36	0,21	0,40	0,34	0,20	0,34	0,26
5	0,27	0,24	0,29	0,30	0,19	0,32	0,29	0,29	0,37	0,46	0,48	0,46	0,33

site differed. The differences in composition and diversity in some research sites can be caused by differences in environmental conditions such as vegetation, food sources and physical and chemical factors at each site (Siregar & Bakti (2016), Saha *et al.* (2014) and Suhonen *et al*. (2010) The index value of species diversity at each location in December 2016 to February 2017 can be seen in Figure 3.

The high index value of species diversity at the third location is thought to be due to the large number of shading trees. Harrington & Stork (1995), reported that the presence of plants will affect herbivorous insects, so that with many bush-level plants at the third site make high insects that can be eaten by dragonfly. The first location has a low index of species diversity due to the relatively more homogeneous plants present in the site. According to Siregar & Bakti (2016) Odonata requires a lot of plants to become perches and copulates, so the first location is a location that is less suitable for the activities of dragonfly.

The diversity of dragonfly species in the area of Sriwijaya University Campus can be classified moderately, with an average diversity index value of 2.05. An index of species diversity above 2.0 can mean that the condition of an environment is not polluted (Sastrawijaya, 2009). According to Lamptey *et al*. (2013); Pamungkas & Ridwan (2015) and Suhonen *et al*. (2010) if species diversity in a region is moderate, then the ecosystem conditions are well balanced and ecological pressure is low.

The highest index of species diversity occurred in the first week of January 2017 of 2.35 whereas the lowest species diversity occurred in the second week of February 2017 at 1.84 (Figure 4). The high values of the species diversity index in January 2017 can be expected due to the number of successful naiads to become adult dragonflies, while in February 2017 the adult dragonfly began to move out of the Sriwijaya University Campus area to search for food and spouses, resulting in the number of species found In February 2017 began to decrease.

The index value of dominance in the third week of January 2017 is seen to increase and begin to close to 0.5 (Table 4), which means that there is a species that began to dominate. Factors contributing to the decline in the index value of the species diversity of dragonfly and damselfly in February 2016 can also be expected due to the increasing number of species that can affect populations of other species. Increasing the number of individuals from a population will lead to competition in the fight for food.

The species dominance index greatly influences the species diversity index. The high index of species dominance will make the index of species diversity low, because in the presence of species that dominate the species will dominate community of the ecosystem. According to Indrawan *et al*. (2007) the extent of species populations is often influenced by other species competing for the same resource.

The stable condition of the community structure at each location occurs from the fourth week of December 2016 to the second week of January 2017, where the value of the dominance index in each observation location is below 0.5 and can be seen in Table 4. Stable community structure can be due to the balanced number

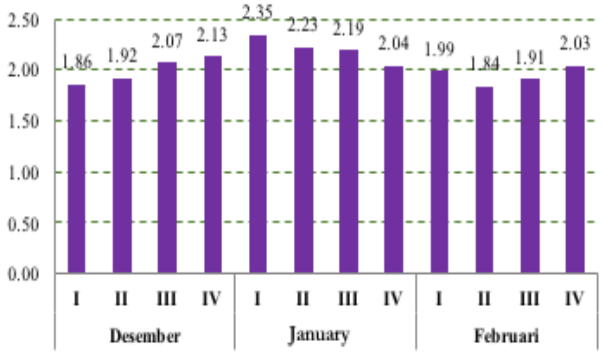

Figure 4. Value of species diversity index in December 2016 to February 2017 at Sriwijaya University Campus, Indralaya

of species and their sources of food.

Predator species that have wide tolerance to the environment will be a key species for other species (Indrawan et al., 2007). Key species at the study sites were *B. contaminata, O. sabina* and *N. ramburii*. The high population of *B. contaminata* is thought to be able to control food resources and make species with fewer populations choose to move to find food sources elsewhere.

A second location with a dominant index value of 0.46 (Table 4) can be interpreted as having started to have dominant species. The high population of *B. contaminata* in January 2017 and R. phyllis in February 2017 allegedly caused other species to lose competing for food needs, so that the second site had a high index of dominance and a low index of species diversity. According to Alikodra (2010) the population reduction of dominant predator organisms is needed to stimulate population growth from other organisms

4. CONCLUSION

The environmental conditions in the area of Sriwijaya University Campus are still good, with the environmental parameters of DO, BOD and COD still meet the environmental quality standards so that the dragonfly can still maintain its generation, so that there are 19 species belonging to 5 families and 2 sub-orders, Species diversity of 2.05 and moderate.

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