Odonata diversity (Anisoptera & Zygoptera) at Purwodadi Botanical Garden, East Java, Indonesia

Achmad Muhaimin Nur Khafi[1], Dita Megasari[1], Wiwin Windriyanti[1], Linda Wige Ningrum[2]

[1]Agrotechnologi Study Program, Faculty of Agriculture, Universitas Pembangunan Nasional "Veteran" Jawa Timur, Indonesia
[2]Center for Ecology and Ethnobiology Research, National Research and Innovation Agency, Indonesia
*Corresponding author's email: dita.megasari.agrotek@upnjatim.ac.id

Received: 05th August 2024 / Accepted: September 30th, 2024

ABSTRACT

Dragonflies are one of the insects that have an important role in maintaining the balance of the food chain and the sustainability of the ecosystem. Dragonflies can be used as a natural indicator of the quality of an ecosystem, changes in an environmental ecosystem, and to assess the level of environmental damage. Dragonflies can also be used as an indicator of air cleanliness. This research aims to inventory the diversity of dragonfly species (Odonata) in the Purwodadi Botanical Gardens, observe the influence of the environment on the behavior of dragonflies (Odonata), and identify the types of dragonflies in the Purwodadi Botanical Gardens. The inventory method for dragonfly species is carried out using the shipping method which includes direct capture, collection, identification of dragonflies, and data analysis, as well as direct observation. 11 species of dragonflies were found which are members of 6 families, namely Libellulidae, Gomphidae Platynemididae, Chlorocyphidae, Coenagrionidae, and Euphaeidae. A diversity of dragonfly types is found in 6 locations in the Purwodadi Botanical Gardens area. The results say that the types of dragonflies are not different, showing a close relationship with the ability to adapt to environmental changes. Dragonflies in the Purwodadi Botanical Gardens are included in medium diversity because they are in the range 1<H'<3 with a value of 1.8. while the Dragonfly Type evenness index shows a value of 0.7, which means high evenness. The results of calculating the distribution of dragonflies show that the overall distribution of dragonflies is regular, except for Euphaea variegata which has a clustered distribution. This research proves that dragonflies have an important role in life, their biological function is as a predator of small insects and as a bioindicator of the quality of an environment.

Keywords*: Anisoptera, dragonfly, diversity, Purwodadi Botanical Garden, Zygoptera.*

INTRODUCTION

Dragonflies are one of the insects that have an important role in maintaining the balance of the food chain and the sustainability of the ecosystem. Dragonflies are predators that prey on mosquitoes and other small insects, aided by their sharp compound eyes and bristle limbs to grip their prey (Rismayani, 2018). The order Odonata is divided into two suborders, namely Zygoptera and Anisoptera. These two suborders have some differences, namely the Anisoptera suborder has the characteristics of the hind wings wider than the front wings and the compound eyes are close together while the Zygoptera suborder has the characteristics of the front wings and hind wings that are equally large, with compound eyes that are far apart. Dragonflies can be used as a natural indicator of the quality of an ecosystem change in an environmental ecosystem and to assess the level of environmental damage. Dragonflies can also be used as an indicator of water cleanliness (Teristiandi & Riyanto, 2021).

Dragonfly habitats are highly dependent on water bodies such as rice fields, rivers, ponds, and swamps (Saputri *et. al.*, 2013). Adult dragonflies are generally found in open areas, especially near the water where they live and breed. Most dragonflies prefer to live in grasses and shrubs that grow around water. The survival of dragonflies is highly dependent on a clean environment so that the life cycle of dragonflies is not disrupted because the majority of dragonflies have a preference for clean water and minimal pollutants (Bruno *et. al.*, 2022).

Some other factors supporting the survival of dragonflies are temperature, pH, humidity, and food availability (Rizal and Hadi, 2015). According to Corbet (1980) in Ansori (2009), differences in the number of individual dragonflies in an area are caused by the influence of the environmental quality of a habitat, such as pH, temperature, air humidity, chemical factor conditions, and food availability. Based on this, there are certainly differences in environmental factors in an ecosystem that allow differences in the types of dragonflies that live in it.

Purwodadi Botanical Garden is a botanical garden located in the dry lowlands, with one of its main tasks being to carry out ex-situ conservation of plants. The existence of a collection of plants in Purwodadi Botanical Garden is in addition to maintaining ecological conditions both related to water, soil, and microclimate conditions that exist around the botanical garden, also the most important thing is to be able to maintain the diversity of plants or rare plants in Indonesia and in the world (Ningrum & Retnosari, 2021). Based on data from the registration unit, Purwodadi Botanical Garden has a plant collection of 1.742 plant species from various families

DOI: https://doi.org/10.21107/agrovigor.v17i2.26406
Agrovigor: Jurnal Agroekoteknologi
http://journal.trunojoyo.ac.id/agrovigor
ISSN: 1979-5777 (*Print*), 2477-0353 (*Online*)

from collections of legumes, ferns, medicinal plants, and aquatic plants. From various types of plants collected in Purwodadi Botanical Garden, there are dragonfly movement activities in the area and research on the inventory of dragonfly species diversity in Purwodadi Botanical Garden is not widely known. Therefore, it is necessary to explore information about dragonfly species diversity. This research contributes to providing information as a basis for dragonfly conservation and environmental influences on dragonfly development.

MATERIALS AND METHODS

This research was conducted from July 2023 to August 2023, this research was conducted at Purwodadi Botanical Garden which is divided into 6 areas, namely Environment I-IV (Figure 1). The tools used in this study consisted of anemometers, insect nets, stationery, mobile phone cameras, tweezers, collection needles, syringes, 5-watt bulbs, scissors, styrofoam, plastic containers, collection boxes, and cardboard. Materials used in this study include 70% alcohol used to kill and preserve dragonflies. The inventory method of dragonfly species was carried out using the roaming method which includes direct capture, collection, dragonfly identification, and data analysis. Direct observation involved recording the types of dragonflies encountered. The dragonflies observed were perching dragonflies, then captured using an insect net and taken pictures with a mobile phone camera until the type of individual could be ascertained. The field-by-field method was carried out at a predetermined location with a direct capture method using an insect net (Gultom, 2020). The captured dragonflies were collected and identified using the literature of Borror, D. J., A, T. C., & Johnson, N. F. (1996), Australian Dragonflies (Watson et. al., 1996) and A Pocket Guide to Dragonflies of Peninsular Malaysia and Singapore (Orr, 2005). which was then subjected to data analysis. Data analysis was used to calculate relative abundance, diversity index, species evenness, and dragonfly distribution. Relative abundance was measured using the following formula:

$$KR = n/N \times 100\%$$

Description:
KR = relative abundance
n = number of dragonfly individuals
N = total number of individuals of all dragonfly species

Dragonfly species diversity in each environment was measured by the Shannon-Weiner index (H'). The calculation of the species diversity index using the Shannon-Wiener index formula (Wijana, 2014) is as follows:

$$H' = - \sum (ni/N \ln ni/N)$$

Description:
H' = Diversity Indeks
N = Total importance value of all species
Ni = Total importance of a species
According to Magurran (1988), the classification of diversity values is as follows:
H' < 1 = Low Diversity
1<H'<3 = Medium Diversity
H' > 3 = High Diversity.

The distribution formula of each dragonfly species can use the variance value formula from Southwood in Ludwig (1988) as follows:

$$\sum(x-\bar{A})2 \; S2 = \text{-----}$$
$$\text{note } \bar{A} = (\sum x)/n) \; n \; -1$$

Description:
X = Number of individuals of each species
N = Number of observation lines
Ã = Average number of individuals per line

The species evenness index was calculated using the following formula (Ludwig & Reynolds, 1988; Magurran, 2004):

$$e' = H' \ln (S)$$

Description:
e' = species evenness index
H' = species diversity index
ln = natural logarithm

The value of the evenness index ranges from 0-1 with the following categories:
$0 < E \leq 0.4$ = small evenness, depressed community
$0.4 < E \leq 0.6$ = moderate evenness, labile community
$0.6 < E \leq 1.0$ = high evenness, stable community

RESULTS AND DISCUSSION

The results of dragonfly catch in 6 environments in the Purwodadi Botanical Garden area that have been identified are obtained 5 families and 11 species of dragonflies Sub-order Anisoptera most commonly found in environment IV and Zygoptera most commonly found in environment II shown in Table 1.

Research on Odonata has been conducted by Ilhamdi (2018) but further research is needed, especially to reveal the composition and distribution of Odonata because the information is not widely available. Comparison of Odonata species composition in 2017 and 2019 showed different results, in 2019 16 species while in 2017 obtained 19 species (Ilhamdi, 2018). This study found eleven species scattered in Purwodadi Botanical Garden, dragonflies are active in the morning-afternoon to fly and look for prey. There are five species from the suborder Anisoptera namely *Orthetrum Sabina, Pantala flavescens, Diplacodes trivialis, Crocothemis servilia, Zyxomma obtusum, Neurothemis ramburii,* and *Ictinogomphus decoratus*. While four species belonging to the Zygoptera suborder are *Copera marginipes, Heliocypha fenestrata*, *Pseudagrion pruinosum,* and *Euphaea variegata* (Figure 2). Based on the number of species found, in the order Anisoptera, only species from the family Libellulidae were found, while in the suborder Zygoptera species from the family Chlorocyphidae were found more than other families.

Relative Abundance

The results of the analysis of the abundance of dragonflies found in Purwodadi Botanical Garden can be seen in (Table 2) shows that the type of dragonfly that has the

highest abundance of *Pantala flavescens* (1%), *Neurothemis ramburii* (1%), *Zyxomma obtusum* (1%), *Pseudagrion pruinosum* (1%), *Euphaea variegate* (1%) and the type of dragonfly that has the lowest abundance is Orthetrum Sabina (0.98%) and *Heliocypha fenestrate* (0.98%). These results indicate that *Pantala flavescens*, *Neurothemis ramburii*, *Zyxomma obtusum*, *Pseudagrion pruinosum*, and *Euphaea variegate* are abundant species, which is closely related to their ability to adapt to environmental changes.

Dragonfly Distribution

The results of the calculation of dragonfly distribution in the table show that the overall distribution of dragonflies is regular, except for Eupheaea variegata which has a clustered distribution. Clustered distribution means that the population distribution of individual dragonflies in the population is clustered (Table 3).

Clustered distribution means that the population distribution of dragonfly individuals in the population is clustered. According to (Odum, 1993) the even or regular nature of the distribution can allow for competition between individuals, either in terms of space or food. This interaction encourages the division of the same space. The nature of the distribution of clusters is generally owned by insects because the tendency to group and gather of various degrees represents the most common trait. Based on the results of the calculation of the number of species in the sample, the nature of the distribution of dragonflies from each family is grouped, (Odum, 1993) suggests that the grouping of individual organisms of population members occurs due to several things, including responding to daily or seasonal weather changes, responding to differences in local habitat conditions, as a result of the reproductive process, as a result of social attraction.

Shannon-Wiener Diversity Indeks

Species diversity is determined by the ratio of the number of individuals of a species to the number of individuals of other species found in the area. Species diversity will increase if the ratio decreases and vice versa species diversity will decrease if the ratio range gets bigger (Odum, 1990).

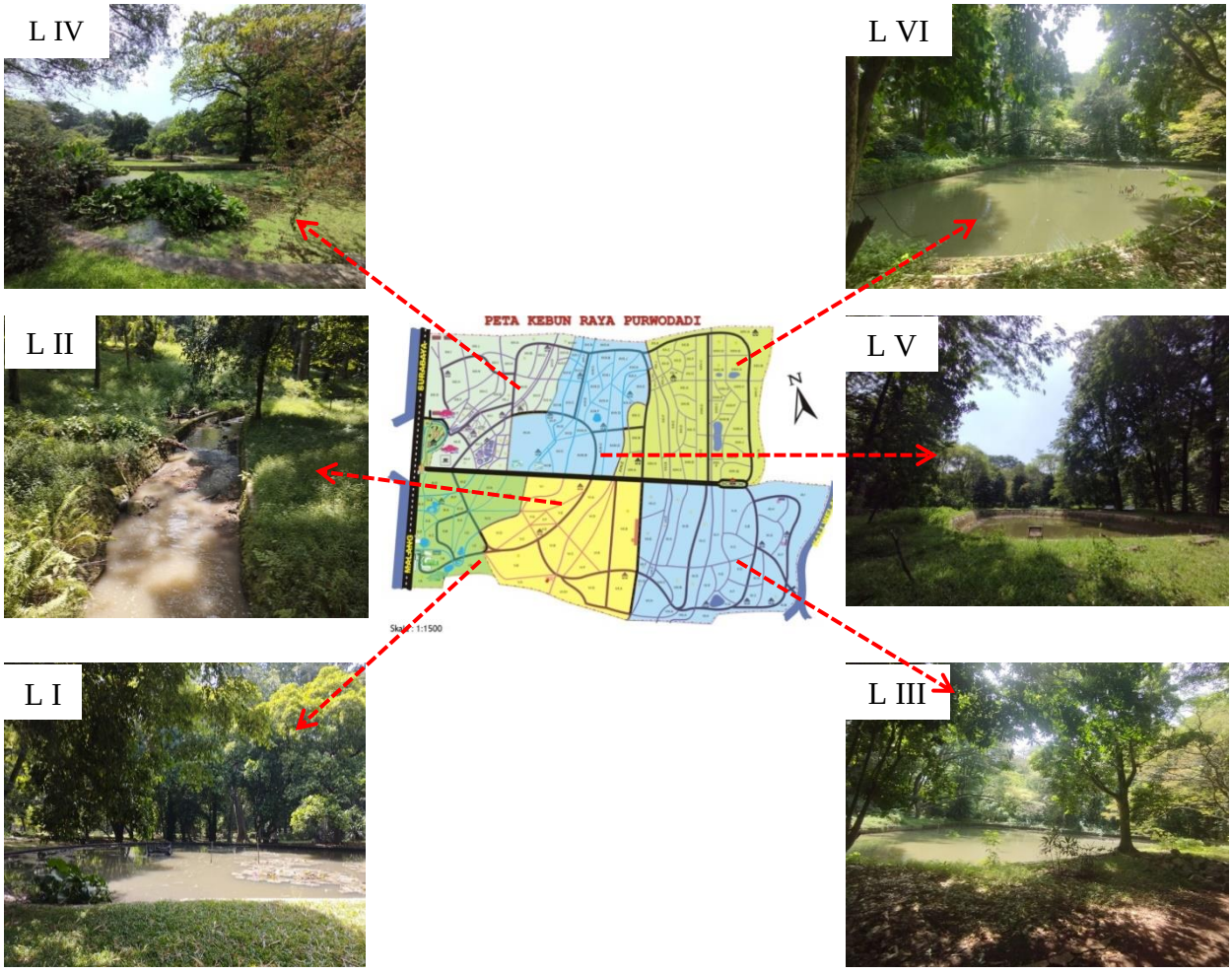

Figure 1. Map of Purwodadi Botanical Garden, Neighbourhood 1 **(LI)**, Neighbourhood 2 **(LII)**, Neighbourhood 3 **(LIII)**, Neighbourhood 4 **(LIV)**, Neighbourhood 5 **(LV)**, Neighbourhood 6 **(LVI)**.

Table 1. Dragonfly species and number of individuals found in Purwodadi Botanical Garden area.

Species Name	Environment						Species Total
	I	II	III	IV	V	VI	
Sub ordo Anisoptera							
Family Libellulidae							
Orthetrum sabina	14	11	25	8	-	-	58
Pantala flavescens	6	1	-	18	-	-	25
Crocothemis servilia	-	1	-	33	-	-	34
Diplacodes trivialis	13	-	-	-	-	11	24
Neurothemis ramburii	2	-	-	-	-	-	2
Zyxomma obtusum	-	-	-	6	-	-	6
Family Gomphidae							
Ictinogomphus decoratus	1	-	-	7	-	-	8
Sub ordo Zygoptera							
Family Platynemididae							
Copera marginipes	13	-	-	-	5	-	18
Family Chlorocyphidae							
Heliocypha fenestrata	7	27	10	1	24	8	77
Family Coenagrionidae							
PseudagrionpPruinosum	1	-	-	-	-	-	1
Family Euphaeidae							
Euphaea Variegata	2	-	-	-	-	-	2
Total	59	40	35	73	29	19	
Total number of individuals	255						

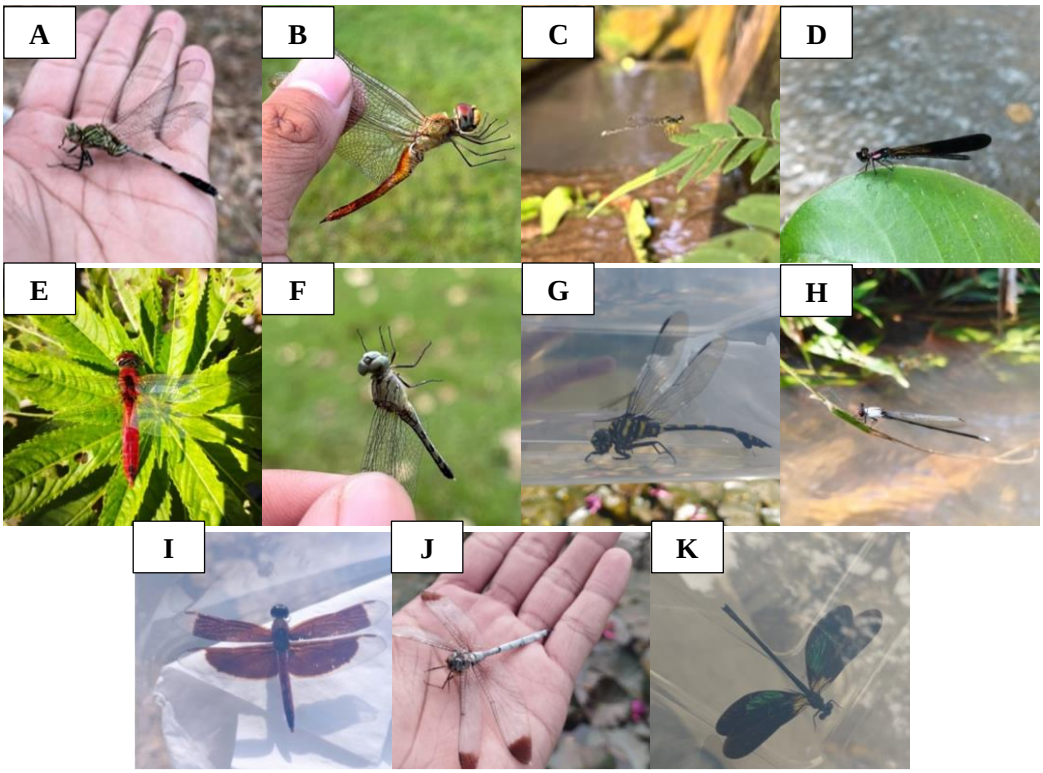

Figure 2. Dragonflies in Purwodadi Botanical Garden 2023
Description: (a) *Orthetrum sabina*, (b) *Pantala flavescens*, (c) *Copera marginipes*, (d) *Heliocypha fenestrata*, (e) *Crocothemis servilia*, (f) *Diplacodes trivialis*, (g) *Ictinogomphus decoratus*, *(h) Pseudagrion pruinosum*, (i) *Neurothemis ramburii*, (j) *Zyxomma obtusum*, (k) *Euphaea variegata.*

Table 2. Relative abundance index of Odonata in Purwodadi Botanical Garden.

Subordo	Species	KR Value (Relative abundance) (%)						Total
		I	II	III	IV	V	VI	
Anisoptera	*Orthetrum Sabina*	0.24	0.18	0.43	0.13	-	-	0.98%
	Pantala flavescens	0.24	0.04	-	0.72	-	-	1%
	Crocothemis servilia	-	0.02	-	0.97	-	-	0.99%
	Diplacodes trivialis	0.54	-	-	-	-	0.45	0.99%
	Neurothemis ramburii	1	-	-	-	-	-	1%
	Zyxomma obtusum	-	-	-	1	-	-	1%
	Ictinogomphus decoratus	0.12	-	-	0.87	-	-	0.99%
Zygoptera	*Copera Marginipes*	0.72	-	-	-	0.27	-	0.99%
	Heliocypha fenestrata	0.09	0.35	0.12	0.01	0.31	0.10	0.98%
	Pseudagrion pruinosum	1	-	-	-	-	-	1%
	Euphaea variegata	1	-	-	-	-	-	1%

Table 3. Dragonfly Distribution in Purwodadi Botanical Garden

No.	Species	s^2	Distribution
1	*Orthetrum Sabina*	1.390444	Organized
2	*Pantala flavescens*	0.912871	Organized
3	*Crocothemis servilia*	1.064581	Organized
4	*Diplacodes trivialis*	0.894427	Organized
5	*Neurothemis ramburii*	0.258199	Organized
6	*Zyxomma obtusum*	0.447214	Organized
7	*Ictinogomphus decorates*	0.516398	Organized
8	*Copera Marginipes*	0.774597	Organized
9	*Heliocypha fenestrata*	1.602082	Organized
10	*Pseudagrion pruinosum*	0.182574	Organized
11	*Euphaea variegata*	0.270801	Group

Tabel 4. Diversity and evenness of species Indeks

No.	Species	total	ni/N	lnni/N	
1	*Orthetrum sabina*	58	0.227451	-1.480820535	-0.336814082
2	*Pantala flavescens*	25	0.098039	-2.32238772	-0.227685071
3	*Crocothemis servilia*	34	0.133333	-2.014903021	-0.268653736
4	*Diplacodes trivialis*	24	0.094118	-2.363209715	-0.222419738
5	*Neurothemis ramburii*	2	0.007843	-4.848116365	-0.038024442
6	*Zyxomma obtusum*	6	0.023529	-3.749504076	-0.088223625
7	*Ictinogomphus decoratus*	8	0.031373	-3.461822003	-0.108606181
8	*Copera marginipes*	18	0.070588	-2.650891787	-0.187121773
9	*Heliocypha fenestrata*	77	0.301961	-1.197458123	-0.361585394
10	*Pseudagrion pruinosum*	1	0.003922	-5.541263545	-0.021730445
11	*Euphaea variegata*	2	0.007843	-4.848116365	-0.038024442
	Individual Total	255			
	Diversity Indeks	1.899	(medium)		
	Equity Indeks	0.791	(high)		

Based on the observation of dragonflies in Purwodadi Botanical Garden, the calculation of dragonfly species diversity index using the Shannon-Wiener formula. The index value of species diversity is used to determine and assess the stability of a community structure. It is said to be stable if a community structure has high biotic diversity. When biotic diversity is high, it will build a more complex food chain system that has the opportunity to create interactions between

organisms (Syarifah et al., 2018). The results of the calculation of the dragonfly species diversity index are presented in (Table 4).

The result of dragonfly species diversity in Purwodadi Botanical Garden is 1.8 in the range of 1 and 3, so it can be interpreted as moderate diversity (Marian and Oka, 2018). The diversity of dragonfly species in Purwodadi Botanical Garden is worth 1.8 which is still in the range of 1<H'<3 so it is included in the medium category. The value of the diversity index is due to habitat or environmental conditions in Purwodadi Botanical Garden is diverse, the more ideal the quality of an environment, the more dragonflies are found and the more polluted the environmental conditions, the fewer dragonflies are found. The evenness index of dragonfly species in Purwodadi Botanical Garden shows a value of 0.7 which means high evenness and stable community. Evenness that is close to 1 indicates that the condition of the species in Purwodadi Botanical Garden is heterogeneous, meaning that the natural resources supporting Odonata life are evenly distributed in all habitats (Magurran, 2004).

CONCLUSION

The diversity of dragonfly species in Purwodadi Botanical Garden is included in moderate diversity because it is in the range of 1<H'<3 with a value of 1.8. The evenness index of dragonfly species in Purwodadi Botanical Garden shows a value of 0.7 which means high evenness and stable community. The relative abundance of Odonata in Purwodadi Botanical Garden shows that dragonflies *Pantala flavescens, Neurothemis ramburii, Zyxomma obtusum, Pseudagrion pruinosum,* and *Euphaea variegata* are abundant species, which is closely related to their ability to adapt to environmental changes. The results of the calculation of the overall distribution of dragonflies are regular, except for Eupheaea variegata which has a clustered distribution, which means that the population distribution of individual dragonflies in the population is clustered.

AUTHORS CONTRIBUTIONS

Thanks to the Agrotechnology program at the Faculty of Agriculture, Veteran National Development University, East Java, and thanks to the National Innovation Research Agency (BRIN) for permission to conduct research at Purwodadi Botanical Garden.

REFERENCES

Abdillah, M. M., Prakarsa, T. B. P., & Tyastirin, E. (2019). Odonata diversity at Sumber Clangap and Sumber Mangli Puncu village sub district of Puncu district of Kediri. Jurnal Biodjati, 4(2), 236-243. DOI: https://10.15575/biodjati.v4i2.4823

Akbar, L.A. & Basukriadi, A. (2021). Diversity of dragonflies and damselflies in lakes of Universitas Indonesia, Depok, West Java. Journal of Physics: Conference Series, 1725(1): 012035. https://doi.org/10.1088/1742-6596/1725/1/012035

Ansori, I. (2009). Kelimpahan dan dinamika populasi odonata berdasarkan hubungannya dengan fenologi padi di beberapa persawahan sekitar Bandung Jawa Barat. *Jurnal exacta*, 7(2), 69-75. https://repository.unib.ac.id/id/eprint/538

Borror, D. J., Triplehorn, C. A., & Johnson, N. F. (1996). Pengenalan Pelajaran Serangga. Edisi Keenam. drh. Soetiyono Partosoedjono, MSc. Penerjemah.

Bruno, C. G. C., Gonçalves, R. C., Dos Santos, A., Facure, K. G., Corbi, J. J., & Jacobucci, G. B. (2022). The relationship between sediment metal concentration and Odonata (Insecta) larvae assemblage structure in Cerrado streams. *Limnetica*, *41*(1), 27-41.

Corbet, P. S. (1980). Biology of odonata. *Annual review of entomology*, *25*(1), 189-217.

Drury, D. (1770). *Illustrations of Natural History: Wherein are Exhibited Upwards of Two Hundred and Forty Figures of Exotic Insects, According to Their Different Genera... With a Particular Description of Each Insect: Interspersed with Remarks and Reflections on the Nature and Properites of Many of Them* (Vol. 1). author and sold.

Ilhamdi, M. L., Al Idrus, A. G. I. L., SANTOSO, D., & Hadiprayitno, G. (2020). Community structure and diversity of Odonata in Suranadi Natural Park, West Lombok Indonesia. *Biodiversitas Journal of Biological Diversity*, *21*(2).

Ilhamdi, M. L. (2018). Pola Penyebaran Capung (Odonata) di Kawasan Taman Wisata Alam Suranadi Lombok Barat. *Jurnal Biologi Tropis*, *18*(1), 27-33.

Irawan, A., & Rahadi, W. S. (2016). *Capung Sumba*. Balai Taman Nasional Manupeu Tanah Daru dan Laiwangi Wanggameti bekerja sama dengan Indonesia Dragonfly Society.

Ludwig, J. A., & Reynolds, J. F. (1988). *Statistical ecology: a primer in methods and computing* (Vol. 1). John Wiley & Sons.

Magurran, A. E. (2013). *Ecological diversity and its measurement*. Springer Science & Business Media.

Magurran, A. E. (2003). *Measuring biological diversity*. John Wiley & Sons.

Ningrum, L. W., & Retnosari, D. (2020). Monitoring Hama dan Penyakit Tanaman Dalam Perlindungan Koleksi Tanaman Di Kebun Raya Purwodadi. *Jurnal Tanah dan Sumberdaya Lahan*, *7*(2), 305-314. doi: https://doi.org/10.21776/ub.jtsl.2020.007.2.15

Odum, E.P. (1993). Dasar-Dasar Ekologi. Tjahjono Samingan (penerjemah).1993. Yogyakarta: Gadjah Mada University Press.

Orr, A. G. (2005). *Dragonflies of peninsular Malaysia and Singapore*. Sabah: Natural History Publications (Borneo), 2005.

Pahari, P. R., Mandal, S. S., Maiti, S., & Bhattacharya, T. (2019). Diversity and community structure of Odonata (Insecta) in two land use types in Purba Medinipur District, West Bengal, India. *Journal of Threatened Taxa*, *11*(6), 13748-13755.

Pamungkas, B. C., Nugrahani, M. P., & Makitan, T. T. (2016). Untring: dragonflies of Banyuwangi. *Yogyakarta: Indonesian Dragonfly Society*.

Pranoto, M. D. P., Mardiono, D., Widiyani, T., Pertiwi, R. A. P., Zhara, F. A., & Izzati, N. (2019). Diversity of dragonflies (Ordo: Odonata) on the natural reserve areas of Mt. Sigogor and Mt. Picis, Ponorogo District, Indonesia. *International Journal of Bonorowo Wetlands*, *9*(1).

Rahadi, W. S., Feriwibisono, B., Nugrahani, M. P., Dalia, B. P. I., & Makitan, T. (2013). *Naga terbang Wendit: keanekaragaman capung perairan Wendit, Malang, Jawa Timur*. Indonesia Dragonfly Society.

Rizal, S., & Hadi, M. (2015). Inventarisasi Jenis Capung (Odonata) Pada Areal Persawahan Di Desa Pundenarum Kecamatan Karangawen Kabupaten Demak. *Bioma: Berkala Ilmiah Biologi*, *17*(1), 16-20.

Saputri, D., & Dahelmi & Elza, S. (2013). Jenis-Jenis Capung (Odonata) Di Persawahan Masyarakat Rimbo Tarok Kelurahan Gunung Sarik Kecamatan Kuranji Padang. *Jurnal Mahasiswa Pendidikan Biologi STKIP PGRI Sumatra Barat*, *2*(2).

Setiyono, J., Diniarsih, S., Oscilata, E. N. R., & Budi, N. S. (2017). Dragonflies of Yogyakarta. *Jenis Capung Daerah Istimewa Yogyakarta, Indonesia Dragonnfly Society, Yogyakarta*.

Susanto, M. A. D. (2022). Diversity and composition of dragonfly (Odonata) at the Punden Sumur Bumi Area, Surabaya, East Java. *International Journal of Applied Biology*, *6*(2), 43-55.

Syarifah, E. B., Fitriana, N., & Wijayanti, F. (2018). Keanekaragaman capung (odonata) di taman mini indonesia indah dan taman margasatwa ragunan, dki jakarta, Indonesia. *Bioprospek: Jurnal Ilmiah Biologi*, *13*(1), 50-58.

Teristiandi, N., & Riyanto, R. (2021). The Abundance of Odonata Insect in Lebak Swamp, Bukit Baru, Palembang, Indonesia. *Jurnal Biologi Tropis*, *21*(1), 255-261.

Watson, J. A. L., & O'Farrell, A. F. (1996). The Insects of Australia, a Text Book for Students and Research Workers volume I.