Community structure of dragonfly (insecta: Odonata) in pond habitat at Sumur Panguripan Cultural Reserve, Surabaya, Indonesia

M A D Susanto, S Zulaikha, S Bahri, N F Firdausi* and E Tyastirin

Department of Biology, Faculty of Science and Technology, Universitas Islam Negeri Sunan Ampel, Surabaya, Indonesia

*Corresponding author e-mail: nirmala_firdausi@yahoo.com

Abstract. The Sumur Penguripan Cultural Reserve is an area of clean water wells in which there are two types of ponds, namely Canopied and Non-Canopied, with unspoiled environmental conditions. So, this area has potential as a natural habitat for the dragonfly community. The community of dragonflies at a location can be an environmental indicator, especially in waters, and also be used as a biological control for the terrestrial environment. This study aimed to report differences in the dragonfly’s structure community from the two types of canopy in the pond area of the Sumur Panguripan Cultural Reserve. This study uses the Visual Encounter Survey (VES) method was modified using the Belt Transect method. The results of a study conducted in this location found that there were 20 species from 4 families, with 294 individuals. The value of species diversity of dragonflies at non-canopied locations is $H' = 2.26$, highest than the value of species diversity of dragonflies at locations with canopied that is $H' = 1.87$. At the canopied pond location, there were eight species with 48 individuals from 3 families. Meanwhile, at the Non-canopied pond location, there were 18 species with 246 individuals from 3 families.

Keywords: Community Structure; Dragonfly; Canopied; Cultural Reserve.

1. Introduction

Sumur Penguripan Cultural Reserve administratively is located in Sumur Welut Village, Lakarsantri District, Surabaya, East Java, Indonesia. Sumur Penguripan Cultural Reserve is a clean water well area in which there are two types of ponds, namely Canopied and Non-canopied. The Sumur Penguripan Cultural Reserve, which has unspoiled environmental conditions with low environmental pollution, has the potential as a natural habitat for various species of dragonflies.

Dragonfly is one of the insects with a high level of diversity [1]. The number of dragonflies in the world (except at the North Pole) is estimated at 6000 species [2]. On the island of Java, 142 species were found [3], out of a total of 1,287 species in Indonesia [4]. The body structure consists of Cepals (Head), Thorax (Chest), Abdomen (Stomach), and has six limbs with a slender body [5;6]. The cephal (head) of the dragonfly consists of antennae, two large round compound eyes, and a chewing mouth type that has a toothed jaw on the lower labium, so it is scientifically classified in the Odonata group [7].

The community of dragonflies at a location can be an environmental indicator at that location, especially in waters [8]. This is because dragonflies have olfactory sensory nerves found in their antennae which act as detectors of chemical compounds in the environment [9]. In addition, in the

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ecosystem, dragonflies also have a role as a predator in the food chain for several tiny insects, one of which is mosquitoes [10]. So, that dragonflies can be used as biological control of the terrestrial environment because they can suppress the population of harmful insect species [11]. Dragonfly habitats include rice fields, plantations, forests and freshwater waters, including reservoirs, rivers, streams and ponds that can support the life cycle [12].

The community structure of the dragonfly in the ecosystem is influenced by various processes that occur in the environment and habitat of dragonflies, such as abiotic effects, competition, the level of distribution and colonization of various species [13]. Knowledge of the structure of the dragonfly community is very important to know the quality of the environment. This is because each dragonfly species has a different habitat selection, distribution, and colonization rate [14]. The lack of information about the structure of the dragonfly community, which is influenced by the different canopies in Indonesia, is the background of this study. The data got is expected to report differences in the dragonfly’s structure community from the two types of canopy in the pond area of the Sumur Ponograph Cultural Reserve as a form of conservation action in urban areas.

2. Study Sites and Methods

2.1 Time and Study area

We conducted this research in June and July 2021; each month, six days of observations were carried out with observation time at 08.00-16.00 WIB. In the Sumur Panguripan Cultural Reserve, Lakarsantril District, Surabaya, East Java, Indonesia, we conducted this research. At the location of the Panguripan Sumur Panguripan Cultural Reserve, it is divided into two observation locations based on differences in canopy conditions, namely Canopied Pond with coordinates (S7° 19’ 33.1 E112° 40’ 2.9) and Non-Canopied Pond (S7° 19’ 33.8 E112° 40’ 25.6).

![Map of located study](image)

**Figure 1.** Map of located study.

The tools used in this research are GPS, stationery, Thermohygrometer, Light Meter, cameras, watches, insect nets and identification books [15;16;17;18].

2.2. Methodology

The types of dragonflies observed were documented using a camera and identified. This study uses the Visual Encounter Survey (VES) method, commonly known as the direct observation method [19]. The VES method is carried out by tracing the observation locations that have been determined by recording the diversity of dragonflies' species and counting the number of individuals. Observations with the VES method in this study were modified using the Belt Transect method [20]. The belt transect method is an observation method by following a predetermined circular line. The dragonflies observed were documented using a camera and identified.
This study also measured microclimate factors comprising 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 canopy cover, ecosystem types and vegetation conditions described in narrative data.

2.3. Data analysis
The dragonfly data obtained was then analyzed for its diversity value using the Shannon-Wiener index based on [21] with the following formula:

$$H' = \sum \left( \frac{n_i}{N} \ln \frac{n_i}{N} \right)$$

Information:
- $H'$ = Shannon-Wiener Diversity Index
- $n_i$ = Total individuals belonging to the $i$ species
- $N$ = Total individuals of population

3. Results and Discussion
The results of observations made in the Sumur Penguripan Cultural Reserve Pond habitat type found that there were 20 species from 4 families comprising 13 species of dragonflies of Suborder Anisoptera and seven species of dragonflies Suborder Zygoptera. The number of individuals found was 294, and we found 48 in the canopied pond and 246 in the Non-Canopied pond (Table 1).

The value of the diversity index of dragonflies in the Sumur Panguripan Cultural Reserve Pond is $H' = 2.44$, showing the diversity value is classified as moderate. This figure shows that the environmental conditions in the Sumur Penguripan Cultural Reserve Pond are good enough to support the dragonfly's natural habitat. The value of dragonfly diversity in the Sumur Penguripan Cultural Reserve Pond is more excellent than the value of dragonfly diversity in the Suranadi Natural Park area, West Lombok Indonesia, namely $H' = 2.18$ [22]. While the value of dragonfly diversity in the Sumur Penguripan Cultural Reserve Pond is smaller than the diversity of dragonflies (Odonata) in the Lempake Dam Area, Samarinda, which is $H' = 2.85$ [23].

The value of species diversity of dragonflies at non-canopied locations, namely $H' = 2.26$, is highest than the value of species diversity at locations with canopied that is $H' = 1.87$. The main factors that caused differences in community structure, diversity and abundance of individual dragonfly species found in the two ponds were differences in canopy conditions and microclimate. The canopy is one of the main factors that make up the natural habitat for several dragonflies. Some types of dragonflies use a canopy to shelter from the high intensity of sunlight [9] and are used to rest [24]. The canopy also includes components that have an essential role in determining the diversity and richness of insect species as a source of dragonfly food [25;26].

The microclimate is a critical factor in supporting the survival of the dragonfly life cycle in its natural habitat [27]. The extreme microclimate will limit the activity of dragonflies [28]. The microclimate in a location consists of light intensity, temperature and humidity. Light intensity is one of the components needed in dragonfly ecology. Most dragonflies are active from morning to noon and only fly in sunny conditions [2]. Dragonflies will have been in activities such as foraging and research [29]. Light intensity is a parameter of weather and microclimate that most influences dragonfly flying activity [30].

Temperature and humidity can affect the natural habitat of small insects as the primary food for dragonflies. These two factors are These two factors of microclimate also affect the flying activity of dragonflies [28;30]. Dragonflies detect temperature and humidity by using the ability of flagella on their antennae [31]. The study of [32] reported that high temperature and low relative humidity would affect the displacement of dragonflies in flight, with the direction of displacement not detected. Temperature is a component that significantly influences the composition of dragonflies in a location [33]. While at low relative humidity will cause displacement of locations from low altitudes to higher altitudes [32].
Based on the microclimate measurements, these two locations have different microclimate values, which indicate that the humidity at Non-canopied (60.5 %) has a lower value than Canopied (66.3 %). Meanwhile, the temperature and Light intensity at Non-canopied (32.8 C and 16480 lux) are higher than Canopied (30.5 C and 4028 lux). The dense canopy and the number of trees on the edge of the Canopied Pond cause the increase in air temperature, and the intensity of the sunlight cannot reflect the air, so the humidity value in this location has a higher value. Meanwhile, the absence of a canopy in non-canopied ponds increases light intensity and air temperature [34].

Table 1. Amount of species dragonfly at Sumur Panguripan Cultural Reserve.

| Subordo & Famili | Spesies                  | Amount | Status Konservasi |
|------------------|--------------------------|--------|-------------------|
|                  |                          | Canoped | Non-canopied     |
| Anisoptera       | Ictinogomphus decoratus  | 2       | LC                |
| Gomphidae        | Acisoma panorpoides      | 8       | LC                |
| Libellulidae     | Brachythemis contaminata  | 71      | LC                |
|                  | Brachydiplax chalybea     | 7       | 62                |
|                  | Crocothemis servilia      | 6       | LC                |
|                  | Diplacodes trivialis      | 6       | 6                 |
|                  | Neurothemis feralis       | 18      | DD                |
|                  | Orthetrum sabina          | 17      | LC                |
| Potamarcha congner |                         | 3       | LC                |
| Rhyothemis phyllis |                          | 5       | LC                |
| Rhodothemis rafa |                         | 3       | 7                 |
| Tholymis tillargga |                         | 6       | 5                 |
| Zyxomma obtusum  |                         | 3       | NE                |
| Zygoptera        | Agriocnemis femina       | 11      | LC                |
| Coenagrionidae   | Agriocnemis pygmeaea     | 4       | LC                |
|                  | Ceriagrion praetermissum | 3       | 5                 |
|                  | Ischnura senegalensis    | 5       | LC                |
|                  | Pseudagrion nigrofasciatum| 4       | DD                |
| Platycnemididae  | Pseudagrion rubriceps    | 11      | 8                 |
|                  | Copera marginipes        | 13      | LC                |
|                  | Total                    | 48      | 246               |

Note: NE (Not Evaluated), DD (Data Deficient) and LC (Least Concern). Source: [35].
The canopied Pond is a pond habitat with a length of ± 7 m and a width of ± 3 m (Figure 4-A). This location has a closed canopy with many trees. Also on the edge of the Pond is dominated by grass. With the condition of the closed canopy at this location, it hampers they hamper the incoming light, and the air temperature is lower than in open places. Therefore, the diversity of dragonflies at this location is lower, and this is because dragonflies require sufficient light intensity to bask and find food. At the canopied pond location, there were eight species with 48 individuals, comprising three families, namely the Libellulidae, Coenagrionidae and Platycnemididae (Figure 5-A).

We found two species only in canopied ponds and not in non-canopied ponds, namely *Pseudagrion negrofasciatum* and *Copera marginipes* species. We only found both species in canopied ponds because this location has a closed canopy condition habitat type. This result is under [1] research, who reported that Pseudagrion negrofasciatum distributes in wet dune slack habitats with canopied areas. We often find this species in high-sunlight intensity habitats [1;17]. Meanwhile, the *Copera marginipes* species is in low-to-moderate light intensity [17].

Non-Canopied Pond is a pond habitat with a length of ± 15 m and a width of ± 12 m (Figure 4-B). Herbaceous plants and grass-dominated the edge of the non-canopied Pond and has an open canopy with few trees. On the edge of the Pond, there are also deadwood trunks to find many dragonflies sunning or just perching there. The condition of vegetation is not too dense, and the canopy is open, making this location a suitable habitat for the natural habitat of the diversity of dragonfly species. At the Non-Canopied Pond location, we found 18 species with 246 individuals, including three families, namely the Gomphidae, Libellulidae and Coenagrionidae families (Figure 5-B).
Twelve species spread in non-canopied ponds, namely *Ictinogomphus decoratus, Acisoma panorpoides, Brachythemis contaminata, Crocothemis servilia, Neurothemis feralis, Orthetrum sabina, Potamarcha congener, Rhyothemis phyllis, Zyxomma obtusum, Agriocnemis femina, Agriocnemis pygmeaea* dan *Ischnura senegalensis*. Species that are only found in canopied ponds because this location has an open canopy habitat type. We found the species only in non-canopied ponds, with species belonging to the Libellulidae family as a dominant of 8 species.

The family Libellulidae is the most frequently encountered group of dragonflies and is frequently abundant in many fresh or slightly brackish water [36]. The various striking patterns on their wings can recognize this group of dragonflies. The abdomen is broad and thin [17]. Members of this family are often very different, shape and colour, and the base of the hind wings is round in both sexes [37]. In all species, pterostigma pales in newly emerged males but becomes reddish, brown or black as they mature. Many members of the Libellulidae family have grey waxy powder on certain parts of their bodies. There are more than 1000 species in the world, and 51 of them exist on the island of Java [18].

Figure 4. Condition of environment at Sumur Panguripan Cultural Reserve A). Pond with Canopied, B). Pond Non-canopied.

Figure 5. Composition of Dragonfly Family A). Pond With Canopied, B). Pond Non-canopied.
The species of *Coepera marginipes* (Figure 6-A) is the species with the highest number of individuals in the canopied location with a total of 13 individuals. The male *Coepera marginipes* species has a thorax that is dominated by black with yellow markings. This dragonfly has a black abdomen and the last two segments to the appendage are white [15]. The species of *Coepera marginipes* has black compound eyes with clearly visible horizontal white lines and yellow legs which are characteristic of this species [18]. Adult female Coepera marginipes individuals have the same coloration as males with a more muted color. The young *Coepera marginipes* species are all white in color [15].

In this study, the species of *Coepera marginipes* was only found in canopied pond locations. This is because the canopied pond has a closed canopy condition and there are lower plants on the edge of the pond, making it a suitable habitat for the *Coepera marginipes* species. This is supported by [18], who reported that the *Coepera marginipes* species were commonly found in pond habitats with low light intensity. In addition, this species is also often found in shady places, rivers, ponds [38], calm flowing rivers and swamps [16]. *Coepera marginipes* species have a habit of perching on herbaceous plants, grass, or twigs [38]. This species is often seen flying from one plant to another in the air [18].

The *Diplacodes trivialis* species (Figure 6-B) is the species with the least number of individuals in the canopied pond location with 1 individual. The dragonfly *Diplacodes trivialis* has a relatively small body size [15]. The *Diplacodes trivialis* species is dominated by blue-gray in its entire body with male compound eyes that are dark blue on the top and light blue on the bottom [17]. This species is similar to the *Orthetrum sabina* species, but the *Diplacodes trivialis* species is much smaller [36]. The female Diplacodes trivialis species is greenish-yellow in color with a black abdomen starting at the 8th segment and a pale yellowish-blue synthora with black-brown stripes on the top and sides [15;36].

In this study, the species *Diplacodes trivialis* was found in the grass on the edge of the canopied pond. Canopied ponds have a closed canopy condition making this location less suitable for their natural
habitat, but the presence of lower plants on the edge of the pond makes Diplacodes trivialis still to be found. This is in accordance with [15], who reported that the Diplacodes trivialis species were mostly found in areas with vegetation and open canopies overgrown with grass. Diplacodes trivialis species can be found in grasses around waters, rivers and can have a distribution in the lowlands to highlands [3;36] and can be found almost all year round [39]. Dragonflies Diplacodes trivialis are often found perched on the ground and grass [40]. Dragonflies Diplacodes trivialis have a solitary habit of living often perched on soil surfaces, rocks, litter, grass and twigs [3;17].

The species Brachythemis contaminata (Figure 6-C) was the species with the highest number of individuals in the Non-canopied pond location with a total of 71 individuals. Brachythemis contaminata species include medium-sized dragonflies [15;18]. This species is dominated by orange and the males have bright orange wings, while the females are pale yellow [15]. Species Brachythemis contaminata male thorax and abdomen of this species is orange-brown in color and on the upper part of the abdomen there are thin and thickened black stripes. This species has yellowish brown compound eyes [18].

In this study, Brachythemis contaminata species were only found in Non-canopied pond locations. This is because the Non-canopied pond has a very open canopy condition, there are bottom plants on the edge of the pond and there are aquatic plants on the pond surface, making it a suitable habitat for Brachythemis contaminata species. This is in accordance with [3;15], who reported that the species Brachythemis contaminata can be found in open habitats on the banks of ponds, rivers, lakes and other calm waters. This dragonfly species has a high tolerance for disturbance, so it can still be found in polluted waters [41;15]. Brachythemis contaminata species have a habit of perching on aquatic plants or dry twigs above open water [18] and this species is always seen close to water [3].

The species Ictinogomphus decoratus (Figure 6-D) is the species with the least number of individuals in the Non-canopied pond location with the number of 2 individuals. The species Ictinogomphus decoratus is a dragonfly that includes a large body size [42]. Male species have a black thorax with a greenish-yellow line from the thorax to the abdomen [16]. The eyes are wide apart and grayish green in color [42]. The male species has an enlargement of the abdomen R8-R10 resembling a club and the tip with a pair of tapered tufts makes it look like a spear [18]. Black yellow male dragonfly head. Both wings are transparent with black pterostigma [17]. Females have the same color and pattern as males with a slimmer R8-R10 [17;18].

In this study, the species Ictinogomphus decoratus was found perched on a wooden branch on the edge of a canopied pond. Non-canopied ponds which have very open canopy conditions, make this location less suitable for their natural habitat. But this location which has a higher solar intensity makes Ictinogomphus decoratus species can still be found in sunbathing activities. Species Ictinogomphus decoratus are often found in flowing water locations and are usually found in the rainy season [17]. This species perches horizontally on the tip of a twig on the edge of a river or lake [16]. The species Ictinogomphus decoratus has a habit of basking in the morning before noon and occasionally flying fast to hunt for its prey. This species is often found perched on the ends of dry branches, tree trunks or bamboo. The range is wider than other species and is solitary [17;18].

4. Conclusion
At the canopied pond location, we found eight species with 48 individuals, including within three families, namely the Libellulidae, Coenagrionidae and Platycnemididae families. Meanwhile, at the Non-Canopied location, 18 species with 246 individuals, within three families, namely the Gomphidae, Libellulidae and Coenagrionidae families. The value of species diversity of the dragonfly at non-canopied locations is $H' = 2.26$, highest than the value of species diversity of the dragonfly at locations with canopied that is $H' = 1.87$.

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