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Diversity and Composition of Dragonfly (*Odonata*) at The Punden Sumur Bumi Area, Surabaya, East Java

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Abstract

The Sumur Bumi Punden is a location used for spiritual tourism. The Punden Sumur Bumi area has a stagnant aquatic ecosystem type and a low level of disturbance and pollution. Therefore, the Punden Sumur Bumi area has the potential to be a natural habitat for dragonflies. This study aims to determine the diversity and composition of the dragonfly community in Sumur Bumi Punden. This study uses the visual day-flying observation technique modified by the transect method. The Punden Sumur Bumi area has a moderate diversity index value, with a value of H' = 2.57. In the Sumur Bumi Punden area, 17 species were found with a total of 124 individuals, including the species with the highest relative abundance, namely *Brachythemis contaminata*. Meanwhile, the species with the lowest relative abundance was *Diplacodes trivialis*. The composition of dragonflies showed that the swamp location had the highest species richness and abundance values, namely 16 species and a total of 79 individuals. Meanwhile, the grassland location has the lowest species richness, namely only 5 species.

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Keyword
freshwater;
composition;
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Odonata

Introduction

Dragonflies are flying insects that in their adult phase live terrestrially (Choong et al., 2020), while dragonfly eggs and nymphs live aquatically (Kietzka et al., 2021). Before becoming terrestrial adults, dragonfly nymphs live aquatically for months to three years (Akhtar et al., 2021). Therefore, dragonflies are highly dependent on freshwater ecosystems (Akhtar et al., 2021; Thongprem et al., 2021). Dragonflies can be found in various freshwater ecosystems such as rivers, ponds, lakes, and swamps (Choong et al., 2020).

Dragonflies are predatory insects in all phases of their life cycle (nymphs and adults) (Thongprem et al., 2021). Dragonflies play an important role in maintaining the food chain in ecosystems, namely by controlling small insects, such as Orthoptera (Tephritidae, Acrididae, and Gryllidae) and Diptera (Culicidae, Muscidae, Chironomidae, and Tetrigidae) (Dalia & Leksono, 2014). Dragonflies also play a role as predators of disease-vectoring insects, such as mosquitoes (Samanmali et al., 2018). In addition, the diversity of species and composition of dragonflies can also be used as an indicator of the quality of an ecosystem's condition (Aziz & Mohamed, 2018). Several dragonfly species are sensitive to changes in environmental quality

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(Buczyński et al., 2020). Dragonfly diversity can decrease due to anthropogenic impacts such as habitat destruction, agriculture, and urbanization (Perez & Bautista, 2020).

The Punden Sumur Bumi is an area where there are wells or springs used for spiritual tourism activities. The Punden Sumur Bumi area is located near the industrial area and quite far from residential areas. This location is administratively located in Karangpilang District, Surabaya City. At the location of the Punden Sumur Bumi area, there are stagnant aquatic ecosystems, namely swamps and ponds, which can become dragonflies natural habitat. Besides that, there are also meadows, so the presence of grassy vegetation can provide a variety of small insects as dragonfly food. Therefore, the Sumur Bumi Punden area has great potential to become a natural dragonfly habitat. But in the Sumur Bumi Punden area, there is no research data on dragonflies. so that this research can become a source of new literature on the diversity and composition of dragonflies in the Sumur Bumi Punden area.

Materials and Methods

Time and Location Study

The research was conducted in October and November 2021, with two repetitions each month. This research was conducted at 8:00–11:00 a.m., which is the active time of dragonflies. The research was conducted in the Punden Sumur Bumi area, Warugunung Village, Karangpilang District, Surabaya, East Java, Indonesia. The research location was divided into three locations; each location has different habitat characteristics. The three locations are swamp, pond, and grassland.

Figure 1. The research location, (A) Swamp, (B) Pond, (C) Grassland

Data Collection

Data collection was carried out using the Visual Encounter Survey (VES) method. Data collection was carried out by recording the diversity of dragonfly species and the number of individuals at each predetermined location. The determination of the research path was carried out using the transect and belt transect methods. The transect method is an observation method by following a straight line (used at grassland location), and the belt transect method is an observation method by following a circular line (used at swamp and pond research locations). Data collection was carried out by capturing dragonflies using sweeping nets, and then each part of the body was documented in detail using a camera. Each individual that has been collected is then identified down to the species level. Identification of dragonfly species was based on morphological keys, including body color, wing pattern, abdominal color pattern, and tuft shape. The identification activity was carried out using a guidebook (Pamungkas, 2016; Setiyono et al., 2017). Data collection in this study also took into account abiotic factors consisting of air temperature, humidity, and light intensity. The temperature and humidity factors were measured using a thermohygrometer, and the light intensity factor was measured using a light meter.

Data Analysis

Dragonflies encountered during the study were analyzed using the relative abundance, diversity Index, dominance index, and evenness index. The following is a formula according to (Magurran, 1988):

Relative Abundance (RA)

$$RA = \frac{ni}{N} \text{ x } 100\%$$

Information:
RA = Relative Abundance
ni = Total individuals belonging to the i spesies
N = Total individuals of population

Diversity Index (H')

$$H' = \sum(pi\ In\ pi)$$

Information:
H' = Diversity index of Shannon-Wiener
pi = ni/N
ni = Total individuals belonging to the i spesies
N = Total individuals of population

Dominance Index (D)

$$D = \Sigma (pi)^2$$

Information:
D = Dominance index
pi = Proportion of each species
ni = Total individuals belonging to the i spesies
N = Total individuals of population

Evenness Index (E)

$$E = H'/ \ln S$$

Information:
E = Evennes index
H' = Diversity index
S = Number of spesies

The study also used multivariate principal component analysis (PCA) to determine the relationship between the study location, the biotic index, and abiotic factors. Next is to analyze the content of dragonfly compounds between research locations using the UPGMA cluster analysis method using the Bray-Curtis index. PCA and UPGMA analyses were performed using PAST 4.11 software.

Results and Discussion

Based on observations made in the Punden Sumur Bumi area, it was found that the diversity of dragonflies amounted to 17 species with a total of 124 individuals from 3 families, namely Gomphidae, Libellulidae, and Coenagrionidae (Table 1). Based on the results of relative abundance, it appears that the species with the highest value is *Brachythemis contaminata* (Figure 2A), with a value of 25.00% (Table 1). Meanwhile, the species with the lowest relative abundance value was *Diplacodes trivialis* (Figure 2B), with a value of 0.81% (Table 1).

Based on data from the International Union for Conservation of Nature (IUCN), the conservation status of species found in the Punden Sumur Bumi area are 15 species with low risk or Learn Concern (LC) status and 2 species with a data deficient conservation status (DD) (Table 1). Species that have DD conservation status are *Neurothemis feralis* and *Pseudagrion nigrofasciatum*.

The conservation status of least concern (LC) is a low-risk status, namely the status for species that are not endangered (Pradana et al., 2019). Least Concern (LC) conservation status is the status of an organism when it has been evaluated based on the Red List criteria and does not meet the requirements for Critically Endangered (CR), Endangered (EN), Vulnerable (VU), or Near Threatened (NT) (IUCN, 2021). Meanwhile, the conservation status of DD is the status of lack of data, namely the conservation status of species that do not have sufficient information to make an assessment of their extinction risk based on their distribution and population status. Species that fall into the DD category need to be studied further to obtain precise data on their abundance and distribution (IUCN, 2021).

Table 1. List of dragonfly species and conservation status

Family	Species	RA (%)	Swamp	Pond	Grassland	Status
Anisoptera						
Gomphidae	*Ictinogomphus decoratus*	2.42	+	-	-	LC
Libellulidae	*Acisoma panorpoides*	8.06	+	+	-	LC
	Brachythemis contaminata	25.00	+	+	-	LC
	Brachydiplax chalybea	5.65	+	+	-	LC
	Crocothemis servilia	4.84	+	+	+	LC
	Diplacodes trivialis	0.81	+	-	-	LC
	Neurothemis feralis	4.03	-	+	-	DD
	Orthetrum Sabina	11.29	+	+	+	LC
	Pantala flavescens	4.03	+	-	+	LC
	Potamarcha congener	4.03	+	+	-	LC
	Rhyothemis phyllis	2.42	+	+	-	LC
	Rhodothemis rufa	5.65	+	+	-	LC
Zygoptera						
Coenagrionidae	*Agriocnemis femina*	7.26	+	-	+	LC
	Agriocnemis pygmaea	1.61	+	-	-	LC
	Ischnura senegalensis	8.87	+	+	+	LC
	Pseudagrion nigrofasciatum	2.42	+	+	-	DD
	Pseudagrion rubriceps	1.61	+	-	-	LC

Information: RA = Relative abundance, (+) present, (-) absent. Conservation Status: DD (Data Deficient) & LC (Least Concern) (IUCN, 2022).

Figure 2. Species of Brachythemis contaminata (A) and Diplacodes trivialis (B)

The Shannon-Wiener Diversity Index in the Punden Sumur Bumi area has a value of H' = 2.57 (Table 3). These results indicate that the diversity of dragonflies at the location of the Punden Sumur Bumi area is classified as medium diversity, so in this study, it still has a fairly good environment and is in accordance with the natural habitat of various types of dragonflies. According to (Purnama et al., 2011), the higher the value of diversity in a location, the higher the complexity of the community, this is because in a community there will be more species interactions.

The evenness index in the Punden Sumur Bumi area shows a value of E = 0.77; this result shows that the evenness of dragonflies in the Punden Sumur Bumi area is quite high. This is in accordance with (Kelsubun & Warmetan, 2019), which state that if the value of the evenness index is greater than 0.6, the evenness is high. The evenness index is an index used to measure the balance of the individual components of each community and is used to describe the level of variation in the number of species (Nurafni et al., 2020). The evenness index value at a location will be higher if all species found have an even number of individuals (Setiadi, 2005). The Dominance Index in the Punden Sumur Bumi area shows a value of D = 0.10. This result indicates that the dominance of dragonflies in the Punden Sumur Bumi area is relatively low. A low dominance index value at a location indicates that the location has a fairly high species richness with an even distribution (Purnama et al., 2011).

The Punden Sumur Bumi area is a suitable location for the natural habitat of various types of dragonflies. This is due to the existence of stagnant aquatic ecosystems (swamp and pond) where various types of dragonflies are used to continue their life cycle, namely by laying eggs and becoming larvae in the waters. This is in accordance with (Laily et al., 2018), who reported that the egg and nymph phases of dragonflies live in water. As a result, adult dragonflies are rarely far from the water (Paulson, 2009; Pumungkas & Ridwan, 2015; Samways, 2008). Most of the life stages of dragonflies are in the water, so most types of dragonflies have their main habitat type in the aquatic ecosystem.

The diversity and abundance of dragonflies found in the swamp at Punden Sumur Bumi are mostly species that are commonly found in various types of habitats and have a fairly high tolerance for changes in environmental quality. This is because the location of the Sumur Bumi Punden Swamp is in an urban area, so the environmental quality is not very good but still allows it to be a natural habitat for various species of dragonflies. Therefore, the diversity of dragonflies found at the observation site is a type of dragonfly that has adapted to the urban environment and has a fairly low sensitivity to changes in environmental quality and disturbances from human activities.

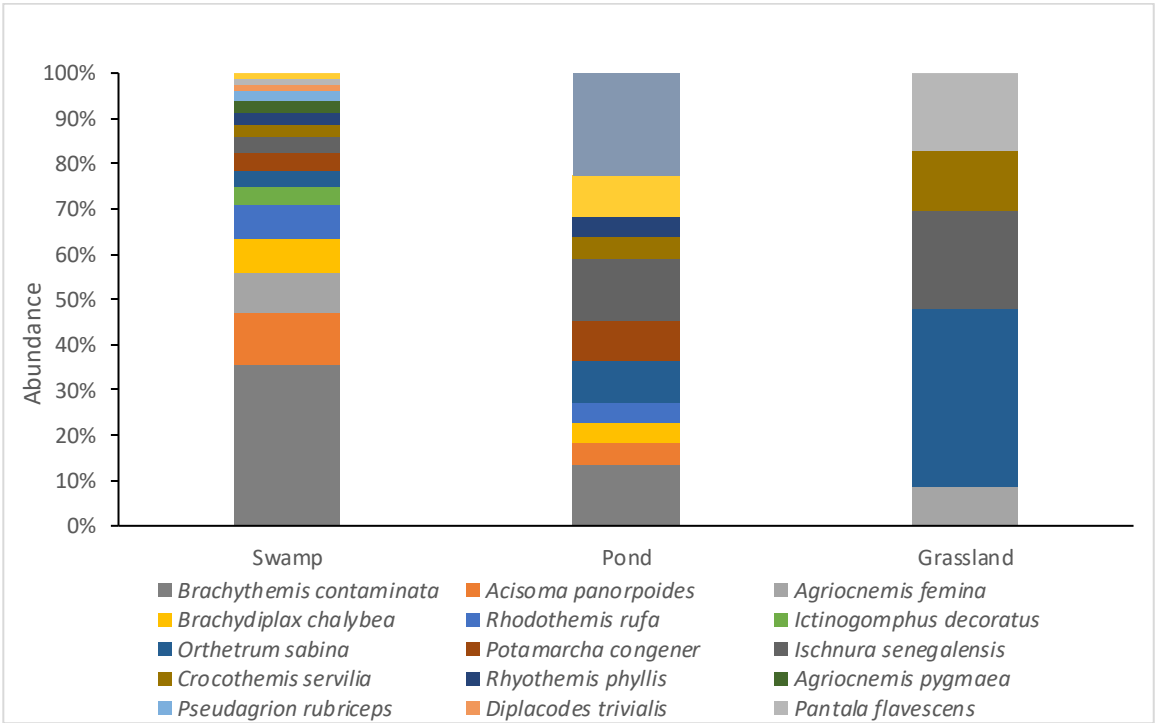

Figure 3. Abundance percentage at three research stations

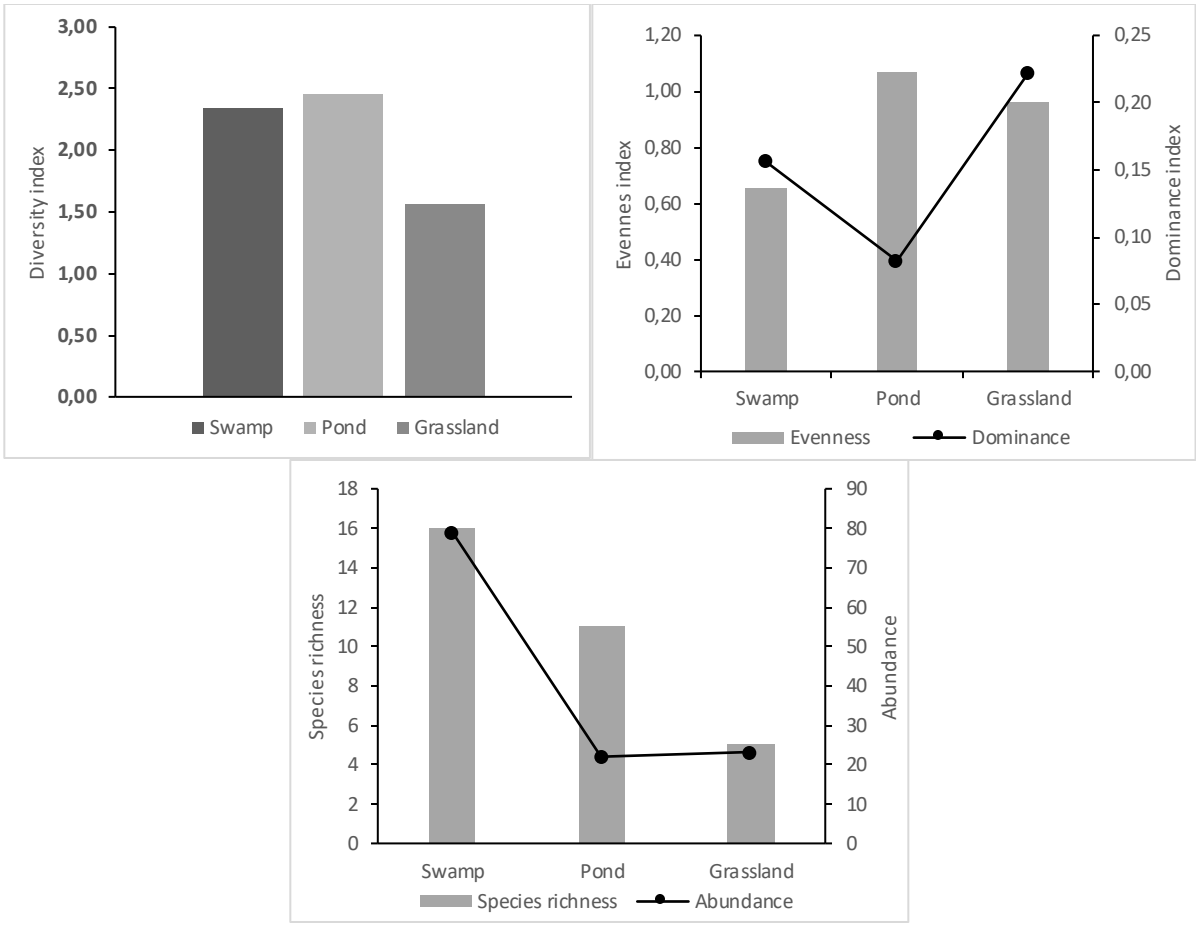

Figure 4. Result of diversity index, evennes index, dominance index, species richness, and abundance

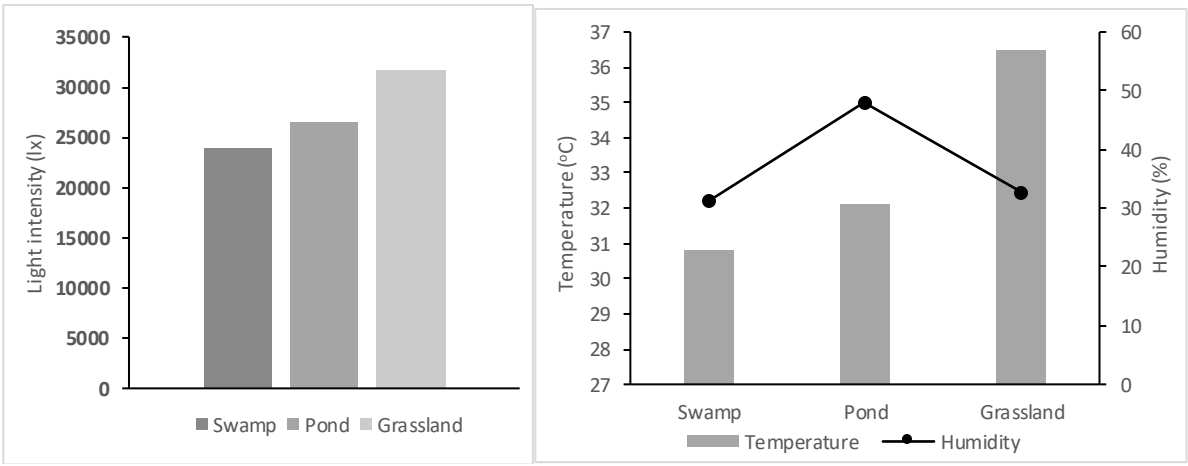

Figure 5. The results of measurements of light intensity, temperature, and humidity

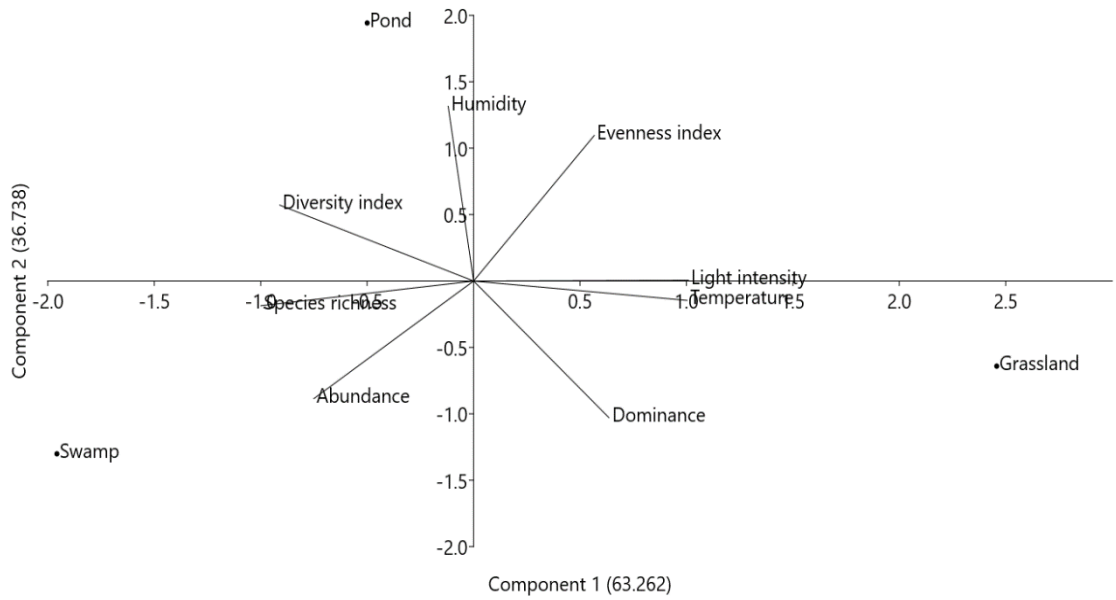

Figure 6. PCA ordinations of three locations

The results of PCA analysis regarding the relationship of abiotic and biotic factors to the community structure of dragonflies showed that the two main component axes contributed a total of 100% (Figure 9). The light intensity and temperature variables (abiotic factors) have a negative correlation with the species richness and diversity index variables (Figure 9). This indicates that the intensity of sunlight is too high at the study site, causing the value of species richness and the diversity index to be low. This can be because, generally, dragonflies will choose not to do activities such as sunbathing, flying, and looking for food if the intensity of sunlight is too high, but there are also certain species that can still carry out their activities.

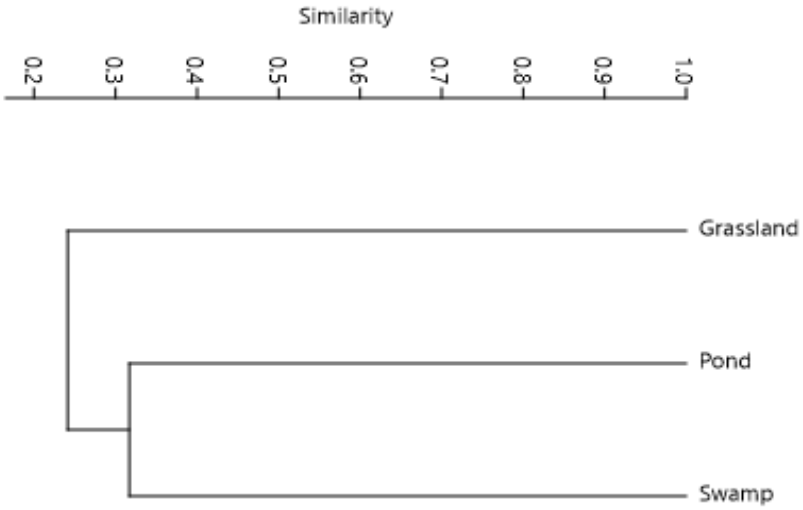

Figure 7. Level of similarity based on the composition of dragonflies

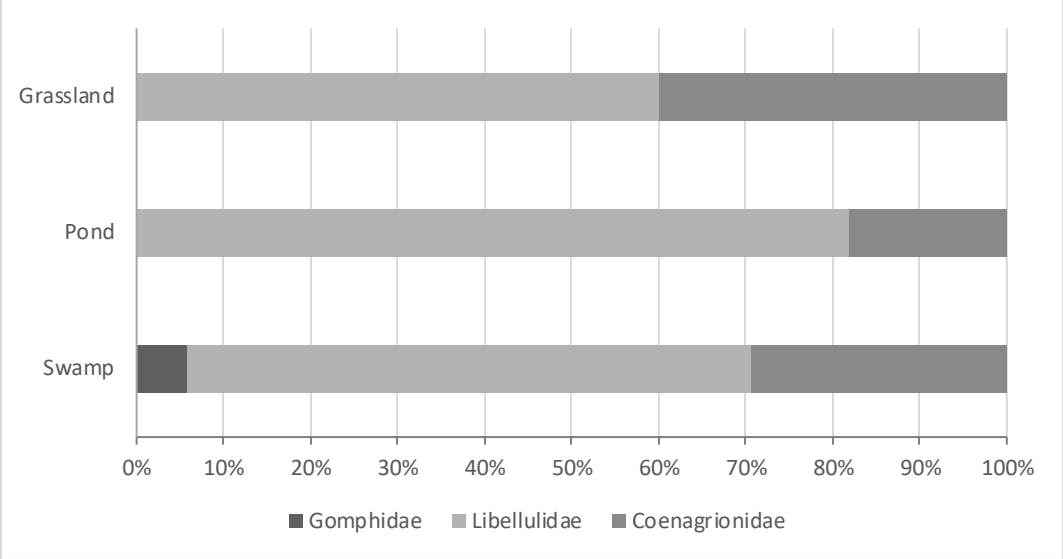

Figure 8. Differences in family composition

Based on the level of similarity of dragonfly composition, pond and swamp locations have the same composition (Figure 7). This could be because the two locations have similar ecosystem types, namely stagnant waters, so the composition of the dragonflies found also has similarities. There are 10 species that can be found in swamp and pond locations, which are *Acisoma panorpoides, Brachythemis contaminata, Brachydiplax chalybea, Crocothemis servilia, Orthetrum Sabina, Potamarcha congener, Rhyothemis phyllis, Rhodothemis rufa, Ischnura senegalensis*, and *Pseudagrion nigrofasciatum.*

The composition of the family at each study site was dominated by the Libellulidae family (Figure 8). The Libellulidae family is a very common dragonfly. This is because the Libellulidae family has a high flying ability and is strong in flight (Helmiyetti et al., 2019). The species *Brachythemis contaminata* was the most common species found at the study site. *Brachythemis contaminata* species are found in aquatic plant vegetation. This is in accordance with (Helmiyetti et al., 2019), who reported that *Brachythemis contaminata* species prefer waters with lots of vegetation around them. In addition, *Brachythemis contaminata* species can also be found in savannas and rice fields (Setiawan et al., 2019). *Brachythemis contaminata* Species is often found in locations with open canopy types (Susanto et al., 2022), and is often found perched on dry tree trunks (Wijayanto et al., 2016), aquatic plants (Susanto et al., 2022), ponds and streams in clean to polluted water conditions, so it can be said as a dragonfly that is tolerant of all water conditions (Kulkarni & Subramanian, 2013).

The location of the pond and grassland is a location that only consists of 2 families, namely the Libellulidae and Coenagrionidae families. The Swamp location is the research location with the most complete family composition compared to the other two research sites, which consist of the Libellulidae, Coenagrionidae, and Gomphidae families. There is only one species of the Gomphidae family found in the swamp, namely *Ictinogomphus decoratus*. The *Ictinogomphus decoratus* species at the study site was found in tree vegetation. This is in accordance with the study of (Susanto et al., 2022), who reported that the species *Ictinogomphus decoratus* was found on wooden branches near the edge of the canopied pond. In addition, *Ictinogomphus decoratus* species can also be found in rice fields, such as in bushes and grass (Ansari et al., 2016). The *Ictinogomphus decoratus* species is often found in locations with clean-flowing waters (Nisita et al., 2020) and is dominated by vegetation.

Conclusions

The Punden Sumur Bumi area has a moderate diversity index value with a value of H' = 2.57. In the Sumur Bumi Punden area, 17 species were found with a total of 124 individuals, including the species with the highest relative abundance, namely *Brachythemis contaminata*. Meanwhile, the species with the lowest relative abundance was *Diplacodes trivialis*. The composition of dragonflies showed that the swamp location had the highest species richness and abundance values, namely 16 species and a total of 79 individuals. The swamp and pond locations have a similar composition of dragonflies, this is because the two locations have a similar type of ecosystem, namely stagnant waters, and there are 10 species of dragonflies that can be found in both locations. The grassland location has the lowest species richness, namely only 5 species, this is because the grassland location has no water, and the grassland location has the highest temperature and sunlight intensity.

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