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Diversity of Zygoptera Dragonflies (Odonata) in the Kenjeran Pond, North Surabaya

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Abstract: Dragonflies (Odonata) are important bioindicators of aquatic ecosystem quality because their diversity and abundance are closely associated with environmental conditions and habitat stability. This study aims to determine the diversity of dragonflies of the order Odonata, suborder Zygoptera, in the Tambak Kenjeran area of North Surabaya. The research methods used were qualitative and quantitative, employing the time-search technique at two observation stations for one hour each, with three repetitions at the same time but on different days. Sampling was conducted with an insect net, and specimens were identified by morphological characteristics. The results showed that 86 dragonfly individuals were found, comprising two species: *Ischnura senegalensis* (Coenagrionidae) and Orthetrum sabina (Libellulidae). At Station 1, 46 individuals were found; at Station 2, 40. The most dominant species was *Ischnura senegalensis* with a total of 69 individuals, while *Orthetrum sabina* was found in 17 individuals. The diversity index values at Station 1 and Station 2 were 0.387212 and 0.588169, respectively, both classified as low. Low diversity index values indicate ecological stress and unstable ecosystem conditions in the pond area. This study is expected to provide information on dragonfly diversity and support efforts to conserve aquatic ecosystems in the Kenjeran Pond area. This confirms that the aquatic ecosystem in Kenjeran Pond is currently under stress and therefore requires serious attention in its management.

Keywords: Aquatic Ecosystem Conservation; Diversity Index; Dragonfly Diversity; Odonata.

Introduction

Dragonflies, as insects that play a vital role in ecosystems, serve as indicators of the surrounding environmental conditions [1]. Additionally, dragonflies act as predators to control pest populations, thereby maintaining the balance of the food chain [2]. With relatively large body sizes and diverse color variations, dragonflies have a slender body shape with two pairs of wings and six legs. Although they have wings, their ability to fly is limited [3]. Dragonflies belong to the class Insecta, a group of animals with high diversity that encompasses various orders, including Odonata, which are commonly found in aquatic habitats [4]. Within the order Odonata, dragonflies are divided into two main suborders, Zygoptera and Anisoptera, with thousands of species widely distributed across various aquatic ecosystems [5]. Dragonflies are found worldwide, particularly in tropical regions such as Indonesia, where various types of dragonflies can be found in forests, gardens, rice fields, rivers, urban environments, and at elevations exceeding 3,000 meters [6].

Previous research relevant to our study includes a study on dragonfly diversity around the Kali Pertambakan area in Bakaran Kulon, Juwana District [7]. The article highlights the diversity of dragonfly species in aquatic habitats, as well as their population status and development in those environments. Specifically, the article states that 110 dragonfly individuals were identified, divided into two suborders: Zygoptera and Anisoptera. The Suborder Anisoptera had the highest number of individuals, with 107 belonging to the family Libellulidae. The dominant species include *Crocothemis erythraea* (30 individuals), *Pantala flavescens* (68 individuals), *Orthetrum Sabina* (8 individuals), and *Diplacodes trivialis* (1 individual). Meanwhile, Suborder Zygoptera consists of only one family, the Coenagrionidae family, with 3 identified species. Pantala flavescens was the most frequently found dragonfly species in this study..

The location we selected for this study is a fish farm located in the Kenjeran subdistrict of North Surabaya. This area features extensive fish farms and a diverse array of wild plants along the edges of the ponds. At this site, there are more than 10 fairly large ponds, and a vast number of wild plants grow densely along the pond edges. Each pond contains a wide variety of farmed freshwater fish. We were interested in the dragonfly diversity in this area because of the possibility that a habitat rich in wild vegetation and close to water could serve as a habitat for various dragonfly species.

Unfortunately, despite the diversity of dragonfly species in the pond, no research has been conducted to determine the specific conditions of the species there in detail, including population size and species identification. The local community has not considered conducting research on the dragonflies in the pond because they view their abundance there as trivial. However, even though there are many dragonflies in the pond, it is important to note the population size of each species—whether it is sufficient, very abundant, or even nearing extinction. This study is expected to contribute to our knowledge, as no previous study has examined the dragonfly population in the Kenjeran Pond in detail. According to a previous study cited by [8], research conducted around the Kenjeran Pond focused on catfish farming.

The Kenjeran Fish Ponds possess distinctive environmental conditions as an urban aquatic ecosystem.

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The area consists of more than ten large ponds used for freshwater fish farming, with pond edges overgrown with dense wild vegetation. This vegetation serves as a semi-natural habitat for various organisms, including dragonflies [9]. Kenjeran Fish Ponds possess ecological uniqueness, as they represent a human-made ecosystem of ponds situated in the heart of a densely populated urban area, with brackish water [10]. These conditions differ from those in other extensively studied natural habitats, thereby conferring novelty to research conducted at this site.

The dragonflies found in Tambak Kenjeran demonstrate their ability to adapt to environments under pressure from human activities, while also underscoring their role as bioindicators of urban aquatic ecosystem health. Dragonflies play a vital role in maintaining ecosystem balance and also function as natural pest controllers. Dragonflies play a vital role in maintaining ecosystem balance [11]**.** High dragonfly diversity indicates that an ecosystem is in a stable and healthy condition [12].

The solution to the issue of dragonfly diversity in the region is to conduct research to identify the dominant dragonfly species and evaluate the status of their populations. Thus, the objective of this study is to provide a better understanding of dragonfly diversity in the Kenjeran pond area and to guide appropriate conservation measures. The research results are expected to assist biodiversity conservation efforts, particularly for dragonflies, and provide deeper insights into their ecology and populations in pond environments and other aquatic ecosystems.

Research Methods

This study was conducted in the Tambak area of Kenjeran Subdistrict, North Surabaya, East Java Province, from January to February 2025. The equipment and materials used in the study included insect nets, a dragonfly identification guide, writing utensils, a cell phone camera, tweezers, a board, pins, glass bottles, 1-ml pipettes, denatured alcohol, 70% alcohol, thick paper, and label paper.

This dragonfly research study employs both qualitative and quantitative methods, involving a series of steps to collect data on behavior, morphology, and environmental factors that influence the presence and abundance of dragonfly populations. The study site includes an artificial aquatic habitat, specifically, a pond selected for its biodiversity. In the Kenjeran Pond area, we divided the area into two stations for the study. Station 1 has many types of trees, such as noni. However, at Station 2, there are no trees; only dense, low-growing shrubs are present.

Next, a field survey was conducted to collect samples of adult dragonflies of various species. After capture, dragonfly specimens of different species were anesthetized with alcohol and then preserved by injecting 1 ml of alcohol into the ventral region to prevent decomposition. Species identification was performed using identification keys and expert consultation, while morphological observations were conducted using a paraffin board and by piercing the dragonfly's wings with a needle to facilitate the identification of morphological features: body length, wing shape, number of wings and legs, and the color of the eyes, thorax, abdomen, and ovipositor [13].

Picture 1. Research Location

This study employed the time-search method, which is a modification of the line transect method [14]. The difference is that observation stations were not limited by a specific distance or area, but rather by time, specifically, 1 hour per station; we used 2 stations. Observers were free to monitor the entire station during the designated time period. Counting begins when the first individual is seen or captured. Observations are conducted without any visual range limitations during dragonfly observations. When the first dragonfly is spotted, the observer records all identifiable individuals within the designated station. If the observer cannot identify the species seen, the individual must be captured for further identification. Observations are conducted along the observation route, with no distance restrictions during the activity.

The validity of the study was enhanced by conducting three repeated observations at each station, consistently during the daytime. These repetitions aimed to provide a more accurate picture of dragonfly activity on different days. In addition, environmental factors such as air temperature, humidity, light intensity, and vegetation conditions were systematically recorded during each observation to determine their influence on dragonfly diversity. Furthermore, the observation results were analyzed using the Shannon-Wiener diversity index formula.

Shannon-Winner Diversity Index Formula [15]:

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

Notes:
H : *Shannon-Winner* diversity index
ni : Number of individuals of species
N : Total number of individuals across all species

Results and Discussion

Based on research conducted at two different stations, 86 dragonflies were recorded, comprising: 2 species *(Ischnura senegalensis* and *Orthetrum sabina*), 2 genera (Ischnura and Orthetrum), 2 families (Coenagrionidae and Libellulidae), 1 suborder (Zygoptera), 1 order (Odonata), 1 class (Insecta), 1 phylum (Arthropoda), and 1 kingdom (Animalia).

Table 1. Data on the Diversity of Dragonflies (Odonata) and Damselflies (Zygoptera) at Two Stations.

No	Family	Species	Station		Number of Individuals
			1	2	
1	Coenagrionidae	*Ischnura senegalensis*	F = 14 M = 26	F = 11 M = 18	69
2	Libellulidae	*Orthetrum sabina*	6	11	17
		Total	46	40	86
		Diversity Index	0.3872	0.5882	

Description
F : Female
M : Male

The results of the study showed that at Station 1, 26 male *Ischnura senegalensis*, 14 female *Ischnura senegalensis*, and 6 Sabina dragonflies (*Orthetrum sabina*) were found. Meanwhile, at Station 2, 18 male *Ischnura senegalensis*, 11 female *Ischnura senegalensis*, and 11 rhinoceros dragonflies (*Orthetrum sabina*) were found.

The dragonflies studied comprised two species: *Ischnura senegalensis* and *Orthetrum sabina*. Physical identification was necessary to observe their differences and similarities. Both species share the common characteristics of having two pairs of wings and six legs (hexapods). In addition to these similarities, the two species have several differences. The main differences between them include physical aspects such as body size, eye structure, wing morphology, body characteristics, and flight behavior. *Ischnura senegalensis* tends to have a larger body and larger eyes compared to *Orthetrum sabina*. Furthermore, the wings of *Ischnura senegalensis* are differently shaped and wider than those of *Orthetrum sabina*. However, identification does not rely solely on physical differences but also involves observing their characteristic flight behavior. The flight behavior of *Ischnura senegalensis* is often faster and more aggressive, while *Orthetrum sabina* tends to have smoother and slower flight movements [4].

The morphology of *Ischnura senegalensis* differs significantly between males and females, reflecting their reproductive patterns and roles within the ecosystem. Male *Ischnura senegalensis* have relatively long and slender bodies, with a body length of approximately 2.5–3 cm. The male's head has a dark greenish-brown background, with a distinctive pale pattern, green eyes, and a pair of small antennae. The male's forewings feature black stripes forming geometric patterns, which aid in navigation and communication [16]. The male's hindwings have a more subtle pattern and are less conspicuous than the forewings. The male's body also features a pale green pattern with black lines forming a design, and its pale yellow tail bears a navy blue stripe [17].

Female *Ischnura senegalensis* have shorter and smaller bodies than males, with a body length of about 2–2.5 cm. The female's head has a light brown background with black stripes and small antennae. The female's forewings also feature geometric patterns that aid in navigation and communication, similar to those of the male. However, the female's hindwings have a more subtle pattern and are not as conspicuous as the forewings. The female's body is light brown with a black dorsal section accompanied by a white stripe, and a black abdomen [16].

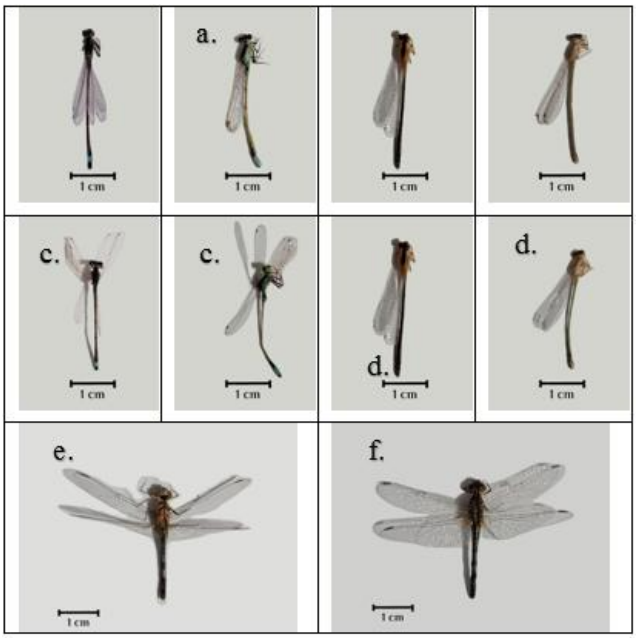
Orthetrum sabina, also known as the rhinoceros dragonfly, has several distinctive morphological characteristics, including wings measuring 2–2.5 cm. Its body is green with black markings; on its head are a pair of small antennae, and its eyes are brown. Its abdomen is greenish-yellow with black markings. This morphology makes *Orthetrum sabina* very similar to *Orthetrum serapia* [18].

A diversity index is a metric used to measure the level of diversity or species richness within a community or ecosystem [16]. There are several commonly used diversity indices, including the Simpson index, the Shannon-Wiener index, and the Margalef index [19]. The primary function of a diversity index is to provide information about the structure and complexity of a biological community. These indices help scientists and researchers understand the biological diversity of a region, evaluate ecosystem health, and compare diversity across locations or over time [20].

The diversity index (H') can be categorized as low, moderate, or high. It is considered high if H' > 3.0, low if H' < 1.0, and moderate if 1.0 < H' < 3.0 (Efendy & Elfamy, 2020). From the data in the table, it can be seen that Station 1 has a diversity index (H') of 0.387212, while Station 2 has a diversity index (H') of 0.588169, meaning both have low dragonfly diversity, which may indicate low productivity, a sign of severe ecological stress and an unstable ecosystem. Low diversity can be caused by several factors, including habitat degradation, pollution, and other ecological disturbances [21]. A decline in diversity reflects ecosystem instability and may also indicate low ecosystem productivity, due to heavy ecological pressure that reduces the environment's ability to support diverse life [22].

The results of this study were compared with a previous study [7] in Bakaran Kulon, which identified 110 dragonfly individuals, dominated by Pantala flavescens, indicating a more stable ecosystem than in Tambak Kenjeran. Another study [9] in an urban water area also reported higher dragonfly diversity at sites with dense tree vegetation. This comparison confirms that dragonfly diversity in Tambak Kenjeran is relatively low, likely due to the scarcity of tree vegetation and ecological pressures from human activities [23]. Additionally, environmental factors such as air temperature, humidity, light intensity, and water quality also play a significant role in influencing diversity [24]. Inappropriate temperature and humidity can suppress dragonfly activity; the lack of tree vegetation reduces perching and oviposition sites; and declining water quality due to pollution can hinder the larval life cycle [25]. The

combination of these factors reinforces the explanation for the low dragonfly diversity in Tambak Kenjeran.



Picture 2. a.) Male *Ischnura senegalensis* from Station 1; b.) Female *Ischnura senegalensis* from Station 1; c.) Male *Ischnura senegalensis* from Station 2; d.) Female *Ischnura senegalensis* from Station 2; e.) Ventral view of *Orthetrum sabina*; f.) Dorsal view of *Orthetrum sabina*

Conclusion

Based on the observation results, two species of dragonflies were found at the Kenjeran Pond at two different stations, namely *Ischnura senegalensis* and *Orthetrum sabrina*. At Station 1, 40 *Ischnura senegalensis* and 6 *Orthetrum sabrina* were found. At Station 2, 29 *Ischnura senegalensis* and 11 *Orthetrum sabrina* were found. Thus, it can be concluded that at both stations, the *Ischnura senegalensis* species was more abundant than *Orthetrum sabrina*. The observations also revealed low diversity indices: 0.37212 at Station 1 and 0.588169 at Station 2. Both stations exhibit low productivity, indicating severe ecological stress and an unstable ecosystem. The results of this study highlight the importance of preserving artificial water bodies such as fish ponds by planting trees, maintaining water quality, controlling pollution, and limiting human activities to ensure the ecosystem's balance is maintained, as trees and diverse vegetation provide dragonflies with places to land, seek shelter, and lay eggs, thereby enhancing biodiversity, while dragonflies themselves serve as natural bioindicators reflecting water and environmental quality, where a decline in their numbers signals ecosystem degradation and forms the basis for planning appropriate conservation efforts.

Author's Contribution

I. Alfiati: conceptualization of the research, data collection, and data analysis; R.D. Nabiilah: conceptualization of the research and data collection.

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