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Diversity of Dragonfly (Odonata) at the Imam Nahrawi Stadium UIN Kiai Haji Achmad Siddiq Jember

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ABSTRACT

This research aims to determine the diversity of dragonflies in the Imam Nahrawi stadium of UIN Kiai Haji Achmad Siddiq Jember. This stadium is an open space full of green grasses. It borders the bedadung river in the south to the west. There are shurbs to trees and there is a mound to the north of the stadium. The design of this research is descriptive exploratory with sampling in two parts, namely the edge of the stadium and the center of the stadium. Sampling is carried out in June 2022, using the field-by-field method at the specified location. The obtained-dragonflies are identified by morphological characteristics and counted by the Shannon-Wiener diversity index formula. The results show that there are 6 types of dragonflies that live in the Imam Nahrawi stadium, including *Orthetrum sabina*, *Pantala flavescens*, *Diplacodes trivialis*, *Potamarca congener*, *Haliocypha fenestra* dan *Copera marginipes* with a diversity index of 1,114. It shows that diversity of dragonflies around the Imam Nahrawi stadium is moderate.

Keywords: diversity, dragonfly.

INTRODUCTION

Indonesia is known as a country that has very high biodiversity in the world. This biodiversity includes the diversity of flora (plants) and fauna (animals) spread throughout Indonesia. In the invertebrate animal group, the arthropod phylum dominates 80% of the total fauna diversity, and 60% of them are insect class. Among these insect class, in Indonesia the order Odonata, that is known as dragonfly, has a diversity level of 15% of the total number of dragonflies in the world (Widjaja *et al*., 2014).

Dragonfly in Indonesia is estimated to number 1.287 species. 500 species of them are found in the Great Sunda region (a group of islands in western Indonesia). Based on data from Lipi's research in 2014, Java island has 174 dragonfly species diversity, Kalimantan island has 283, Sulawesi island has 200 and Sumatera island has 263. However, the number of Indonesian endemics has not been recorded perfectly and is still known as many as 24 species *(Widjaja et al*., 2014).

The existence of dragonfly is highly dependent on the aquatic ecosystems because it is related to their life cycle. Waters are the place used by dragonflies to lay their eggs until they turn into nymphs. The nymph form is the longest period in the life cycle stage of dragonfly in the water. Good quality water is a comfortable place for dragonfly nymphs, therefore dragonfly can be used as bioindicators of waters (Meidyna Putri *et al*., 2019). Besides having a relationship

with waters, dragonfly is also related to vegetation cover. In this case, the dragonfly that lives in open area tends to have different types of that lives in closed area (Buchori *et al*., 2019).

Based on the observation result, the researcher found that there were large number of dragonflies flying at the Imam Nahrawi stadium on January 3, 2021, that had been catching attention of the participants of the Ministry of Religion Charity Day ceremony (HAB) at the time. He saw that those flying dragonflies are classified into sub-order of Anisoptera, but he could not identify the number of species. The presence of dragonfly in large numbers at Imam Nahrawi Stadium is assumed first to be due to its location next to the Bedadung river.

Bedadung river is the largest river in Jember regency. Fahri (2019) have identified the diversity of dragonflies in the upper, middle and lower reaches of the Bedadung river. He have revealed that there found 7 species of dragonflies from 3 families (Libelliludae family, Clorocyphidae family and Platycemididae family) in the vicinity of the Bedadung river. The total number of individuals from the found-dragonflies have been 245 individuals with a moderate level of diversity. It means that the Bedadung river is in good condition with the quite balanced ecosystem (Fahri, 2019). In line with Fahri, Novita have also said that the water quality of the Bedadung river, which passes through the activity center of the urban area of Jember, is in good condition based on the load value of its pollution load-bearing capacity (Novita *et al*., 2020). Thus, the diversity of dragonflies around the Imam Nahrawi stadium is pre-assumed to have a medium level of diversity.

Because of the most important information about the environment quality and the diversity of dragonfly at the Imam Nahrawi stadium having not been available yet, it becomes interesting for the researcher to conduct research about it. The research hopefully presents the diversity of dragonfly at the area of UIN KHAS Jember, especially at the Imam Nahrawi stadium and the point of Bedadung river next to it. The research is also hopefully able to provide an overview of the ecosystem quality at the stadium and its surroundings based on natural indicator in a natural bioindicator in aquatic and terrestrial ecosystems around the stadium, as what Klym and Quinn (2003) in (Sonia *et al*., 2022) said that a decrease in the number of dragonflies in an area indicates the change in water quality and the environment. Overall, the research is expected to provide information in the form of dragonfly diversity data for being able to use to the interests of the campus in particular and the residents around the campus in general.

METHOD

This research uses an exploratory descriptive research design. In this case, it deeply describes the identification result of the obtained-dragonflies from the Imam Nahrawi stadium of UIN KHAS Jember based on their characteristics and diversity. Imam Nahrawi stadium is chosen as the research location because this stadium is one of the unique deltas formed the Bedadung watershed, which is known as the largest watershed in Jember regency (Santoso *et al*., 2010). The water that flows along the upper, middle and lower reaches of the Bedadung river is utilised by local residents to fulfil domestic needs, agricultural and plantation areas, livestock, industry and tourism (Kustiawan Alfarisy *et al*., 2023). In addition, the Imam Nahrawi stadium of UIN KHAS Jember as one of the campus open areas adjacent to the mound as a campus green

park is an important factor in supporting ecosystem stability. The relatively good condition of the ecosystem on campus is evidenced by the number of dragonflies flying around Imam Nahrawi stadium every morning and evening. The results of the researcher's observation show that the Bedadung river locating in the south to the west of Imam Nahrawi stadium is the place for laying eggs as well as the breeding ground for dragonfly nymphs. Meanwhile, the open area of the Imam Nahrawi stadium is utilised by dragonflies to get enough sunlight in order to strengthen their muscles. Furthermore, there so many small insects living and breeding in campus mound locating in the north of the stadium become source of sufficient food availability for dragonflies.

This research uses the field-by-field method as a sampling technique, in which researchers travel to capture some dragonflies at the specified location. Exploration in taking dragonfly samples is carried out in two locations, namely (1) the center of the stadium and (2) the edge of the stadium, which includes the riverbank to the edge of the stadium with lush trees. This sampling is carried out in June 2022 for 7 times every at 08.00-10.00 WIB.

The caught-dragonflies at this range site as research samples is treated carefully and thoroughly with several practical steps. Firstly, the dragonfly that has just been caught is immediately captured with a mobile phone camera for documentation purpose. Secondly, the dragonfly is then put into triangular paper to maintain the condition of the wings. Thirdly, the dragonfly is immediately preserved with acetone liquid for 6-8 hours. The fourth step is the observation of dragonfly morphology and identification of dragonflies up to the species level. During sampling process, researchers count the total number of obtained-dragonflies and also separate the count of dragonflies while sorting out the types of dragonflies based on the place they are caught. The calculation of Odonata species diversity index is done by using the *Shannon-Wiener* formula (H').

$$H' = -\sum pi \; In \; pi$$

Information: *H'* = index Shannon-Wiener

Pi = the proportion of individuals found in species I (Magurran, 2021)

The Shannon-Wiener diversity index criteria can be seen in table 1 below.

Table 1. Criteria for the value of H' According to (Magurran, 2021s)

Criteria	**Indicator**	**Information**
Low diversity	$H' < 1$	Low diversity and very low productivity of dragonfly indicates the heavy ecological pressure and unstable ecosystem.
Moderate diversity	$1 < H' < 3$	Moderate diversity and sufficient productivity of dragonfly indicates the moderate ecological pressure and fairly balanced ecosystem conditions.
High diversity	$H' > 3$	High diversity and high productivity of dragonfly shows the resistance toward ecological pressure and stable ecosystem stabilities.

RESULT AND DISCUSSION

Based on the results of data collection at the Imam Nahrawi stadium carried out during June 2022, researchers have found 6 species of the Odonata orders, namely *Orthetrum sabina*, *Pantala flavescens*, *Diplacodes trivialis*, *Potamarca congener*, *Haliocypha fenestra*, *Copera marginipes*. The researchers also present a tally of 6 Odonata order species based on the place they are caught, namely those captured at the edge of the stadium and those captured at the center of the stadium. The identification results of the six types of Odonata order species can be seen in Table 2.

Table 2. The result of the identification of the type of dragonfly at the Imam Nahrawi Stadium

No	Suborder	Family	Species	Amount of Dragonflies		Total
				Edge	Center	
1	Anisoptera	Libellulidae	*Orthetrum sabina*	182	14	196
2	Anisoptera	Libellulidae	*Pantala flavescens*	11	48	59
3	Anisoptera	Libellulidae	*Diplacodes trivialis*	2	0	2
4	Anisoptera	Libellulidae	*Potamarca congener*	0	1	1
5	Zygoptera	Chlorocyphidae	*Haliocypha fenestra*	6	0	6
6	Zygoptera	Platycnemididae	*Copera marginipes*	28	0	28
		Total amount		229	63	292

The results of dragonfly species identification at the Imam Nahrawi stadium as presented in the Table 2 above show that there are differences in the number and types of dragonflies found between those captured at the edges of the stadium and those captured in the center of the stadium. Those captured-dragonflies at the edge of the stadium are 229 individuals with five species, namely *Orthetrum sabina, Pantala flavescens, Diplacodes trivialis, Haliocypha fenestra and Copera marginipes*. It is in contrast to the dragonflies captured in the center of the stadium, which are 63 individuals with three species, namely *Orthetrum sabina, Pantala flavescens* and *Potamarca congener*. The center of the stadium only has grass plants with sufficient sunlight. This condition is very supportive of the existence of dragonflies belonging to the sub-order Anisoptera, the majority of which are large, have strong muscles and wide range. Meanwhile, the edge of the stadium has shadier conditions because the plants that grow are not only grasses but also herbaceous plants, shrubs and trees. These conditions provide a source of food for dragonflies as well as shelter, making it possible for all types of dragonflies to reside in this area. The stadium edge area is also very favorable for dragonflies of the Zygoptera sub-order, which have a slender body size with a narrow range. These are some reasons why dragonfly species at the edges of the stadium are more varied.

The classification, pictures and descriptions of the dragonflies found around the Imam Nahrawi stadium are described as follows.

Classification
Fillum : Arthopoda
Class : Insecta
Order : Odonata
Sub Order : Anisoptera
Family : Libellulidae
Genus : Orthetrum
Species : *Orthetrum sabina*

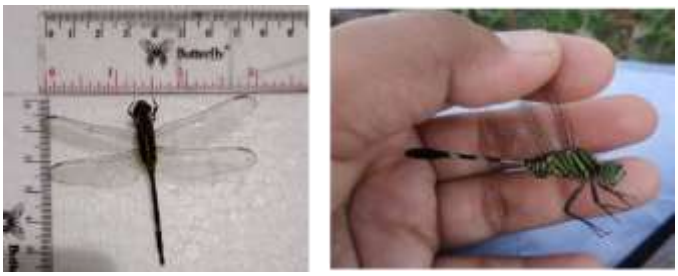

Figure 1. *Orthetrum sabina*
(Source: personal documentation)

Description: It's classified as a large dragonfly with an average body length of 5 cm. It has compound eyes with a pale green color, green thorax with black lines, green and black abdomens. Abdomen in segments 1-3 enlarges with green and black lines. Abdomen in segments 4-6 is slender in shape with green interspersed with black lines. Abdomen enlarges again in segments 7-10 with black color. The appendage that is located at the end of the abdomen is white. The wings are transparent with black venation and brown wing venation. The length wing venation is averages 7 cm and the pterostigma is brownish.

Classification
Fillum : Arthopoda
Class : Insecta
Order : Odonata
Sub Order : Anisoptera
Family : Libellulidae
Genus : Pantala
Species : *Pantala flavescens*

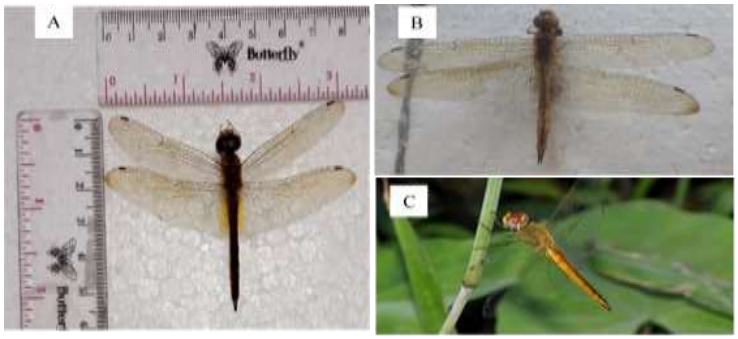

Figure 2. *Pantala flavescens*
(Source: A-B: personal documentation, C: (Andi & Rahadi, 2018)

Description: It's classified as a large dragonfly with an average body length of 5,5 cm. the thorax and abdomens are yellowish brown with black thin lines. It has a round head shape with yellowish-brown compound eyes. The upper abdomen is black strip and there is a black patch at the end of the abdomen. The wings are transparent with yellowish venation and the base of the wings is yellowish. While pterostigma is orange. The wing venation has an average length of 8 cm (Figure 2).

Classification
Fillum : Arthopoda
Class : Insecta
Order : Odonata
Sub Order : Anisoptera
Family : Libellulidae
Genus : Diplacodes
Species : *Diplacodes trivialis*

Figure 3. *Diplacodes trivialis*
(Source: personal documentation)

Description: It's classified as a small dragonfly with an average body length of 3,1 cm. The thorax and abdomens are yellow-green with thin black lines. The head is rounded with greenish-brown compound eyes. Abdomen in the 7-10th segment is black with white appendage at the very end of the abdomen. It has transparent wings with black venation. While the pterostigma is yellowish. The wing venation has an average length of 3 cm. (Figure 3).

Classification
Fillum : Arthopoda
Class : Insecta
Order : Odonata
Sub Order : Anisoptera
Family : Libellulidae
Genus : Potamarca
Species : *Potamarca congener*

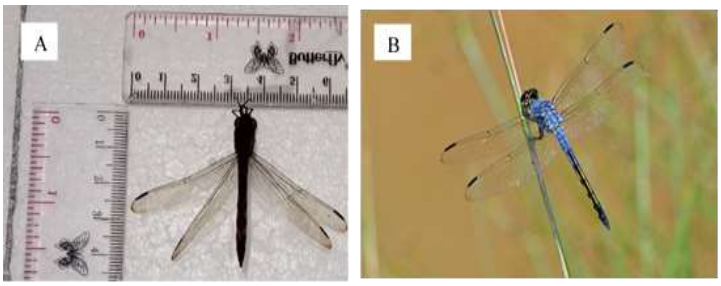

Figure 4. *Potamarca congener*.
(Source: A. personal documentation, B. Andi & Rahadi, 2018)

Description: It's classified as a medium-size dragonfly, with an overall body length of 4,5 cm. Thorax and abdomen in segments 1-4 are dark blue, while the abdomen in segments 5-8 are black with orange longitudinal lines. The abdomen in the 9-10th segment is black and there is a black appendage at the end. It has transparent wings with black venation. The size of the wings with black venation is up to 7 cm and the pterostigma is black (Figure 4).

Classification
Fillum : Arthopoda
Class : Insecta
Order : Odonata
Sub Order : Zygoptera
Family : Chlorocyphidae
Genus : *Heliocypha*
Species : *Heliocypha fenestrata*

Figure 5. *Heliocypha fenestrata*.
(Source: A. personal documentation, B. Bahasa et al., 2002)

Description: *Heliocypha fenestrata* has an average body lenght of 3 cm. Thorax of the female damselfly is brownish and yellow. It has the colour dark brown of abdomen with thin yellow lines on the side of the abdomen in segments 1-5. It has transparent brown wings with iridescent reflections when exposed to sunlight. It has a broad head shape with brown compound eyes. While the thorax in male damselfly is black with light blue and pink markings. Abdomen has completely black colour except for light blue lines on segments 1-5. It has black-coloured wings with pink colour reflections when exposed to sunlight. The head of it is broad with compound eyes coloured black. The wings of it have an average venation length of 2.95 cm and are longer than the abdomen (Picture 5).

Clasification
Fillum : Arthopoda
Class : Insekta
Order : Odonata
Sub Order : Zygoptera
Family : Platycnemididae
Genus : *Copera*
Species : *Copera marginipes*

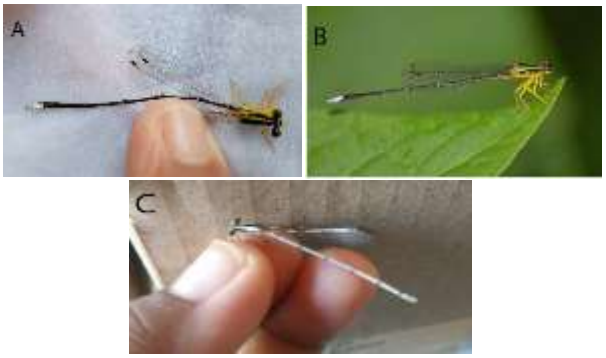

Figure 6. *Copera marginipes*.
(Source: A & C. personal documentation, B. Buchori *et al*., 2019)

Description: *Copera marginipes* has an average body lenght of 3,7 cm. The adult male damselfly has a black thorax with yellow lines. The colour of its feet is bright yellow. The abdomen is black with white lines between the segments. The last segment up to the embellishment has a white colour. The entire body of its young female has white colour which is separated by black lines on the segments (Picture 6).

All of the dragonflies which are caught at the Imam Nahrawi stadium are classified to species level before being recorded. Furthermore, researchers calculate the diversity index of each dragonfly species by using the Shannon-Wiener formula (H'). The results of the diversity index calculation are shown in the Table 3 below.

Table 3. Dragonfly Species Diversity Index at Imam Nahrawi Stadium

No	Spesies	Jumlah	Proporsi (pi)	In (pi)	H'
1	*Orthetrum sabina*	196	0.760	-0.28	0.21
2	*Pantala flavescens*	59	0.229	-1.47	0.34
3	*Diplacodes trivialis*	2	0.008	-4.83	0.04
4	*Potamarca congener*	1	0.004	-5.81	0.02
5	*Heliocypha fenestrata*	6	0.021	4.51	0.09
6	*Copera marginipes*	28	0.096	4.51	0.43
Total amount		292	1	-12,4	1,114

Information: *H'* = index *Shannon-Wiener*
Pi = proportion of individuals found in species 1st

Table 3 above shows that Odonata species diversity index at the Imam Nahrawi stadium is 1,114. It proves that the diversity of Odonata at the Imam Nahrawi stadium has medium diversity level.

Based on the results of the research on dragonflies around the Imam Nahrawi stadium, researchers have discovered 6 species of dragonflies. Four of them belong to the sub order anisoptera, including *Orthetrum sabina, Pantala flavescens, Diplacdes trivialis* dan *Potamarcha congener*. While the other two of them belong to the sub order zygoptera, namely *Heliocypha fenestra* and *Copera marginipes*.

The most captured dragonfly species are *Orthetrum sabina* with 196 individuals. This species of dragonfly is found at the periphery and the center of the stadium. *Orthetrum sabina* is a dragonfly that is very abundant because it has a very wide distribution and is also adaptive with a high tolerance to environmental changes, especially changes in water conditions (Pamungkas, 2015). This dragonfly species can also live in various habitats (Bahasa *et al*., 2002). Yaspeta also confirmed in her research in 2019 that *Orthetrum sabina* was found in all zones, especially in plants around grasses (Yaspeta, 2019).

Pantala flavescens becomes the most common dragonfly species found being flying above the stadium, but there are only 59 individuals caught. The researchers are only able to capture 48 individuals of this species in the middle of stadium. The researchers are also able to capture 11 individuals of this species in the periphery of stadium. This species is often seen in hundreds of individuals to migrate together in long distance (Bahasa *et al*., 2002). The group of this dragonfly species often flies away from waters, rice fields, and fields (Andi & Rahadi, 2018). This species is able to fly quickly and in groups with similar species in the open area (Rismayani, 2018 in (Rohman & Faradisa, 2020)).

Diplacodes trivialis and *Potamarcha congener* are the dragonfly species found in the least number. It is caused by a small size of its body so that it is often used as prey by the larger dragonfly such as *Orthetrum sabina*. *Orthetrum sabina* is a species that likes to eat the smaller size of damselfly and/or similar species of dragonfly (Soendjoto, 2016). Meanwhile, *Potamarcha congener* is classified as a medium-sized dragonfly. This species has an inferior ability of flying, moreover under flying ability of the other dragonfly in the Libellulidae family.

All dragonfly species found in the center of Imam Nahrawi stadium belong to one family, the family Libellulidae, and belong to one suborder, Anisoptera. The groups of dragonfly species in this family are dominated by *Orthetrum sabina* and *Pantala flavescens*. Both of them have large bodies, strong muscles and a wide cruising range. Both of them are seen flying a lot in the morning when the sun shines, in the reason that they need sunlight to strengthen their body muscles. Anisoptera suborder are found more in open areas than Zygoptera suborder (Buchori *et al*., 2019). In addition, the dragonfly species found in open habitats are mostly dragonfly groups that have large members and are cosmopolite, which can live in various habitats (Hartika *et al*., 2017), (Nuraeni *et al*., 2019) and (Ruslan, 2020).

While the dragonfly species found on the edge of the stadium are the dragonfly species of Libellulidae family, Chlorocyphidae family, and Platycnemididae family. The dragonfly species of Libellulidae family belongs to the Anisoptera suborder. Chlorocyphidae and Platycnemididae families belong to the Zygoptera suborder. The edge of the stadium is an area that has dense vegetation because it has many types of plants, ranging from grasses, herbs, shrubs to trees. This condition allows the availability of adequate food sources for dragonflies and provides shelter for them. So, it is not surprising that at the edges of the stadium more dragonfly species are found, including the Zygoptera suborder. Dragonflies of the Zygoptera suborder have slender bodies, are relatively calm, have the ability to fly at close range, and like cool and shady places (Buchori *et al*., 2019; Soendjoto, 2016).

The diversity index value (H') in the dragonflies found at the Imam Nahrawi stadium

shows a value of 1,114, which means that the level of diversity is relatively medium. In this case, there are 6 different species with a total of 292 individuals obtained. In detail, *Orthetrum sabina* is the most commonly found species, with 196 individuals. The second most commonly found species is *Plantala flavescens* with 59 individuals. The next species is *Copera marginipes* with 28 individuals, *Heliocypha fenestra* with 6 individuals, and *Diplacodes trivialis* with 2 individuals and an individual of *Potamarcha congener*.

The diversity of dragonfly is influenced by several factors, including abiotic factors (physical conditions) and biotic factors (Fahri, 2019). The results of measurements on abiotic factors at the time of capturing dragonfly at the Imam Nahrawi Stadium is obtained an average air temperature of 32,5^{0}C, air humidity of 70,3% and an average light intensity of 336,8 lux. These results are in accordance with the research conducted by Yaspeta (2019) and Fahri (2019). Libellulidae family is found in areas with temperatures ranging from 27^{0}C-36^{0}C (Yaspeta, 2019). Meanwhile, Libellulidae, Chlorocyphidae and Platycnemididae are found in the Bedadung river area with a temperature of 36,3^{0}C, 55% humidity and 521 lux light intensity (Fahri, 2019). Temperature, humidity and light intensity affect the life of several dragonfly species *(Julaika et al*., 2018). It affects the activities of flying, looking for prey, and using wings. Wing venation is going to work well if it is supported by good abiotic factors. Sufficient light intensity is able to help the thorax muscles moving the wings to fly with a minimum temperature of 20^{0}C and a minimum humidity of 70% (Julaika *et al*., 2018).

The biotic factors that influence the existence of dragonflies are the existence of the other living things. In this case, dragonfly nymphs become predators of small animals in the waters, such as mosquito larvae and smaller fish. Meanwhile, the adult phase (imago) of dragonflies preys on leafhoppers, mosquitoes, flies and other insects on plants (Meidyna Putri *et al*., 2019). If the availability of living things that are used as food for dragonflies is small, then the presence of dragonflies in that place is also small. It becomes competition among dragonflies or even between dragonflies and the other insects to get food. Moreover, large dragonflies will prey on smaller dragonflies. Therefore, the presence of the *Orthetrum sabina* dragonfly dominates at the Imam Nahrawi stadium. In addition to being a predator, dragonflies are also prey for other predators. In this case, dragonfly eggs or nymphs in water become prey for water beetles, frogs and toads (Soendjoto, 2016). Meanwhile, birds, spiders, lizards and frogs become predators for adult dragonflies (Dalia & Leksono, 2014). Researchers also find birds flying around during the dragonfly catching process at the stadium. It is also one of the factors that affect the level of dragonfly diversity in the stadium, which is classified as moderate diversity.

The other common factors which influence the number of dragonflies are human activities, namely waste disposal activities in rivers and deforestation (Virgiawan *et al*., 2015). Imam Nahrawi stadium is bordered by Bedadung river, where to the south and west of the riverside area, there are residents' villages. Some residents are known having thrown garbage on the banks of the river. Rubbish is also found in streams, which affects dragonfly diversity. It is undeniable that dragonflies cannot be separated from aquatic habitats, where dragonflies lay their eggs and as a place of settlement for dragonfly nymphs. Water with good quality is a comfortable place for dragonfly nymphs to live, therefore dragonflies are used as bioindicators of a water

body (Meidyna Putri *et al*., 2019).

In addition to a clean aquatic environment, dragonflies also like place that have lots of vegetation around them or vegetation in the water. Dragonflies lay their eggs on the stems of plants in the water (Rizal & Hadi, 2015). Whereas the vegetation around the water is used to find food and as a refuge from predators (Hartika *et al*., 2017). It reinforces the fact that the dragonflies that are mostly caught are those on the edge and perched on grass or shrubs.

CONCLUSION

The results of the research at Imam Nahrawi Stadium UIN KHAS Jember present that the value of *Shannon-Wiener* diversity index is 1,114 (1 < H' < 3). It means that the diversity of Odonata around the stadium is moderate. The found-dragonflies consist of Libelliludae family, Chlorocyphidae family, and Platycnemididae family with 292 individuals, namely 196 species of *Orthetrum sabina*, 59 species of *Pantala flavescens*, 2 species of *Diplacodes trivialis*, 1 species of *Potamarca Congener*, 6 species of *Haliocypha fenestra* and 28 species of *Copera marginipes*.

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