First Odonata Survey and Utilization of Odonata Diversity as Bioindicator for Sungai Chiling Habitat Quality

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DOI: https://doi.org/10.51584/IJRIAS.2024.907056

Received: 22 June 2024; Revised: 10 July 2024; Accepted: 15 July 2024; Published: 20 August 2024

ABSTRACT

A study was conducted at Sungai Chiling Fish Sanctuary in Selangor in assessing the habitat quality by utilizing the Odonata diversity. Sampling using sweep net was conducted for three days from 0900 hours to 1700 hours through the six river crossings. Results showed 48 individuals from 15 species and 6 families were collected and no significant difference for species richness and abundance across the crossings. The species diversity, evenness and species present there indicate good water quality. However, slight disturbance at the entrance based on the Damselfly and Dragonfly species richness and disturbance-associated species present there.

Keywords: biodiversity, odonata, bioindicator, conservation, habitat quality

INTRODUCTION

Throughout Malaysia, there are about 342 species in the order Odonata and the two suborders which are Zygoptera and Anisoptera are estimated to have 161 species within 10 families and 181 species within 5 families respectively while in Peninsular Malaysia along with Singapore, there are about 226 species of Odonata (Yule & Yong, 2004). 11% of the Odonate species in Peninsular Malaysia are endemic.

Odonata play various roles in the ecosystem such as predators and prey during both of their life stages, larvae and adult (Luke et al., 2017). They could occur in wide range of habitats which cover both lotic and lentic water body (Vilenica, 2017). Due to their sensitivity towards environmental changes which include both physical and chemical components of the habitat, they can be used as bioindicator for habitat quality.

Furthermore, as their life cycle cover both aquatic and terrestrial realm, they are a convenient biological tool in assessing both aquatic and terrestrial habitat (Ab Hamid et al., 2016). Various factors such as vegetation, light intensity, turbidity, and water velocity could affect Odonata species composition especially during larval stage while adults are more affected by the microhabitat quality and vegetation structure (Clausnitzer et al., 2009; Orr, 2006; Vilenica, 2017). Every species has their own preferences for the habitat that fulfil the requirement for them to survive (Ab Hamid et al., 2016).

On 18th September to 22nd September 2023, the Selangor State Forestry Department with the cooperation of Universiti Putra Malaysia has conducted a mini expedition at Sungai Chiling Fish Sanctuary known as “Mini Ekspedisi Saintifik Biodiversiti Sungai Chiling, Hutan Simpan Ulu Selangor” which involves researchers from various local universities (Universiti Malaya, Universiti Putra Malaysia, Universiti Kebangsaan Malaysia, and Universiti Teknologi MARA).

Up to date, there was no record on Odonata survey has been conducted at Sungai Chiling Fish Sanctuary to the best of the authors knowledge, thus this will be the first record in understanding the Odonata population at Sungai Chiling. The aim of this study is to assess the habitat quality of Sg. Chiling using Odanata diversity as bioindicator.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS | Volume IX Issue VII July 2024

METHODOLOGY

A. Study Site

Sungai Chiling Fish Sanctuary, Kuala Kubu Bharu Selangor was located about 21 km from the Kuala Kubu Bharu Town and under the management of Selangor Fisheries Department. It is famous as an ecotourism spot in Selangor. One of the attractions is the remarkable waterfall that as high as three storey building. Interestingly, the shape of the stone on the right cliff of the waterfall was said to resemble gorilla. The trail allocated by Selangor State Forestry Department consists of six river crossings and one trail that extend beyond the Chiling Waterfall. In this study, we divided the crossing into five groups where some crossings were grouped together as they are located closely together. The groups were at different elevation: Cross 1 (~259 m), Cross 2n3 (~319 m), Cross 4 (~330 m), Cross 5n6 (~340 m) and the highest level that we could access, we name it as Highest point (~419 m) (Fig. 1).

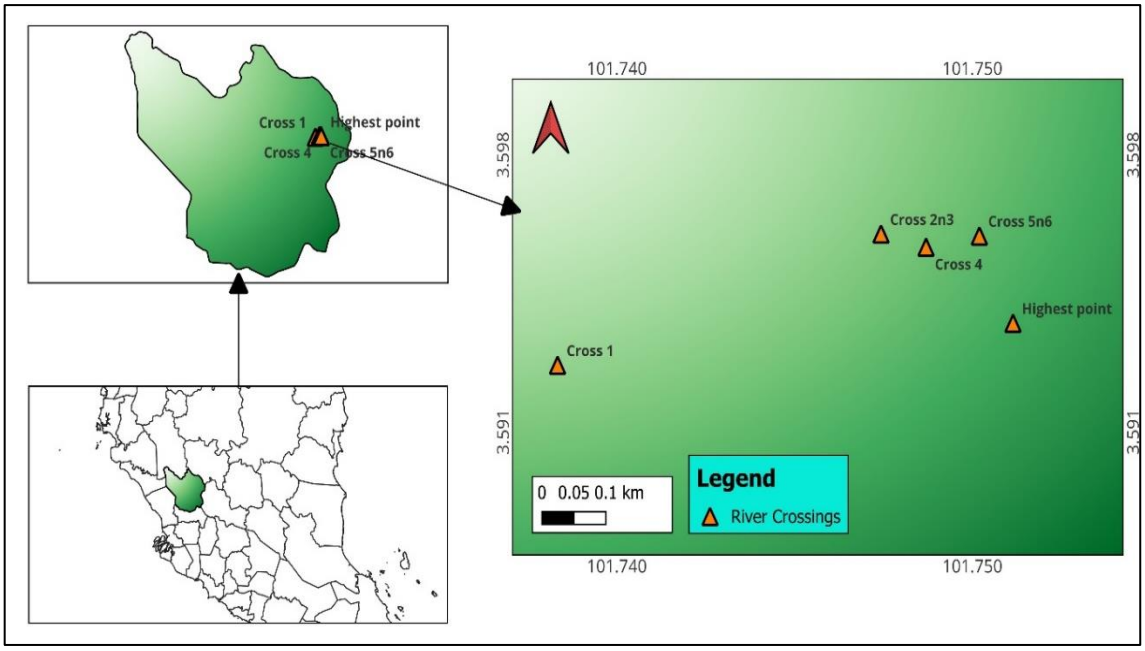

Fig.1 Crossings in Sg. Chiling Fish Sanctuary, Selangor.

B. Odonata Sampling, Preservation and Identification

Adult damselfly and dragonfly sampling was conducted from 19th September to 21st September 2023 at Sungai Chiling Fish Sanctuary, Kuala Kubu Bharu, Selangor. Samples were caught using sweep net from 0900 hours to 1700 hours by walking through selected trail by Selangor State Forestry Department where the trail consists of six river crossings and one trail that extend beyond the Chiling Waterfall as shown in Figure 1. The samples caught were euthanized by pinching the thorax after being removed from net (Azmi et al., 2006) which then inserted into triangular envelopes. After that, samples were brought to the lab and preserved by drying in oven at 45 ˚C following (Orr, 2003). Preserved samples were deposited at Museum of Zoology, Faculty of Science, Universiti Malaya. Sample were identified by using morphological key identification according to Yule and Yong (2004) and Orr (2003, 2005).

C. Statistical Analysis

Descriptive analysis such as bar chart such as family abundance and species abundance were constructed. Then, the odonatan species diversity and distribution were calculated using Shannon-Weiner Diversity Index (H'), Simpson's Diversity Index (Ds) and Pielou's Evenness Index (J'). Species richness and abundance of both damselfly and dragonfly were constructed according to different crossings found in Sungai Chiling. Finally, Kruskal-Wallis test was conducted to determine if there are significant difference on species richness and

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS | Volume IX Issue VII July 2024

abundance between the crossings using SPSS.

RESULTS

A. Species Diversity and Distribution

This study managed to sample 48 individuals from 15 species and 6 families (Table I). This consist of four families of Zygoptera (Calopterygidae, Chlorocyphidae, Euphaeidae, and Platycnemididae) and two families of Anisoptera (Gomphidae and Libellulidae). Libellulidae recorded the highest abundance (56.3%) from the total sample, and this followed by Chlorocyphidae (20.8%), Euphaeidae (16.7%) and the other three families only with a single sample make up the rest (6.2%) (Fig. 2). Similar with abundance, Libellulidae recorded highest species richness which is 10 species while all other families only consist of a single species.

Table I: Odonata Species and Abundance Sampled (Lc=Least Concern, N/A=Not Available)

Family	Species	Abundance	IUCN Status
Calopterygidae	*Vestalis amethystina*	1	LC
Chlorocyphidae	*Aristocypha fenestrella*	10	LC
Euphaeidae	*Euphaea ochracea*	8	LC
Platycnemididae	*Prodasineura humeralis*	1	N/A
Gomphidae	*Megalogomphus sumatranus*	1	LC
Libellulidae	*Orthetrum testaceum*	1	LC
	Orthetrum chrysis	6	LC
	Orthetrum glaucum	5	LC
	Tyriobapta torrida	2	LC
	Diplacodes trivialis	1	LC
	Neurothemis fluctuans	5	LC
	Trithemis aurora	1	LC
	Zygonyx iris	4	LC
	Zygonyx ida	1	LC
	Orchithemis pulcherrima	1	LC

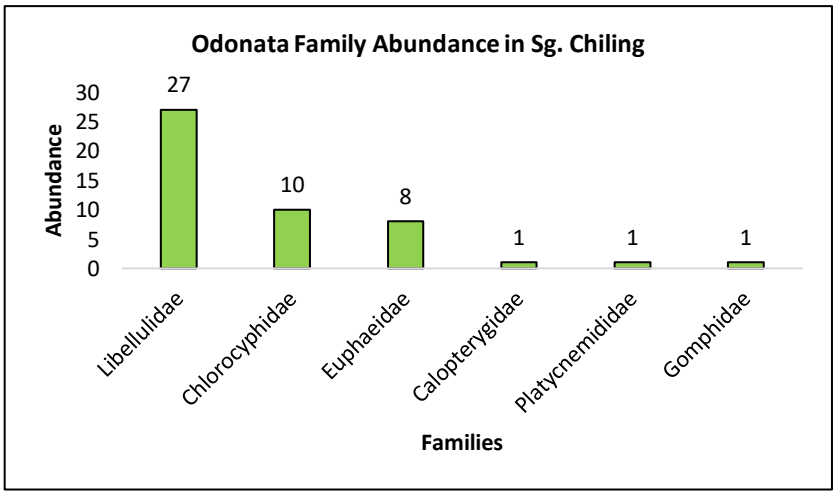

Fig. 2 Families abundance of Odonata in Sg. Chiling.

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS | Volume IX Issue VII July 2024

Based on the sample, the genus with highest abundance is *Orthetrum* sp. represent (25%) of the total samples, this followed by genera *Aristocypha* sp. (20.8%), *Euphaea* sp. (16.7%), *Neurothemis* sp. (10.4%), *Zygonyx* sp. (8.3%), *Tyriobapta* sp. (6.3%), while other genera only represented by single individual make up the rest (12.5%) (Table 1). Then, in terms of species, *Aristocypha fenestrella* showed the highest abundance represent (20.8%) of the total sample. This followed by *Euphaea ochracea* (16.7%), *Orthetrum chrysis* (12.5%), *O. glaucum* (10.4%), *Neurothemis fluctuans* (10.4%), *Zygonyx iris* (8.3%), *Tyriobapta torrida* (4.2%) and the rest 8 species only represented by a single individual make up the rest (16.7%) (Fig. 3).

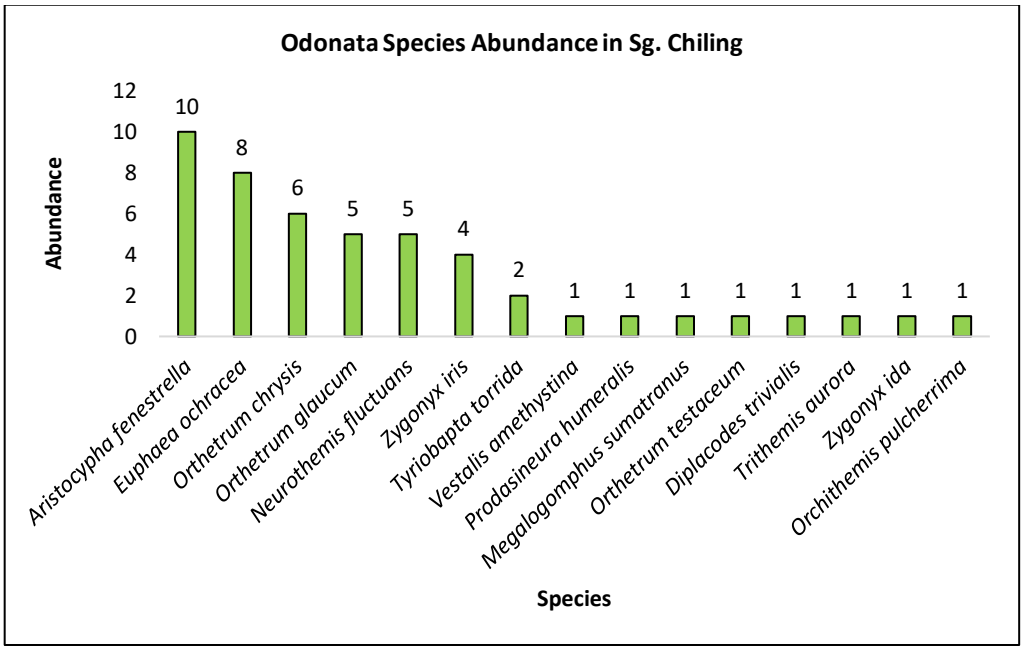

Fig. 3 Odonata species abundance in Sg. Chiling.

The Simpson's Diversity Index (1-D) and Shannon-Weiner Diversity Index (H') showed a considerable high value which are 0.8793 and 2.3412 respectively (Table II). This also the same for the Pielou's Evenness Index which is 0.8646 indicating less dominance in the habitat. Finally, the ratio of Damselfly-Dragonfly Species Richness showed low proportion of damselfly species compared to dragonfly.

Table II: Diversity Index, Evenness Index and Species Richness Ratio

Indices	Value
Species Richness (S)	15
Simpson's Diversity Index (1-D)	0.8793
Shannon-Weiner Index (H')	2.3412
Pielou's Evenness Index (J')	0.8646
Damselfly-Dragonfly Species Richness Ratio	0.36

B. Odonata Species Richness and Abundance Across Crossings

Comparing all the crossings, dragonfly recorded higher species richness than damselfly in Cross 1 and Cross 2n3, compared to other crossings where the species richness is relatively the same in Cross 4 and Highest point except for Cross 5n6 that has no sample of dragonfly (Fig. 4). This also the same for abundance where dragonfly showed higher abundance in Cross 1 and Cross 2n3, compared to Cross 4 and Highest point where there was similar abundance except Cross 5n6 with only damselfly and no dragonfly sample (Fig. 5).

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS | Volume IX Issue VII July 2024

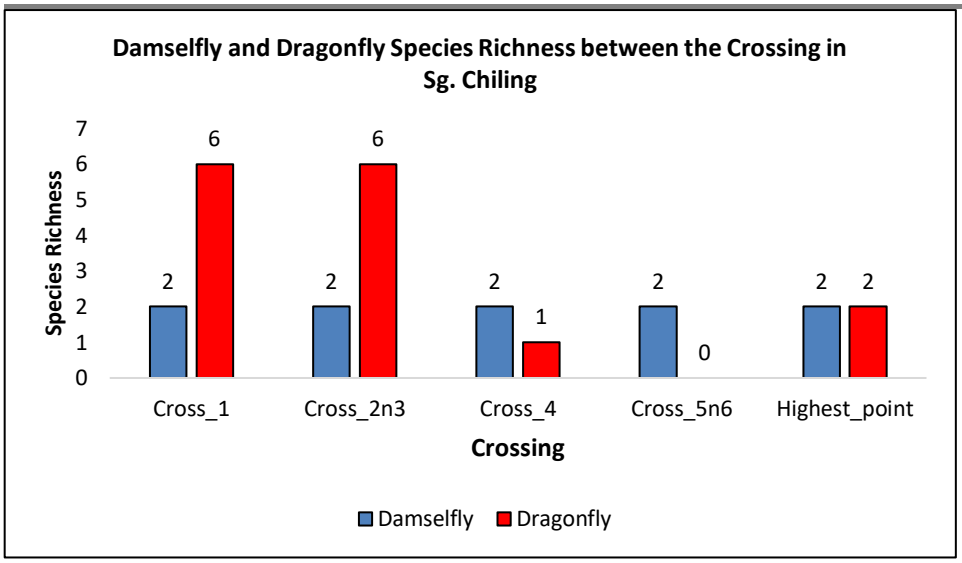

Fig. 4 Comparison of species richness between damselfly and dragonfly in crossings of Sg. Chiling.

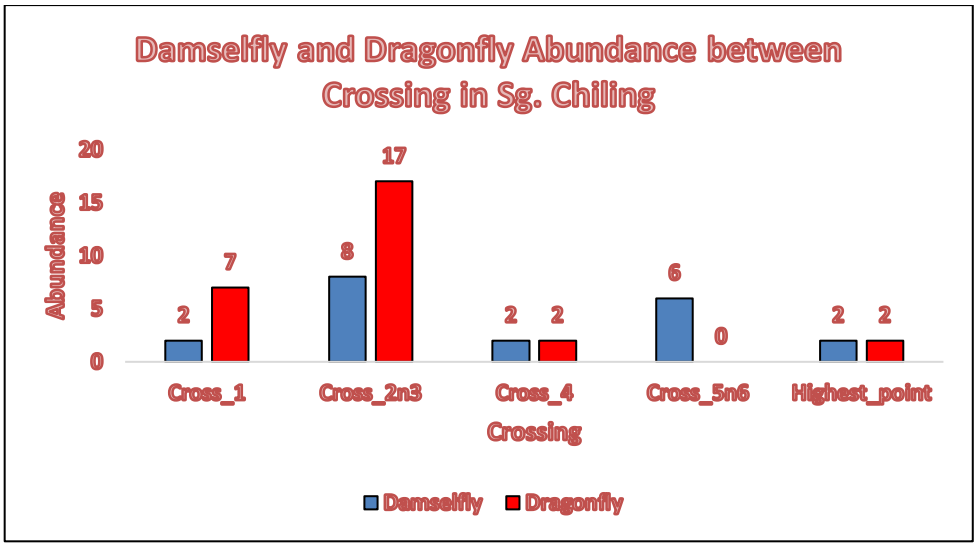

Fig. 5 Comparison of abundance between damselfly and dragonfly in crossings of Sg. Chiling.

Only two species that can be found in almost all crossings which are *Aristocypha fenestrella*, *Euphaea ochracea* and *Orthetrum chrysis* while most other species such as *O. testaceum*, *Megalogomphus sumatranus*, *O. glaucum*, *Diplacodes trivialis*, *Neurothemis fluctuans*, *Trithemis aurora*, *Zygonyx iris* and *Orchithemis pulcherrima* are more confined in Cross 1 and Cross 2n3 (Table III). *Vestalis amethystina* and *Tyriobapta torrida* are only found in Cross 4 while *Z. ida* at the Highest point.

Table III: Odonata Species Distribution Across Crossings (Elevation) in Sg. Chiling.

Species	Elevation				
	Cross 1	Cross2n3	Cross4	Cross5n6	Highest point
	(~259 m)	(~319 m)	(~330 m)	(~340 m)	(~419 m)
Vestalis amethystina	0	0	1	0	0
Aristocypha fenestrella	0	3	1	5	1
Euphaea ochracea	1	5	0	1	1
Prodasineura humeralis	1	0	0	0	0

Megalogomphus sumatranus	0	1	0	0	0
Orthetrum testaceum	1	0	0	0	0
Orthetrum chrysis	1	4	0	0	1
Orthetrum glaucum	1	4	0	0	0
Tyriobapta torrida	0	0	2	0	0
Diplacodes trivialis	0	1	0	0	0
Neurothemis fluctuans	0	5	0	0	0
Trithemis aurora	1	0	0	0	0
Zygonyx iris	2	2	0	0	0
Zygonyx ida	0	0	0	0	1
Orchithemis pulcherrima	1	0	0	0	0

Kruskal-Wallis test showed there is no statistically significant difference of species richness and abundance between all crossings, (H (4) =5.645, p =0.227), and (H (4) = 5.023, p = 0.285) respectively (Table IV and Table V).

Table IV: Kruskal-Wallis Test on Odonata Species Richness Between Crossings in Sg. Chiling.

Components	Value
Total N	15
Test Statistic	5.645
df	4
Asymtotic sig. (2-sided test)	0.8646

Table V: Kruskal-Wallis Test on Odonata Abundance Between Crossings in Sg. Chiling.

Components	Value
Total N	15
Test Statistic	5.023
df	4
Asymtotic sig. (2-sided test)	0.285

DISCUSSION

A. Odonata Diversity and Distribution

High diversity index value is resulted by the evenness of the species distribution which result in less domination of certain species. This could also be contributed by the high diversity of microhabitat at Sungai Chiling where there are various types of water body along the trail ranging from small, stagnant ponds under falling logs, shallow slow flowing water along the trail of Pteridophytes, to deep and shallow fast-flowing streams that cover

both lentic and lotic environments. These microhabitats provide wide range of habitat for various species of Odonata to thrive. However, need to note that there are many species in the sample that were being represented only by two or a single individual, this could be resulted by non-ideal weather conditions during the sampling where there was cloudy weather during the second day of sampling and short evening raining during the third day of sampling as mentioned by Abdul Aziz and Mohamed (2019), Odonata are mostly active during sunny weather with low wind velocity.

In addition, further study on the Odonata diversity with longer sampling period and wider coverage are highly recommended in the future. In comparison, other study in Selangor state showed a total of high species richness which is 33 species from 11 families in Sungai Dusun Wildlife Reserve (Choong & Alwen, 2018), while another study showed lower number of species richness at Sungai Sendat Recreational Forest and Sungai Gabai Waterfalls which are 5 and 14 species respectively (Mamat, 2018). Similar with (Choong & Alwen, 2018), this study recorded highest species richness in Libellulidae family, which is 10 species in comparison with the former, 14 species.

Other study in Johor that survey on 9 different localities also recorded highest abundance and species richness from Libellulidae family (Aziz et al., 2018), as Libellulidae family tend to dominate open habitat of water body (Mamat & Mohamed, 2012). *Aristocypha fenestrella* from Chlorocyphidae has the highest abundance in this study as Chlorocyphid has its greatest diversity in South-East Asia (Hämäläinen & Karube, 2001). Moreover, Mamat (2018) also recorded highest abundance in *A. fenestrella* after surveying 22 localities across 11 states in Peninsular Malaysia.

Based on the samples collected all 15 species have the status of Least Concern (LC) in IUCN Red List of Threatened Species except for *Prodasineura humeralis* where the status is not available (Table I). However, still, conservation on Odonata is important as they also play roles to certain extent as attraction for tourists in ecotourism (Janra & Herwina, 2020) due to their radiant and colourful appearances along with remarkable behaviour (Ilhamdi et al., 2021).

B. Odonata Diversity and Habitat Quality

The high value of diversity (Table II) that consists of high species richness suggested unpolluted river in Sungai Chiling. Polluted rivers tend to have low species richness with high abundance for each species while unpolluted river will have high species richness with considerably low abundance for each species (Godfrey, 1978).

High abundance of *Aristocypha fenestrella* from Chlorocyphidae and *Euphaea ochracea* from Euphaeidae showed clean river condition as both tend to inhabit clear and fast-flowing streams (Orr, 2005). The presence of *Vestalis amethystina* from Calopterygidae also indicates clean river water (Orr, 2003). Interestingly, only a single individual from Gomphidae family showed that the Sungai Chiling River undergone disturbance as Gomphid are among the most sensitive towards the environmental disturbances (Ab Hamid et al., 2016).

In contrast, there were also species that commonly associated with disturbances. The presence of *Orthetrum chrysis* especially at the Cross 1 and Cross 2n3 indicate slight disturbance as *O. chrysis* can thrive in disturbed habitat and usually found along with *Trithemis aurora* (Aziz et al., 2018), which also found within the same crossings in this study. However, the presence of these species is only in relatively low abundance and confined at Cross 1 and Cross 2n3 which are the first two crossings along the trail from the entrance. These crossings are more accessible compared to other crossings that located deeper which might face less disturbances.

C. Odonata Species Richness and Abundance Across Crossings

High dragonfly species richness and abundance especially at Cross 1 and Cross 2n3 probably because of the Cross 1 and Cross 2n3 have open surroundings where dragonfly thrive better than damselfly. Consequently, the low Damselfly-Dragonfly species richness ratio indicates that Sungai Chiling do experiences some disturbances which could be resulted from overcrowded of tourists and alteration of habitat as it is one of the ecotourism spots as fish sanctuary for two fish species locally known as Kelah and Tengas. According to Cruz et al. (2021), damselfly prefer to occupy pristine forest habitats compared to dragonfly that is able to thrive in

disturbed and open habitat and high value of Damselfly-Dragonfly Species Richness Ratio indicate well-preserved habitat and while low value showed sign of habitat alteration and disturbances. In addition, other crossings are located deeper into the forest that provide shade for most damselfly species that are stenotopic (shade lover) (Aziz et al., 2018) and this explain the reduction in dragonfly species richness and abundance as approaching the inner forest area.

In comparison, Cross 4, Cross 5n6 and Highest point are areas with more shade as larger trees are present in such areas. These areas are more favoured by the damselfly due to their suitability of habitat such as presence of small streams that flow from forest hill into the main river is a habitat for *Vestalis amethystina* was found in this study, and clear water with fast-flowing current also found which is suitable for *Aristocypha fenestrella* and *Euphaea ochracea* (Orr, 2005).

Zygonyx ida was only found at elevation about 419 m where this study refers as Highest point station that we reached in Sungai Chiling. Orr (2005) stated that this species mostly can be found in submontane forest. *Tyriobapta torrida* was found perching vertically on suspended branch over a stagnant water body in Cross 4 in this study. This matched the description by Orr (2005) and Aziz et al. (2018).

The Kruskal-Wallis test showed no significant difference for both species richness and abundance of Odonata between the crossings. This could be resulted by insufficient sampling effort due to time constraints, unexpected weather conditions which limit the number of samples acquired and small sample size. Furthermore, although each crossing was differing to some extent, the locations are not too far from each other which allow movements of highly mobile species which allow them to appear in more than one crossing such as *Aristocypha fenestrella* and *Euphaea ochracea* that appear in all crossings except Cross 1 and Cross 4 respectively (Table 3). *E. ochracea* and *A. fenestrella* are found in both lowland and highland (Orr, 2003) up to 1000 m and 1700 m respectively (Orr, 2005).

CONCLUSION

This study suggests that Sungai Chiling Fish Sanctuary, Kuala Kubu Bharu, Selangor have good water quality and have high variety of microhabitat based on the high diversity and evenness of Odonata. However, this area also experienced slight disturbances based on the low Damselfly-Dragonfly Species Richness Ratio. The clean water was also indicated by high abundance of species from families that usually thrive in clean water such as Chlorocyphidae, Euphaeidae and Calopterygidae. Slight disturbances were indicated by the presence of disturbance-associated species such as *Orthetrum chrysis* and *Trithemis aurora*. The disturbance is more focused on the front part of the trail that are more accessible and closer to the entrance. We suggest limiting the number of visitors to reduce the disturbance impacts towards local Odonata community. Finally, we highly recommend future studies with longer sampling period and wider coverage for a complete understanding on Odonata species composition in Sungai Chiling.

ACKNOWLEDGEMENTS

We would like to thank Selangor State Forestry Department and Universiti Putra Malaysia (UPM) for organising “Mini Ekspedisi Saintifik Biodiversiti Sungai Chiling, Hutan Simpan Ulu Selangor” along with the mountain guide that help us in walking through the trail during the expedition.

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