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Development of Odonata as A Nature Tourism Product for Peat Swamp Ecosystem in North Ayer Hitam Forest Reserve, Johor

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Abstract: Odonates are water quality indicator for the health of freshwater ecosystem, had been used in pharmacology, as dietary items, predators and controlling human diseases. Odonata have a strong tradition of being involved in relaxation and recreation activities in various Asian nations, such as China and Japan. A study on odonate as tourism product was carried out at North Ayer Hitam Forest Reserve, Johor for eight days. The study firstly aimed to determine the diversity of odonate on site. Ten flagships species was then selected based on criteria of a good nature tourism product. The research continued to develop odonatourism as a new product in North Ayer Hitam Forest Reserve, Johor. The method used for species inventory were sticky trapping, sweep netting, and point-counting survey. A total number of 35 species with 465 individuals - had been collected during the research. Data collected revealed that the diversity of odonate in the sampling region is medium as evidenced by the Shannon Weiner Species Diversity Index (2.6126). Analyzing the 35 species of odonates, gauging against the eight Criteria of a Good Nature Tourism Product, 10 species indicated having potentials to be developed into nature tourism products. Based on the selected 10 flagship species, a promotional brochure and a prototype of souvenir were created. Although this research mainly dealt with promoting odonate as potential nature tourism products the necessity to maintain North Ayer Hitam Forest Reserve in Johor is also highlighted.

Keywords: Odonatourism, dragonflies, damselflies, sticky trapping, flagship species, brochure, souvenir, Johor

1. Introduction

Odonate (dragonflies and damselflies) is a well-known order of insects and an iconic symbol in Japanese and Native American art and culture [1]. The order Odonata is split into three suborders based on wing venation [1] which is Zygoptera (damselflies), Anisoptera (dragonflies) and Anisozygoptera, which mostly concerns living groups with fossilized wings going all the way back to the Triassic period in history. Anisoptera and Zygoptera are currently used as

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two life forms represented throughout the world [2]. There are 6,323 odonata species [2] that have been described to date in the world.

The odonate fauna in Malaysia is relatively well-known, thanks to the ground-breaking studies by several researchers such as [3][4][5], and there are newer researcher showing interest. According to the book of 'Ancient Creatures: Dragonflies and Damselflies of Malaysia' [6], nearly 400 odonate species had been recorded in Malaysia. At least 180 species are dragonflies and not less than 210 species are damselflies. Of these, more than 50 species are endemic to Malaysia. Many risks to the population of Odonata in Southeast Asia have been identified, including loss and degradation of aquatic habitats, industrialization, and agricultural operations [7]. Protected areas and ecotourism are two possible methods used to conserve odonate species [7].

In the north-western part of Johor, 30 kilometers from the Pagoh, is where the North Ayer Hitam Forest Reserve (AHFR) is located. AHFR is, according National Forestry Act 1984, the only remaining protected areas of the peat swamp forest in Johor as a Hutan Negeri with an area of 3800 hectares to be sustained as a protected area. The continuous campaigning of Wetlands International has just succeeded in this little forest reserve being designated as a State Park [7].

The goal of this study is to examine the current odonate diversity in this location since North Ayer Hitam Forest Reserve is a distinctive peat swamp habitat. In addition, the study looks at the development of odonates into natural tourism product as a tourism attraction. These efforts would, create interest of the site, give value to it and facilitate in supporting the conservation of both the odonates as well the peat swamp.

2. Methodology

2.1 Sampling Area

North Ayer Hitam Forest Reserve (AHFR) is currently a protected area in Johor and is shown in Figure 1. AHFR is the largest and only preserved part of the peat swamp forest in Johor and covers an area of 3,800 hectares [7]. North Ayer Hitam Forest Reserve was a former bauxite mining site, and it is prone to fire due to the draining of the peat swamp forest, as well as biodiversity loss due to habitat damage.

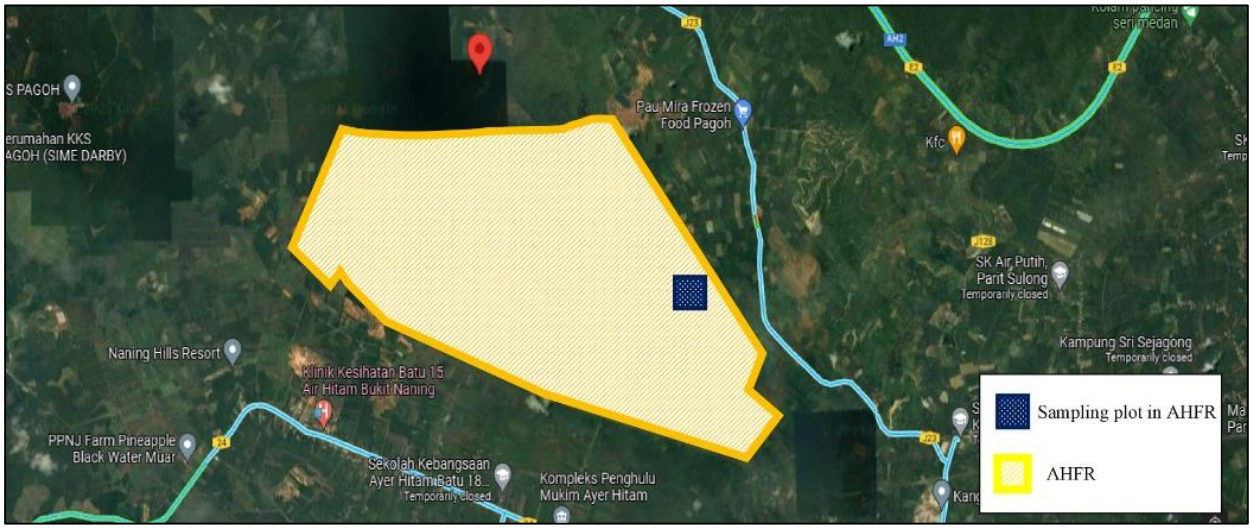


Fig. 1 - Location of North Ayer Hitam Forest Reserve, Johor

2.2 Sampling Methods, Preservation and Identification

The collection was done throughout the day since adult odonates are frequently seen during the day with good weather from 9 a.m. to 3 p.m. Adult odonates were gathered with an aerial net, which was ideal for collecting certain insects that are either flying around or perching on twigs, vegetation and grasses. Larger-hooped aerial nets are ideal for catching huge, fast-moving insects such as dragonflies and butterflies. The second approach utilized was a sticky trap, which consisted of coconut skewers covered with glue to create stickiness in order to trap the odonate that passed by the route "Denai Interpretasi" (Figure 2). These skewers resembling twigs of tiny tree branches. It was trussed into the forest floor bent a 45-degree bend toward the ground along the path. As seen in Figure 3, the wooden skewers are approximately 75 cm long. The sticky portion comprised one third of the length of the skewers from the apex. The third method was a point-count method along the research site, which is represented in Figure 4. This approach was used in conjunction with the research location, where 5-point count stations were possible to be designated strategically positioned 50 meters from the beginning point.

a b

Fig. 2 - Figure description (a) trail "Denai Interpretasi" for setting up the sticky trap; (b) length of sticky trap

Fig. 3 - The point-count approach will be carried out in an open area

Specimens would be preserved by first immersing them in acetone and then drying or immersing them in ethanol. Once an odonate has been obtained, it could be removed from the net by hand, and if the captured odonate is no longer needed as a sample or has been confirmed and photographed, it is then released into the environment. If an odonate specimen is kept as a sample, it is kept alive in a glassine envelope to retain its wings in good condition for identification in the laboratory. The date, collector name, and location of each specimen obtained or photographed are documented on a label for future reference. Odonates were morphologically recognized for identification using the book 'Dragonfly of Peninsular Malaysia and Singapore' [5].

2.3 Data Analysis

Species diversity may be assessed using mathematical calculations based on species richness and abundance. Species diversity was calculated using the Shannon Weiner Diversity Index (H). The eight criteria of a good nature tourism product based on WTO and the recommendations of previous workers to select the flagship species dragonfly and damselfly species in North Ayer Hitam Forest Reserve [8]. The eight criteria are safety, reliability of sighting, appealing morphology, behavior enticement, rarity, endemism, cultural and ecological link.

3. Results and Discussion

3.1 Odonate Checklist

A total of 465 individuals represented by 35 species from 5 families were collected and observed during the sampling as shown in Table 1. The total number of individuals gathered for the suborder Anisoptera was 390, whereas Zygopetera had 75. Similar to a previous research [9], the survey from several places in Selangor revealed a higher abundance of Anispotera (701) than Zygoptera (597). The high number of Anisoptera individuals is explained by their ability to endure disturbance and having shorter life cycle. However, unlike Anisoptera, Zygoptera is a stenotopic species that prefers shade and requires environmental requirements such as high oxygen content for larvae to live [10]. Table 2 shows that number of species that have been captured in each family. Family Libellulidae was the most dominant with 389 individuals (83.66%) captured and observed. Second was family Coenagrionidae comprising 44 individuals (9.46%), third highest was family Megapodagrionidae with 27 individuals (5.81%). The second lowest number of individual captured was family Chlorocyphidae with 4 individuals (0.86%) and the lowest was family Gomphidae with one

individual (0.22%) captured. Similar to earlier research done in Malaysia [7] [10] [11] [12] [13], the majority of the libellulids were expected daylight species, which are often found in open environments. The Libellulidae family was a widespread family that dominated open lentic environments.

Table 1 - Odonate species and number of individuals, captured and observed for each species in North Ayer Hitam Forest Reserve, Johor

Family	No.	Scientific Name	Common Name	Iucn Status	No of Individual
Chlorocyphidae	1	*Libellago hyalina*	Clearwing Jewel	LC	3
	2	*Libellago lineata*	Golden Jewel	LC	1
Megapodagrionidae	3	*Podolestes buwaldai* *	Buwalda's Flatwing	NE	27
Coenagrionidae	4	*Agriocnemis femina*	Pinhead Midget	LC	1
	5	*Agriocnemis pygmaea*	Wandering Midget	LC	3
	6	*Argiocnemis rubescens rubeola* *	Variable Sprite	LC	10
	7	*Ceriagrion auranticum*	Orange-tailed Sprite	LC	2
	8	*Ceriagrion cerinorebellum* *	Ornate Coraltail	LC	18
	9	*Onychargia atrocyana*	Black Marsh Dart	LC	3
	10	*Pseudagrion microcephalum*	Blue Sprite	LC	6
	11	*Teinobasis ruficollis*	Red-tailed Sprite	NE	1
Gomphidae	12	*Ictinogomphus decoratus*	Common Flangetail	LC	1
Libellulidae	13	*Acisoma panorpoides*	Trumpet Tail	LC	2
	14	*Aethriamanta gracilis*	Pond Adjutant	LC	2
	15	*Agrionoptera insignis*	Grenadier	LC	1
	16	*Brachydiplax chalybea*	Blue Dasher	LC	3
	17	*Brachydiplax farinosa*	Dark mouth Dragonfly	LC	9
	18	*Brachygonia oculata* *	Pixie	LC	94
	19	*Hydrobasileus croceus*	Amber-winged Glider	LC	12
	20	*Lyriothemis biappendiculata*	Red-and-white Bombardier	LC	3
	21	*Nannophya pygmaea* *	Scarlet Pygmy	LC	51
	22	*Neurothemis fluctuans* *	Common Parasol	LC	61
	23	*Orchithemis pulcherimma*	Variable Sentinel	LC	1
	24	*Orthetrum sabina*	Variegated Green Skimmer	LC	6
	25	*Orthetrum chrysis* *	Spine-tufted Skimmer	LC	7
	26	*Raphismia bispina* *	Spiny-chested Percher	LC	27
	27	*Rhodothemis rufa*	Spine-legged Redbolt	LC	6
	28	*Rhyothemis obsolescens* *	Bronze Flutterer	LC	82
	29	*Rhyothemis phyllis*	Yellow-barred Flutterer	LC	2
	30	*Rhyothemis plutonia*	Greater Blue Wing	LC	1
	31	*Tetrathemis irregularis*	Elf	LC	3
	32	*Tramea transmarina* *	Red Glider Dragonfly	LC	10
	33	*Trithemis aurora*	Crimson Dropwing	LC	1
	34	*Tyriobapta torrida*	Treesitter	LC	2
	35	*Urothemis signata*	Scarlet Basker	LC	3
		TOTAL			**465**

Table 2 - Number of individuals of odonate in each family recorded in North Ayer Hitam Forest Reserve, Johor

Family	No. of individual	Percentage (%)
Chlorocyphidae	4	0.86
Megapodagrionidae	27	5.81
Coenagrionidae	44	9.46
Gomphidae	1	0.22
Libellulidae	389	83.66
Total	465	100

3.2 Odonate Recorded By Three Methods

According to Figure 4, the number of individuals of odonates captured and recorded by the sticky trap method gave the lowest catch of the three methods used throughout the research period. It was because when left for 24 hours, the glue covering the skewers was found not sufficiently sticky to retain the odonate, particularly the dragonfly, which is powerful and robust odonate. Many dragonflies escaped from the sticky trap. Thereafter, the coconut skewers were coated with multiple coatings of the fly-glue for extra adhesive strength to hold the dragonfly and damselfly until the next day for counting.

The aerial net was the most efficient sampling method, with the largest number of individuals recorded on day four of sampling, which is 71. The second-highest number of odonate captured with an aerial net occurred on day seven, with 57 individuals. During the sampling on day three, the number of odonate collected was lowest due to the weather being gloomy and rainy. Odonates cannot be viewed on a rainy day since they prefer a sunny and dry day.

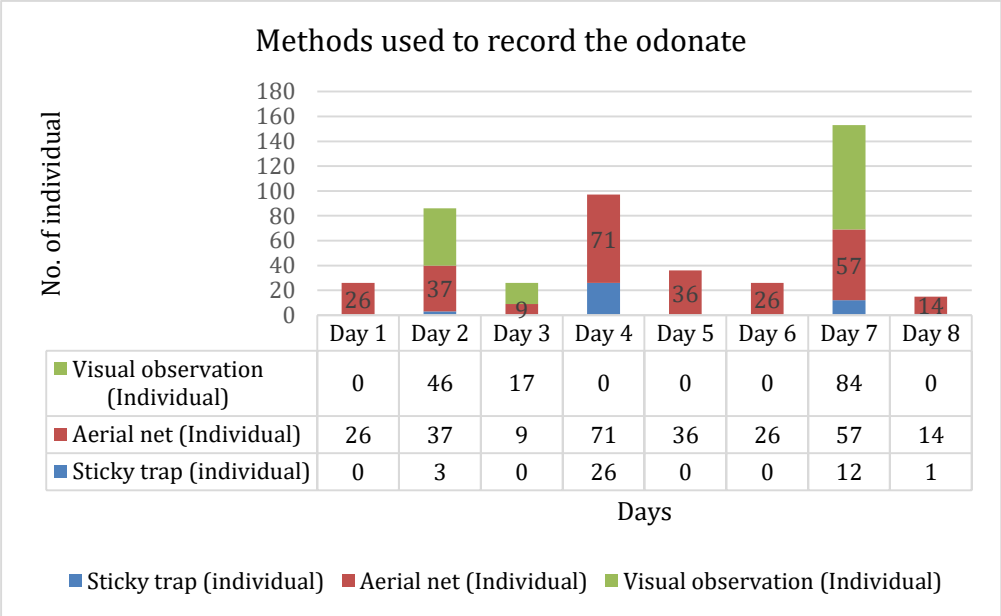


Fig. 4 - Odonate that recorded by three methods

3.3 Species Accumulation Curve

Figure 5 shows species accumulative curve during the days of sampling. The total number of species was 35 species. Species accumulation curves are used to estimate or indicate the total number of species in a given location. Figure 5 demonstrates that there is insufficient sampling effort since the accumulation curve does not reach the asymptote.

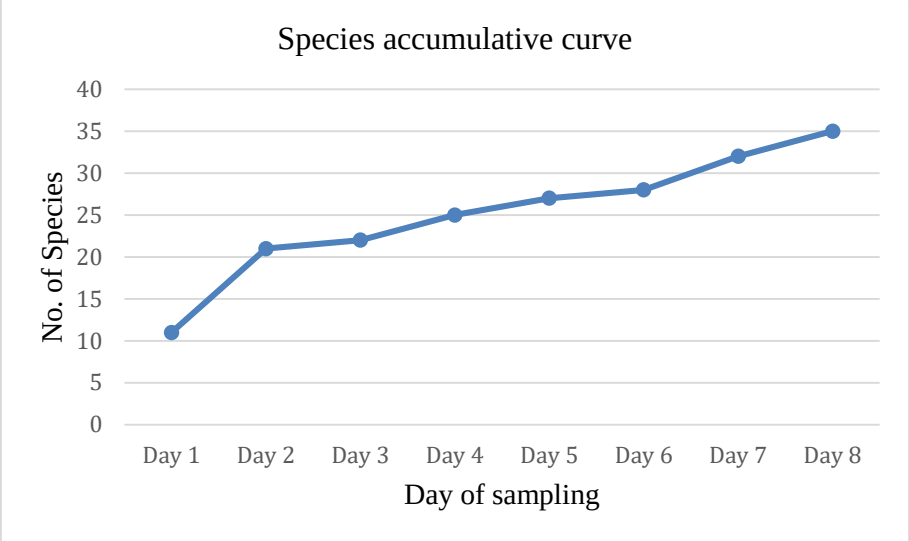


Fig. 5 - Species accumulative curve

3.4 Data Indices

Calculation of the Shannon's Index (H) resulted in the value of 2.6126. This value indicated a medium diversity of odonate. In Shannon's Index, a value of 1 to 1.5 would indicate a low diversity, 2 to 3 a medium, and 4 and above a high diversity. With more sampling effort resulting more species and number of individuals caught, the index value could be improved.

3.5 Odonate As Tourism Product

Endemism, rarity, sighting reliability, physical appeal, behavioural enticement, safety, and connectivity to local cultures are some of the recommended criteria utilised to design a good nature tourism product [14]. Anuran Tourism, a new industry for nature tourism promoting frogs and toads that has been successfully established in Sabah, is an example of organism-based tourism in Malaysia [8][14]. Refer to the Appendix A for the table list of 10 flagship odonates that have been chosen as potential nature tourism product. They are discussed below.

- *Podolestes buwaldai, Argiocnemis rubescens* and *Ceriagrion cerinorebellum*

  These species are considered safe tourism product since they do not sting or bite human. This species are not harmful in general and their size are modest. *Podolestes buwaldai* mostly can be seen through inside the trail "Denai Interpretasi" because they prefer the shaded area. This species is smaller than *Podolestes orientalis*, recognized by their salmon-red legs and have a yellow marking throughout their body. *Argiocnemis rubescens* is a damselfly species which adult male have all marking blue and female olive colour markings. *Ceriagrion cerinorebellum* has greenish eyes, bluish above the abdomen, thorax is yellowish green and brick red colour tail. Unfortunately, these species do not fulfill the behavioral enticement, rarity and also endemism criteria. These species are not rare, it can be found all over the world. To date, no endemic odonates species had been identified in North Ayer Hitam Forest Reserve. Perhaps further sampling would reveal new records or species in the future. For damselflies, there are not much information about its cultural link with some people in Malaysia. Both damselflies and dragonflies are appreciated for their ability to serve as bioindicators in freshwater habitats.

- *Brachygonia oculata, Nannophya pygmaea, Neurothemis fluctuans, Orthetrum chrysis, Raphismia bispina, Rhyothemis obsolescens* and *Tramea transmarina*.

  The safety of an organism-based nature tourism product is an important and vital feature, and dragonflies are considered as safe tourism products since they do not sting or either bite human. Most of these dragonflies can be seen at the open area where dragonflies may easily caught and observed, especially during sunny and dry weather conditions. Dragonflies are thought to be predictable in terms of their presence, as they are plentiful and easily spotted. Most of these dragonflies have a brilliant and eye-catching colour that may interest the visitors. For example, *Brachygonia oculata* may be identified by its small size and a combination of powder blue and orange on the abdomen, but its females vary from the males in that they are brown with minor features. *Raphismia bispina* has blue colour on their abdomen and dark clour on its tail. *Nannophya pygmaea* is more easily spotted since it is the tiniest

anispoteran in the region and one of the smallest in the world; mature adults have almost totally red abdomens, while young are light brown. *Orthetrum chrysis* was the biggest of the selected flagship species and was clearly identified by its crimson abdomen. *Neurothemis fluctuans* can easily spotted which their male adult mainly brown abdomen, have a red marks on their wings and have distinctive hindwing pattern, while female has hyaline wings and slightly yellow tint at base. *Rhyothemis obsolescens* also easy to spotted which both male and female have similar characteristics that easily recognized by its bronze wings with a slight magenta reflex and variety of light and dark markings. However, these species do not fulfill the rarity and endemism criteria. These species are not rare and can be found all over the world. To date, no endemic odonates species had been identified in North Ayer Hitam Forest Reserve. Perhaps further sampling would revealed new records or species in the future. For the behavioral enticement, the dragonfly swirls in surprising movements in the air, hovering momentarily before immediately migrating to a new spot. Dragonflies are not fast, yet they are extremely acrobatic fliers. They have the ability to drive themselves upwards, downwards, backwards, forwards, side to side, and even float in midair. This is owing to the incredible construction of their two sets of wings. Dragonflies can fly in all directions because each wing can move independently of the others. Their wings are both robust and flexible, allowing them to bend, cut through the air, and hover even in the facing of the greatest headwind [15]. Its fore and hind wings are regulated by different muscles, and the phase relationship between those wings during various moves is a distinguishing element of the dragonfly's wing movement [16]. The dragonfly is known as "dediyui" by the Jakun people of Kampung Peta. Dragonfly myths are associated with the phenomena of dragonflies appearing in huge numbers in the house neighborhood and entering the house. This is a symptom of the sickness season, which includes fevers, colds, coughs, and headaches. The Jakun village prohibited the catching of dragonflies during the time, despite the fact that dragonflies were frequently used as children's toys [17]. Dragonflies are appreciated for their ability to serve as bioindicators in freshwater habitats. Odonate larvae are used as biocontrol agents for insect pests. They are also necessary for controlling insect infestations. Their adults are potent biocontrol agents against key commercial agricultural pests in Pakistan (rice, cotton, and sugarcane). Adults of aphids, jassids, whiteflies, leaf folders, and leaf hoppers have been recorded feeding by the dragonflies [18].

3.6 Development and Packaging of Odonate As Nature Tourism Product For AHFR

For the product development in Odonatourism there are six process. Firstly, the potential organism was identified. In this case, the identification of the odonate based on the book [5]. Secondly, more research and secondary data and information about the organism had been done through internet searching using search engine such as google. Information needed are include their morphology, characteristic, and behaviour. Thirdly, from the obtained data on the diversity odonate, the odonates were evaluated against the eight characteristics of a good nature tourism product. The species of odonate recorded will be evaluated and compared using eight criteria of a good organism-based tourism product that was suggested by [8][14]. The species with the highest score were chosen as flagship species. The eight criteria are endemism, rarity, reliability of sightings, morphological attractiveness, behavioural enticement, safety, linkage to the local cultures and ecologically linkage. Fourthly, the chosen species would package based on a good and systematic story board. Lastly, these packages are promoted through brochures, multimedia or social media and advertisements. The proposed brochure design is as in the Appendix B and Appendix C. To complete the process, prototypes of souvenir was be produced to accompany the promotion of Odonatourism package which is the customized tote bag designed by the first author. A memento is a kind of cross-cultural product including ethnic marketing. The idea of this prototype could be made by the students itself with a low budget which a tote bag with an eye catching design and have the branding logo that promoting North Ayer Hitam Forest Reserve as the main attraction. This quality handmade tote bag is pretty and useful and the pricing still in the affordable range.

4. Conclusion

To summarise, this study provided the most recent preliminary data on odonates diversity in North Ayer Hitam Forest Reserve, with a total of 35 odonate species reported during the sampling period. The Shannon Weiner Species Diversity Index is H=2.6126, indicating that there was a medium diversity of odonate in North Ayer Hitam Forest Reserve, highlighting the potential development of odonates as a tourism product. Ten species had been identified as flagship species with potentials of being nature tourism products. A prototype for souviner had been produced.

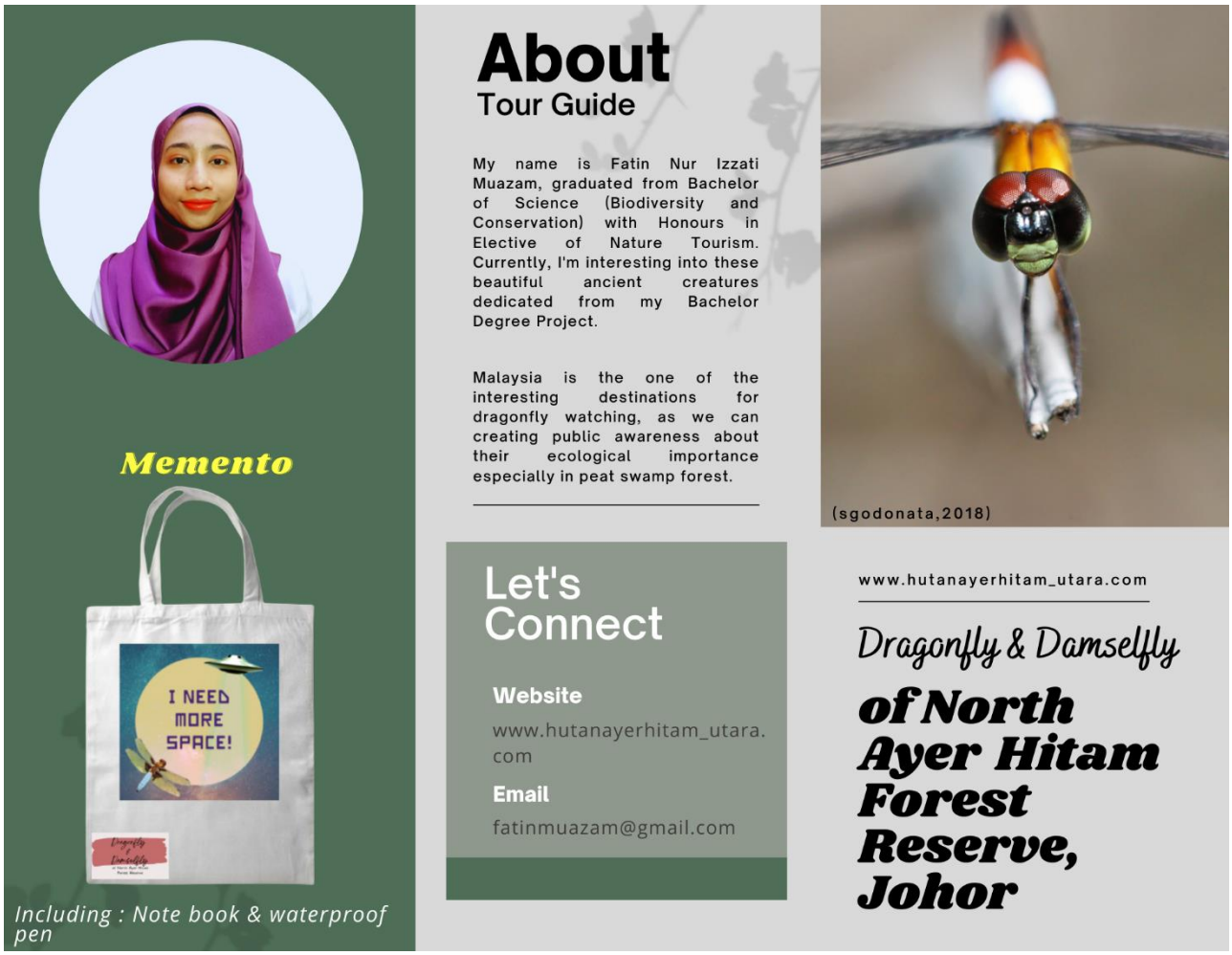
Acknowledgement

The authors would like to thank the Faculty of Applied Sciences and Technology, Universiti Tun Hussein Onn Malaysia, Pagoh Campus for providing facilities for this research. Huge thanks to the staff of Johor Forestry Department for the guidance during the research sampling. This research was conducted under research permit Grant Tier 1 Vot No H996 awarded to Associate Professor Dr. Alona Cuevas Linatoc. Gratitude are also extended to Nur Fatini Binti Mohamed Zamri, Abdul Muhaimin Bin Abdul Halim, Muhamad Qamarul Abidin Bin Mohd Zawawi, and Fasihah Binti Abu Hasan for their assistance throughout the study period.

Appendix A: The Criteria of Ten Flagships of Species in North Ayer Hitam Forest Reserve, Johor.

Species/Criteria	Safety	Reliability of sightings	Morphological attractiveness	Behavioural enticement	Rarity	Endemism	Cultural linkage	Ecological importance	Score
1. *Podolestes buwaldai*	/	/	/					/	4
2. *Argiocnemis rubescens*	/	/	/					/	4
3. *Ceriagrion cerinorebellum*	/	/	/					/	4
4. *Brachygonia oculata*	/	/	/	/			/	/	6
5. *Nannophya pygmaea*	/	/	/	/			/	/	6
6. *Neurothemis fluctuans*	/	/	/	/			/	/	6
7. *Orthetrum chrysis*	/	/	/	/			/	/	6
8. *Raphismia bispina*	/	/	/	/			/	/	6
9. *Rhyothemis obsolescens*	/	/	/	/			/	/	6
10. *Tramea transmarina*	/	/	/	/			/	/	6

Appendix B: The Front Page of Brochure



Appendix B: The Second Page of Brochure

Flagship species

The ten species selected as flagship species can be seen at the trail.

Podolestes buwaldai

Is a damselfly species that known as Buwalda's Flatwing. It has obscure yellow marking and salmon-red legs.

Argiocnemis rubescens

Is a damselfly species that known as Red-tipped Shadefly. Adult male have all marking blue, and female olive colour markings.

Ceriagrion cerinorebellum

Is a damselfly species that known as Orange-tailed marsh dart. It has greenish eyes,bluish above, thorax is yellowish green and brick red colour tail.

Brachygonia oculata

Is a dragonfly species known as Pixie. It easily recognized by small size and combination of powder blue and orange in their abdomen. Below is female, it has brown in color and have small size too.

Raphismia bispina

Is a dragonfly species known as Spiny-chested Percher. Its abdomen slightly expanded, has blue colour in body and dark colour on its tail.

Nannophya pygmaea

Is a dragonfly species that known as Scarlet Pgymy, easily recognized, one of the smallest in region. Male mature adult almost entirely red, while female mature adult (above) are in light brown colour.

Neurothemis fluctuans

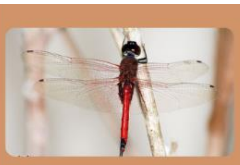
Is a dragonfly species that known as Red Grasshawk Dragonfly. Male adult mainly brown abdomen, lacking in red marks and has distinctive hindwing pattern. While female, has hyaline wings and slightly yellow tint at base.

Orthetrum Chrysis

Is a dragonfly species that known as Red Grasshawk Dragonfly. Male adult mainly brown abdomen, lacking in red marks and has distinctive hindwing pattern. While female, has hyaline wings and slightly yellow tint at base.

Rhyothemis obsolescens

Is a dragonfly species that known as Bronze Flutter. Both male and female have similar characteristics which is easily recognized by its bronze wings with a slight magenta reflex and variety light and dark markings.



Tramea transmarina

Is a dragonfly species that known as Red Glider Dragonfly. Easily recognized by dark patch at base of hindwing, have dark thorax and bright abdomen in red.

WANT TO KNOW THEM?

Package A: Workshop with me

"Get your Dragonfly & Damselfly knowledge for appreciating them"

- Open to the student or school children
- RM 20/person
- 9.00 am - 1.00 pm
- 1 hour 30 minutes tour guide

TENTATIVE:
9.30 am- 10.30 am: Seminar (Introducing with Dragonfly & Damselfly in North Ayer Hitam Forest Reserve
10.30 am- 11.45 am: Fun with some activities
11.45 am- 1.15 pm: Watching Dragonfly & Damselfly

Package B: Dragonfly & Damselfly race

"Spend your time for watching them and try to identifying tnem"

- Open to the adults
- RM 25/person
- 10.00 am - 1.00 pm
- 1 hour 30 minutes tour guide

TENTATIVE:
10.00 am- 10.15 am: Briefing the safety to the tourists
10.15 am- 12.00 pm: Race start along the trail
12.00 pm- 1.00 pm: Identify the species with tour guide
1.00 - 2.15 pm: Learn about how to curate the Dragonfly and Damselfly properly
2.15 pm- 2.30 pm: Take tourists to look at the mini-exhibitions (Dragonfly & Damselfly display box)
2.30 pm- 2.45 pm: Sharing session (Feedback)
2.45 pm- 3.00 pm: Photo session and tour end

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