ENHANCED KNOWLEDGE IN SCIENCES AND TECHNOLOGY
e-ISSN: 2773-6385

EKST

Vol. 4 No. 2 (2024) 673-679
https://publisher.uthm.edu.my/periodicals/index.php/ekst

Digitizing Odonata Specimens and Enhancing Data Accessibility through the BIDARA Database

Ely Ezleen Roslin[1], Arney Sapaat[2]*

[1] *Faculty of Applied Science and Technology, Universiti Tun Hussein Onn Malaysia (UTHM), Pagoh, Muar, 84600, Johor, MALAYSIA*
[2] *Centre of Research for Sustainable Uses of Natural Resources (CoR-SUNR) Universiti Tun Hussein Onn Malaysia (UTHM), Pagoh, Muar, 84600 Johor, MALAYSIA*

*Corresponding Author: arney@uthm.edu.my
DOI: https://doi.org/10.30880/ekst.2024.04.02.072

Article Info

Received: 28 December 2023
Accepted: 13 January 2024
Available online: 12 December 2024

Keywords

Digitization, digitize, odonata, BIDARA, natural history museum

Abstract

Natural history museum collections are an invaluable source of information on storing the remains biodiversity of the Earth from the past until present, particularly for providing detailed historical data and morphological reference specimens. The data and information are mostly store in physical form, and digitization of collections offers public access to the information of specimens and images data to discuss species ecological distribution and morphological for future actions on conservation efforts. Many museum collections of Odonata around the world still lack comprehensive digitization, posing several challenges and limitations to researchers and educators. This study aims to set up a database platform for Odonata specimens from UTHM Natural History collection and to digitize Odonata specimens into Biodiversity Data Integration for Research Assets (BIDARA) database. To achieve the objective, a low-cost methods for digitization process is conducted, from pre-digitization, during and exporting images and information of digitized odonata specimens from UTHM Natural History collection into BIDARA, a biodiversity database platform develops under efforts of Centre of Research for Sustainable Uses of Natural Resources (COR-SUNR). At the end of this study, the odonata specimens from UTHM Natural History collection were successfully digitized and included in the BIDARA database. The digitized odonata specimens in this study contributed to Johor biodiversity information. The images of odonata specimens served as the reference for future studies.

1. Introduction

Odonata is an order name which means “tooth” originally from Greek refers to sturdy toothed mandibles. The Odonata are a class of ancient insects whose remains have been found in Permian-era North America and Russia. A fossil species that was alive at the time had a wingspan more than 70 cm. Only three of the Odonata's several suborders still exist today which is Anisoptera (dragonflies), Zygoptera (damselflies), and Anisozygoptera, which consists of a small family found in the Himalayas and Japan [1]. These three suborders are divided based on their wing venation [2] while Anisozygoptera is a transitional element between the dragonflies and the damselflies [1]. [3] defines digitization as a process for converting a target specimen into a digital format and stated that natural

objects, such as insects and plants, have been important targets of digitization because digital formats have various benefits in which they are deterioration-free, space-efficient, and highly accessible.

The main objective of this study is to set up a database platform for Odonata specimens in UTHM Natural History collection, which the public can access on the availability of various specimens in UTHM Natural History collection. In addition, to digitize Odonata specimens into Biodiversity Data Integration for Research Assets (BIDARA) database, to preserve and monitor the physical form of the specimens, BIDARA serves as a backup on store the specimen's information and data in digital form. By settings up database platform for Odonata specimens, this study will contribute to Odonata species identification, conservation status and its distribution. The database should be accessible to everyone, especially researchers for identification of odonata species, educators and students for educational and learning purposes. The establishment of Biodiversity Data Integration for Research Assets (BIDARA) database will offer partnerships and collaborations opportunities for data sharing, collaboration, and integration with other biodiversity databases such as MyBis, GBIF, and iDigBio, and further in promoting interdisciplinary research and a deeper understanding of the interactions between Odonata and its environments. By digitizing the Odonata specimens, enable the users to explore and learn various species of Odonata available within Johor.

2. Materials and Methods

2.1 Collection Site

In this study, Odonata specimens are primarily obtained from the Centre of Research for Sustainable Uses of Natural Resources (CoR-SUNR) workshop, Shared Physics Laboratory 1 (Taxonomy) and Shared Laboratory 2 (Ecology). Different species of odonata specimens are gathered from various collections of different identifier or collector from 2016 until the present.

2.2 Digitization Process

2.2.1 Photography

A single DSLR Canon EOS 70D camera with a macro lens Tamron 90 mm attached, are angled at the exposed side of mini light box studio, captured the specimens and focused on the important features and characteristics of odonata specimens. The shooting function of camera are optimized unto manual shooting mode – M, aperture – F9.0, shutter speed – 1/100, ISO speed – 100, flash exposure compesation – +1/2 and image-recording quality – RAW + L; to capture a raw images format and processed images to create and save as JPG file format.

Fig. 1 shows the proposed setup for digitization process. The stage is made of A4 cut styrofoam and a A4 foam board with 5mm thickness. A measurement ruler is stick up onto the foam board for measurement of the pinned odonata specimens' forewings , hindwings and its body length. This measurements is significant, mainly for species identification and classification.

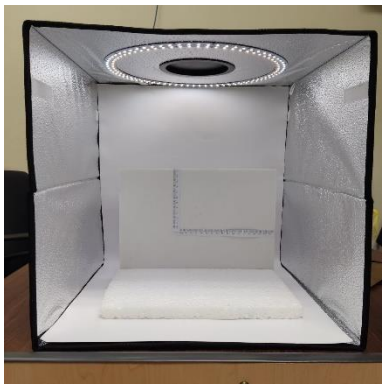


Fig. 1 *Setup for digitization process*

2.2.2 Information of the specimens

Scientific name, common name, taxonomic classification, collector's name and location of collected species is adjusted with the information to the collected specimen. Label collected specimen proceeded to digitization

Enhanced Knowledge in Sciences and Technology Vol. 4 No. 2 (2024) p. 673-679

process. The data information of collected specimen inputted and adjusted with the captured images of odonata specimen into BIDARA database.

2.2.3 Upload specimens information into database

The images and data information of specimen from UTHM Natural History collection are compiled and adjusted, and uploaded into BIDARA database and grouped according to its order of insects (i.e. Class Insecta) by following [1], Order Odonata and divided into suborders: Anisoptera (dragonflies), Zygoptera (damselflies), and Anisozygoptera.

2.3 BIDARA Database

BIDARA is an abbreviation for Biodiversity Data Integration for Research Assets which, this platform combines a biodiversity database with Geographic Information Systems (GIS) mapping and image recognition, established by UTHM. BIDARA intends to offer a sustainable biodiversity research ecosystem aided by data sharing with a centralised chain from biodiversity data collection, verification, and dissemination in UTHM. UTHM also established BIDARA database to promote further research advancements and moving towards modernization by digitizing physical specimen, thus safeguarding the specimen with data. These effort promotes further research advancement and commitment to nationhood and community.

3. Results and Discussion

3.1 Digitization of Odonata specimens

The odonata specimens collected from the collection site, Centre of Research for Sustainable Uses of Natural Resources (CoR SUNR) workshop were primarily damselflies (Zygoptera) and dragonflies (Anisoptera). Table 1 shown a total of 10 individuals belongs to different species from 2 families, were gathered for digitization process. Family Libellulidae had 9 individuals, recorded the most abundant odonata specimens from suborders Anisoptera (dragonflies) whereas Family Coenagrionidae from suborders Zygoptera (damselflies) had 1 individual.

In terms of odonata population in Johor, UTHM Pagoh was the most frequent location where specimens were collected, with 5 individuals found at the site. The abundance of waterbodies in UTHM Pagoh is likely a major factor contributing to its high population of odonata. The majority of specimens collected at UTHM Natural History collection were categorized as Least-Concern (LC) according to the IUCN Red List.

Table 1 *Odonata specimens gathered from UTHM Natural History collection site for digitization*

Family	No.	Scientific Name	Common Name	Collector/ Identifier	Location	IUCN Status	No. of Individual
Libellulidae	1	*Acisoma panorpoides*	Asian Pintail	Aisyah A.	UTHM Pagoh	LC	1
	2	*Macrodiplax cora*	Cora's Pennant	Ely Ezleen	UTHM Pagoh	LC	1
	3	*Neurothemis ramburii*	Red Percher	Ely Ezleen	UTHM Pagoh	LC	1
	4	*Orthetrum luzonicum*	Marsh Skimmer	Ely Ezleen	Ayer Hitam Utara Forest Reserve	LC	1
	5	*Orthetrum sabina*	Slender Skimmer	Izzah Kamal	UTHM Pagoh	LC	1
	6	*Orthetrum testaceum*	Orange Skimmer	Wh. Wong	Pagoh Residential College	LC	1
	7	*Rhyothemis obsolescens*	Bronze Flutterer	Ely Ezleen	Ayer Hitam Utara Forest Reserve	LC	1
	8	*Rhyothemis phyllis*	Yellow-barred Flutterer	Lee Tze Jien	Perwira Residential College	LC	1
	9	*Tholymis tillarga*	Old World Twister	Ely Ezleen	UTHM Pagoh	LC	1
Coenagrionidae	10	*Ischnura senegalensis*	Tropical Bluetail	Aneesa	Endau-Rompin Johor National Park	LC	1
		TOTAL					**10**

3.2 Images exportation into BIDARA

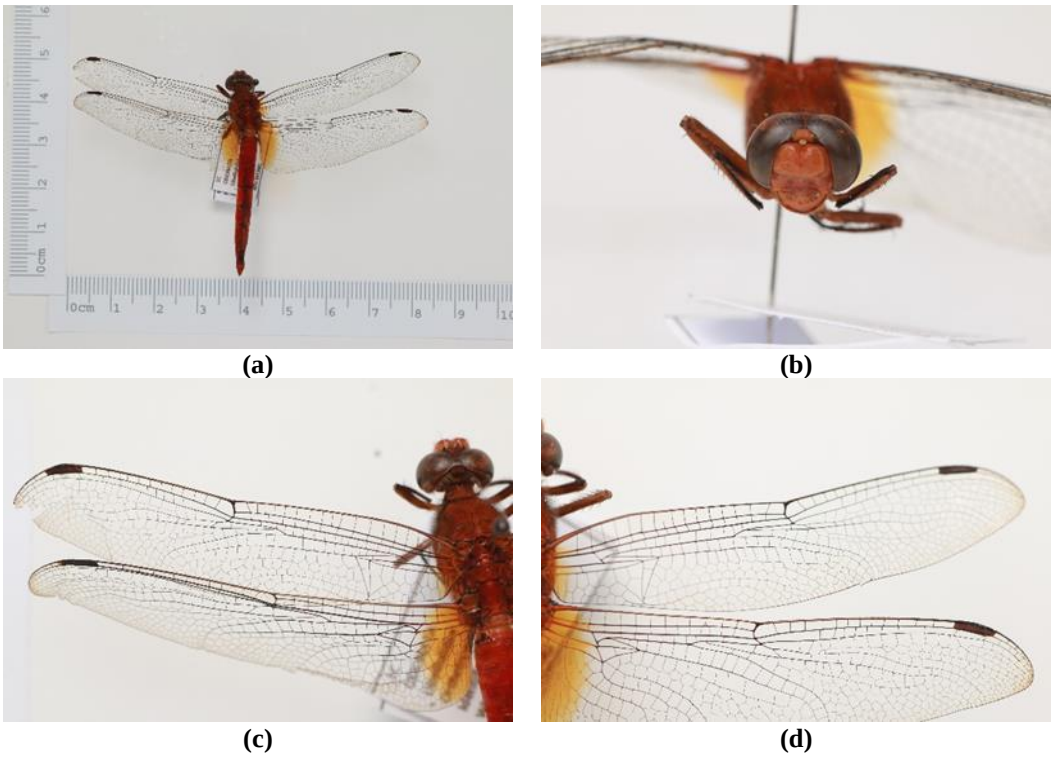


Fig. 2 *Images of Orthetrum testaceum (a) Whole body; (b) Front head; (c) Left forewings and hindwings; (d) Right forewings and hindwings*

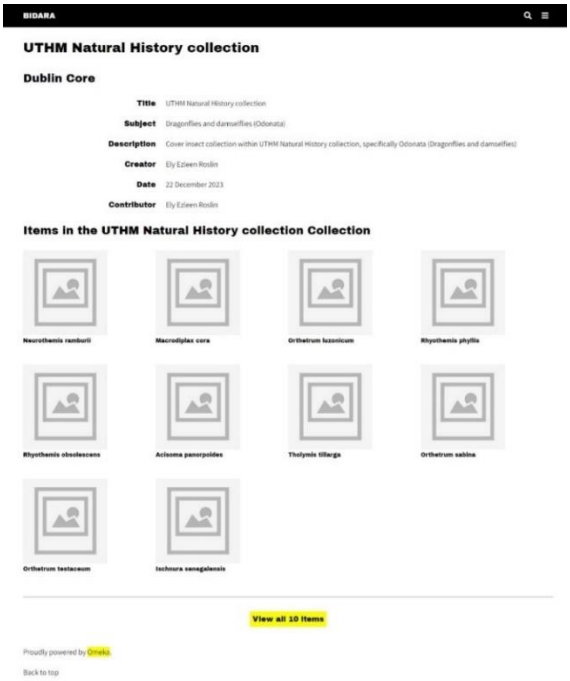
Fig. 2 shows the results of high-resolution quality captured image of *Orthetrum testaceum* in JPG file format. For damselfly and dragonfly specimens, the hindwings, forewings, and body length measurements contribute significantly to their identification. High-quality photographs of Odonata wing venation are important to capture the microstructure on their wing veins. This microstructure, such as saw-tooth ridges and other venation patterns, is often visible in high-resolution images, allowing for detailed study. For instance, a study on the golden ratio in venation patterns of dragonfly wings used high-resolution images to explore the naturally optimized venation structure in dragonfly wings [4]. Therefore, high-quality photographs are essential for accurately documenting and studying the intricate details of Odonata wing venation [5].

A study on *Cordulegaster boltonii* [6], a species widely distributed in the western Palaearctic, quantified the main characteristics of its wing venation, including the number of antenodal and postnodal cross-veins, and the number of cells in the anal triangle and anal loop. The study revealed variations in these characteristics among males and females, as well as among populations from different geographic regions. Moreover, a structural engineering approach to the wing morphology of Odonata [7] highlighted the importance of small cross-veins as stiffeners within the wing structure, allowing the membrane to carry web shearing forces as pure tension. Thus, provided high-quality photographs of hindwings and forewings of odonata, contributes to research for taxonomic differentiation and understanding the mechanical properties of wing venation of odonata specimens.

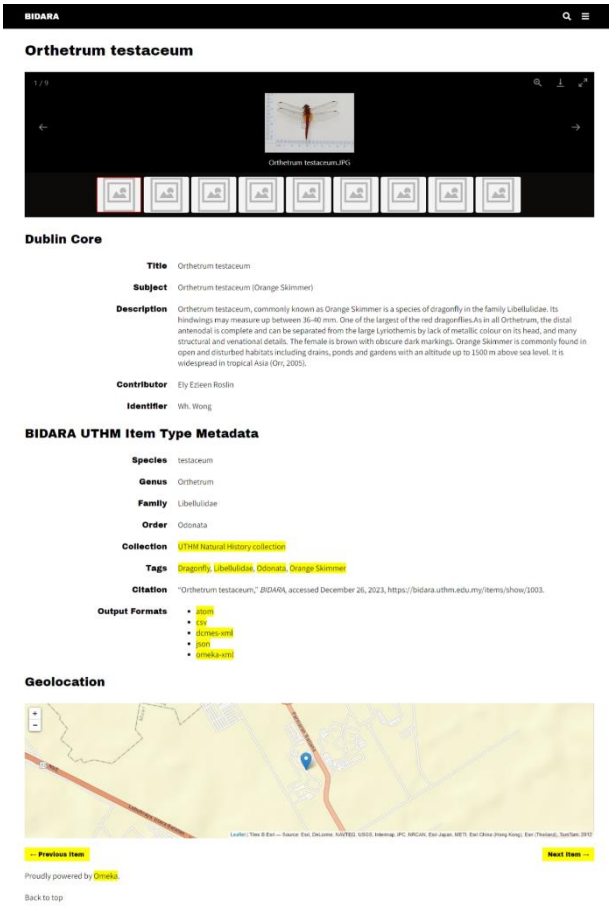
The result of photographs taken is significant for 3D modeling of Odonta. Another study published in PLOS ONE [8] presented an automated device for the digitization and 3D modeling of insects, including Odonata, combining extended-depth-of-field and all-side multi-view imaging. The resulting images can be used to generate a calibrated and real color texturized 3D model by 'structure from motion' with a visibility consistent mesh generation. Such models are ideal for obtaining morphometric measurement data in 1D, 2D, and 3D, thereby opening new opportunities for trait-based research in taxonomy, phylogeny, eco-physiology, and functional ecology.

Enhanced Knowledge in Sciences and Technology Vol. 4 No. 2 (2024) p. 673-679

(a)



(b)



(c)

Fig. 3 *BIDARA interface (a) Homepage of BIDARA; (b) Digitized Odonata specimens in BIDARA collection; (c) Details information of specimens in BIDARA webpage*

Fig. 3(a) depicts the public view of the Featured Collection homepage in BIDARA. Featured collection put on view at the main webpage of BIDARA for users to direct access the collection. Additionally, the BIDARA webpage, as shown in Figure 3(b), displays the items, which the Odonata specimens represented with the scientific name in collection. Scientific name that put as the title on every digitized odonata made for users to navigate through UTHM Natural History collection, allowed the users to explore various odonata species. Figure 3(c) displays detailed information about the odonata specimens, specifically their taxonomic classification divided into Order, Family, Genus, and Species. Specimen descriptions, identifier information, and the geographical location of collection displayed in BIDARA webpage, offered users to view more of the specimens information.

Furthermore, [10] proposed an online database named OdoBD, which the database allowed public to submit species to keep up-to-date on the database. These section in webpage ease the admin to collect data and photographs from public, contributing to Bangladesh biodiversity data, differ from BIDARA does not have the submit species section. Besides, OdoBD provided information of flight season, local and global distribution, IUCN status and, gene and protein sequences of every species of Odonata unlike BIDARA. [10] captured photos mostly from photos deposited on the database from year 2012 to 2016, specifically collected photographs from citizen scientist from the website portal and credited the photographers, unlike BIDARA captured photos of physical specimens from UTHM natural history collection.

Another online database, named Odonate Phenotypic Database (OPD) is an online resource that provides information on the morphology, abundance, gene and protein sequences, local and global distribution, and conservation status of dragonflies and damselflies [9]. Unlike BIDARA, OPD offered details information of males and females body size, body colors, morphisms, behaviour, location and habitat, and wing pigmentation. However, OPD did not provide images of specimens instead, OPD allowed to download a lists of Odonata in Excel file format, while BIDARA provided images of specimens.

4. Conclusion

At the end of this study, the odonata specimens from UTHM Natural History collection were successfully digitized and included in the BIDARA database. The digitized odonata specimens in this study contributed to Johor biodiversity information. The images of odonata specimens served as the reference for future studies. This study has some limitations, which some specimens is molded, the forewings and hindwings is damaged, and the color of wings and body faded resulting in difficulties to identify the species of specimens. Moreover, the preview images of specimens did not appear after uploading into BIDARA.

Acknowledgement

Our appreciation to the Centre of Research for Sustainable Uses of Natural Resources (CoR-SUNR) for making this research possible and allowing us to conduct this research by using the specimens in UTHM Natural History collection.

Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The author confirms sole responsibility for the following: ***study conception and design***, ***data collection***, ***analysis*** *and* ***interpretation of results***, *and* ***manuscript preparation***.

References

[1] Gibb, T. J., & Oseto, C. (2019). Insect collection and identification: techniques for the field and laboratory. Academic Press. pp. 192-193. https://doi.org/10.1016/C2018-0-00136-X

[2] Muhamad Amirul Ashraf Abdul Aziz, Maryati Mohamed, & Lili Tokiman. (2018). Faunistic studies of odonates (Insecta: Odonata) in Johor, Peninsular Malaysia. Serangga, 23 (2(SI)). pp. 14-35. ISSN 1394-5130

[3] Ijiri T, Todo H, Hirabayashi A, Kohiyama K, Dobashi Y (2018) Digitization of natural objects with micro CT and photographs. PLoS ONE 13(4): e0195852. https://doi.org/10.1371/journal.pone.0195852

[4] Lu, K., Shen, S., Miller, L. M., & Huang, X. (2023). Golden ratio in venation patterns of dragonfly wings. Scientific Reports, 13(1), 7820.

[5] Tann, J. T. J. (2021). Images of Australian Odonata wings. Technical Reports of the Australian Museum online, 33, 1-101.

[6] Nunes, L. F., Santamaría, T., Casanueva, P., Sánchez-Sastre, L. F., Ferreras-Romero, M., Romero, Á., ... & Hernández, Á. (2023). Patterns of variation in wing venation of Iberian Cordulegaster boltonii (Donovan, 1807)(Odonata: Cordulegastridae). International Journal of Odonatology, 26, 164-171.

[7] Newman, D. J. S., & Wootton, R. J. (1986). An approach to the mechanics of pleating in dragonfly wings. Journal of Experimental Biology, 125(1), 361-372.
[8] Nel, A., Garrouste, R., & Schubnel, T. (2019). Response to Trueman and Rowe (2019) 'The wing venation of Odonata. International Journal of Odonatology". International Journal of Odonatology, 22, 115 - 119.
[9] Waller, J. T., Willink, B., Tschol, M., & Svensson, E. I. (2019). The odonate phenotypic database, a new open data resource for comparative studies of an old insect order. Scientific data, 6(1), 316. https://doi.org/10.1038/s41597-019-0318-9
[10] Shah MNA, Khan MK (2020) OdoBD: An online database for the dragonflies and damselflies of Bangladesh. PLoS ONE 15(4): e0231727. https://doi.org/10.1371/journal.pone.0231727