How to Reclaim Your Dragons? A Retrospective Review on Odonatology in West Sumatra, Indonesia

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Abstract. Dragonflies and damselflies (Odonata) were not really popular subjects for biological studies at least until a decade ago in West Sumatra. In many scientific publications published by Lieftinct, a colonial era odonatologist, not many localities in West Sumatra mentioned as the origin of his odonata specimens. In this study, we intend to review the extent of current odonatological works in West Sumatra to gain perspective on the ongoing scientific aspects of this taxon. We used literature study method to compile data from historical and recent bibliographies, published works and other resources regarding dragonflies in West Sumatra. As result, from around 294 odonate species ever recorded in Sumatra Island, 98 species have been recognized from within the borders of West Sumatra Province with more than half recently re-observed. Albeit most publications are taxonomical and inventorial in their nature, further survey works are still needed to gain thorough insight on West Sumatran odonates. Meanwhile, the current studies and researches indicate the possibilities that dragonflies can also be integrated into the wider aspects, such as ecotourism, pest management, landscaping, environmental impact assessment, aesthetic and many others. Hence, introducing odonates as fascinating study object to the new generation of biologists can help furthering the advance and diversification of odonatological study in West Sumatra.

Keywords: Ecotourism; Lieftinct; Odonatologist; Taxonomical; Universitas Andalas

1. Introduction

More than 6000 Odonata species, consist of dragonflies and damselflies, roam the earth surface and most of them distributed around tropics where abundant aquatic habitats available [1,2]. The Oriental, Australasian and Neotropical regions in the world hold the most diverse odonate species, in which predicted between 1,000 – 1,500 species are still waiting to be described [3]. As part of Oriental region, Indonesia possesses ample amount of odonate species, especially in its big islands such as Borneo, Java and Sumatra. Unfortunately, these islands (especially Sumatra) face tremendous threats during recent decade, mainly from deforestation of its primary forest cover, shifted into various human made landscapes [4]. Dragonflies become one of those biodiversity that seriously impacted in this situation, which might severely result into local to national extinction of the species [5,6].

Indonesian odonates have been studied as early as the second half of eighteenth century, where an officer of the Dutch colonial started collection and description of an array of the insect groups from the archipelago [7]. The colonialism period from seventeenth century until mid-twentieth century became a golden period where many odonate species were described and numerous museum or private specimen collections amounted which later serve as valuable reference materials [8]. Meanwhile in Sumatra, prominent works on odonates shown by Ris and subsequently Lieftinck [9,10]. The latter listed more
than 180 species description based on Sumatran specimens, provided a rigid step for the full coverage of odonate species in this island. Currently, Sumatra is estimated to harbor around 300 odonate species [11].

Last decade was thought to be the emergence of interest among Indonesians to odonatology [8]. Supported with the social media and sophisticated gadgets, many of them that are from young generation diligently document odonates from their surrounding and amass online database for Indonesian Odonata. This positive awakening, however, is seen more pronounced in Java as it is the central region of the country with many supporting factors on its behalf. Including here the existence of many prominent research institutions that contribute in promoting the interest in odonatology. In other parts of the country, especially outside Java, where considered to have much less favorable conditions, it is necessary to assess how odonatology have progressed through time. Hence, in this paper we discuss what have been done up until recent time on West Sumatran odonatology, which in turn helping to determine possible steps to further develop it.

2. Material and Methods
This study reviewed the literatures on dragonflies that consisted of published papers, articles, journal and other scientific materials that related to Odonata and West Sumatra. The materials were sought using keywords such as ‘odonata’, ‘dragonfly(-ies)’, ‘damselflly(-ies)’, ‘capung’, ‘capung jarum’, ‘Anisoptera’, combined with ‘Sumatera Barat’, ‘West Sumatra’, ‘Padang’ and other localities in the province. Literature searching involved the use of online searching engine like Google Scholar and ResearchGate, where Odonata scientific literatures were then downloaded from open-access journals, university repositories as well as using personal copies of Odonata article.

Literature review was the main method used in this research. It has been recognized as reliable tool to analyze and synthesize research problems as mentioned above [12,13]. All gathered materials then sorted and tabulated according criteria such as year, nationality of author(s), locality of study site, research topics and others. Based on the tabulation of these criteria, we analyze the trend in West Sumatran odonatology, what have and have not been done and what can be further done in the future.

3. Results and Discussion
3.1. Current literatures and species inventory for West Sumatran Odonata
There were twenty publications on Odonata that are related, in overall or partially, to West Sumatra region. Six of those publications were authorized by foreign researchers (Figure 1). The earliest publication came from year 1926, discussing about odonata in Mentawai Island [14], along with other four publications [9,10,15,16] belong to the period of pre-2000 publications (Figure 1). One publication by foreigner author [17], along with Indonesian authors’ papers were published post 2000 period [18-31]. Most of Indonesian publications are university-based student thesis, except those published through scientific journals. All Odonata publications for West Sumatra recorded in this paper represent 5.6% of total Odonata publications for Indonesia region [8].

Most of publications are in English, regardless the authors’ citizenship (Figure 1). Language used in publishing a scientific paper will influence the scope of readers it can reach. English is considered as one major language in research and communication despite it may be less globally popular than Mandarin Chinese, Hindi and Spanish [32]. One publication was published in Dutch language [9], however, there might more untraceable publications regarding West Sumatran Odonata from the Dutch colonial era. The keywords used in online searching engines may have limitation in reaching these old literatures nor they have not been digitalized which shortened their traceability through internet network.
The species diversity became the most popular topic observed among West Sumatran Odonata publications (Figure 2). It is understandable, as field exploration to exhaustively record every possible existing species is necessary to reveal total taxa in a certain area. The data is essential to provide a baseline for further advance studies. It can be seen in some recent publications that expanded their fields of study into ‘species ecology’ that discussed the dynamic of odonata community in certain habitat, ‘taxonomy’ where new species described, or into more applicative area such as ecotourism and rearing efforts.

An assessment of the total number of species ever observed within the administrative boundary of West Sumatra was made by combining the historical and current data of Odonata in this province (Table 1). There have been recorded ninety-eight species of dragonflies and damselflies from thirteen families for West Sumatra Province, where more than half of this number was recently re-observed [27-30]. The Odonata species that have not been re-observed in this inventory become imminent tasks for any odonatologist who works in this province to reconfirm them, in addition to keep looking for new species, new distribution record and other pertinent aspects. Some species from historical surveys are also required reconfirmation for their validity as current knowledge and technology may help revealing their actual taxonomic position and identity, something which might not be available in the past.

The current odonatological work in West Sumatra grows involving more aspects other than mere species diversity. It also covers ecological aspects on adult dragonflies and their nymphs [22-26], the possibility to develop ecotourism-based dragonfly-watching [30] and an attempt to rearing damselfly within laboratory setting [31]. Even after such rigorous efforts to do the inventory on Odonata, there is still opportunity to describe new species that might be missed from many previous surveys, including in West Sumatra Province [17].

Table 1. Summary of West Sumatran Odonata from historical and current data

| No | Family       | Species               | Source |
|----|--------------|-----------------------|--------|
| 1  | Devadattidae | *Devadatta argyoides* (Selys, 1859) | 10,30  |
| No | Family          | Species                           | Source                  |
|----|----------------|-----------------------------------|-------------------------|
| 2  | Lestidae       | Lestes praemorsus praemorsus Selys | 10                      |
| 3  |               | Orolestes wallacei Kirby, 1889     | 10                      |
| 4  |               | Podolestes orientalis Selys, 1862 | 10                      |
| 5  | Platystictidae | Drepanosticta draco Phan, Karube & Sasamoto, 2018 | 30, 33                  |
| 6  |               | Drepanosticta bispina Fraser, 1932 | 10, 29                  |
| 7  | Calopterygidae | Echo uniformis Selys, 1879        | 10                      |
| 8  |               | Neurobasis chinensis (L. 1758)     | 10, 27, 30              |
| 9  |               | Vestalis luctuosa (Burmeister, 1839) | 10, 27, 30            |
| 10 | Chlorocyphidae | Heliochypa fenestrata (Burmeister, 1839) | 10                      |
| 11 |               | Heliocypa vantoli Hämäläinen, 2016 | 17                      |
| 12 |               | Libellago lineata (Burmeister, 1839) | 10, 27, 30            |
| 13 |               | Libellago sselmanni Selys          | 10                      |
| 14 |               | Libellago sumatrina Albarda, 1879  | 10                      |
| 15 |               | Rhinocypha selysi Krüger, 1898     | 10, 30                  |
| 16 | Euphaidae      | Euphaea bocki McLachlan, 1880      | 10                      |
| 17 |               | Euphaea variegata Rambur, 1842     | 10, 27, 30              |
| 18 |               | Euphaea modigliani Selys, 1898     | 10, 30                  |
| 19 |               | Euphaea aspasia Selys, 1853        | 10, 30                  |
| 20 | Platycnemididae| Coeliccia membranipes (Rambur, 1842) | 10, 27                |
| 21 |               | Copera acutimargo Kruger          | 10                      |
| 22 |               | Copera annulata Selys, 1863        | 10                      |
| 23 |               | Copera ciliata (Selys, 1863)       | 10, 27, 30              |
| 24 |               | Copera lobimargo Kruger (=vittata) | 10                      |
| 25 |               | Copera marginipes (Rambur, 1842)   | 10, 27, 30              |
| 26 |               | Elatoneura coomansi Lieftinck, 1937 | 10, 18                 |
| 27 |               | Prodaseinea collaris (Selys, 1860) | 10, 27, 30             |
| 28 |               | Prodaseinea verticalis (Selys, 1860) | 10, 27, 30            |
| 29 | Coenagrionidae | Aciagrion bornensee Ris, 1911      | 10                      |
| 30 |               | Agriocnemis femina (Brauer, 1868)  | 10, 27, 30              |
| 31 |               | Archibasis melancyna Selys, 1877   | 10                      |
| 32 |               | Archibasis viola Lieftinck, 1948   | 10, 27, 30              |
| 33 |               | Argiocnemis rubescens Selys, 1877  | 10                      |
| 34 |               | Ceriagrion erubescens Selys, 1891  | 10                      |
| 35 |               | Ishnura senegalensis (Rambur, 1842) | 10, 27, 30            |
| 36 |               | Onychargia atrocyana Selys, 1865   | 10                      |
| 37 |               | Pericnemis stictica Hagen in Selys, 1863 | 10, 30                 |
| 38 |               | Pseudagrion bengalense Selys, 1876 | 10                      |
| 39 |               | Pseudagrion pruinosum (Burmeister, 1839) | 10, 27, 30            |
| 40 |               | Pseudagrion pruinosus ranauense Schmidt | 10                      |
| 41 | Aeshnidae      | Anaciaeshna jaspidea Burmeister, 1839 | 10                      |
| 42 |               | Anax gibbosulus Rambur, 1842 subspec fumosus? | 10                      |
| 43 |               | Anax guttatus (Burmeister, 1839)   | 10, 29                  |
| No | Family          | Species                                   | Source          |
|----|----------------|-------------------------------------------|-----------------|
| 44 | Gynacantha     | Gynacantha bayadera Selys, 1891            | 10              |
| 45 | Gynacantha     | Gynacantha dohrni Kruger, 1899             | 10,30           |
| 46 | Gynacantha     | Gynacantha limbalis Karsch, 1892          | 10,30           |
| 47 | Gynacantha     | Gynacantha subinterrupta Rambur, 1842     | 10              |
| 48 | Indaeschna     | Indaeschna grubaueri (Forster, 1904)      | 10,30           |
| 49 | Tetracanthagyna| Tetracanthagyna plagiata (Waterhouse, 1877)| 10,30           |
| 50 | Gomphidae      | Gomphidae                                 |                 |
| 51 |                | Chlorogomphus spec. nov.                  | 10              |
| 52 |                | Ictinogomphus decoratus (Selys, 1854)     | 10,27,30        |
| 53 |                | Ictinus melaenops Selys ?                 | 10              |
| 54 |                | Gomphidion maclachlani, Selys 1873        | 10,29           |
| 55 |                | Leptogomphus gracilis Krüger, 1899        | 10              |
| 56 |                | Megalogomphus sumatranus (Krüger, 1899)   | 10,30           |
| 57 | Macromiidae    | Macromia cincta Rambur, 1842              | 10,30           |
| 58 |                | Macromia westwoodi Selys, 1874            | 10,30           |
| 59 | Corduliidae    | Corduliidae                               |                 |
| 60 |                | Epophthalmia vittigera Rambur, 1842       | 10              |
| 61 | Libellulidae   | Libellulidae                              |                 |
| 62 |                | Aceri s panorpoides Rambur, 1842          | 10,18           |
| 63 |                | Aethriamanta gracilis Brauer, 1878        | 10              |
| 64 |                | Agrionoptera insignis (Rambur, 1842)      | 10,27,30        |
| 65 |                | Brachygonia oculata Brauer, 1878          | 10              |
| 66 |                | Brachythemis contaminata (Fabricius, 1793)| 10,18           |
| 67 |                | Camacinia gigantea (Brauer, 1867)         | 10,27,30        |
| 68 |                | Cratilla lineata (Brauer, 1878)           | 10,30           |
| 69 |                | Cratilla metallica (Brauer, 1878)         | 10,30           |
| 70 |                | Crocothemis servilia (Drury, 1770)        | 10,27,30        |
| 71 |                | Diplacodes nebulosa Fabricius, 1793       | 10              |
| 72 |                | Diplacodes trivialis (Rambur, 1842)      | 10,27,30        |
| 73 |                | Lathrecista asiatica (Fabricius, 1798)    | 10,30           |
| 74 |                | Lyriothemis biappendiculata Selys, 1878   | 10              |
| 75 |                | Nannophya pygmaea Rabur, 1842             | 10              |
| 76 |                | Neurothemis fluctuans Fabricius, 1793     | 10,27,30        |
| 77 |                | Neurothemis ramhurii (Kaup in Brauer, 1866)| 10,27,30        |
| 78 |                | Neurothemis terminata Ris, 1911           | 10,27,30        |
| 79 |                | Onychothemis culminicola Förster, 1914    | 10,30           |
| 80 |                | Orchthemis pulperrima Brauer, 1878        | 10              |
| 81 |                | Orthetrum chrysis Selys, 1891             | 10,30           |
| 82 |                | Orthetrum luzonicum Brauer, 1868          | 10              |
| 83 |                | Orthetrum pruinum (Burmeister, 1839)     | 10,27,30        |
| 84 |                | Orthetrum sabina (Drury, 1770)            | 10,27,30        |
| 85 |                | Orthetrum testaceum (Burmeister, 1839)    | 10,27,30        |
| 86 |                | Pantala flavescens (Fabricius, 1798)      | 10,27,30        |
| No | Family | Species | Source |
|----|--------|---------|--------|
| 86 |  | Pornothemis serrata  | Krüger, 1902 | 10 |
| 87 |  | Potamarcha congener  | (Rambur, 1842) | 10 |
| 88 |  | Rhodothemis rufa  | Rambur, 1842 | 10 |
| 89 |  | Rhyothemis obsolescens  | Kirby, 1889 | 10 |
| 90 |  | Rhyothemis triangularis  | Kirby, 1889 | 10 |
| 91 |  | Tholymis tillarga  | (Fabricius, 1798) | 10,27,30 |
| 92 |  | Tramea transmarina  | Selys, 1878 | 10,27,30 |
| 93 |  | Trithemis festiva  | (Rambur, 1842) | 10,27,30 |
| 94 |  | Trithemis aurora  | Burmeister, 1839 | 10,18 |
| 95 |  | Tyriobapta torrida  | Kirby, 1889 | 10 |
| 96 |  | Zyxomma obtusum  | (Albarda, 1881) | 10,27,30 |
| 97 |  | Zyxomma petiolatum  | Rambur 1842 | 10,29 |
| 98 |  | Zygonyx ida  | Hagen, 1867 | 10,30 |

Explanation: Numbers in column ‘Source’ refer to publication number in References section of this article. Species without year of publication or with question mark are either doubtful or unconfirmed.

Family Lestidae consisted of damselflies with typical feature of spread wings during perching [10]. None of the members of this family have been re-observed in modern works and papers from West Sumatra. On the hand, there were two new species added into the list; *Heliocypha vantoli* and *Drepanosticta draco* [17,33]. The first species was described from Mentawai Island, while the second from North Sumatra region. Individuals with similar features described for *Drepanosticta draco* were recently observed in the forested area of Universitas Andalas [30], hence this species was then included into West Sumatran list.

3.2. Ongoing and future direction of West Sumatran Odonatology

The historical and modern literatures on Odonata not only give basis to construct species inventory, they help to determine which locality had been surveyed and how well it was surveyed. In the past, Padang Panjang (mentioned as ‘Padangsche Bovenlanden’ in Dutch or ‘Padang Highlands’ in English) and Pasaman Barat (‘Ophir District’) became the most prominent localities for Odonata records in the mainland [10], while Mentawai Islands despite the harshness of environment to survey during the colonial era still had 53 species recorded [14,17]. A locality named as ‘Kaloeng’ where *Anaciaeshna jaspidea* (*Aeshnidae*) ever recorded, cannot be traced its whereabouts in the modern map. On the other hand, Padang becomes the locality in modern day with most recorded species. This is in large part due to the existence of Universitas Andalas as scientific institutional that harbors researchers and faculty staffs responsible for investigating the natural resources therein, which include the organisms such as dragonflies. As the continuous survey work is still demanded, it can be effectively directed to survey localities with poor or having no previous records.

The analysis on the data collected from historical and current bibliography was then furthered to see landscapes and habitats where the studies ever implemented. Most literatures were based on the studies conducted in the mainland of West Sumatra Province. The accessibility was presumed to be a reason for this opted survey location beside more odonata diversity can be found in the mainland given the size of landmass. The offshore islands, on the other hand, offered possibility to observe unique yet undescribed species as the harsh environment and difficult access might have preserved them from so far scientific exploration. Some studies used comprehensive landscape approach, i.e. by including both mainland and offshore islands to gain holistic inventory on the species and their distribution beyond the boundary of West Sumatra Province.
Table 2. Localities of Odonata surveys in West Sumatra and respective recorded species

| Localities                                   | No. Species | Source          |
|----------------------------------------------|-------------|-----------------|
| Alahan Panjang                               | 2           | 10              |
| Kaloeng                                      | 1           | 10              |
| Lake Singkarak                               | 4           | 10              |
| Mentawai Islands                             | 53          | 14,17           |
| Padang                                       | 50          | 10,27,29,30     |
| Padang Panjang (Padang Highlands)            | 34          | 10              |
| Pasaman Barat (Airbangis)                    | 1           | 10              |
| Pasaman Barat (Lubuk Sikaping)               | 2           | 10              |
| Pasaman Barat (Ophir district)               | 18          | 10              |
| Payakumbuh (Harau)                           | 8           | 10              |
| Sawahlunto (Kandi)                           | 15          | 18              |
| Solok Selatan (Muaralabuh)                   | 3           | 10              |
| Tanah Datar and Lubuk Tarap                  | 1           | 10              |

Numbers in column ‘Source’ refer to publication number in References section of this article.

In similar way to the landscape, the literatures also pointed out types of habitat where the researches and studies conducted. Forested habitat, in its various successive stages, promised the highest species diversity that have attracted many researchers and scientists to come and explore it. The dynamics of Odonata community in habitats affected by human activity currently provided interesting insight in understanding how dragonflies perceive to the environmental dynamics imposed by human. Hence, researches on dragonflies in habitats such as paddy field, human settlements, and other human activities got more attention this lately. The mountain habitat, which is common feature in Sumatra, as result from the existence of Bukit Barisan mountainous chain also provide interesting insight when studying Odonata. The typical features in mountain habitat are thought to be factors in setting the speciation for many wildlife [34], which is also the case for insects such as dragonflies. Nevertheless, despite its extreme altitude and weather, the peak of Mount Talamau at approximate 2,912 m elevation in Pasaman Barat of West Sumatra Province still contains a unique species of Corduliidae [28]. Similar to what described above for the offshore islands, mountains are frequently with unease access and extreme environmental conditions which in most of the time limits people from visiting it.

Figure 3. Landscape and habitat where the West Sumatran Odonata studies undertaken

The odonatology in West Sumatra is in needs for more works to catch up with the current state of global odonatology. It does, of course, require tremendous efforts to achieve this objective. The natural habitats where dragonflies live are still massive in this province that have not been yet fully explored, while some species are currently labelled as Data Deficient albeit their validity were confirmed (e.g. Drepanosticta bispina from Harau in Payakumbuh). The existence of Universitas Andalas as a
prominent education and research institution in this province should be seen as a solid factor to attract many odonatological researches and exploration in the region in the future. The university can serve as the home base for research cooperation as well as home for storing specimens produced from the fieldworks across Sumatra, beyond the border of the province. Therefore, Universitas Andalas may need to promote this among its scholars and students it houses as well as extending it to people outside campus, by doing attempts such as holding odonatology lectures or establishing scientific cooperation with other domestic and foreign institutes. It is believed that the more aspects revealed from conducting Odonata researches, the better understanding will be gained and in turn provides more steady foundation for future conservation and management needed for this insect group.

4. Conclusion
Our study summarized twenty bibliographies on West Sumatran Odonata to identify the current condition of odonatology in this province. Ninety-eight species were confirmed from various localities therein, with more than half of this number recently re-observed. The strength and lack on the aspects such as research topics, habitat and landscape covered in the odonata studies were also recognized in order to give perspective on what can be done in this field in the future.

Acknowledgements
The authors would like to thank Irviandi Yonanta for his assistance during fieldwork. This work was made possible by financial support provided by the 2020 Fundamental Research Grant from Faculty of Mathematics and Natural Science, Universitas Andalas with contract number 27/UN.16.03.D/PP/FMIPA/2020 (on behalf Muhammd Nazri Janra).

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