Parasitism on Riparian Dragonflies (Odonata) at Biology Education and Research Forest, Universitas Andalas

M N Janra¹, H Herwina¹

¹ Biology Department, Faculty of Mathematics and Natural Sciences, Universitas Andalas, Padang, Indonesia

Corresponding author’s e-mail address: mnjanra@sci.unand.ac.id

Abstract. Parasitism on dragonflies (Odonata) may become the least attention in most entomological studies in Indonesia, since it possesses much indirect effect to human being. The odonata parasitism is caused by the infestation of water mite larvae onto the body of adult dragonflies. In this paper we discuss the result of odonatological survey we did at two tributaries in Biology Education and Research Forest (BERF), Universitas Andalas. The survey had been conducted between August to November 2019. We recorded 17 dragonfly species bound to these tributaries, 12 Zygopterans and 5 Anisopterans. Water mite infestation was observed to happen on four Zygopteran species and one Anisoptera. The highest prevalence was shown by Orthetrum testaceum (100%), followed by Euphaea variegata (16.67%), Prodasineura verticalis (14.29%), Euphaea modigliani (3.57%) and Helicypha angusta angusta (0.85%). In overall, the prevalence on community level reached 3.29%. The parasitism case observed in the tributaries of BERM can be classified as low incident, each infested odonate only contained a single water mite except for O. testaceum with two water mites. We presume that habitat condition may contribute to the rate of dragonfly parasitism, where a good habitat help lowering the parasitism incident.

Keywords: anisoptera, HPPB, prevalance, tributaries, zygoptera

1. Introduction

Odonata has been reported as one among aquatic insects that is parasitized by water mites. Water mites are considered as true parasites to dragonflies and damselflies, as they exploit the odonates for food and dispersal [1]. The mites may attach to their dragonfly hosts during the period of maturity and detach when the dragonflies oviposit [2]. Despite there is a lot of sexual dimorphism observed among odonates, some previous studies indicated that there was no significant parasite infestation between sexes; it may have significant difference between dragonfly parasitism and damselfly parasitism where the latter infested more than first [3].

Parasitic water mites, although often neglected, are thought to have crucial role in the ecosystem. They serve as the limiting factor for controlling mosquito population, either as parasite during their larval stage or being predator after reaching adult stage [4]. Aside from affecting the longevity and flight performance, their attachment to certain body parts of other aquatic insects can impede the copulation or sperm transference [5, 6, 7]. Through its brief parasitic and phoretic association with other aquatic insects, parasitic water mites get food, transported and extend their range [8]. The larvae of Arrenurus spp. are commonly known as the ectoparasites on adult odonates [9, 10]. This genus contains 800 species, with most of them act as parasites to Odonata, Diptera and Coleoptera [11, 12]. The larval stages
are the parasitic phase for water mites *Arrenurus* out of seven life cycles they have; egg, inactive pre-larvae, larvae, protonymph, deutonymph, tritonymph and adult [13].

In Indonesia, despite the rampant interest in studying Odonata, the attention is paid more to the biodiversity, taxonomy and systematics, biogeography, ecology, education, ethnozoology, history and molecular [14]. Parasitology, in its association with odonata, has been neglected prior to 2020 in Indonesia despite its potential to give robust support onto the use of odonata community as environmental indicators. Two damselfly species, *Euphaea variegata* and *Heliocypha angusta angusta*, were reported on 2020 to be infested by *Arrenurus* spp. in Bengkulu, Indonesia [15]. No other published works regarding parasite association with Odonata after that in Indonesia. Hence, it is necessary to share equal attention toward this field. In this paper, we discuss preliminary observation of water mite parasitism on Odonata at Biology Education and Research Forest (BERF), Universitas Andalas.

2. Materials and Methods

2.1. Study Site and Sampling Method

The observation on Odonata had been conducted from August to November 2020 at two tributaries in Hutan Pendidikan dan Penelitian Biologi (Biology Education and Research Forest, hereinafter BERF). It is located around GPS coordinates 0° 54' 24.69" S, 100° 27' 55.76" E and at elevation 264 m above sea level (Figure 1). The BERF area is mixed between secondary and primary forest, managed under the supervision of Biology Department, Universitas Andalas [16]. In addition to its ecological functions as water catchment area for Padang City, BERF also functions as field laboratory and biodiversity research area for Biology Department.

![Figure 1. Map of study site. BERF (or HPPB) is the area signified with dark green](image-url)

The odonata observation was conducted through field survey along the 150-170 m line transect erected within the tributaries. All odonates that seen within and at the proximity of water body were recorded. Water mites were also visually detected from any sighted odonate and counted to determine parasite load in each infested individual. The sighting then documented using Nikon Coolpix P900, set at macro mode with fine resolution (pixellation rate 4608x3456) [17]. Species identification was guided using published materials related to the region [18,19,20].
2.2. Data Analysis
We used two indices in the descriptive analysis, which are prevalence of parasitism (percentage of infested host odonate over all counted odonate individual) and intensity of infestation that counted from number of parasites on a given odonate [21].

3. Results and Discussion

3.1. Odonate Species in BERF Tributaries and the Prevalence of Water Mite Parasitism

Our observation resulted in the inventory of seventeen odonates that bound to the aquatic body of tributary. These species consisted of 12 Zygoptera or damselflies (species 1-12 in Table 1) and 5 Anisoptera or dragonflies (species 13-17 in Table 1). Some of these recorded species were not in the previous record for Universitas Andalas campus complex, i.e. Drepanosticta draco (Platystictidae), Euphaea aspasia, E. modigliani (Euphaeidae), Devadatta argyoides (Devadattidae), Vestalis luctuosa, Neurobasis chinesis (Calopterygidae) and Zygonyx ida (Libellulidae) [17,24]. Heliocypha angusta angusta (Chlorocyphidae) was counted as species with most individuals, followed by Euphaea modigliani (Euphaeidae) and Libellago hyalina (Chlorocyphidae). These dominant species were observed at open stream area. These dominant species are damselflies with metallic color in their wings, prefer environment with direct exposure from the sunlight, used not only to warm themselves but also to increase their sexual performance during reproduction [22]. A male-on-male agonistic competition over mating site was also observed on Euphaea aspasia from this area [23].

Odonata species with most infested was Heliocypha angusta angusta with three individuals observed carrying water mite larval in their body. The prevalence for this species, however, is the lowest among other infested species (2.54%); it was apparently due to the sheer abundance of this species at the survey area. Similar to Euphaea modigliani which recorded with two infested individuals, its prevalence rate is as low as 3.57%, in consequence of its abundance population. In contrary, Orthetrum testaceum became odonate species with the highest prevalence (100%), as only a single individual encountered during the survey, in which the parasites observed. This species is indicated as common in the vicinity of Universitas Andalas [17], yet its proximity to stream or other moving water bodies is not well defined. Other infested species are Euphaea variegata (16.67%) and Prodasineura verticalis (14.29%). These two species were known at the survey area from a handful of individuals. The overall prevalence for water mite parasitism on odonates at BERF’s tributaries was 3.29%. The parasitism prevalence in our study area fall between the range of prevalence observed in many previous studies, however, the infested species are not listed [25].

From the Table 1, we can also see that Zygopterans are more parasitized than Anisopterans at our survey area. Parasitic water mites are known to parasitize more common insects in a certain habitat rather than the rare ones, as it increases their opportunity to get their host [26]. Heliocypha angusta angusta and Euphaea modigliani are from the families that known to be living around aquatic body in most of their time, hence improves the possibility for water mites to return to water as soon as their parasitic phase ended [1,2]. Albeit there is common thought that parasite will choose large host as it provides better resources and habitat for them, it is still unclear on the case of parasitic water mites as they have been observed infesting various sizes of odonates [27,28]. Since the size of odonate species will affect their density in a habitat, it is understandable that the smaller an odonate, the more their population therein [29]. Hence, the preference on common but small odonates rather than on big but rare ones can be thought as a tradeoff made by the water mites to carry on their live.

Table 1. Odonate species in the tributarie of BERF, total individual and infested individual per species and prevalence of parasitism

| No | Family        | Species                        | Observation | ∑ ind | ∑ infs | Prev   |
|----|---------------|--------------------------------|-------------|-------|-------|--------|
| 1  | Devadattidae  | Devadatta argyoides (Selys, 1859) |             | 4     |       |        |
3.2. Detail on Odonate Parasitism

As previously implied, there is lack of publications for parasitic water mites in Indonesia [15], while what currently available mostly came from the works in central and eastern parts of the country [30]. During fieldwork, following the documentation on infested odonates, our attempt to collect the water mites failed to yield any result as the mites always escaped whenever their host insects captured. Their small and inconspicuous body made it difficult to follow as soon as their detachment from host body. Tentatively, we identified the parasitic water mites infested the odonates observed at BERF’s tributaries as *Arrenurus* spp. by account that this genus is more widespread in tropical affinities and contains numerous species [2, 31]. In Table 2 below, we summarized our observation on infested odonates.

| Species                        | Sex | ∑ mite | Mite position on host body                  |
|-------------------------------|-----|--------|--------------------------------------------|
| *Euphaea modigliani*           | M   | 1      | Dorsal prothorax                           |
| *Euphaea modigliani*           | F   | 1      | Dorsal abdomen, 1st segment                 |
| *Euphaea variegata*            | F   | 1      | Right lateral of thorax                     |
| *Heliocypha angusta angusta*   | M   | 1      | Dorsal abdomen, 7th segment                 |
| *Heliocypha angusta angusta*   | F   | 1      | Dorsal abdomen, 5th segment                 |
| *Heliocypha angusta angusta*   | F   | 1      | Dorsal abdomen, unspecified                 |
| *Prodasineura verticalis*     | F   | 1      | Abdomen, unspecified                       |
| *Orthetrum testaceum*         | M   | 2      | Dorsal abdomen, 5th-6th segment             |

Female odonates seemed to be more prone for water mite infestation than the males. Major assumption thinks that mites prefer female dragonflies as they tend to have more robust body and broader distribution which help the feeding and dispersal of mites [32]. Nevertheless, more studies in this matter revealed that male and female odonates can be equally parasitized [33,34]. Meanwhile, the load of parasite in each infested odonata was only one, except for *Orthetrum testaceum* with two parasites. This number was much lower than what observed at Protected Forest Management Unit Seluma in Bengkulu, where an individual of *Heliocypha angusta angusta* was observed with 10 mites.
and an *Euphaea variegata* was infested with 44 mites [15]. It still needs further study regarding what factors driving the infestation of water mites onto dragonflies, however we presume that environmental conditions could contribute. The tributaries in BERF are clean running water bodies, while in the observation in Bengkulu, the stream was slow, turbid and surrounded with agricultural area that affect water condition. Many accounts on parasitic water mites are without description on their environmental preference, as it is probably referred to habitat of odonates they infest on. *Arrenurus* mites in North America were reported to prefer temporary or permanent lentic or slow lotic water bodies [34,35], which included turbid or unclean water bodies. On further observation on mite load on odonate body, we found that mites attach more onto abdominal segments than the thoracical area of odonates. As it needs to be confirmed with more observation, mites’ preference for attachment may be derived by the accessibility and sufficiency of food source. Abdominal parts of odonata mainly house digestive and reproductive apparatus, which govern sufficient flow of body fluid and nutrition into this body part.

**Figure 2.** Infested odonates at BERF’s tributaries. White rows point to the water mites in odonate body. Male *Euphaea modigliani* (top left), female *E. modigliani* (top right), female *Heliocypha angusta angusta* (middle left), male *H. a. angusta* (middle right), male *E. variegata* (bottom left), and male *Orthetrum testaceum* (bottom right).
4. Conclusion
There were 17 dragonfly species observed in this study existing in the tributaries of Biology Education and Research Forest, consist of 12 Zygopterans and 5 Anisopterans. Water mites that were tentatively identified as *Arrenurus* spp. by the fact of their extensive distribution in tropics area. Its infestation was observed to happen on four Zygopteran species and one Anisopteran. The highest prevalence was shown by the only infested Anisopteran *Orthetrum testaceum* (100%), followed by *Euphaea variegata* (16.67%), *Prodasineura verticalis* (14.29%), *Euphaea modigliani* (3.57%) and *Heliocypha angusta angusta* (0.85%). The prevalence at community level reached 3.29%. The parasitism case observed in the BERF’s tributaries can be classified as low parasitism incident if compared to the infestation level previously reported for water mites associated with odonates. Each infested odonate only contained a single water mite except for *O. testaceum* that was documented with two water mites. We presume that habitat condition may contribute to the rate of dragonfly parasitism, where a good habitat helps lowering the parasitism incident.

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 Muhammad Nazri Janra).

References
[1] Andrew RJ, Thaokar N and Verma P 2012 Ectoparasitism of Anisopteran dragonflies (Insecta: odonata) by water mite larvae of *Arrenurus* spp. (Arachnida: Hydrachnida: Arrenuridae) in Central India *Acarina* 20(2) 194-198
[2] Andrew JA, Verma PR and Thaokar NR 2015 A parasitic association of odonata (insecta) with *Arrenurus* Dugés, 1834 (Arachnidae: Hydrachnida: Arrenuridae) water mites *Journal of Threatened Taxa* 7(1) 6821-6825
[3] Ivonen JJ, Kaunisto KM and Suhonen J 2016 Are sexes equally parasitized in damselflies and dragonflies? *Oikos* 125 315-325
[4] Atwa AA, Bilgrami AL and Al-Saggaf AIM 2017 Host-parasite interaction and impact of mite infection on mosquito population *Revista Brasileira de Entomologia* 61 101-106
[5] Bonn A, Gasse M, Rolff J and Martens A 1996 Increase fluctuation asymmetry (FA) in the damselfly *Coenagrion puella* correlated with ectoparasite water mites: implication for fluctuation asymmetry theory *Oecologia* 108 596-598
[6] Forbes MRL 1991 Ectoparasites and mating success of male *Enallagma ebrarium* damselfly (Odonata: Coenagriionidae) *Oikos* 60(3) 36-42
[7] Forbes MRL and Baker RL 1991 Condition and fecundity of the damselfly, *Enallagma ebrarium* (Hagen): the importance of ectoparasites *Oecologia* 86(3) 35-41.
[8] Mumcuoglu KY and Braverman Y 2010 Parasitic and phoretic mites of Diptera in Israel and the Sinai Peninsula, Egypt *Israel Journal of Entomology* 40(1) 195-203
[9] Smith IM and Oliver DR 1986 Review of parasitic associations of larval water mites (Acari: Parasitengona: Hydrachnida) with insect host *The Canadian Entomologist* 118 407-472
[10] Corbet PS 1999 *Dragonflies: behavior and ecology of Odonata* (England: Harley Books) p 829
[11] Smit H 2010 Two new species of the genus *Arrenurus* from Pohnpei, Federal States of Micronesia (Acari: Hydrachnida: Arrenuridae) *Zootaxa* 2006 50-54
[12] Zawal A 2006 Phoresy and parasitism: water mite larvae of the genus *Arrenurus* (Acari: Hydrachnida) on Odonata from Lake Binowskie (NW Polandia) *Biology Letters* 43(2) 257-276
[13] Smith BP 1988 Host-parasite interaction and impact of larval water mites on insects *Annual Review of Entomology* 33(1) 487-507
[14] Lupiyaningdyah P 2020 The past, present and future of dragonfly research in Indonesia *BIO Web*
of Conference 19 1-4

[15] Janra MN, Gusman D, Susanto D, Yatap H, Fahrudin A, Andriyansyah F, Prameswara A and Herwina H 2020 Field observation on water mite parasitism on two damselfly species in Protected Forest Management Unit Seluma, Bengkulu, Indonesia Agrion 24(1) 14-15

[16] Rizaldi, Mairawita, Novarino W, Nurainas, Nurdin J and Idris M 2018 An introduction to the biological education and research forest of Andalas University (Padang, Indonesia: Andalas University Press)

[17] Janra MN 2018 Inventory of dragonflies and damselflies (Odonata) in Andalas University’s Limau Manis campus complex, Padang: Using photographic approach Jurnal Natural 18(2) 89-96

[18] Bártá D and Dolný A 2013 Dragonflies of Sungai Wain. Ecological Field Guide to the Odonata of Lowland Mixed Dipterocarp Forest of Southeastern Kalimantan (Czech: Taita Publisher)

[19] Rembold K and Schröter A 2017 Dragonflies and damselflies of the EFForTS study area in Jambi and Bogor (Indonesia). Version 2. Biodiversity, Macroecology & Biogeography (Germany: Faculty of Forest Sciences and Forest Ecology of the University of Goettingen)

[20] Setiyono J, Diniarish S, Oscilata ENR and Budi NS 2017 Dragonflies of Yogyakarta. Jenis Capung Daerah Istimewa Yogyakarta (Yogyakarta: Indonesia Dragonfly Society)

[21] Zawal A and Buczynski P 2013 Parasitism of Odonata by Arrenurus (Acari: Hydrachnidia) larvae in the Lake Swidwie, nature reserve (NW Poland) Acta Parasitologica 58(4) 486-495

[22] Schulz TD and Fincke OM 2009 Structural colors create a flashing cue for sexual recognition and male quality in a Neotropical giant damselfly Functional Ecology 23 724-732

[23] Janra MN, Herwina H and Gusman D 2020 Rumble in the stream: mating site preference in endemic Euphaea aspasia (Zygoptera: Euphaeidae) Agrion 24(3) 179-183

[24] Janra MN and Herwina H 2020 Some additional records to the inventory of dragonflies and damselflies (Odonata) in Andalas University’s Limau Manis campus complex, Padang, West Sumatra Jurnal Natural 20(1) 1-5

[25] Ilvonen JJ, Kaunisto KM and Suohon J 2018 Odonates, gregarine and water mites: why are the same host species infected by both parasites? Ecological Entomology 43(5) 591-600

[26] Grant PBC and Samways MJ 2007 Ectoparasitic mites infest common and widespread but not rare and red-listed dragonfly species Odonatologica 36 255-262

[27] Poulin R and Moran S 2000 The diversity of parasites The Quarterly Review of Biology 75(3) 277-293

[28] Ilvonen JJ 2018 A comparative study of parasitism in insects: Why some odonata species have parasites and others do not? Doctoral Thesis in Biology (Finland: University of Turku)

[29] White EP, Emerst SKM, Kerkhoff AJ and Enquist BJ 2007 Relationships between body size and abundance in ecology Trend in Ecology and Evolution 22 323-330

[30] Wiles PR 2004 Water mites (Acari; Hydrachnidia) from South-East Asia, Thailand and Sulawesi Tenggara (Indonesia): descriptions of new species and new records Journal of Natural History 38 2153-2165

[31] Pešić V and Smit H 2018 A checklist of the water mites of Central Asia with description of six new species (Acari, Hydrachnidia) from Kyrgyzstan Acarologia 58(1) 165-185

[32] Abro A 1990 The impact of parasites in adult population of Zygoptera Odonatologica 19 223-233

[33] Forbes MR, Muma KE and Smith BP 2004 Recapture of male and female dragonflies in relation to parasitism by mites, time of season, wing length and wing cell symmetry Experimental and Applied Acarology 34(1-2) 79-93

[34] Peckarsky BL, Fraissinet PR, Penton MA and Conklin JD 1990 Freshwater macroinvertebrates of northeastern North America (New York: Cornell University Press)

[35] Lajeunesse MJ 2007 Ectoparasitism of damselflies by water mites in Central Florida Florida Entomologist 90(4) 643-649