ODONATA DIVERSITY AROUND THE ARFAK MOUNTAINS, WEST PAPUA

KEANEKARAGAMAN ODONATA DI SEKITAR PEGUNUNGAN ARFAK, PAPUA BARAT

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Abstract

West Papua is known to harbor high biodiversity and endemicity. Odonata is one taxon that has a high diversity and endemism and plays an important role as an environmental bioindicator. As with many other taxa, field research on the diversity, distribution, and habitat of dragonflies is still very limited in West Papua. Yet, its habitats are under threat due to forest and land conversion for infrastructure developments. This study was designed to document the diversity of Odonata around the Arfak Mountains; especially in Uyehegbrik Village (Prafi District), Hijou Village (Neney District) and Anggra Village (Minyambou District). Data was collected using the purposive sampling technique. The Shannon Diversity Index and t-test were used to calculate and compare species diversity at each research location; and Sorensen Index was used to analyze the similarity of species in each location. About 21 species from 7 families were recorded during this study, 10 of which species are likely new. Our main conclusions include: the Shannon Weaner Index (H') at the study sites 1.43-1.89 indicates moderate diversity; standing water is the main habitat of dragonflies; the temperature has positive, but weak correlation with species diversity and species abundance. Discovery of new species indicates that this area remains understudied.

Keywords: Arfak Mountains, neney, minyambow, odonata diversity, prafi

Inti Sari

Provinsi Papua Barat diketahui memiliki keanekaragaman hayati dan tingkat endemik yang tinggi. Odonata adalah salah satu taksa dengan keragaman jenis dan tingkat endemik yang tinggi dan berperan penting sebagai indikator keadaan lingkungan. Sebagian besar taksa lainnya, penelitian lapangan mengenai keragaman jenis, penyebaran dan habitat Odonata (capung) masih terbatas di Papua Barat. Namun habitat Odonata terus terancam akibat konversi hutan dan lahan untuk pembangunan infrastruktur. Penelitian ini dirancang untuk mendokumentasikan keragaman Odonata di sekitar Pegunungan Arfak, terutama di Kampung Uyehegbrik (Distrik Prafi), Kampung Hijou (Distrik Neney) dan Kampung Anggra (Distrik Minyambou). Data lapangan dikoleksi secara puposif. Indeks Keragaman Shannon (H') dan uji t digunakan untuk menghitung dan membandingkan keragaman jenis antara lokasi penelitian, dan Indek Sorensen untuk membandingkan kesamaan spesies antara lokasi penelitian. Ada 21 spesies dari 7 family yang berhasil dicatat dalam penelitian ini. Hasil penelitian menunjukkan Indeks Keragaman Shannon (H') berkisar antara 1,43 – 1,89 menunjukkan keragaman moderat, kolam merupakan habitat utama. Ada korelasi positif antara suhu dan kelimpahan spesies (individu). Penemuan beberapa spesies yang mungkin baru menunjukkan bawah masih banyak belum diketahui.

Kata Kunci: Pegunungan Arfak, neney, minyambow, keanekaragaman odonata, prafi

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I. Introduction

Papua and West Papua Provinces are known to harbor high species diversity and endemism (Marshall & Beehler, 2009). The Arfak Mountains, an isolated range located on the ‘Bird’s Head’ of West Papua Province are considered an important area for biodiversity conservation in Indonesia (CI, 1997), and in 1982 the mountains were declared by the national Government as a Cagar Alam Pegunungan Arfak or Arfak Mountains Strict Nature Reserve (Craven & De Fretes, 1987) due to the high concentration of biodiversity and endemism there.

Unfortunately, since this declaration, only limited actions have been taken to effectively manage the area for conservation and infrastructure development continues to threaten the park and its resident species. If the trend of infrastructure development continues or accelerates without proper planning, and without significant improvement in the reserve management, we may lose many species before they are even documented.

Habitat alteration is by far the main threat to many taxa with special habitat requirements or limited geographic distributions. One such taxon is Odonata (dragonflies and damselflies). This group remains poorly known in West Papua, but it is an excellent bioindicator and many species in New Guinea are restricted to good quality forests and streams (Kalkman & Orr, 2013; Orr & Kalkman, 2015). Furthermore, a high proportion of New Guinea’s odonates are endemic to the region and many have small known distributions (Michalski, 2012).

A spectacular example of a locally endemic odonate species in the Arfak Mountains is the red and black damselfly *Palaiargia ernstmayeri*, a poorly known species known only from two localities (Orr et al., 2013). Given the potential usefulness of odonates as indicators of environmental change, and the poor state of knowledge about the odonate fauna of the Arfak Mountains, this study was designed to document odonate diversity in different habitats at several sites in the Arfak Mountains representing lowland habitat; Hijou in District Neney (S 01° 26' 49,3" E 133° 00' 28,00", about 932 m a.s.l) representing mid-mountain habitat; and Anggra in District Minyambouw (S 01° 08' 09,4" E 133° 53' 01,00", about 1570 m a.s.l) representing high mountain habitat (Fig 1).

II. Methods

Field data were collected from June - August 2019 in three villages: Uyehegbrik in Prafi District (S 00° 55' 27,2" E 133° 48' 25,7", ‘about 178 m above sea level-a.s.l) representing lowland habitat; Hijou in District Neney (S 01° 26' 49,3" E 133° 00' 28,00", about 932 m a.s.l) representing mid-mountain habitat; and Anggra in District Minyambouw (S 01° 08' 09,4" E 133° 53' 01,00", about 1570 m a.s.l) representing high mountain habitat (Fig 1). Sampling was conducted in the morning 09:00 - 11:00 and in the afternoon 14:00 - 16:00 with two insect nets, 30 cm in diameter. All species captured and coordinates, temperature and moisture as well as major habitat types were recorded. Species were identified using the field guides *Panduan Lapangan Capung Jarum di New Guinea* (Kalkman & Orr, 2013) and *Panduan Lapangan Capung Biasa di New Guinea* (A. Orr & Kalkman, 2015), and later with the assistance of Stephen Richards from the South Australian Museum.

1) Species Diversity and Diversity between the Sites

The Shannon-Weiner Diversity Index ($H'$) and student t-test were used to calculate species diversity in each site and to compare species diversity between sites. The Shannon Diversity t-test Calculator (Gardener, 2017) was used to calculate Shannon Index Diversity for each site and to compare diversity between sites.

$$H' = - \sum_{i=1}^{n} p_i \ln p_i$$

where:

- $H'$ = Shannon-Weiner Diversity Index
- $p_i$ = the proportion of individual found in the $i$th species
- $n_i$ = the total number of individuals in the $i$th species
\[ \ln = \text{the logarithm natural} \]
\[ N = \text{the total individual of individuals} \]

2) **Relative Abundance and Evenness**

Relative abundance was calculated with

\[ RA = \frac{n_i}{N} \times 100\% \quad (2) \]

where,
- \( RA \) = relative abundance,
- \( n_i \) = the number of individuals of \( i'th \) species,
- \( N \) = the total individuals of all species observed.

Species evenness was calculated using (Magurran, 2013).

\[ E = \frac{H'}{\ln(S)} \quad (3) \]

where:
- \( E \) = species evenness,
- \( H' \) = Shannon Weiner Diversity Index,
- \( S \) = total number of species, and
- \( \ln = \text{logarithm normal} \).

3) **Species Similarity between the Sites**

Sorensen Coefficient of Similarity was used to compare species similarity between sites (Krebs, 1999)

\[ S_i = \frac{2a}{2a+b+c} \quad (4) \]

where:
- \( S_i \) = Sorensen Coefficient of Similarity;
- \( a \) = the total number of species found on both sites (site 1 and site 2);
- \( b \) = the total number of species found only on site 1 and
- \( c \) = the total number of species found only on site 2.

4) **Correlation between Numbers Individual with Temperature**

Corel at Excel Software was used to examine the correlation between the number of individuals observed and temperature.

| No. | Family          | Species              | U | H | A |
|-----|----------------|----------------------|---|---|---|
|     | Aeshnidae       | *Ictinogomphus lieftincki* | √ | - | - |
|     |                 | Oreaeschna dictatrix | - | - | √ |
|     | Argiolestidae   | *Argiolestes* sp.    | - | √ | - |
|     | Calopterigidae  | *Neurobasis* sp.     | - | √ | - |
|     | Chlorocyphidae  | *Rhinocypha tintica* | - | √ | - |
|     | Coenagrionidae  | *Agriocnemis* femina | √ | - | - |
|     |                 | *Coenagrionidae* sp. | - | √ | - |
|     |                 | *Papuagrion* sp.     | - | √ | - |
|     |                 | *Pseudagrion silaceum* | √ | - | - |
|     |                 | *Teinobasis* sp.     | - | √ | - |
|     | Libellulidae    | *Diplacina* sp.      | - | - | √ |
|     |                 | *Huonia* sp.         | - | √ | - |
|     |                 | *Lanthanusa* sp.     | - | - | √ |
|     |                 | *Nannophya pygmaea*  | √ | √ | - |
|     |                 | *Neurothemis* stigmatizans | √ | √ | - |
|     |                 | *Orthetrum* glaucum  | √ | √ | √ |
|     |                 | *Orthetrum* sp.      | √ | - | - |
|     |                 | *Orthetrum* villosovittatum | √ | √ | √ |
|     |                 | *Pantala* flavescens | √ | - | - |
|     |                 | *Rhyotemis* resplendens | - | √ | - |
|     | Synthemistidae  | *Palaeosynthemis* sp. | - | - | √ |

| Total |    | 7  | 21  | 9   | 12  | 6  |

Table 1.
Number of Species Recorded at Uyehegbrik (U), Hijou (H) and Anggra (A)

Odonata Diversity Around the Arfak Mountains, West Papua
Keliopas Krey, Ade Rahayu Pattiran, Agustinus Kilmaskossu, Yance de Fretes
III. RESULTS AND DISCUSSIONS

A. Number of Species (S)

Twenty-one species from seven families were observed across all three sites (Table 1). About 10 species recorded from Libellulidae, five species from Coenagrionidae, while the remaining families were represented by less than five species. About 12 species were recorded from Hijou village followed by nine species at Uyehegbrik, and six species at Anggra.

Table 1 reveals that four of the seven families recorded during this study were represented by a single species: Aeshnidae by two species and Coenagrionidae by five species. The most species-rich family was Libellulidae with 10 species represented, two of which (*Orthetrum glaucum* and *Orthetrum vilosovitattum*) were recorded at all three study sites: that this from the lowland up to the Arfak Mountain (ca. 1700 m asl). However, most species (80%) were observed only at a single study site. More systematic studies over a longer time are required to satisfactorily document the species diversity and their distribution patterns.

Figure 2 shows the 21 species were recorded from 7 families, only one family (Libellulidae) contains all species, while other families only have one species. Similar results were documented from previous studies in Wondiwoi Mountains, Papua Barat, in which 9 of 14 species belongs to Libellulidae (Simanjuntak, 2009), and in Misool Islands, where 12 of 17 species recorded in Misool Island came from the same family (Rambu, 2015).

B. Habitat Preference

Figure 3 was constructed from the record of 123 individuals from 21 species. Habitat types were assigned to the most dominant habitat where individuals were observed. At least four major habitat types were recognized across all study sites. Figure 3 shows that standing water (56% observed individuals) and open forest (16%) are the most preferred habitats. *Orthetrum galucum, Orthetrum vilosovitattum, Neurothemis* etc.

![Figure 2. The 10 Most Abundant Species from 3 Study Sites. All the Species are Belonging to Libellulidae](image-url)
stigmatizans, Nannophya pygmaea, Rhyothemis resplendens, Diplacina sp., Lanthanus sp., Agriocnemis femina and Pseudagrion silaceum, all the most common species at the open water. Orthetrum villosovittatum was observed in all habitat types. Prior studies (Rambu, 2015; Simanjuntak, 2009) suggested that this species has the ability to fly over long distances, and therefore can be seen in almost all habitats within study sites.

C. Species Diversity Index

Figure 5 shows the Shannon-Wiener Diversity Index (H'); Uyehegbrik, 1.89; Hijou 1.88; and Anggra 1.4. Figure 4 revealed that Hijou and Uyehegbrik have similar species diversity, despite the fact that Hijou has more species than Uyehegbrik (Table 1). The number of individuals sampled in Uyehegbrik may contribute to more diverse species compared to Anggra. Figure 5 shows the t-test of Shannon Weiner Diversity Index between the sites. These results indicate that Odonata diversity in highly disturbed habitats is low to moderate in the study area (Krebs, 1999).

Figure 6 shows there is no significant difference between species diversity at Uyehegbrik and Hijou but there are significant differences in diversity between Uyehegbrik and Anggra and between Anggra and Hijou (Table 2).

D. Relative Abundance

Figure 7 shows the relative species abundance between the study sites. At Uyehegbrik, Pantala flavescens most abundance 35% of the total, and the lowest was Ictinogomphus lieftinck (4%). At Hijou, the most abundant species was Orthetrum villosovittatum (23%), and the lowest were Rhynotemis resplendens, Papuagrion sp., Teinobasis sp., Coenagrionidae sp., and Argiolestes sp. (only 1% of the total). In Anggra, the most abundant species was Orthetrum glaucum (31%) and the least was Oreaeschna dictatrix and Palaeosynthemis sp. (1%).
Figure 5. Comparison of Shannon-Weiner Diversity Index Between the Study Sites

Figure 6. Relative Abundance at the Study Sites
E. Evenness

Figure 8 shows that Uyehegbrik has the most evenness (0.86), Hijou (0.76) and Anggra (0.79). Therefore, it can be concluded that species are evenly distributed between the sites.

F. Species Similarity Between the Sites

Table 2 shows there is high species similarity between Uyehegbrik and Hijou (0.739), but low similarity with Anggra. This is remarkable as Anggra and Hijou are geographically close to each other, situated at the mid to high mountain habitat, whereas Uyehegbrik is located at the lowland. Further research is needed to examine this result.

| No | Comparing Between Sites | t-value | t-critical | p-values | Remarks |
|----|-------------------------|---------|------------|----------|---------|
| 1  | Uyehegbrik vs Hijou     | 0.146   | 1.963      | 0.08     | no significant |
| 2  | Uyehegbrik vs Anggra    | 10.987  | 1.964      | 0.05     | significant  |
| 3  | Hijou vs Anggra         | 10.091  | 1.964      | 0.01     | significant  |

Table 3.
Species Similarity Index between the Sites

|                  | Uyehegbrik | Hijou | Anggra |
|------------------|------------|-------|--------|
| Uyehegbrik       | 1          | 0.739 | 0.266  |
| Hijou            | 1          | 1     | 0.222  |
| Anggra           |            |       | 1      |
G. Temperature and Abundance

Habitats, including temperature plays important roles in the presence or absence of species and number of individuals. Figure 9a shows that many individuals were observed at temperatures between 26-34\(^\circ\) Celsius, while Fig 8b shows that there is a positive correlation between the number of observed individuals and temperature. The number of observed individuals increases as temperature

Plate 1. *Ictinogomphus lieftincki*

Plate 2. *Orthetrum* sp. 1
One of Common Genera in the Survey Sites.

Plate 3. *Orthetrum villosovittatum.*
The Common Species Distributed from Lowland to Highest Mountains in Arfak Region and Elsewhere

Plate 4. *Orthetrum glaucum*

Plate 5. *Pantala flavescens*

Plate 6. *Nannophya pygmaea*

Plate 7. *Huonia* sp. 1

Plate 8. *Oreaeschna dictatrix*
A New Record for Arfak Mountains or New Species

Figure 9. Some of the species observed in this study
Table 4.
Species from Field Study Sites Around Arfak Mountains, Wondiwoi Mountains (Simanjuntak, 2009) and Misol Island (Rambu, 2015), Bird Head Region, Papua Barat.

| Species                  | Study Areas |
|--------------------------|-------------|
|                          | Uyehegbrik | Hijou | Anggra | Wondiwoi | Misol |
| Agriocnemis femina       | ✓           | -     | -      | ✓         | ✓     |
| Agrionoptera longitudinalis | -         | -     | -      | ✓         | ✓     |
| Anax sp.                 | -           | -     | -      | ✓         | ✓     |
| Argiolestes sp.          | -           | ✓     | ✓      |            |       |
| Camacinia gigantea       | -           | -     | -      | ✓         |       |
| Coenagrionidae sp.       | -           | ✓     | ✓      |            |       |
| Diplacina sp.            | -           | -     | ✓      |            |       |
| Diplacodes triavilis     | -           | -     | ✓      | ✓         | ✓     |
| Gynacantha sp.           | ✓           | -     | -      |            |       |
| Huonia sp.               | ✓           | ✓     | -      |            |       |
| Ictinogomphus lieftincki | ✓           | -     | -      |            |       |
| Lanthanusa sp.           | -           | -     | ✓      |            |       |
| Lestes praemorsus        | -           | -     | ✓      |            |       |
| Lyrothemis hirundo       | -           | -     | ✓      |            |       |
| Nannophya pygmaea        | ✓           | ✓     | -      |            | ✓     |
| Nesoxyenia mysis         | ✓           | -     | -      |            |       |
| Neurobasis sp.           | -           | ✓     | -      |            |       |
| Neurothemis stigmatizans | ✓           | ✓     | -      |            |       |
| Nosoticia plagiata       | -           | -     | ✓      |            | ✓     |
| Oreaschna dictatrix      | -           | -     | ✓      |            |       |
| Orthetrum glaucum        | ✓           | ✓     | ✓      |            |       |
| Orthetrum sabina         | -           | -     | ✓      |            |       |
| Orthetrum serapia        | ✓           | -     | -      |            |       |
| Orthetrum sp.            | ✓           | -     | -      |            |       |
| Orthetrum villosovittatum| ✓           | ✓     | ✓      | ✓         |       |
| Palaeosynthemis sp.      | -           | -     | ✓      |            |       |
| Pantala flavescens       | ✓           | -     | -      |            | ✓     |
| Pauagron sp.             | -           | ✓     | -      |            |       |
| Protothermis coronate     | -           | -     | ✓      |            | ✓     |
| Pseudagron silaceum      | ✓           | -     | -      |            |       |
| Rhinocypha tincta        | -           | ✓     | -      | ✓         |       |
| Rhyotemis resplendens    | -           | ✓     | -      |            |       |
| Rhyothemis phylis        | -           | -     | ✓      | ✓         |       |
| Teinobasis ruftorax      | ✓           | -     | -      |            |       |
| Teinobasis sp.           | -           | ✓     | -      |            | ✓     |
| Tholymis tillarga        | -           | -     | -      | ✓         |       |
| Tramea sp.               | ✓           | -     | -      |            |       |
| Xiphiagron sp.           | -           | -     | -      | ✓         |       |
| Zyxomma multinervorum    | ✓           | -     | -      |            |       |
increased, but this is not a linear relationship as at a certain temperature (ca. 34°C), number of individuals decreased.

Table 3 show result from prior field studies on Odonata diversity around the Bird Head Region (Wondiwoi Mountains and Misool Islands) by students from Papua University. Although, these studies show similar number of species recorded, but very different in the species compositions. For instance, only one species (Agriocnemis femina) was observed in the Arfak Mountain Area (Uyehegbrik), Wondiwoi and Misool Islands. About 5 species were shared between Wondiwoi and Misool Islands (Agriocnemis femina, Agrionoptera longitudinalis, Anax sp., Diplacodes triavilis and Rhyothemis phylis), but only 3 species (Neurothemis stigmatizans, Orthetrum villosovittatum, and Rhinocypha tincta) were shared with Wondiwoi and Arfak Mountains. Only 3 species (Nannophya pygmaea, Pantala flavescens, and Teinobasis sp.) were shared between Arfak Mountains and Misol Island. This pattern shows all of the sampling seems to have been done in highly disturbed habitats and the faunas are dominated by common, widespread species.

IV. CONCLUSION

Although, the Shannon Weaner Index of Diversity revealed Odonata diversity in all study sites are low-medium diversity, many species recorded are the widespread species. This may due to the sampling that disturbed habitat. Although it would be essay, but, in order to capture a better representation of species, sampling must be done in forested area or more pristine areas. Due to proper species identification in the field, some specimens remain unknown, but the rest species may be new to science, indicates the richness of this mountain range remain unknown and more studies are needed.

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112
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