Diversity of dragonflies (Insecta: Odonata) in Ujung Kulon National Park

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Abstract. Ujung Kulon National Park is a lowland tropical forest that was still preserved. There was limited information about the diversity of dragonflies in Ujung Kulon National Park. The purpose of this study was to study species diversity of dragonfly in Ujung Kulon. The research was conducted in Ujung Kulon Peninsula, Banten, Indonesia in five locations and three types of aquatic habitats i.e., natural ponds, streams in forests, and rivers. The transect line method is used to collect adult dragonflies. Thirty-one species of dragonflies belong to two anisopteran families and six zygopteran families were reported in this study. Twenty-two species were as new records based on previous publications. There were different species compositions in all habitat types (R = 1, p = 0.0016, one-way ANOSIM with Bray-Curtis similarity index). Natural ponds have the highest anisopteran species richness compared to other habitats. Eight species Anisoptera only were found in natural ponds. Meanwhile, zygopteran species prefer in flowing water habitat.

Keywords: diversity, dragonflies, Ujung Kulon, tropical forest.

1. Introduction
Dragonflies are the most ancient insects which are divided into three suborders, the Zygoptera (damselflies), Anisoptera (true dragonflies) and Anisozygoptera that have some feature of Zygoptera and Anisoptera [1]. Anisozygoptera have two extant species from Japan and the eastern Himalayas [2]. Some authors classified Anisoptera and Anisozygoptera under a new name Epiprocta [3].

Ujung Kulon National Park (UKNP) is lowland tropical forest ecosystem that still preserved [4]. The region lies from 6°30’ - 6°52’ S and 102°02’ - 105°37 W [5]. Information and research about dragonflies in Ujung Kulon is still limited. Previous studies of dragonflies in Ujung Kulon were reported by Yukawa and Yamine [6] and Van Tol [7]. From those studies, eleven species has been reported.

Dragonfly survey in Ujung Kulon was one of the efforts to reassemble data on the diversity of dragonflies in Java Island. The recent information about dragonflies fauna in Java Island is still limited. Information related to their diversities, distribution, and habitat were still poorly studied [8]. The first list of dragonfly species in Java Island was reported by Lieftinck on 1934 [9]. One hundred forty-two species of dragonflies were recorded in Java [9]. The recent information on dragonflies in Java is obtained from the results of a survey conducted by the Indonesia Dragonfly Society in several areas in Java [10]. There are 88 species of dragonflies have been re-recorded [10]. Some area in Java have not been resurveyed yet, included in Ujung Kulon areas. The objective of this study was to re-inventory of the diversity of adult dragonfly species in various habitat types in Ujung Kulon.
2. Methods

2.1. Survey location
The survey was conducted in Ujung Kulon Peninsula, Banten, Java Island, Indonesia in five sampling locations (figure 1). Survey of dragonflies was conducted in August 2018. First sampling location (06° 50’29,4“ S, 105° 27’11,0” E) is in a natural pond in coastal forest, Karang Ranjang (KR) resort area. Width and length of the pond is about 30 m, with muddy substrate and some plant litter substrate. The second sampling location (06° 48’ 20,85” S, 105° 17’36, 05” E) is in a small stream in the forest at Cibunar Resort (CBR1). The streams have slow-flowing water, the width of streams ranged 0.5 - 1.5 m, with the rocky substrate and plant litter substrate. The third and fourth sampling locations located at the river in the Cibunar forest (CBR2 and CBR3) and the distance between each location is about 1000 m. Width of the river ranged 5 - 7 m. The third location (06° 48’ 01,89” S, 105° 17’48,59” E) is in shady river. The fourth location (06° 48’ 01,89” S, E: 105° 17’48,59” E) is in openness river, there is no trees in 100 m around this location, but shrubs, grass and some plant were found. Both locations have the same river substrate. River substrate consist of leaf litter, twigs, logs, rocks, and sands. The fifth location (06° 45’49,5” S, 105° 15’ 52,1” E) is in shady river in the forest at Cidaon Resort (CDN). Width of the river ranged 3 - 3.2 m. This location was similar to CBR2 (figure 2).

![Figure 1. Location of dragonflies sampling in Ujung Kulon Peninsula.](image)

2.2. Dragonfly survey methods
Dragonfly was collected in sunny weather in 10.00–12.00 am and 05.00-06.00 pm. Each location was surveyed in four-time in four days. The transect method was used to collect data. Dragonfly was collected in 100 m long transects or along with aquatic habitats if it's size less than 100 m. The transect width is 2 m: 1 m in the edge and 1 m in the water body from the edge. Dragonfly was observed in one hour, with a walking speed of 1.6 meters/minute to avoid double counting [11]. Species and the number of individuals were recorded. Dragonflies were observed directly or use a binoculars and the camera and then identified using a field guide. Dragonflies that cannot be identified directly, were captured using insect nets and their morphology, such as wings venation, lateral, dorsal and ventral body view was documented using Canon EOS 1300D camera. Samples of dragonflies were identified by using Fraser [12] and Orr [13]. The classification of Zygoptera based on Klaas-Douwe et al. [14]. Some information about global distribution, endemicity and conservation status of dragonfly was added from IUCN database.
2.3. Data analysis
The similarity of species composition in each sampling location was measured by analysis of similarity (ANOSIM) with the Bray-Curtis method. Data of species found per day was used as a replication. The vegan package in R program was used to analyze the data [15]. The Jaccard similarity index was used to show the similarity of dragonfly composition in each habitat using PAST software.

![Figure 2](image_url)

Figure 2. Habitat of dragonflies in sampled locations A: natural ponds in coastal forest at Karang Ranjang (KR), B: small streams in the forest (CBR1), C: openness river habitat in forest Cibunar (CBR2), D: shady river habitat in forest Cibunar (CBR3), and E: shady river in forest Cidaon (CDN).

3. Results
Thirty-one species of dragonflies were reported in this study. Twenty-five species were found at the determined sampling sites and six species were found at the another location (table 1). Species found in another location includes *Cratilla metallica* (Brauer, 1878), *Crocothemis servilia* (Drury, 1773), *Diplacodes trivialis* (Rambur, 1842), *Macrodiplax cora* (Kaup in Brauer, 1867), *Lathrecista asiatica* and *Ischnura senegalensis* (Rambur, 1842). The composition of dragonflies consists of 18 species belong to anisopteran families (Libellulidae and Gomphidae) and 13 species belong to six zygopteran families (Calopterygidae, Chlorocyphidae, Coenagrionidae, Euphaidae, Platycnemididae, and Protoneuridae).
Table 1. Checklist of dragonflies species found in Ujung Kulon National Park (KR= pond habitat in Karang Ranjang Resort Area, CBR1: small streams, CBR2 & CBR3: river habitat, CDN: river habitat in Cidaon Resort Area).

| Family       | Species                                | KR | CBR 1 | CBR 2 | CBR 3 | CDN |
|--------------|----------------------------------------|----|-------|-------|-------|-----|
| Aeshnidae    | Gynacantha basigutatta Rambur, 1842     |    | 1     | 0     | 0     | 0   |
|              | Agrionoptera insignis (Rambur,1842)     |    | 1     | 1     | 0     | 0   |
|              | Brachydiplax chalybea Brauer, 1868      |    | 1     | 0     | 0     | 0   |
|              | Camacinia gigantea (Brauer, 1867)       |    | 1     | 0     | 0     | 0   |
|              | Nesoxenia lineata (Selys, 1868)         |    | 1     | 0     | 0     | 0   |
|              | Neurothemis ramburii (Kaup in Brauer, 1866) |    | 1     | 1     | 1     | 1   |
|              | Orchetrum chrysis (Selys, 1891)         |    | 0     | 1     | 1     | 1   |
|              | Orchetrum sabina (Drury, 1773)          |    | 1     | 0     | 0     | 1   |
|              | Pantala flavescens (Fabricius, 1798)    |    | 1     | 0     | 0     | 0   |
|              | Tetraphemis irregularis Brauer, 1868    |    | 0     | 0     | 5     | 0   |
|              | Tholymis tillarga (Fabricius, 1798)     |    | 1     | 0     | 0     | 0   |
|              | Tramea transmarina Brauer, 1867         |    | 1     | 0     | 0     | 0   |
|              | Zyxomma obtusum Albarda, 1881           |    | 1     | 0     | 0     | 0   |
| Calopterygidae| Vestalis luctuosa (Burmeister, 1839)    |    | 0     | 0     | 1     | 0   |
| Chlorocyphidae| Heliochrysa fenestrata (Wiedemann in Burmeister, 1839) |    | 0     | 0     | 1     | 1   |
|              | Libellago aurantiaca (Selys, 1859)      |    | 0     | 0     | 0     | 1   |
| Coenagrionidae| Pseudagrion pruinosum (Burmeister, 1839) |    | 0     | 0     | 0     | 1   |
|              | Pseudagrion microcephalum (Rambur, 1842) |    | 0     | 0     | 0     | 1   |
| Euphaidae    | Euphaea variegata Rambur, 1842          |    | 0     | 0     | 1     | 1   |
| Platycnemididae| Coeliccia membranipes (Rambur, 1842)   |    | 0     | 1     | 0     | 0   |
|              | Copera marginipes (Rambur, 1842)        |    | 1     | 0     | 0     | 1   |
|              | Copera vittata (Selys, 1863)            |    | 0     | 1     | 0     | 0   |
|              | Prodasineura autumnalis (Fraser, 1922)  |    | 0     | 0     | 1     | 1   |
|              | Prodasineura delicatula (Lieflintck, 1930) |    | 0     | 1     | 1     | 0   |
| Protoneuridae| Nososticta insignis (Selys, 1886)       |    | 0     | 1     | 1     | 0   |

Natural pond showed a higher number of species richness of Anisoptera compared to another habitat. Nine species only were found at the natural pond, includes G. basigutatta, B. chalybea, C. gigantea, N. lineata, O. chrysis, P. flavescens, T. tillarga, T. transmarina, and Z. obtusum. Meanwhile, zygopteran prefer in flowing water habitat. Three species, G. basigutta, Z. pruinosum and T. tillarga were only found in crepuscular time. The ratio of zygopteran and anisopteran from the highest to lowest were CDN, CBR3, CBR2, CBR1, and KR. Some species only were found in specific habitat such as, C. membranipes was found in shadier small streams and P. pruinosum was found in the sunniest river. Copera marginipes (damsel fly) can be found in stagnant and flowing water habitats,
while C. vitatta prefers in flowing and shadier water. Neurothemis ramburri and O. chrys is have wider distribution among all sampling locations. Heliocypha fenestrata, L. aurantiaca, V. luctuosa, E. variegata are zygopteran that has higher abundance among other zygopteran. Heliocypha fenestrata (Javan endemic damselfly) prefer in shadier flowing water, while L. aurantiaca prefer in openess river (CBR2, CBR3, CDN). Vestalis luctuosa (near threatened damselfly based on IUCN) was more abundance in river forest (CBR2 and CDN).

This study showed dissimilarity of dragonfly communities among all locations (R=0.997, p=0.0016, ANOSIM with the Bray-Curtis similarity index). Karang Ranjang has the lowest similarity index compared to another habitats. Composition of species in river habitats (CBR2 and CDN) have the highest similarity index (table 2).

| Study Sites | KR   | CBR1 | CBR2 | CBR3 | CDN  |
|-------------|------|------|------|------|------|
| KR          | 1.00 | 0.12 | 0.05 | 0.16 | 0.09 |
| CBR1        | 0.12 | 1.00 | 0.33 | 0.13 | 0.36 |
| CBR2        | 0.05 | 0.33 | 1.00 | 0.36 | 0.62 |
| CBR3        | 0.16 | 0.13 | 0.36 | 1.00 | 0.47 |
| CDN         | 0.09 | 0.36 | 0.62 | 0.47 | 1.00 |

4. Discussion
This study added information on the diversity of dragonfly species in Ujung Kulon National Park. This study added dragonfly data of Yukawa and Yamane [6] and Van Tol [7] and 35 species were noted by Lieftinck [16]. In our survey, there are five species of dragonflies that have not been checklisted in previous publication. These species are C. lineata, L. magnificata, L. praemorsa, N. terminata, and O. testaceum. Three species, C. lineata, L. magnificata, and L. praemorsa are uncommon species in Java [16]. Yukawa and Lieftinck were reported those species in Panaitan Island, while Van Tol [7] was explored at Panaitan Island, Peucang Island, and other locations in Ujung Kulon Peninsula, included Cidaon and Cibunar. A total of 22 species of dragonflies were reported as new records for Ujung Kulon Peninsula. The diversity of dragonflies in UKNP is 21% of the total species of dragonflies found in Java Island published by Lieftinck [9]. More observation in Ujung Kulon Peninsula and surrounding islands can increase the species list of dragonfly.

This survey recorded two endemic damselflies species in Java. Heliocypha fenestrata and P. delicatula [9, 17]. Ujung Kulon is a conservation habitat for V. luctuosa. This damselfly was listed as near to threatened insect in IUCN red list data [18]. Vestalis luctuosa has higher abundance compared to another damselflies. This information was similar to Herlambang et al. [19]. According to the recent publication, V. luctuosa was found on Java [19, 20, 21, 22, 23]. This species was categorized as flagship species for freshwater ecosystems in the Greater Sunda Islands [24]. Information found in this research supported the future conservation. There are three species of damselfly only distributed in Sumatra, Java, and Bali Island i.e., N. insignis, V. luctuosa, and E. variegata [9, 17, 25]. Based on Virgiawan et al. [26] and Fitriana [27], we categorized D. trivialis, N. ramburri, O. sabina, O. chrys is, P. flavescens, Z. obtusum, I. senegalensis, and P. pruinum as are common dragonflies species. Its distribution has been reported from conservation areas to urban and landuse water ecosystem [26, 27].

Anisopteran dominated in pond habitat compared to river and streams habitat. This condition was similar to Seidu et al. [28] and Rener et al. [29], the lentic ecosystem was dominated by anisopteran, while zygopteran was often found in the lotic ecosystem. Freshwater habitat types such as stream, river, natural and artificial pond determined the dragonfly community structures [28, 29, 30].
Conclusion
Thirty-one species has inventoried in this study. There are belonging to two Anisopteran families and six zygopteran families. Twenty-two species were reported as new records based on previous publications and its added the new total number of species found in Ujung Kulon has reached 35 species. Anisopteran communities more dominant in stagnant water (lentic ecosystem) while zygopteran species prefer in flowing water habitat (lotic ecosystem).

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