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Cover: Long-tailed Shrike *Lanius schach* resting on a dry branch after courtship. Digital illustration on Procreate. © Aakanksha Komanduri.

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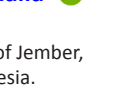

ARTICLE

The dragonfly (Odonata) community structure at Sukamade Resort, Meru Betiri National Park, Indonesia

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Abstract: Sukamade Resort, located within Meru Betiri National Park, is a conservation management area. Dragonflies have significant diversity and extensive spread, and their presence in conservation areas is linked to the availability of ecological resources such as abundant vegetation near aquatic habitats. This study ascertained the composition of the dragonfly community in Sukamade Resort at four sampling sites to provide data for conservation area management. Of the 17 species recognized, *Orthetrum sabina* and *Pseudagrion microcephalum* had the greatest population density across all locales. The diversity index indicated a moderate level, the Margalef index demonstrated low requirements, the dominance index was low, and evenness was high. The important value index (IVI) indicates that *Neurothemis ramburii*, *Orthetrum sabina*, and *Libellago lineata* had the highest ecological importance (IVI = 0.38). Canonical correspondence analysis indicates that *Pseudagrion microcephalum*, *Zyxomma obtusum*, *Ischnura senegalensis*, *Diplacodes trivialis*, and *Trithemis festiva* are associated with air humidity characteristics at the Great Estuary location. It is concluded that the presence of dragonflies is influenced by habitat factors such as aquatic substrate composition, abiotic parameters (light, temperature, humidity), and riparian vegetation. Protecting riparian habitats and maintaining good water quality are crucial for the conservation of dragonflies, which reflect healthy ecological conditions and support the sustainability of aquatic ecosystems.

Keywords: Abiotic, abundance, conservation, diversity, ecosystem, environmental, forest, habitat, tropical.

Resort Sukamade, yang terletak di dalam Taman Nasional Meru Betiri, merupakan kawasan pengelolaan konservasi. Capung memiliki keanekaragaman yang signifikan dan persebaran yang luas, serta keberadaannya di kawasan konservasi terkait dengan ketersediaan sumber daya ekologis seperti vegetasi yang melimpah di dekat habitat perairan. Penelitian ini bertujuan untuk mengetahui komposisi komunitas capung di Resort Sukamade pada empat lokasi pengambilan sampel guna menyediakan data bagi pengelolaan kawasan konservasi. Dari 17 spesies yang teridentifikasi, *Orthetrum sabina* dan *Pseudagrion microcephalum* memiliki kepadatan populasi tertinggi di seluruh lokasi. Indeks keanekaragaman menunjukkan tingkat sedang, indeks Margalef menunjukkan kebutuhan rendah, indeks dominansi rendah, dan indeks kemerataan tinggi. Indeks nilai penting (INP) menunjukkan bahwa *Neurothemis ramburii*, *Orthetrum sabina*, dan *Libellago lineata* memiliki kepentingan ekologis tertinggi (INP = 0,38). Analisis korespondensi kanonik menunjukkan bahwa *Pseudagrion microcephalum*, *Zyxomma obtusum*, *Ischnura senegalensis*, *Diplacodes trivialis*, dan *Trithemis festiva* berasosiasi dengan karakteristik kelembapan udara di lokasi Muara Besar. Disimpulkan bahwa keberadaan capung dipengaruhi oleh faktor-faktor habitat seperti komposisi substrat perairan, parameter abiotik (cahaya, suhu, kelembapan), serta vegetasi riparian. Perlindungan habitat riparian dan pemeliharaan kualitas air yang baik sangat penting bagi konservasi capung, yang mencerminkan kondisi ekologis yang sehat serta mendukung keberlanjutan ekosistem perairan.

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Author contribution: AR: Conceptualization, supervision, and revision of the manuscript and manuscript writing. WS: Methodology, validation, and data analysis. DAA: Data collection, analysis, and manuscript writing.

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INTRODUCTION

Meru Betiri National Park is a conservation management area that includes Sukamade Resort, a lowland forest. Dragonflies exhibit specific habitat preferences within the region. Dragonflies exhibit significant diversity and a wide distribution across various habitats (Kalkman et al. 2008). The presence of dragonflies in conservation areas is intricately linked to the availability of natural elements essential for their life cycle, particularly robust and diverse aquatic environments. Dragonflies exhibit considerable variability in their distributions, contingent upon the prevailing environmental conditions and habitat types in a given locale. Consequently, examining dragonfly communities across many habitats and conservation areas is crucial for comprehending the interplay between dragonfly species and their ecosystems and developing more effective conservation measures. Furthermore, conducting inventories is essential to ascertain the composition and abundance of species within an ecosystem, facilitating the examination of diversity, abundance, dominance, and evenness, which collectively depict community structure (Navarro et al. 2018).

Dragonflies have a crucial function in the ecosystem as bioindicators of aquatic quality and environmental contamination (Virgiawan 2016; Yuditaningtyas et al. 2022; Datto-Liberato et al. 2024). Furthermore, they function as predators and pest management agents (Lino et al. 2019). The availability of water and vegetation influences the presence of dragonflies. The nymph stage occurs in aquatic environments, while adults remain near the water (Nasirianda & Irvine 2017; Da Silva-Méndez et al. 2022). The research by Orlofske et al. (2024) shows that several river dragonfly larval taxa in the mountains co-occur; yet, during emergence, specific species may react differently to distinct stream characteristics. Certain adult dragonfly species prefer flowing rivers, particularly those with moderate to gentle currents. Dragonflies are distributed along streams about light intensity and canopy cover (French & McCauley 2018).

The research by Chovanec et al. (2015) established a dragonfly association index that correlates rivers with dragonflies to evaluate the ecological condition of rivers. Conservation zones with robust vegetation surrounding water habitats also affect the presence of dragonflies. The varied forest structure and dense vegetation can influence the distribution and quantity of dragonflies (O'Malley et al. 2020). Thick foliage offers refuge, roosting, foraging, and breeding opportunities. Dragonfly populations are typically more abundant in conservation areas with substantial vegetation cover along riverbanks. The advantageous and varied environmental conditions create an optimal ecosystem for dragonflies, enabling them to efficiently reproduce and fulfil their ecological functions (Hykel et al. 2020). The composition of the substrate also influences water quality (Vanderzwalmen et al. 2022).

The substrate of a river influences odonate makeup. Organic substrates, such as leaf litter and riparian zones, exhibit greater richness than inorganic substrates like rocks and gravel. Perron & Pick (2020) research indicates that water quality significantly affects the nymphal phase (Perron et al. 2020). Additionally, a correlation exists among riparian vegetation, water quality, and land cover, which may yield high-quality habitats for dragonflies. O'Malley et al. (2020) assert that dragonfly conservation through river habitat management must encompass the protection of riparian habitats alongside the preservation of water habitats and their quality. Riparian ecosystems characterized by diverse and dense plant life offer optimal habitats for dragonfly populations, but sparser and more open vegetation is also conducive to their presence. This study fills the knowledge gap by providing baseline data on the structure and diversity of dragonfly communities in Sukamade Resort, Meru Betiri National Park, which has not been widely studied. This study offers novelty by comprehensively analyzing habitat variables that can collectively affect dragonfly communities. This study provides an innovative methodology in the Meru Betiri National Park context by applying the dragonfly association index to assess ecological conditions. The study results are expected to be a strong scientific basis for more effective management and formulation of conservation policies, especially in efforts to protect habitats and support the sustainability of the ecological function of dragonflies as bioindicators of environmental quality and control agents. Based on this background, this study will analyze the composition, diversity, and structure of dragonfly communities in the Sukamade Resort Area, which will later become basic data for policymaking in managing the conservation area of Meru Betiri National Park.

MATERIALS AND METHODS

Study area

This study was conducted from June to August 2024 in Sukamade Resort, Meru Betiri National Park (TNMB) (Image 1). The approach employed for determining

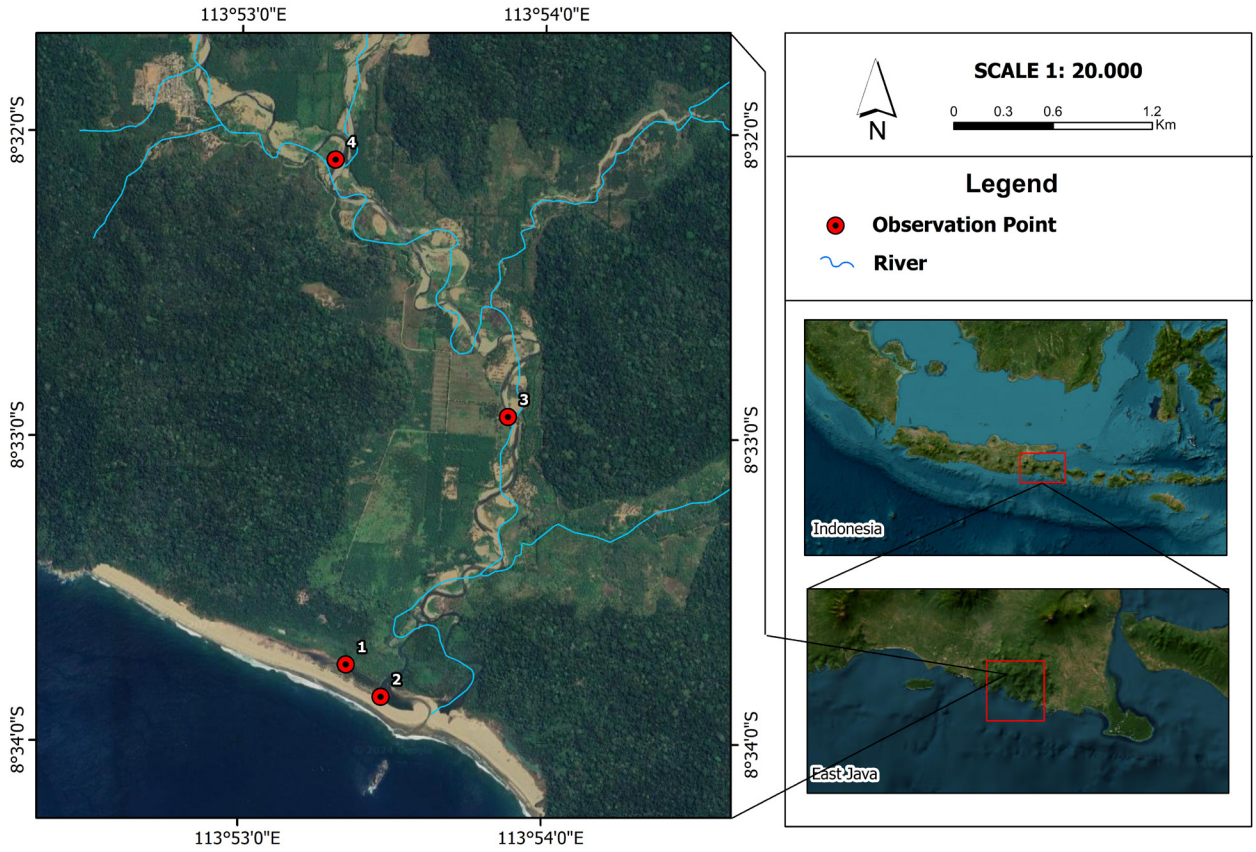

Image 1. Research location Sukamade Resort, Meru Betiri National Park.

sampling points was purposive sampling. Data collection on dragonflies was conducted throughout the river flow and categorized into four locations: great estuary, small estuary, Getean River, and Hamlet River.

Dragonfly data collection

The study employed the road sampling technique, which involved traversing a sampling area of 100 m in length and 10 m in width at each research site. Samples were collected using the sweeping technique (Rohman et al. 2024). Field data were gathered on different days, with each sampling session repeated three times. Sampling was conducted between 0600 h and 1700 h Western Indonesian Time (WIB). The parameters recorded included the species of dragonflies encountered and the number of individuals per species. Species identification was carried out by examining the morphological characteristics of each individual, guided by standardized identification keys. The identification process relied on validated scientific references, including identification manuals published by Orr (2005), Kalkman & Orr (2013), Orr & Kalkman (2015); Setiyono et al. (2017).

Substrate composition measurement

The composition of the water substrate was determined on a 1 m^2 plot located near the water's edge at the beginning, middle, and end of the transect. The substrate composition listed includes: mud, sand, rocks, gravel, plant substrate, leaf litter, and twigs or tree trunks.

Measurement of abiotic factors

The abiotic parameters examined include air temperature, light intensity, humidity, and wind speed.

Instruments and materials

Sweep net, stationery, ruler, styrofoam, needles, insect needles, cardboard paper, cotton, cardboard, papilot paper, syringe, camera, 5 watt yellow light, lux meter, thermohygrometer, anemometer, killing jar, and Garmin GPSmap 60CSx. The dragonflies that had been obtained were then dried and preserved and identified.

Data analysis

Assessment of conservation status according to the International Union for Conservation of Nature (IUCN)

Red List of Threatened Species (https://www.iucnredlist.org). Data analysis utilizing PAST4.09 software: Shannon-Wiener diversity index (H'), evenness (E), and dominance (D). The IVI was calculated for dragonfly communities based on their density, frequency, and dominance, which was utilized to evaluate the significance of species at each location.

The Shannon-Wiener diversity index (H') (Odum 1996) can be calculated using the formula:

$$H' = -\sum\{\left(\frac{ni}{n}\right) In \left(\frac{ni}{n}\right)\}$$

Information:

H' = Shannon-Wiener diversity index

ni = Number of individuals of type i

N = Number of individuals of all types

The evenness index (E/evenness) is used to determine the evenness of the number of individuals who form a community (Magurran 2004) as follows:

$$E = \frac{H'}{Ln\ S}$$

Information:

E = Evenness index

H' = Shannon-Wiener diversity index

S = Number of species found

Species dominance is determined using the Simpson's index using the formula:

$$D = \sum_{i-l}^{s} (\frac{ni}{n})^2$$

Information:

D = Dominance index

ni = Number of individuals of type i

N = Number of individuals of all types

The similarity index (Iss) is used to determine the similarity of species between locations as follows:

$$Iss = \frac{2C}{A+B} x\ 100$$

An importance value index (IVI) was determined for dragonfly communities based on their density, frequency and dominance, which was used to assess the importance of the species present at each location.

$$\text{Density} = \frac{\text{The number of species}}{\text{Area of measuring}}$$

$$\text{Relative density} = \frac{\text{Species density}}{\text{Density of all species}} \times 100\%$$

$$\text{Frequency} = \frac{\text{The number of plots containing a s}}{\text{The sum of all plots}}$$

$$\text{Relative frequency} = \frac{\text{Species frequency}}{\text{Frequency of all species}} \times 100\%$$

$$\text{Dominance} = \frac{\text{Species dominance}}{\text{Dominance of all species}}$$

$$\text{Relative dominance} = \frac{\text{Species dominance}}{\text{Dominance of all species}} \times 100\%$$

IVI = Relative Density (%) + Relative Frequency (%) + Relative Dominance (%)

Environmental parameters (abiotic) were analyzed using canonical correspondence analysis (CCA) to demonstrate the impact of abiotic factors on dragonfly presence in a habitat.

RESULTS

Dragonfly Diversity at Sukamade Resort, Meru Betiri National Park

A total of 133 individuals representing 17 dragonfly species from six families were documented (Table 2): *Neurothemis ramburii*, *Orthetrum sabina*, *Orthetrum pruinosum*, *Diplacodes trivialis*, *Zyxomma obtusum*, *Onychothemis culminicola*, *Potamorcha congener*, *Trithemis festiva*, *Libellago lineata*, *Ischnura senegalensis*, *Agrocnemis pygmaea*, *Agrocnemis femina*, *Pseudagrion microcephalum*, *Pseudagrion pruinosum*, *Pseudagrion rubriceps*, *Prodasineura humeralis*, and *Eupaea variegata*. *Orthetrum sabina* and *Pseudagrion microcephalum* had the greatest abundance across all locations. The family Libellulidae comprised eight dragonfly species, the family Coenagrionidae included six species, and the families Chlorocyphidae, Protoneuridae, and Euphaeidae each contained one species.

The Libellulidae had the highest proportion of species (47%), followed by the Coenagrionidae (35%), Chlorocyphidae, Protoneuridae, and Euphaeidae families with 6% each (Figure 1). This signifies that Libellulidae predominates in all locations and is the most prevalent family across diverse ecosystems.

Dragonfly index parameters

Figure 2 illustrates the computation of data analysis employing the diversity index, Margalef index, dominance index, and evenness index at Sukamade Resort of Meru Betiri National Park (MBNP). The variety index is valued at 1.99. The diversity index (H') is categorized as moderate ($1 \leq H' < 3$) based on the criteria. The subsequent index

Table 1. Description of the four research locations in Sukamade Resort, Meru Betiri National Park.

	Location	Coordinates		Elevation (m)	Description
		Latitude	Longitude		
1	Great Estuary	-8.562	113.889	29	The large river estuary has a width of 35 m with lentic brackish water conditions. This area is dominated by *Sonneratia griffithii* tree vegetation, which reaches heights of over 5 m, as well as riparian plants such as *Axonopus compressus.*
2	Small Estuaries	-8.564	113.891	27	The river with a smaller estuary has a width of 6 m and lentic water conditions. This area is dominated by *Sonneratia griffithii* tree vegetation, with heights exceeding 5 m, riparian plants such as *Axonopus compressus.*
3	Getean River	-8.548	113.898	31	The river, which has a smaller estuary, has a width of 15 m and lotic water conditions. This area is dominated by *Calliandra surinamensis* tree vegetation and riparian plants such as *Cymbopogon schoenanthus.*
4	Hamlet River	-8.534	113.888	33	The river, which has a smaller estuary, has a width of 9 m and lotic water conditions. This area is dominated by *Albizia chinensis* tree vegetation and riparian plants such as *Arachis hypogaea L*.

parameter is the Margalef index, which has a value of 2.18. Sukamade Resort exhibits a low species richness index, with R values below 2.5. The dominance index (D) of dragonflies in the Small Estuary is 0.24, categorizing it as low (D < 0.5). The species uniformity index (Evenness) of dragonflies in the Hamlet River is the greatest at 0.92, followed by the Geaten River at 0.84, the Great Estuary at 0.78, and the Small Estuary at 0.77, indicating a high level of uniformity (E > 0.6).

Figure 3 illustrates the relative abundance of dragonflies at Sukamade Resort in MBNP, indicating that at the Great Estuary (36.96) and Small Estuary (45) sites, the species *Pseudagrion microcephalum* exhibits the highest abundance. Conversely, at the Getean River site, the species *Orthetrum sabina* shows the highest abundance (30.77), and similarly, at the Hamlet River site, *Orthetrum sabina* also has the highest abundance (28.57).

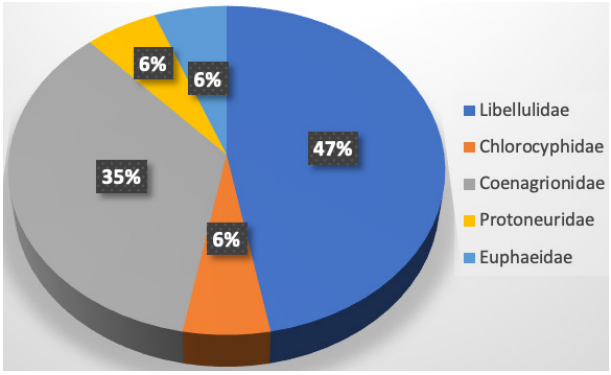

Figure 1. Dragonfly family composition at Sukamade Resort, Meru Betiri National Park.

Important value index dragonfly

The relevance index evaluation at the four locations encompassed Great Estuary, Small Estuary, Geean River, and Hamlet River (Figure 4). The initial site (Great Estuary) exhibited three species with the highest importance index: *Potamarcha congener*, *Ischnura senegalensis*, and *Pseudagrion microcephalum*, with an IVI of 0.34. The second site, Small Estuary, *Onychothemis culminicola*, exhibited the greatest significance index at 0.45. The Getean River exhibited that *Neurothemis ramburii*, *Orthetrum sabina*, and *Libellago lineata* possessed the highest importance index of 0.38. The Hamlet River exhibited the highest significance score of 0.4, attributed to *Potamarcha congener* and *Prodasineura humeralis*.

Measurement of substrate composition

The measurement of aquatic substrate composition in estuarine and riverine areas reveals significant variations depending on environmental characteristics and the dominant sources of organic and inorganic materials. In the Great Estuary, the aquatic substrate consists of inorganic materials such as sand, rocks, and gravel and organic materials such as plant substrates, leaf litter, twigs, or woody debris. A similar composition is observed in small estuaries, which are dominated by sand, rocks, gravel, plant substrates, leaf litter, and twigs or woody debris. This indicates that small and large estuaries share comparable sedimentation dynamics and organic material inputs. In contrast, the substrate composition in the Getean River is predominantly characterized by fine mud and twigs or woody debris, reflecting intensive sedimentation processes and organic material input from riparian vegetation. In the Hamlet River, the aquatic substrate primarily consists of mud and leaf litter, highlighting the influence of leaf decomposition and the accumulation of fine sediments. These variations in substrate composition underscore the diverse environmental processes and material sources shaping aquatic ecosystems in different locations. Further studies are needed to explore the

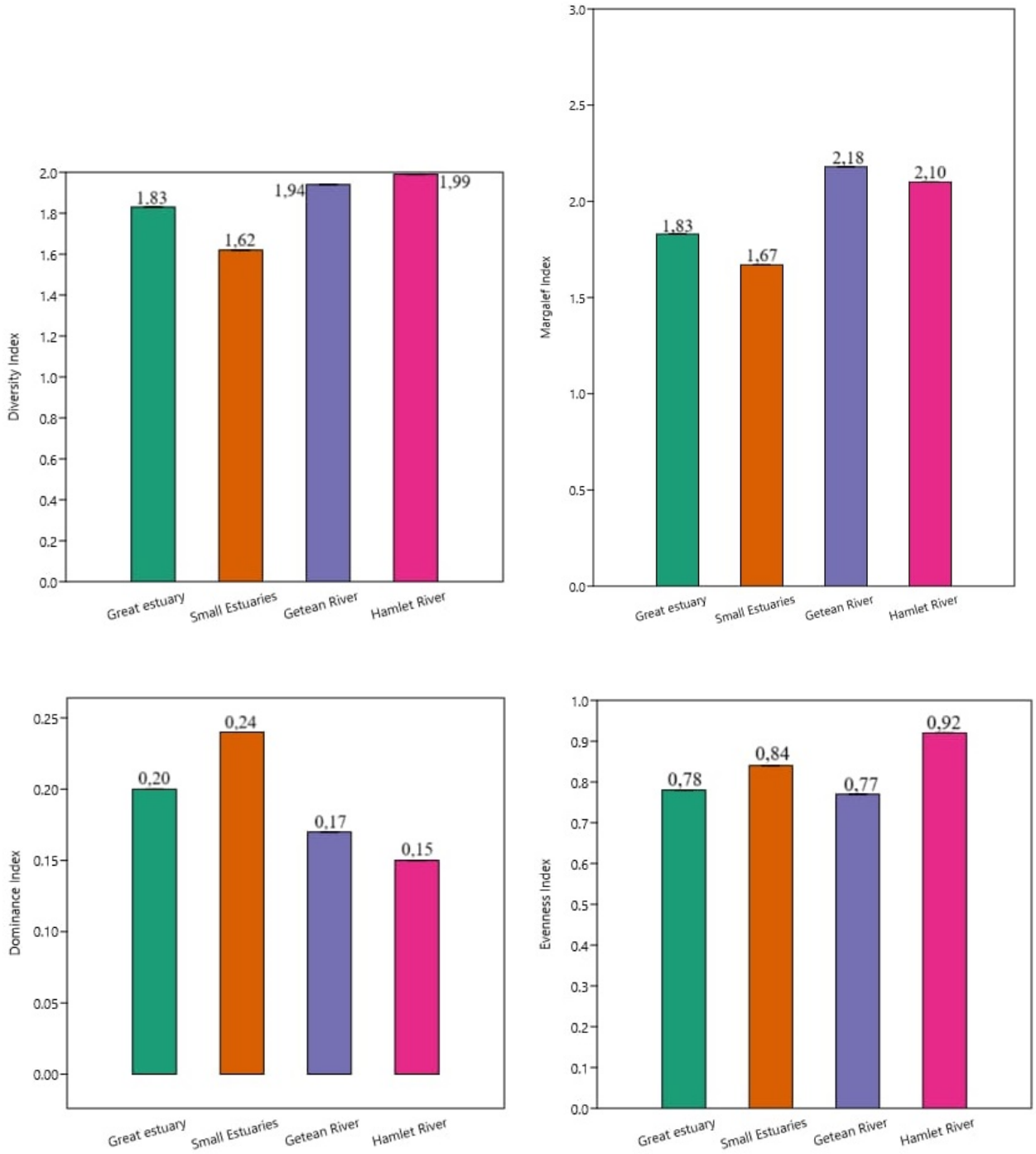

Figure 2. Diversity, Margalef, dominance, and evenness index parameters at Sukamade Resort, Meru Betiri National Park.

ecological implications of these substrate variations on aquatic biodiversity and ecosystem functions.

Abiotic parameters at Sukamade Resort, MBNP

The light intensity parameter ranged 2054.3–81866.7 lux. Compared to other sites, the Getean River exhibited the maximum intensity at 81,866.7 lux. Air temperature ranged 27.4–33.7 °C. This temperature range is ideal for insects. The air temperature in Getean River was higher (33.7°C) than other locations. Air humidity ranged 67–81.8. Humidity was lower at Getean River (67) than other locations. Wind speed ranged 0–2.3 (Table 3).

Table 2. List of dragonflies found in Sukamade Resort, Meru Betiri National Park.

	Suborder	Family	Species	Protection and conservation status of the species			Relative abundance				
				IUCN	CITES	NS	Great Estuary	Small Estuaries	Getean River	Hamlet River	Total
1	Anisoptera	Libellulidae	*Neurothemis ramburii* (Nr)	LC	NA	NP	17,39	10	23,08	10,71	22
2	Anisoptera	Libellulidae	*Orthetrum sabina* (Os)	LC	NA	NP	19,57	20	30,77	28,57	33
3	Anisoptera	Libellulidae	*Orthetrum pruinosum* (Op)	LC	NA	NP	0,00	5	0,00	0,00	1
4	Anisoptera	Libellulidae	*Diplacodes trivialis* (Dt)	LC	NA	NP	4,35	0	0,00	0,00	2
5	Anisoptera	Libellulidae	*Zyxomma obtusum* (Zo)	LC	NA	NP	6,52	5	0,00	0,00	4
6	Anisoptera	Libellulidae	*Onychothemis culminicola* (Oc)	LC	NA	NP	0,00	15	0,00	0,00	3
7	Anisoptera	Libellulidae	*Potamarcha congener* (Pc)	LC	NA	NP	6,52	0	0,00	7,14	5
8	Anisoptera	Libellulidae	*Trithemis festiva* (Tf)	LC	NA	NP	4,35	0	0,00	0,00	2
9	Zygoptera	Chlorocyphidae	*Libellago lineata* (Ll)	LC	NA	NP	0,00	0	15,38	7,14	8
10	Zygoptera	Coenagrionidae	*Ischnura senegalensis* (Is)	LC	NA	NP	4,35	0	0,00	0,00	2
11	Zygoptera	Coenagrionidae	*Agriocnemis pygmaea* (Ap)	LC	NA	NP	0,00	0	2,56	0,00	1
12	Zygoptera	Coenagrionidae	*Agriocnemis femina* (Af)	LC	NA	NP	0,00	0	5,13	0,00	2
13	Zygoptera	Coenagrionidae	*Pseudagrion microcephalum* (Pm)	LC	NA	NP	36,96	45	12,82	7,14	33
14	Zygoptera	Coenagrionidae	*Pseudagrion pruinosum* (Pp)	LC	NA	NP	0,00	0	0,00	3,57	1
15	Zygoptera	Coenagrionidae	*Pseudagrion rubriceps* (Pr)	LC	NA	NP	0,00	0	2,56	0,00	1
16	Zygoptera	Protoneuridae	*Prodasineura humeralis* (Ph)	NE	NA	NP	0,00	0	5,13	25,00	9
17	Zygoptera	Euphaeidae	*Eupaea varigeata* (Ev)	NE	NA	NP	0,00	0	2,56	10,71	4

Note: IUCN: NE—Not Evaluated | DD—Data Deficient | LC—Least Concern | NT—Near Threatened | VU—Vulnerable | EN—Endangered | CR—Critically Endangered | EW—Extinct in the Wild and Extinct. CITES: NA—Not Appendix | A.I—Appendix I | A.II—Appendix II | National Status (NS): P—protected | NP—not protected (P.106 /MENLHK /SETJEN /KUM.1/12/2018).

Canonical corresponding analysis

Canonical correspondence analysis categorizes dragonflies into four quadrants. Quadrant 1 indicates that the species *Pseudagrion microcephalum*, *Zyxomma obtusum*, *Ischnura senegalensis*, *Diplacodes trivialis*, and *Trithemis festiva* are associated with air humidity characteristics at the Great Estuary location. Quadrant two species, *Potamarcha congener*, *Eupaea variegata*, *Prodasineura humeralis*, and Pseudagrion pruinosum, exhibited a correlation with wind speed at the Hamlet River site. Quadrant three includes *Orthetrum sabina*, *Neurothemis ramburii*, *Libellago lineata*, *Pseudagrion rubriceps*, *Agriocnemis pygmaea*, and *Agriocnemis femina*, which are connected with water temperature and light intensity at the Getean River. Quadrant four species of *Orthetrum pruinosum* and *Onychothemis culminicola* are associated with the proximity of tiny estuaries (Figure 5).

Table 3. Abiotic parameters at Sukamade Resort, Meru Betiri National Park.

	Parameters	Great Estuary	Small Estuaries	Getean River	Hamlet River
1	Light intensity (lux)	2054.3 ± 102.9	45500 ± 2351.6	81866.7 ± 62185.7	45966.7 ± 5718.7
2	Air temperature (°C)	29.5 ± 0.5	27.4 ± 0.6	33.7 ± 1.5	30.7 ± 0.6
3	Air humidity	81.8 ± 2.8	77.3 ± 3.2	67 ± 8.5	69.3 ± 3.8
4	Wind speed (m/s)	0 ± 0.0	0.1 ± 0.3	0.8 ± 0.1	2.3 ± 0.1

Plant diversity in Sukamade Resort, Meru Betiri National Park

Eighteen (18) plant species were found in Sukamade Resort, Meru Betiri National Park (Table 4). Nine tree

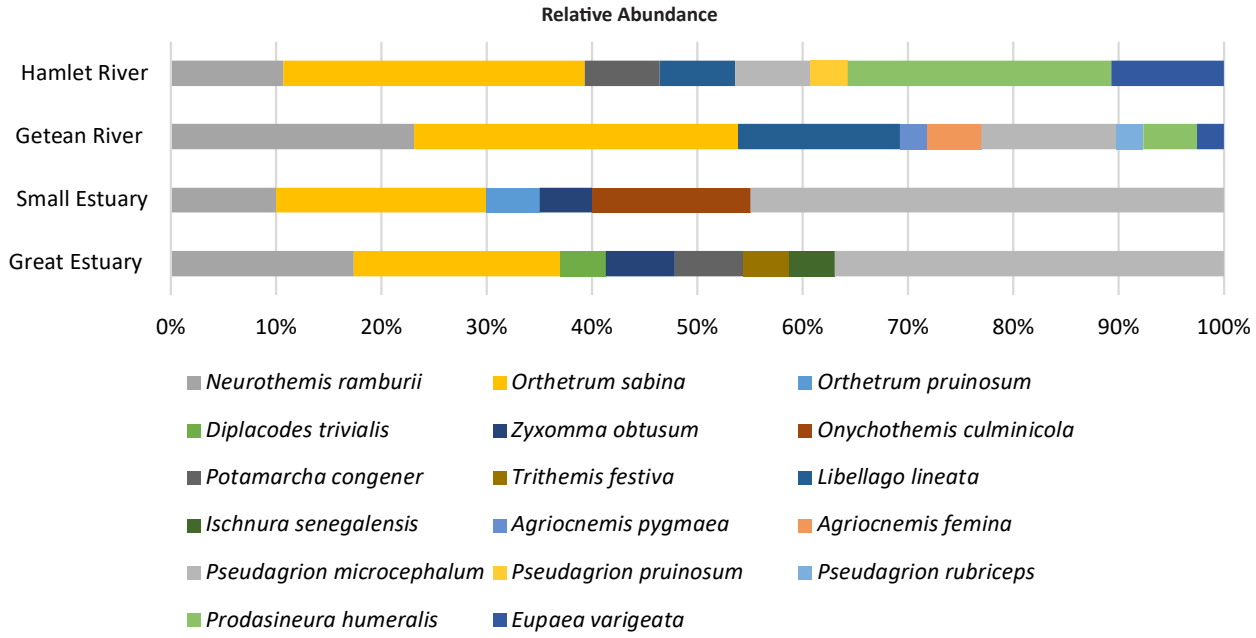

Figure 3. Relative abundance of dragonflies at Sukamade Resort, Meru Betiri National Park.

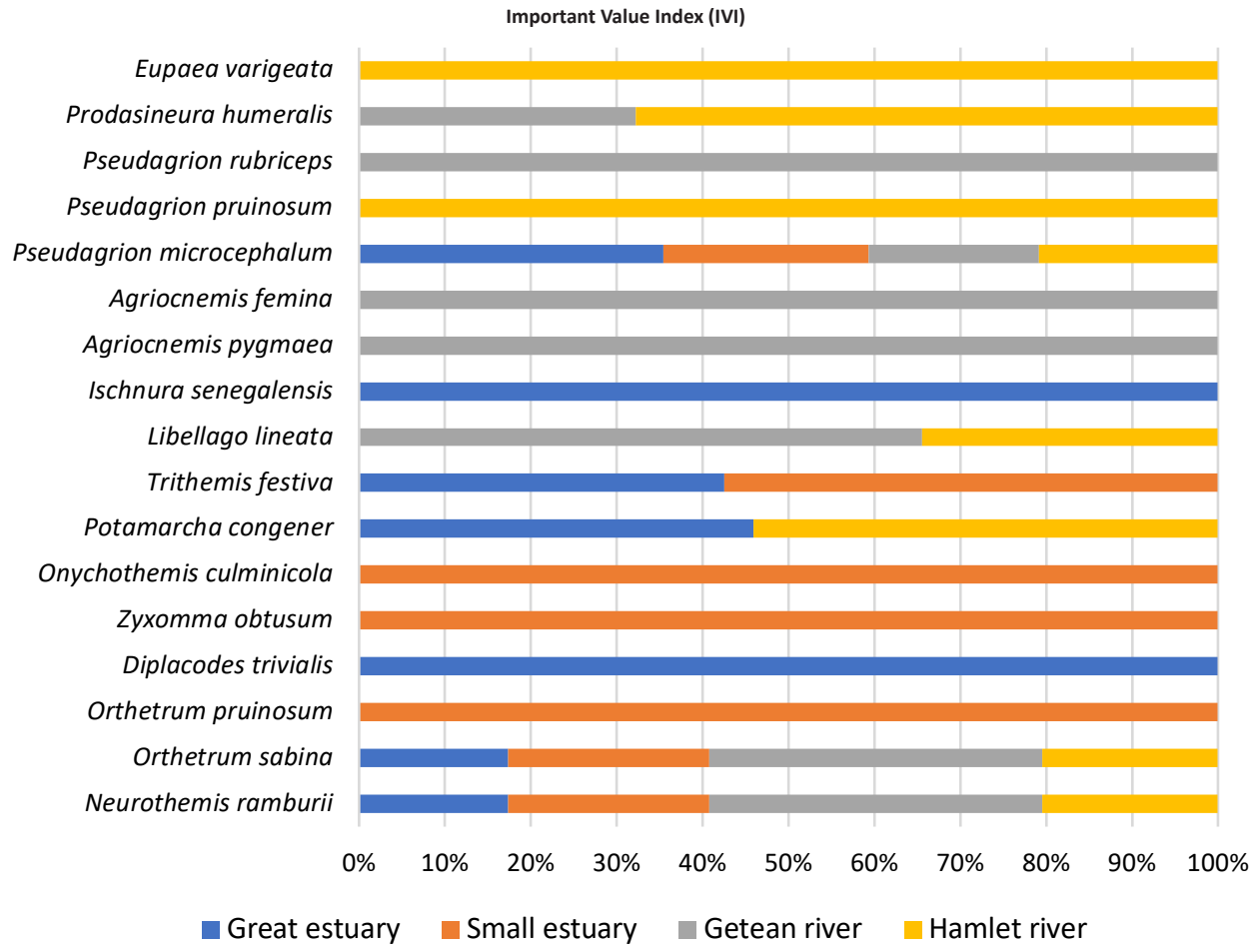

Figure 4. Dragonfly importance index at Sukamade Resort, Meru Betiri National Park.

Table 4. List of plant diversity in Sukamade Resort, Meru Betiri National Park.

	Plants	Family	Species	Great Estuary	Small Estuaries	Getean River	Hamlet River
1	Trees	Pandanaceae	*Pandanus tectorius*	12	38	0	0
2	Trees	Calophyllaceae	*Calophyllum inophyllum*	14	24	0	0
3	Trees	Fabaceae	*Albizia chinensis*	0	0	0	55
4	Trees	Fabaceae	*Cassia alata* L.	0	0	32	29
5	Trees	Fabaceae	*Calliandra surinamensis*	0	0	145	42
6	Trees	Moraceae	*Ficus elastica*	0	0	0	25
7	Trees	Lythraceae	*Sonneratia griffithii*	78	49	0	0
8	Trees	Musaceae	*Musa paradiciaca*	0	0	0	18
9	Trees	Arecaceae	*Cocos nucifera*	0	0	0	19
10	Riparian	Convolvulaceae	*Ipomoea indica*	0	16	23	0
11	Riparian	Amaranthaceae	*Celosia argentea*	0	0	25	0
12	Riparian	Ranunculaceae	*Ranunculus repens*	0	0	24	0
13	Riparian	Zygophyllaceae	*Tribulus terrestris*	0	0	28	0
14	Riparian	Apocynaceae	*Wrigtiya Antidysenterica*	0	64	0	23
15	Riparian	Poaceae	*Cymbopogon schoenanthus*	95	86	55	48
16	Riparian	Poaceae	*Axonopus compressus*	128	93	0	0
17	Riparian	Fabaceae	*Arachis hypogaea* L.	0	0	0	225
18	Riparian	Verbenaceae	*Stachytarpheta jamaicensis*	0	0	53	75

and riparian species were identified. Hamlet River is the location with the highest number of plant species (10 species). Followed by the Getean River (8 species), Small Estuaries (7 species), and Great Estuary (5 species).

DISCUSSION

Seventeen species of dragonflies were documented at Sukamade Resort, Meru Betiri National Park (Table 1). According to IUCN statistics, two species are classified as 'Least Concern': *Orthetrum sabina* and *Pseudagrion microcephalum*. According to CITES classification, the species *Orthetrum sabina* and *Pseudagrion microcephalum* are not listed in the Annexures. The national status of the species *Orthetrum sabina* and *Pseudagrion microcephalum* has not been documented as protected. The *Orthetrum sabina* species were observed roosting in riparian zones and huge trees adjacent to the Getean River. Berliani et al. (2024) identified the *Orthetrum sabina* species in riverine environments, natural habitats, and rice paddies. As per Rohman et al. (2024) *O. Sabina* is also present in utilization woods. *Pseudagrion microcephalum* was observed mating in the vicinity of the Great Estuary. This species is also present in streams (Salsabiela et al. 2022). Moreover, both species (*Orthetrum sabina* and *Pseudagrion microchepalum*) inhabit regions following lakes (Gultom 2022).

The Libellulidae family has the largest contribution, followed by Coenagrionidae. Both families exhibit a broad distribution in proximity to streams, rice fields, agricultural areas, freshwater environments, parks, and gardens (Rohman & Faradisa 2020; Salsabiela et al. 2022; Berliani et al. 2024). Their high adaptability to various environmental conditions and dependence on freshwater resources make Libellulidae and Coenagrionidae groups often found in these locations. Their presence reflects good ecological conditions and confirms their important role as bioindicators of environmental health, especially in monitoring water quality and the sustainability of aquatic ecosystems. Recent studies have shown that these two families have a significant ecological role in maintaining the balance of the food chain, both as predators and as prey for other organisms (Kehar et al. 2025; Palacino-Rodríguez et al. 2020).

Data analysis indicates that the diversity index parameter (H') is categorized as moderate ($1 \leq H' < 3$) (Magurran 2004). Dharmawan et al. (2022) demonstrated a moderate diversity index value in the national plant Alas Purwo at Pancur Resort. Hastomo et al. (2019) indicate a low diversity index value at the Kuningan

Resort of Mount Ciremai National Park. The Margalef index registers a value of 2.18. Sukamade Resort exhibits a low species richness index (R < 2.5) according to the standards established by Magurran (2004). Hastomo et al. (2019) demonstrated a low Margalef index value at the Kuningan Resort of Mount Ciremai National Park. The dominance index (D) of dragonflies in the Small Estuary is 0.24, categorizing it as low (D < 0.5). Nafisah & Soesilohadi (2021) indicate a low dominance index value in natural forests and tourist locations. The Evenness index for the four locations indicates a high level of homogeneity (E > 0.6). Nafisah & Soesilohadi (2021) indicate a high evenness index value in natural forests and tourist locations. According to Susanto et al. (2023), the degree of regularity in aquatic ecosystems is high.

The Great Estuary critical index study revealed three species with the highest importance index: *Potamarcha congener*, *Ischnura senegalensis*, and *Pseudagrion microcephalum*, with an IVI of 0.34. All three species exhibit extensive distribution. *Potomarcha congener* predominantly flies in open terrain and is capable of migration. Astuti et al. (2022) indicate that *P. congener* inhabits both agricultural and forested regions. *I. senegalensis* and *P. microcephalum* exhibit habitat traits associated with moving waters (rivers and irrigation systems) and stagnant waters (reservoirs, swamps, rice fields, and ponds). As per Nicolla et al. (2021), *I. senegalensis* inhabits both canopied and non-canopied environments. The second Small Estuary site, *Onychothemis culminicola*, possesses the greatest significance index of 0.45. Zulhariadi et al. (2024) indicate that the species inhabits areas surrounding ponds. Potential within aquatic ecosystems. In the Getean River, there are three species, namely *Neurothemis ramburii*, *Orthetrum sabina* and *Libellago lineata*. possess the greatest significance index of 0.38. As per Salsabiela et al. (2022), *O. Sabina* exhibits a broad dispersion. The three species inhabit areas surrounding rivers, irrigation systems, rice paddies, and ponds. The fourth location, Hamlet River, possesses the greatest significance score of 0.4, attributed to *Potamarcha congener* and *Prodasineura humeralis*. Salsabiela et al. (2022) indicate that *P. congener* species inhabit areas adjacent to streams with dense vegetation and near wells. The extensive distribution across several environments enables these species to attain the highest Important Value Index. Furthermore, assistance is available from nutritional resources and shelters. The existence of the three dragonfly species is contingent upon water availability. Dragonflies rely highly on aquatic environments, particularly during the nymph stage (Salsabiela et al. 2022). Moreover, variations in altitude can influence the distribution of certain dragonfly species (Table 1).

Aquatic substrate composition plays a critical role in determining the presence and abundance of dragonfly nymphs (Odonata), the aquatic phase of the dragonfly life cycle. Dragonfly nymphs typically inhabit waters with substrates that provide shelter and food sources, such as organic materials (leaf litter, twigs, or woody debris) and plant substrates. In the Great Estuary and small estuaries, the presence of sand, rocks, and gravel, along with organic materials, creates ideal habitats for dragonfly nymphs, as these substrates offer spaces for shelter from predators and areas for foraging. In the Getean River and Hamlet River, the dominance of mud and organic materials such as twigs or leaf litter also supports the life of dragonfly nymphs, albeit with different characteristics. Mud can serve as a suitable substrate for nymphs more tolerant of fine sediment conditions, while leaf litter and twigs provide detritus and microorganisms as food sources. According to Worthen & Horacek (2015), species are distributed differently across various sediment types. Family Gomphidae are commonly found in sand, while Family Cordulegastridae prefer a mixture of sand and cobbles. Family Gomphidae also tend to dominate in cobbles and coarse sediments, whereas family Aeshnidae favour coarse sediments. The average size of nymphs varies among species, and these habitat preferences contribute to differences in average size across sediment types. Overall, variations in aquatic substrate composition influence the distribution and abundance of dragonfly nymphs, with each substrate type providing distinct habitat conditions for specially adapted nymph species.

The Getean River exhibited the highest intensity of abiotic parameters measured at 81,866.7 lux, signifying exceptionally significant sunshine exposure relative to other sites. The Getean River features riparian vegetation along its banks, interspersed with open spaces. The Great Estuary exhibited the lowest intensity at 2054.3 lux (see Table 3). This site is characterized by vegetation and a canopy, resulting in increased shade and shelter. The air temperature varied between 27.4°C and 33.7°C. This temperature range is optimal for insects. The air temperature at Getean River was elevated at 33.7°C compared to the other locations. This location has a higher temperature than others due to its open space, which allows unimpeded light intensity. The intensity of light correlates with temperature; elevated light intensity facilitates dragonfly mobility, particularly in flight, due to its association with the wing veins (Liu et al. 2022). Air humidity varied between 67 and 81.8. The

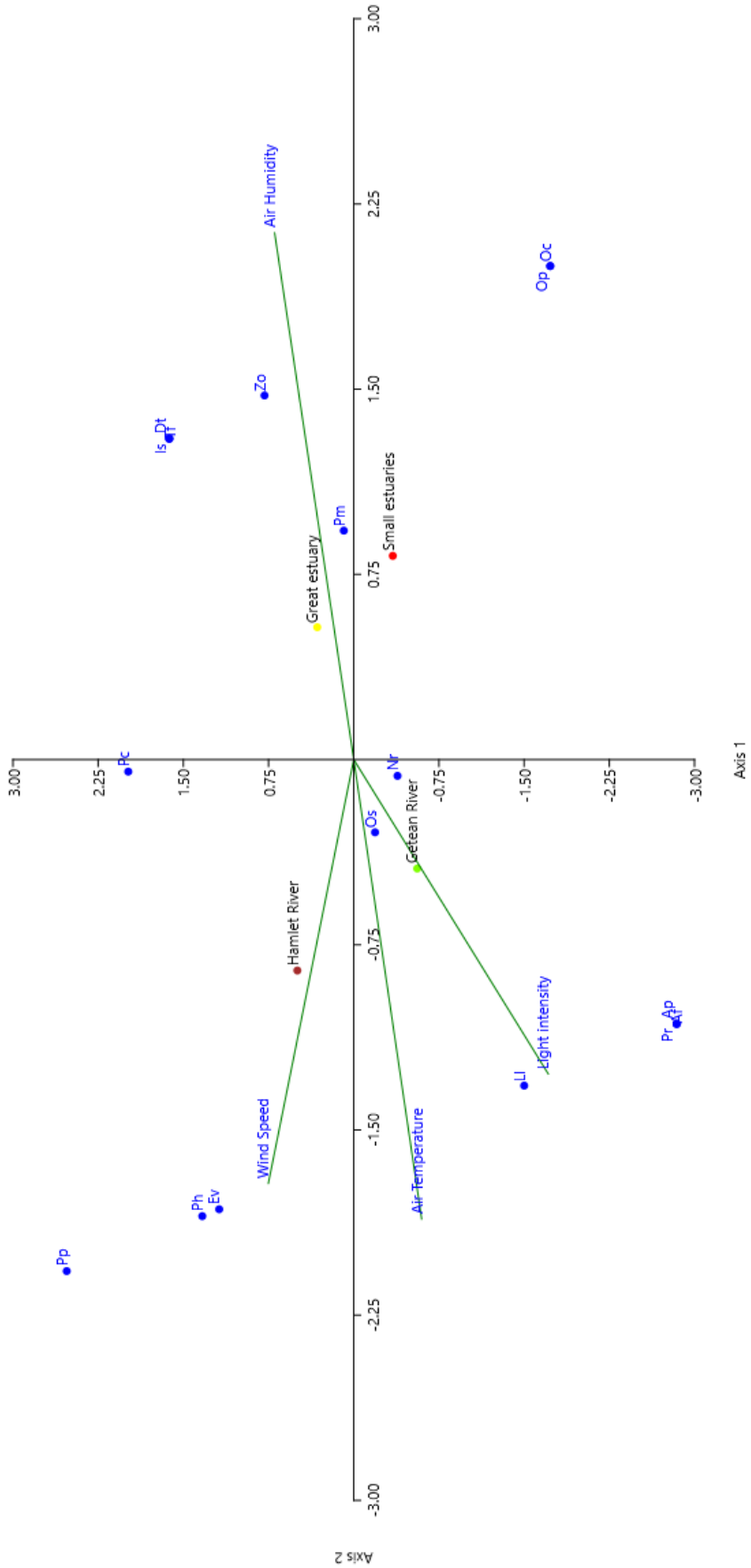

Figure 5. Canonical corresponding analysis at Sukamade Resort, Meru Betiri National Park.

air humidity at the Getean River (67) was lower than at other locations. Low air humidity will impact dragonfly motility (Susanto et al. 2024). Wind speed varied 0–2.3. This range signifies that the wind is not very strong, facilitating the movement of dragonflies.

Canonical Correspondence Analysis indicated that five dragonfly species (*Pseudagrion microcephalum*, *Zyxomma obtusum*, *Ischnura senegalensis*, *Diplacodes trivialis*, *Trithemis festiva*) had a positive correlation with the water humidity parameter in the Great Estuary. Rohman et al. (2023) demonstrated a positive association between various dragonfly species *Diplacodes trivialis* and air humidity (Figure 6).

Vegetation investigation reveals the presence of 18 plant species at Sukamade Resort, Meru Betiri National Park (Table 3). Nine varieties of trees located along riverbanks provide shade over the water. Zulhariadi et al. (2022) indicated that dragonfly diversity correlates with alterations in land cover along the river. Moreover, escalating land cover alterations may result in numerous dragonfly species' extinction. Water bodies that offer diverse riparian habitats can sustain dragonflies. Dragonflies frequently utilize riparian areas for roosting. Cheri (2020) asserts that the structure of dragonfly communities is significantly connected with riparian-specific vegetation factors. Dragonflies exhibit sensitivity to riparian conditions in stream habitats within the Nearctic area. O'Malley et al. (2020) assert that the development of dragonfly populations is linked to aquatic and terrestrial influences. Diversity primarily pertains to terrestrial variables such as canopy cover and slope. Therefore, proposals for the National Park regarding river habitat management for dragonfly conservation should encompass the protection of riparian habitats while preserving aquatic habitats and their quality.

CONCLUSIONS

The researchers identified seventeen species of dragonflies. The dragonfly population exhibited variability across the four locations. The Shannon-Wiener diversity index (H') is defined as a medium, the Margalef index indicates low criteria, the dominance index falls within the low category, and evenness is high. Canonical correspondence analysis (CCA) indicated that five dragonfly species correlated with the air humidity parameter (Quadrant 1). The findings of our investigation demonstrate a correlation between the existence of dragonflies and vegetation in the forest. Consequently, the significance of the forest in Sukamade Resort of TNMB as a protection zone, particularly for dragonfly habitats, is paramount.

REFERENCES

Astuti, A., I.N. Nayasilana, S. Sugiyarto & A. Budiharjo (2022). Community structure of dragonflies (Odonata) in Gunung Bromo's Forest area with special purpose (FASP), Karanganyar, Central Java, Indonesia. *Biodiversitas Journal of Biological Diversity* 23(5): 2493–2501. https://doi.org/10.13057/biodiv/d230529

Berliani, N., R. Kardiman & R. Satria (2024). Species diversity of Odonata as a bioindicator of water pollution in the Batang Harau watershed, Tanah Datar District, West Sumatra. In IOP Conference Series: Earth and Environmental Science 1346(1): 012026. https://doi.org/10.1088/1755-1315/1346/1/012026

Cheri, C.R. (2020). Dragonflies and Damselflies (Insecta: Odonata) as Indicators for Riparian Condition in Ozark Spring Streams. (Thesis) Cameron Riley Cheri, Missouri State University.

Chovanec, A., M. Schindler, J. Waringer & R. Wimmer (2015). The dragonfly association index (Insecta: Odonata)—A tool for the type-specific assessment of lowland rivers. *River Research and Applications* 31(5): 627–638. https://doi.org/10.1002/rra.2760

Datto-Liberato, F.H., V.M. Lopez, T. Quinaia, R.F. do Valle Jr, M J. Samways, L. Juen, C. Valera & R. Guillermo-Ferreira (2024). Total environment sentinels: Dragonflies as ambivalent/amphibiotic bioindicators of damage to soil and freshwater. *Science of The Total Environment* 934: 173110. https://doi.org/10.1016/j.scitotenv.2024.173110

Da Silva-Méndez, G., S. Riso, M.O. Lorenzo-Carballa & A. Cordero-Rivera (2022). Sampling larvae, exuviae or adults of Odonata for ecological studies: a test of methods in permanent rivers in the Iberian Peninsula. *Odonatologica* 51(1–2): 63–81. https://doi.org/10.60024/odon.v51i1-2.a4

Dharmawan, D.P.R., W. Subhan, J. Prihatin, V.E. Susilo & S. Ariyunita (2022). Diversity of Dragonflies (Odonata) at Pancur Resort Alas Purwo National Park, Indonesia. Borneo *Journal of Resource Science and Technology* 12(2): 57–62. https://doi.org/10.33736/bjrst.4668.2022

French, S.K. & S.J. McCauley (2018). Canopy cover affects habitat selection by adult dragonflies. *Hydrobiologia* 818(1): 129–143. https://doi.org/10.1007/s10750-018-3600-5

Gultom, S. (2022). Indentifikasi Jenis Capung Di Taman Wisata Alam Danau Sicikeh-Cikeh Kabupaten Dairi Sumatera Utara. *SITek (Jurnal Sains, Informasi dan Teknologi)* 1(1): 20–29.

Hastomo, S.O.E., Z. Muttaqin & K.D. Cita (2022). Inventory and diversity of dragonflies (Odonata) at Kuningan Resort of Mount Ciremai National Park, West Java Province. In: IOP Conference Series: Earth and Environmental Science 959(1): 012019. https://doi.org/10.1088/1755-1315/959/1/012019

Hykel, M., J. Růžičková & A. Dolný (2020). Perch selection in Sympetrum species (Odonata: Libellulidae): importance of vegetation structure and composition. *Ecological Entomology* 45(1): 90–96. https://doi.org/10.1111/een.12778

IUCN (2024). The IUCN Red List of Threatened Species. https://www.iucnredlist.org/en. Accessed on 20.vi.2024.

Kalkman, V.J. & A.G. Orr (2013). Field Guide to the damselflies of New Guinea. *Brachytron* 16(2): 3–118.

Kalkman, V.J., V. Clausnitzer, K.-D.B. Dijkstra, A.G. Orr, D.R. Paulson & J. van Tol (2008). Global diversity of dragonflies (Odonata) in freshwater. *Hydrobiologia* 595; 351–363. https://doi.org/10.1007/s10750-007-9029-x

Kehar, G.R., A.M. Shaikh, W.A. Panhwar, N. Solangi & N.A. Kehar (2025). A comprehensive assessment of the species diversity and ecological distribution of the dragonfly family Libellulidae in Taluka Garhi Khairo, District Jacobabad, Sindh, Pakistan. *Pure and Applied Biology* 14(3): 980–990. https://doi.org/10.19045/

bspab.2025.140089

Lino, J., R. Koneri & R.R. Butarbutar (2019). Keanekaragaman capung (Odonata) di tepi sungai kali desa kali Kabupaten Minahasa Sulawesi Utara. *Jurnal MIPA* 8(2): 59–62. https://doi.org/10.35799/jmuo.8.2.2019.23767

Liu, C., R. Du, F. Li & J. Sun (2022). Bioinspiration of the vein structure of dragonfly wings on its flight characteristics. *Microscopy Research and Technique* 85(3): 829–839. https://doi.org/10.1002/jemt.23952

Magurran, A.E. (2004). *Measuring Biological Diversity*. Blackwell Publishing, Oxford, pp. 40-69.

Nafisah, N.A. & R. H. Soesilohadi (2021). Community structure of dragonfly (Ordo: Odonata) in natural forest and tourist sites petungkriyono Forest, Central Java, Indonesia. *Journal of Tropical Biodiversity and Biotechnology* 6(3): 67328. https://doi.org/10.22146/jtbb.67328

Nasirian, H. & K.N. Irvine (2017). Odonata larvae as a bioindicator of metal contamination in aquatic environments: application to ecologically important wetlands in Iran. *Environmental Monitoring and Assessment* 189: 1–18. https://doi.org/10.1007/s10661-017-6145-6

Navarro, A.M., A. Estrada, X. Font, M.G. Matias, C. Meireles, M. Mendoza, J.P. Honrado, H.D. Prasad, J.R. Vicente & R. Early (2018). Community structure informs species geographic distributions. *PLOS ONE* 13(7): 1–16. https://doi.org/10.1371/journal.pone.0197877

Nicolla, A.C., A.N. Irsyad, W. Firdasia, Z. Sarifah, E.I. Nilamsari, N. Umah, R. Daradwinta & S. Sukirno (2021). Comparison of Damselfly (Odanata: Zygoptera) diversity in wet dune slack habitat with canopied and non-canopied areas of Gumuk Pasir Parangkusumo, Yogyakarta, Indonesia. In: IOP Conference Series: Earth and Environmental Science 736 (1): 012046. https://doi.org/10.1088/1755-1315/736/1/012046

Odum EP. (1996). *Dasar-Dasar Ekologi. Edisi Ketiga*. Universitas Gajah Mada Press, Yogyakarta, Indonesian, 131-139 pp.

Orr, A.G. (2005). *Dragonflies of Peninsular Malaysia and Singapore: A Pocket Guide*. Kota Kinabalu: Natural History Publications, Borneo.

Orr, A.G. & V.J. Kalkman (2015). *Field Guide to the Damselflies of New Guinea*. Brachytron Supplement, 190 pp.

Orlofske, J.M., B.R. Wilson, D.E. Tesar, C.D. Tyrrell & R. Headley (2024). Fluvial habitat associations of riverine dragonflies (Odonata, Gomphidae) in the Huron Mountains (Michigan, USA). *River Research and Applications* 40(10): 2022–2034. https://doi.org/10.1002/rra.4339

Palacino-Rodríguez, F., M. Altamiranda-Saavedra, D.A. Palacino & A.C. Penagos (2020). Ecology of *Mesamphiagrion laterale* (Odonata: Coenagrionidae): abundance, reproduction and interactions with co-occurring species. *International Journal of Odonatology* 23(2): 165–182. https://doi.org/10.1080/13887890.2020.1739567

Perron, M.A.C. & F.R. Pick (2020). Water quality effects on dragonfly and damselfly nymph communities: A comparison of urban and natural ponds. *Environmental Pollution* 263: 114472. https://doi.org/10.1016/j.envpol.2020.114472

Rohman, A., F.S.K. Nurwulan, W. Subchan & Y.C. Buana (2024). Community structure of dragonflies (Odonata) at Garahan Resort, Sempolan, Perhutani, Forest Management Unit (KPH) Jember. *BIO Web of Conferences* 101: 03004. https://doi.org/10.1051/bioconf/202410103004

Rohman, A. & N. Faradisa (2020). Dragonfly Diversity (Insect: Odonata) in Asem Binatur River, Pekalongan, Indonesia. *Borneo Journal of Resource Science and Technology* 10(1): 79–84. https://doi.org/10.33736/bjrst.1986.2020

Salsabiela, N., A. Novitasari, A.C. Windianingsih, R.B. Alfian, A. Setyaningrum, B.E. Yudharta, O.A. Safa'ah & S. Sukirno (2022). Effect of altitude on odonata biodiversity in the Paddy Field of Sleman Regency, Special Region of Yogyakarta. In 7th International Conference on Biological Science (ICBS). Atlantis Press, 171–180 pp. https://doi.org/10.2991/absr.k.220406.026

Setiyono, J., S. Diniartsih, E.N.R. Oscilata & N.S. Budi (2017). Dragonflies of Yogyakarta. Jenis Capung Daerah Istimewa Yogyakarta. Indonesia Dragonflya Society, Yogyakarta.

Susanto, M.A.D., N.F. Firdhausi & S. Bahri (2023). Diversity and community structure of dragonflies (Odonata) in various types of habitat at Lakarsantri District, Surabaya, Indonesia. *Journal of Tropical Biodiversity and Biotechnology* 8(2): 76690. https://doi.org/10.22146/jtbb.76690

Susanto, M.A.D., Z.P. Gama & A.S. Leksono (2024). Habitat characteristics and threats of little-known endemic dragonfly, *Neurothemis feralis* (Burmeister, 1839) (Odonata: Libellulidae) in East Java, Indonesia. *Biodiversitas Journal of Biological Diversity* 25(7): 2907–2920. https://doi.org/10.13057/biodiv/d250712

Virgiawan, C., L. Hindun & Sukarsono (2015). Studi Keanekaragaman Capung (Odonata) Sebagai Bioindikator Kualitas Air Sungai Brantas Batu-Malang Dan Sumber Belajar Biologi. *Jurnal Pendidikan Biologi Indonesia* 1(2): 188–196. https://doi.org/10.22219/jpbi.v1i2.3330

Vanderzwalmen, M., D.S. Lacalle, P. Tamilselvan., J. McNeil, D. Delieuvin, K. Behlouli, A. Hursthouse, I. McLellan, M.E. Alexander, F.L. Heriquez, D. Snellgrove & K.A. Sloman (2022). The Effect of Substrate on Water Quality in Ornamental Fish Tanks. *Animals* 12(19): 2679. https://doi.org/10.3390/ani12192679

Worthen, W.B. & H.J. Horacek (2015). The distribution of dragonfly larvae in a South Carolina stream: Relationships with sediment type, body size, and the presence of other larvae. *Journal of Insect Science* 15(1): 31. https://doi.org/10.1093/jisesa/iev013

Yuditaningtyas, M., M. Hadi & U. Tarwotjo (2022). Struktur komunitas dan habitat odonata di kawasan wisata waduk Jatibarang Semarang. *Bioma: Berkala Ilmiah Biologi* 24(1): 73–79. https://doi.org/10.14710/bioma.24.1.73-79

Zulhariadi, M., M. Mirnawati, D.N. Andriani, A. Aesi & R. Algipari (2024). Diversity of Dragonflies (Order: Odonata) in the Suranadi Nature Tourism Park Area, West Lombok. *Penbios: Jurnal Pendidikan Biologi Dan Sains* 9(01): 01–08.

Zulhariadi, M., R.D. Irawan, A. Zulfaeda & N. Hidayani (2022). Dragonflies diversity and land cover changes in the Batubolong River, West Lombok District. *Biotropia* 29(2): 112–123. https://doi.org/10.11598/btb.2022.29.2.1637

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