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Harsh Tiwari
Department of Zoology, Lab. No. 104, PMCoE, Government J.S.T. Post Graduate College, Balaghat, Madhya Pradesh, India

Sneha Nandanwar
Department of Zoology, Lab. No. 104, PMCoE, Government J.S.T. Post Graduate College, Balaghat, Madhya Pradesh, India

Avani Goswami
Department of Zoology, Lab. No. 104, PMCoE, Government J.S.T. Post Graduate College, Balaghat, Madhya Pradesh, India

Durgesh Agase
Department of Zoology, Lab. No. 104, PMCoE, Government J.S.T. Post Graduate College, Balaghat, Madhya Pradesh, India

Correspondence
Harsh Tiwari
Department of Zoology, Lab. No. 104, PMCoE, Government J.S.T. Post Graduate College, Balaghat, Madhya Pradesh, India

Assessment of odonate diversity in the Wainganga river basin, Balaghat district, Madhya Pradesh

Harsh Tiwari, Sneha Nandanwar, Avani Goswami, and Durgesh Agase

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Abstract
Odonata, which includes both dragonflies and damselflies, are valuable bioindicators of the health of freshwater ecosystems due to their sensitivity to changes in the habitat, being tied closely to aquatic habitats. The present study, in the Wainganga River Basin, Balaghat District, Madhya Pradesh, from June to October 2024, aimed to assess odonate diversity and understand community structure. Field observations were established on marshes and waterways, and species were classified following well-known field guides. Diversity was analyzed using ecological index calculations such as Simpson's Index, Shannon-Wiener Index and Pielou's Evenness Index to assess species richness, dominance, and distribution. The study indicated a stable and well-balanced odonate community that belonged to two families: Libellulidae and Coenagrionidae. The data reinforce the ecological role of odonates, such as regulating insect populations and promoting ecosystem balance, as well as the important use of odonates as bioindicators of wetland health and conservation. Overall, the study provides baseline information on odonate diversity from Balaghat and can promote future ecological and conservation research in central India.

Keywords: Bioindicators, conservation, diversity, odonata

Introduction
India, with its wide geographical extent and different ecological niches, is home to a diverse and abundant array of Odonata, the insect order that includes dragonflies and damselflies. These colourful species play an important part in the complex web of freshwater ecosystems, acting as both predators and markers of environmental health. Dragonflies and damselflies, collectively known as Odonates, are commonly seen flying above forests, grasslands, meadows, ponds, and rivers. These insects are a part of an ancient lineage that originated around 250 million years ago during the Permian period. Globally, there are around 6,000 known species of these insects. India, with more than 500 identified species, is considered a region of significant odonate diversity (Aghade *et al.*, 2022) [3]. The life cycle of odonates is closely linked to wetland environments. Adults deposit their eggs in particular aquatic settings, where the emerging larvae become predators, feeding on a variety of aquatic creatures, including small crustaceans, insects, tadpoles, and even small fish. (Andrew *et al.*, 2008) [4] Typically, adult odonates appear in the early morning or late evening. Odonates that have emerged take over the area around the swamp. Odonates are highly sensitive to landscape changes due to their specific habitat and environmental needs, making them dependable indicators of wetland ecosystem health. They are essential to several biological processes, including seed dispersal, pollination, and predation, which are key to sustaining the balance of ecosystems on land and in water (Sharma *et al.*,2024) [8] Many Odonate species present in agricultural ecosystems act as natural pest regulators, playing an important role in controlling pest populations. They are necessary for many vital biological processes that are vital to preserve the equilibrium of terrestrial and aquatic ecosystems, including pollination, seed dispersion, and predation (Tiple *et al.*, 2012) [7]. India is home to 498 of these species, mostly in marshy places like rivers, lakes, ponds, and ditches. Throughout their entire cycles, they mostly live in watery habitats. Because of their sensitivity to variations in habitat, temperature, and climate, odonates are useful environmental indicators (Dawn, 2021) [5].

Odonates are exceptional flyers, outperforming all other insect groups in aerial agility. They have independent (uncoupled) wing pairs, allowing for precise flight control. This enables them to hover and execute sharp turns, including 180-degree rotations (Andrew *et al.*, 2008) [4]. Odonates are seasonal insects that are most commonly seen during the monsoon and post-monsoon months. This is because fresh water becomes available in abundance during rains,

creating suitable breeding sites. They prefer freshwater habitats such as ponds, lakes, riversides, canals, puddles, and especially paddy fields. These areas provide not only water for egg laying but also plenty of small prey for their larvae.

Materials and Methods

Study Area

In the forest area of the Wainganga River Basin in the Balaghat district, which is situated in the southeast of Madhya Pradesh, India, the current study on dragonfly diversity was carried out. Geographically, Balaghat lies between Latitude 21°30′ to 22°30′ and 80°00′ to 81°00′ East Longitude), with an average elevation of approximately 288 meters above sea level (Agase *et al.*, 2025) [2]. The districts of Mandla in the north, Rajnandgaon and Durg in the east and south, and Seoni in the west enclose Balaghat District. **(**Agase *et al.*, 2021) [1]. The region is a portion of the Satpura Mountain ranges, which are covered with dense tropical deciduous forests that are primarily composed of bamboo, teak (Tectona grandis), sal (Shorea robusta), and mixed species. Summer, monsoon, and winter are the three main seasons in this subtropical climate. With an average of 1200 to 1600 mm of rainfall each year, the area is lushly vegetated and sustains biodiversity (Agase *et al.*, 2025) [2].

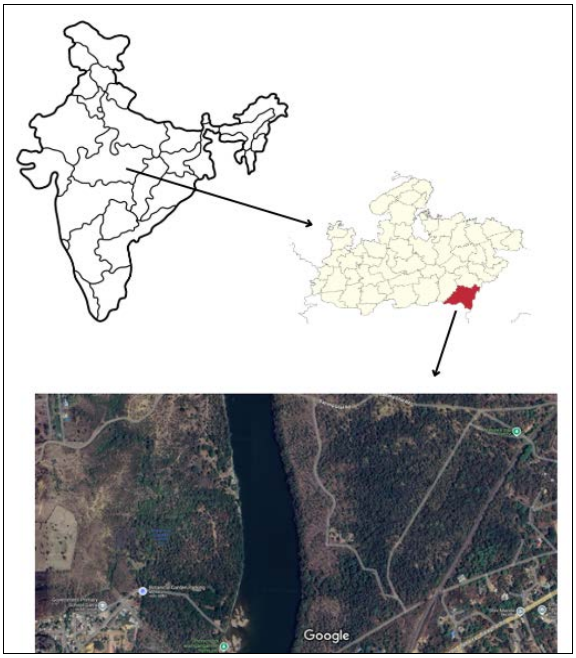

Fig 1: Satellite view of Wainganga River Basin of Balaghat (M.P)

Specimen Observation and Photography

The current survey was conducted in 2025 from July to September. Field observations and field trips were conducted on a regular basis during the day. Since Odonates show notable responses to temperature, observations were conducted between 6 AM to 10 Am., their activity increases with rising temperature, when dragonflies and damselfly are most active. Visual surveys were conducted by walking slowly along the edges of water bodies, marshes, and vegetation to detect perching, flying, mating, and oviposition behaviours of dragonflies and damselflies. The adult Odonates were identified using the Handbook on Common Odonates of Central India, (Andrew *et al.*, 2008) [4]. The investigation did not involve the collection of living specimens.

Data Analysis

Relative abundance (RA) of each species was measured to determine prevalence. To evaluate the community structure, a few ecological indices were utilized. Simpson's Index was used to measure species dominance by indicating the probability that two individuals chosen at random from a collection belong to the same species. The Shannon-Wiener Index indicated overall species diversity, and Pielou's Evenness Index was utilized to index the evenness or variability with which individuals are distributed among the species. Together, these indices represented a multi-faceted understanding of the community composition of odonate and these methods provided a comprehensive understanding of the diversity and distribution patterns of Odonate families in the study area (Table 1 & 2, Graphs 2,3,4,5).

Results

During the study, carried out in the Wainganga River Basin in the Balaghat District between July and September 2025, a total of 1,198 adult odonates were sampled from 18 species in two families of Odonata, Libellulidae and Coenagrionidae. The Libellulidae family was most predominant and included various subfamilies; for the Coenagrionidae family, two species, *Ceriagrion coromandelianum* and *Ischnura aurora* were noted. The relative abundance varied by species, with *Diplacodes trivialis* (11.84%) the most common, followed by *Ceriagrion coromandelianum* (9.34%) and *Crocothemis servilia* (7.76%). *Pantala flavescens* was the least abundant at 1.33%. The ecological indices suggested a community that was diverse and stable, including a Simpson's Index (D) of 0.933, indicating that no one species was highly dominant, the Shannon-Wiener Index (H′) of 2.784 indicated a moderate diversity of species, and the Pielou's Evenness (J′) index of 0.968 demonstrating that the populations of species were relatively even. In conclusion,

this study has demonstrated that the area sampled supports a diverse and stable odonate community comprising both common and rare species in a combination of wetlands and freshwater habitats of Balaghat, demonstrating the importance of conserving odonates.

S.N.	Scientific Name	Family	Subfamily	Relative Abundance	Proportion (pi)	pi²	ln(pi)	pi × ln(pi)
1	*Neurothemis tullia*	Libellulidae	Sympetrinae	2.67	0.0267	0.00071	-3.624	-0.0968
2	*Orthetrum albistylum*	Libellulidae	Libellulinae	5.34	0.0534	0.00285	-2.930	-0.1563
3	*Bradinopyga geminata*	Libellulidae	Libellulinae	3.42	0.0342	0.00117	-3.376	-0.1155
4	*Orthetrum chrysis*	Libellulidae	Libellulinae	3.84	0.0384	0.00147	-3.262	-0.1252
5	*Crocothemis servilia*	Libellulidae	Libellulinae	7.76	0.0776	0.00602	-2.558	-0.1985
6	*Diplacodes trivialis*	Libellulidae	Sympetrinae	11.84	0.1184	0.01402	-2.135	-0.2528
7	*Brachythemis contaminata*	Libellulidae	Sympetrinae	6.01	0.0601	0.00361	-2.808	-0.1687
8	*Rhyothemis variegata*	Libellulidae	Rhyothemistinae	2.75	0.0275	0.00076	-3.597	-0.0989
9	*Orthetrum sabina*	Libellulidae	Libellulinae	5.59	0.0559	0.00313	-2.886	-0.1614
10	*Urothemis signata*	Libellulidae	Urothemistinae	7.42	0.0742	0.00551	-2.601	-0.1930
11	*Sympetrum danae*	Libellulidae	Sympetrinae	5.09	0.0509	0.00259	-2.978	-0.1516
12	*Pantala flavescens*	Libellulidae	Trameinae	1.33	0.0133	0.00018	-4.319	-0.0575
13	*Sympetrum semicinctum*	Libellulidae	Sympetrinae	7.34	0.0734	0.00539	-2.611	-0.1916
14	*Potamarcha congener*	Libellulidae	Libellulinae	6.92	0.0692	0.00479	-2.671	-0.1850
15	*Tholymis tillarga*	Libellulidae	Zyxommatinae	3.25	0.0325	0.00106	-3.428	-0.1114
16	*Brachydiplax chalybea*	Libellulidae	Libellulinae	3.84	0.0384	0.00147	-3.262	-0.1252
17	*Ceriagrion coromandelianum*	Coenagrionidae	Ceriagrioninae	9.34	0.0934	0.00873	-2.372	-0.2215
18	*Ischnura aurora*	Coenagrionidae	Ischnurinae	6.17	0.0617	0.00381	-2.785	-0.1717
	Total (N = 1198)			100.00	—	0.06736	—	-2.7837

Table 1: Relative abundance, Diversity indices of Odonate species in the Wainganga River Basin of Balaghat (M.P)

Simpson's Index (D)	0.933
Shannon Index (H′)	2.784
Evenness (J′)	0.968

Table 2: Diversity indices of Odonate species in the Wainganga River Basin of Balaghatm (M.P)

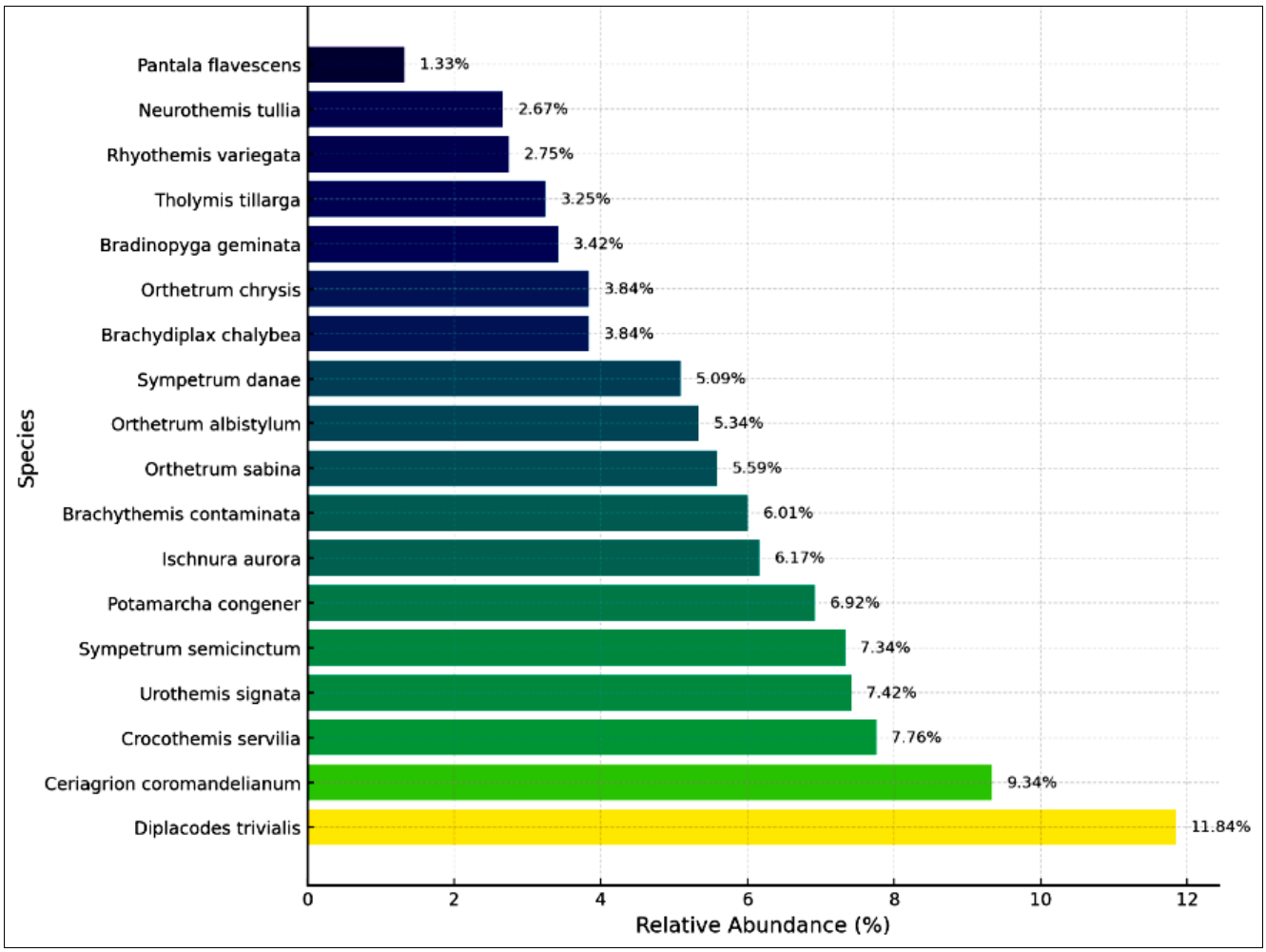

Fig 2: Species abundance Graph of Odonate species in Wainganga River Basin of Balaghat (M.P)

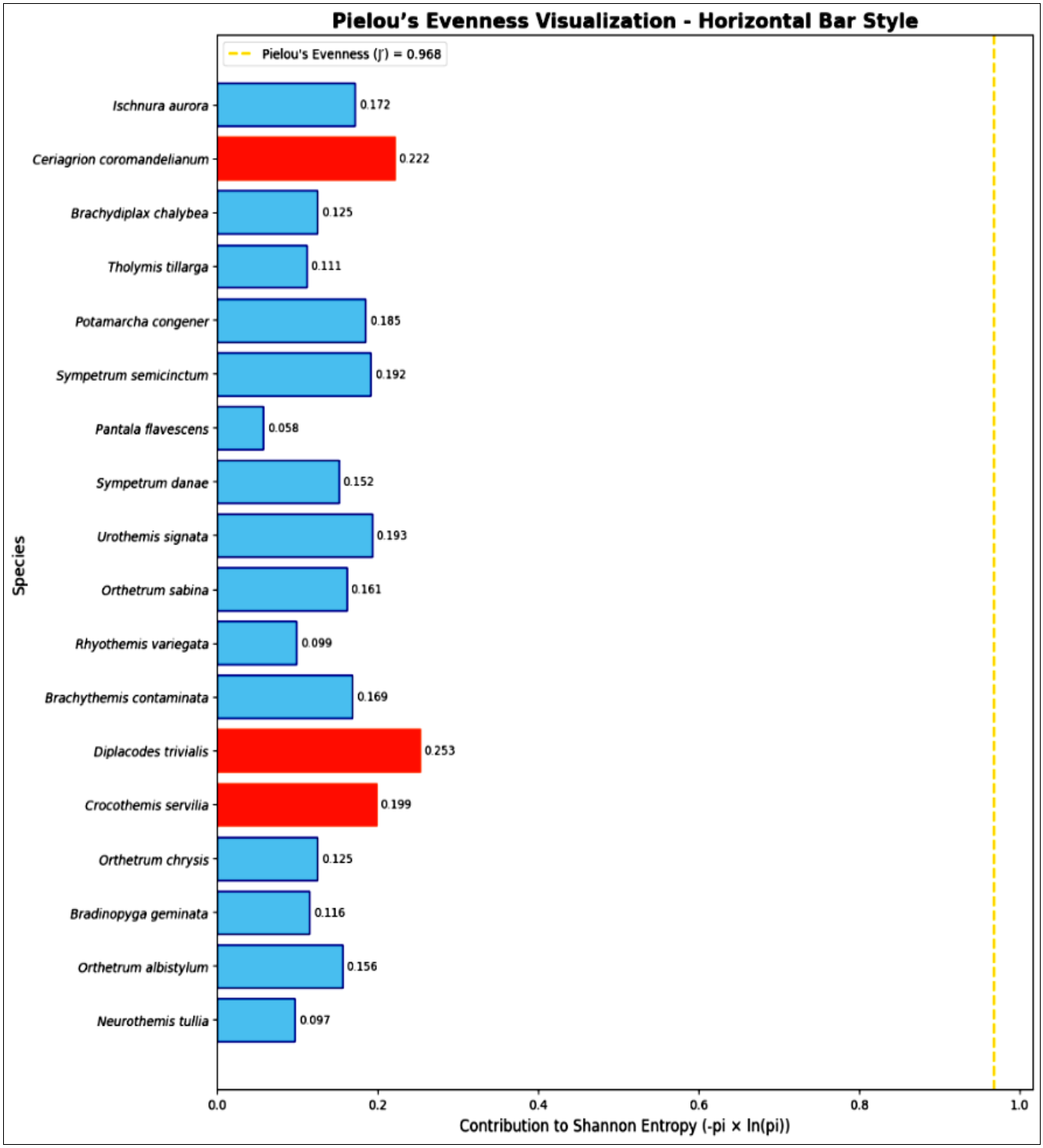

Fig 3: Evenness index visualization- Horizontal Bar style graph using Pielou's Index per odonate species of Wainganga River Basin, Balaghat (M.P)

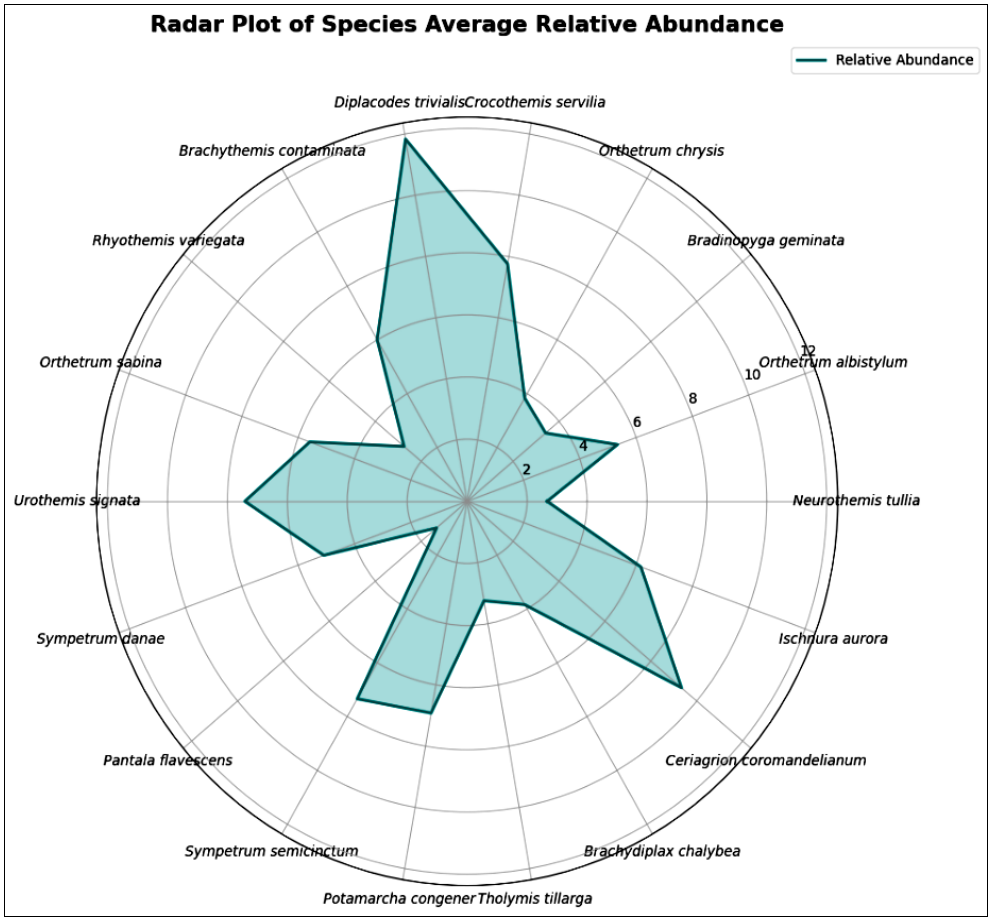

Fig 4: Radar (Spider) plot based on Average Relative Abundance of Odonate species observed in the Wainganga River Basin, Balaghat (M.P).

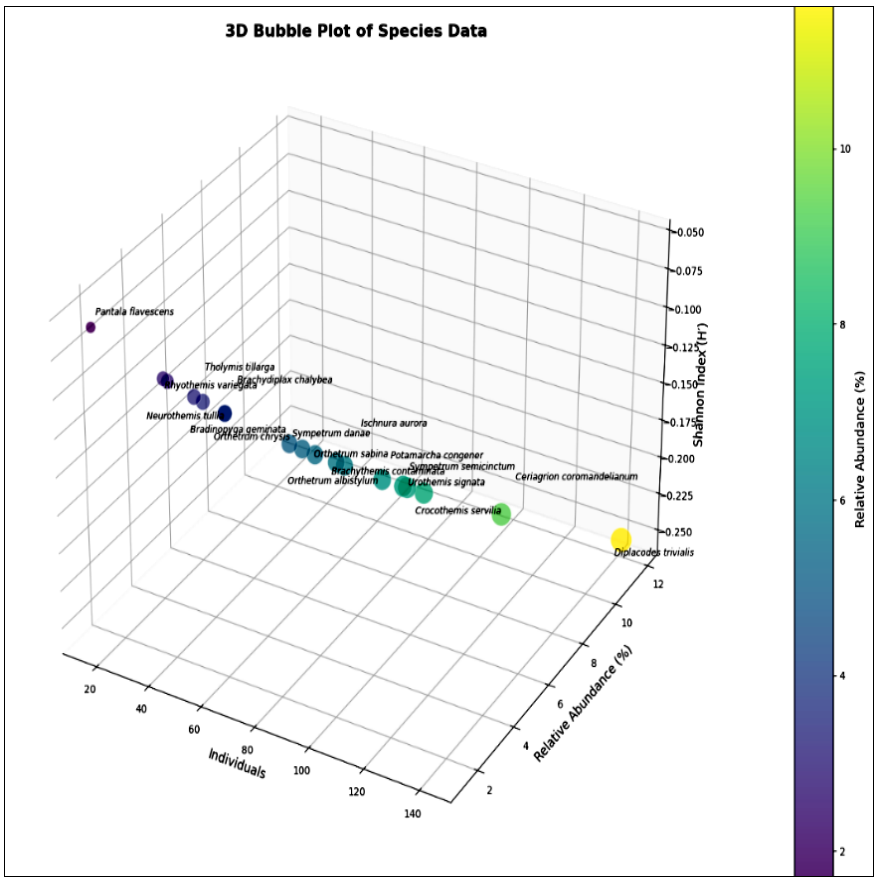

Fig 5: 3D Bubble plot based on individual species, Relative Abundance and Shannon's index of Odonate species observed in the Wainganga River Basin, Balaghat (M.P)

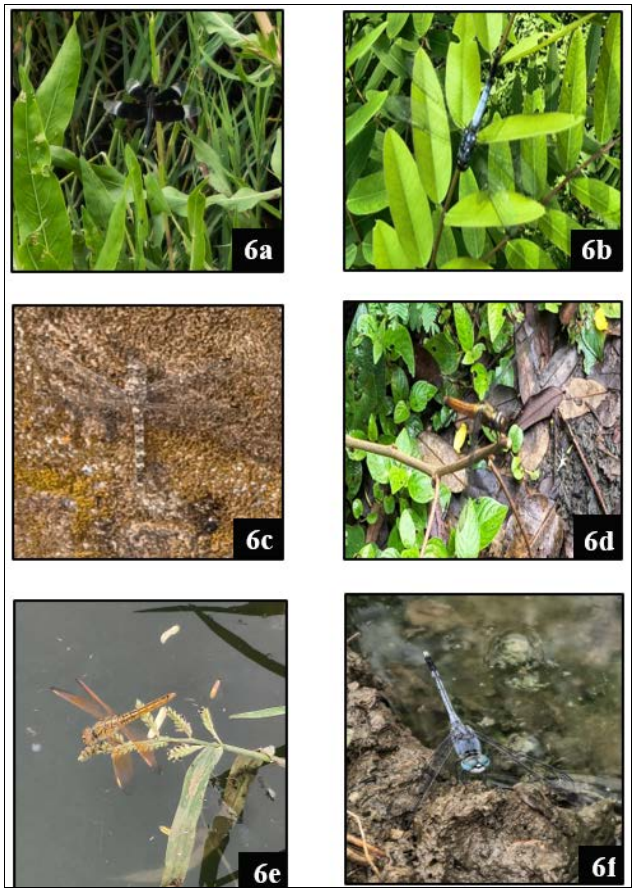

Fig 6(a-f): Photographs of Odonates observed in the study area. 6a. *Neurothemis tullia*; 6b. *Orthetrum albistylum*; 6c. *Bradinopyga geminata*; 6d. *Orthetrum chrysis*; 6e. *Crocothemis servilia*; 6f. *Diplacodes trivialis*.

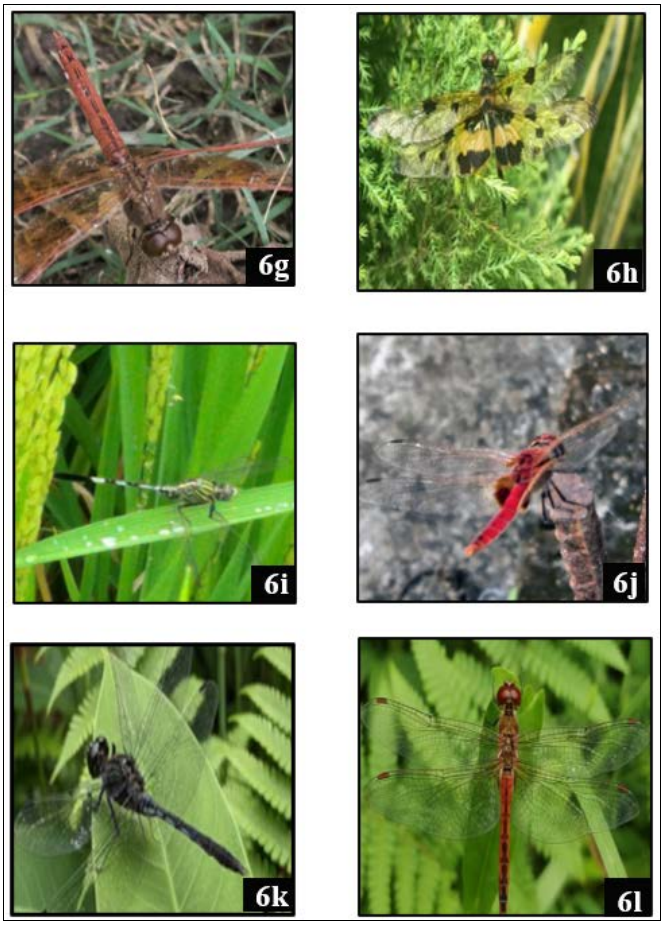

Fig 6(g-l): Photographs of Odonates observed in the study area. 6g. *Brachythemis contaminata;* 6h. *Rhyothemis variegata;* 6i. *Orthetrum sabina;* 6j. *Urothemis signata;* 6k. *Sympetrum danae*; 6l. *Pantala flavescen.*

Fig 6(m-r): Photographs of Odonates observed in the study area. 6m. *Sympetrum semicinctum;* 6n. *Potamarcha congener;* 6o. *Tholymis tillarga;* 6p. *Brachydiplax chalybea;* 6q *Ceriagrion coromandelianum*; 6r. *Ischnura aurora.*

Discussion

The current research offers new information on the species richness, density and community structure of Odonates from the forested habitats of the Wainganga River basin, Balaghat, Madhya Pradesh. Eighteen species were recorded from two families, Libellulidae and Coenagrionidae. The Libellulidae were the most abundant, as indicated by previous studies in central India that found Libellulid dragonflies to be the most abundant group in freshwater habitats (Andrew *et al*., 2008) [4].

Relative abundance showed that *Diplacodes trivialis* (11.84%) and *Ceriagrion coromandelianum* (9.34%) were the most abundant species in the study area, suggesting these species are well suited to the local aquatic habitats and are able to obtain required prey resources. Other species like *Pantala flavescens* (1.33%) and *Neurothemis tullia* (2.67%) were less abundant perhaps due to habitat-specificity or competitive interactions. Again, these findings are consistent with previously published studies which showed that odonate distribution is significantly influenced by habitat heterogeneity and microclimatic factors (Sharma *et al.*, 2024) [8].

The calculated diversity indices confirm the presence of remarkable diversity and evenness of the Odonate community in the study area. Simpson's Index (D = 0.933) suggests that no single species is overly dominant, indicating overall community stability. The Shannon-Wiener Index (H′ = 2.784) further supports that species richness is relatively high in the Odonate community, while Pielou's Evenness Index (J′ = 0.968) portrays individual distribution being even across species. Such high evenness could be associated with the presence of various microhabitats and ecological “hot spots” such as food sources in the freshwater ecosystems investigated. The seasonal and continuous observations from July to September indicated that the Odonates demonstrated peak activity in the early morning period, likely correlated with the best temperature and bright conditions for foraging and mating where these taxa are known to exhibit proclivity to these temperature/light conditions in general (Andrew *et al.*,2008) [4].

Conclusion

The study conducted in the Wainganga River Basin at Balaghat, a total of 18 Odonata species were recorded, across two families, Libellulidae and Coenagrionidae. Libellulidae was the most dominant family, with Coenagrionidae represented with two species. *Diplacodes trivialis* had the highest relative abundance, and *Pantala flavescens* were the least abundant. The diversity indices suggested community stability with Simpson’s Index (0.933) indicating low dominance, Shannon-Wiener Index (2.784) indicating moderate species diversity, and Pielou’s Evenness Index (0.968) suggested an even spread of species in the community. The results suggest that the freshwater habitats of Balaghat support a diverse and stable odonate community overall.

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