The Study of Diversity of Odonata (Dragonflies and Damselflies) Fauna of Angod Village, District- Uttara Kannada, India

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ABSTRACT

Purpose: *The purpose of this checklist is to provide comprehensive documentation of dragonfly and damselfly species observed in the study area, thereby contributing to the existing biodiversity records. It aims to facilitate understanding of species distribution and abundance, which is crucial for informing conservation efforts and habitat management. Additionally, this checklist serves as a baseline for future ecological research and monitoring programs, enabling comparisons over time. It acts as a valuable resource for educators, researchers, and enthusiasts in the study of Odonata, while also enhancing taxonomic clarity and supporting accurate species identification within the region.*

Methodology:
During June and July 2021, field surveys were conducted to observe dragonflies and damselflies using the Pollard Walk Method (PWM), with observations made twice daily—once in the morning from 7:00 am to 8:00 am and again in the evening from 5:00 pm to 7:00 pm-targeting their peak activity periods. No specimens were collected or disturbed, and individuals that were challenging to identify in the field were photographed or observed carefully until sufficient data were gathered, adhering to ethical guidelines and ensuring minimal impact on the species and their habitats.

Results & Findings: *The survey in Angod recorded 14 species of dragonflies and 5 species of damselflies, demonstrating the region's odonate diversity. Dragonflies were predominantly observed near open water sources such as ponds, streams, and agricultural fields, while damselflies favoured more shaded areas with dense vegetation near still water bodies. The survey found that dragonflies were generally more adaptable to a variety of habitats, whereas damselflies exhibited specific preferences for calm, undisturbed waters. This variation in habitat selection suggests different ecological roles played by dragonflies and damselflies in the local ecosystem. The presence of these species highlights the richness of the Western Ghats and underscores the importance of protecting aquatic habitats to maintain biodiversity.*

Originality/Value: *This research offers a unique contribution to the study of dragonfly and damselfly diversity in the relatively unexplored region of Angod, located within the Western Ghats of India, a biodiversity hotspot. Unlike previous studies that often focus on more widely surveyed regions, this study provides the first detailed documentation of odonate species in Angod. The methodology, involving non-invasive photographic documentation during key activity periods, ensures minimal disturbance to the species and their habitats.*

Type of Paper: *Survey-based exploratory research.*

Keywords: Ecological, Biodiversity, Angod, Odonata, Western ghat, Conservation, Pollard Walk Method, Habitat, Hotspot, Ecosystem.

1. INTRODUCTION :

The vast and majestic terrain of India is renowned not only for its rich culture, architectural marvels, and historical heritage, but also for its dense jungles, thriving forests, and diverse wildlife. (Kannagi Anita, Sivakumar V. and Santhi V. (2016). [1]). The Western Ghats stand as one of India's key biodiversity hotspots. (Varghese Aby P., Nikesh P.R. & Mathew Jijo. (2014). [2]). Dragonflies have

been a recurring theme in folklore and traditional tales across various Indian cultures since ancient times. (K A. Subramanian (2014). [3]).

The origins of odonatology in India date back to the pioneering work of Carl Linnaeus and Selys-Longchamps, who were among the earliest to classify and describe species from the region. (Gopalan Sujith V., Sherif Muhamed & Vivek Chandran A. (2022). [4]). The order Odonata, encompassing both dragonflies and damselflies, represents a captivating and intricate group of insects. (Adarsh C.K., Aneesh K.S. & Nameer P.O. (2014). [5]). The order Odonata, comprises three suborders: Zygoptera (damselflies), Anisoptera (dragonflies), and Anisozygoptera (group of odonates exhibits a unique combination of characteristics, blending traits of both damselflies and dragonflies) (Sharma Gaurav. (2019) [6]). The larvae of Odonata are aquatic, while the adults are winged forms. A majority of Odonata species predominantly inhabit areas in proximity to aquatic ecosystems. (Prasad M. (1996). [7]). These insects undergo hemimetabolous development, with aquatic egg and nymph stages and terrestrial adult stages. After concluding its aquatic larval development, an odonate larva departs from the water, securing itself onto a suitable substrate, where the winged adult undergoes ecdysis, emerging from the larval exuvia. (Andrew. R.J. (2013). [8]). Odonates are integral to both aquatic and terrestrial ecosystems, with their nymphs acting as voracious predators in freshwater habitats and adults preying on various insect species. Globally, there are approximately 6,383 species of odonates, with India hosting 493 species and 27 subspecies across 154 genera and 18 families (Sharma Gaurav. (2020). [9]). Odonates are highly sensitive to their environments, making them valuable bioindicators for assessing habitat quality and ecological changes. Odonates can act as a crucial bioindicator, reflecting shifts in environmental quality. (Susanth Kumar. C. and Anooj S.S. (2020). [10]). Although not precisely measured, the sheer number of crop pests, such as aphids and plant hoppers, that are preyed upon by odonates is likely vast. (Rathod Darshana M. et. al. (2021). [11]). Dragonflies, belonging to the suborder Anisoptera, are particularly adaptable and can be found in a variety of waterbodies, whereas damselflies (suborder: Zygoptera) have more specific habitat requirements and limited dispersal abilities. Factors such as habitat structure, predation, pollution, and water chemistry significantly influence the diversity and assemblage of odonate populations. India's diverse odonate fauna includes more than 500 species, many of which are endemic to specific regions and sensitive to environmental changes (Mokaria Kalavanti and Jethva Bharat. (2019) [12]). Dragonflies are proficient aerial hunters, intercepting prey such as mosquitoes, midges, and bee mid-flight, frequently utilizing elevated perches for brief, targeted sorties. Males possess specialized claspers on their terminal abdominal segments, which they employ to grasp the female by the cephalic or prothoracic regions during copulation. (Dragonflies and Damselflies (Insecta: Odonata) of India" by K. A. Subramanian and R. Babu, and "Dragonflies and Damselflies of Peninsular India" by K. A. Subramanian (2005).[13]). Identifying females of Zygoptera and Anisoptera is often more complex and problematic than identifying males (Abbott. John C. (2005). [14]).

These insects have ancient origins, dating back to the Carboniferous period, around 250 million years ago (Solanki Devendra. (2014). [15]). They are commonly found near water bodies, including ponds, lakes, rivers, and streams, where they play crucial roles in controlling insect populations and maintaining ecological balance (Gain Bibha Ishwar and Kulkarni Rajlaxmi Ranrag. (2023). [16]). Although dragonflies and damselflies exhibit distinct differences, their ecological needs and life cycles are strikingly parallel. (Dragonflies and damselflies of Orissa and Eastern India by Nair. V. Manoj). [17]). Their presence and diversity serve as indicators of healthy aquatic ecosystems (Bora Atanu. (2019). [18]), making them an essential focus for conservation efforts and ecological research. Lesser-known fauna, aside from Lepidoptera and to a certain extent Odonata and Arachnida, have largely been overlooked in research. (Rangnekar Parag, Borkar Manoj & Dharwadkar Omkar. (2010). [19]). Odonates predatory nature and sensitivity to environmental changes underscore their importance in both scientific study and biodiversity conservation initiatives.

2. OBJECTIVES OF THE PAPER :

The objectives of this paper are to identify and document the dragonfly and damselfly species present in the study area, as well as to analyse their distribution patterns in relation to environmental factors and habitat types. Additionally, the study aims to assess the relative abundance of each species observed during the survey. By evaluating the implications of these findings for conservation strategies and habitat management, the research seeks to contribute to the broader body of knowledge on Odonata in

the region. Furthermore, it aims to raise awareness about the ecological significance of dragonflies and damselflies among local communities and stakeholders, fostering interest in their conservation.

3. REVIEW OF LITERATURE :

Table 1: Summary of review of related scholarly papers

S. No.	Area of Research	Focus and Outcome	Reference
1	Odonate diversity	Surveying species diversity and distribution of Odonata	Rathod Darshana M. et. al. (2021). [11]
2	diversity of dragonfly	Systematic recording of dragonfly diversity	Solanki Devendra. (2014). [15]
3	Factors affecting diversity and physiological processes	Odonate diversity and the effect of temperature on their physiology	Gain Bibha Ishwar and Kulkarni Rajlaxmi Ranrag. (2023). [16]
4	Factors affecting the species richness	Analysing the relationship between odonate diversity	Bora Atanu. (2019). [18]
5	Odonate diversity as indicators of environmental quality	Diversity and abundance assessment of Odonates	Bora Atanu and Meitei. L. R. (2014). [23]
6	Odonate species distribution and conservation status	Odonate diversity assessment	Tiple Ashish, Sharma Vivek & Padwad Sonali V. (2022). [25]
7	Insect biodiversity	Diversity assessment in an urban forest ecosystem	Dolai Sayak et. al. (2023). [28]
8	Odonata diversity and its association with ecological conditions	establish baseline data on Odonata diversity	Supanekar Santosh P. et. al. (2021). [29]
9	Odonatology	Species diversity and distribution in Goa	Parag Rangnekar et. al. (2014). [30]

Based on the current findings in the study of Odonata diversity of Angod, Uttara Kannada district, it is evident that this region, part of the Western Ghats, showcases significant biodiversity. Dragonflies and damselflies have been documented, with distinct habitat preferences observed between the species. However, despite the richness of the data, there is a notable research gap in understanding the long-term impacts of environmental changes such as habitat fragmentation, climate change, and water quality on odonate populations in this region. Future research should focus on these factors to develop effective conservation strategies for this under-researched area.

4. RESEARCH METHODS :

Study area:

The study area, Angod, is situated in Yellapur Taluk, Uttara Kannada district, which is a part of Western Ghats. This region is distinguished by its exceptional scenic beauty, prominence as a tourist destination, and remarkable biodiversity.

Angod spans 2406.79 hectares, with a significant portion allocated to agricultural land use. The area's topography is characterized by an average elevation of 541 meters (1774 feet) above mean sea level. Geographically, the study area is bounded by coordinates 14°59'56.5" N and 74°41'22.5" E. The local climate is marked by high precipitation, with average annual rainfall ranging from 2500 to 3000 mm. Temperature extremes have been recorded, with a maximum of 43°C in April 2024 (summer) and a minimum of 10°C in winter.

Methodology:

Field visits were carried out during the months of June and July 2021, targeting peak activity periods of dragonflies and damselflies by employing Pollard Walk Method (PWM). Observations were made twice daily: in the morning from 7:00 am to 8:00 am and in the evening from 5:00 pm to 7:00 pm. These

times were chosen to capture different activity patterns and species compositions during both early morning and early evening hours.

The survey employed direct observation methods without the use of light traps or any method that could potentially harm the species. Special care was taken to minimize disturbance to the natural habitats of dragonflies and damselflies. Species were meticulously observed in their natural settings, and high-resolution photographs were taken for later identification and documentation.

Dragonflies and damselflies encountered during the survey were identified using authoritative references, namely "Dragonflies and Damselflies (Insecta: Odonata) of India" by K. A. Subramanian and R. Babu [20], and "Dragonflies and Damselflies of Peninsular India" by K. A. Subramanian (2005) [21]. For identification of some of the common names of the dragonflies and damselflies preferably gone through "An updated checklist of Dragonflies and damselflies (odonata) of Kerala with their Malayalam names." (Nair Vinayan Padmanabhan. (2022). [22]). These resources provided comprehensive descriptions and keys for accurate species identification based on morphological characteristics and distribution data.

No specimens were collected or disturbed during the survey. The study strictly adhered to ethical guidelines to ensure minimal impact on the local dragonfly and damselfly populations. Individuals that were difficult to identify in the field were either photographed or observed until sufficient data for identification were gathered, after which they were left undisturbed in their natural habitat.

Table 2: List of dragonfly species documented during the survey

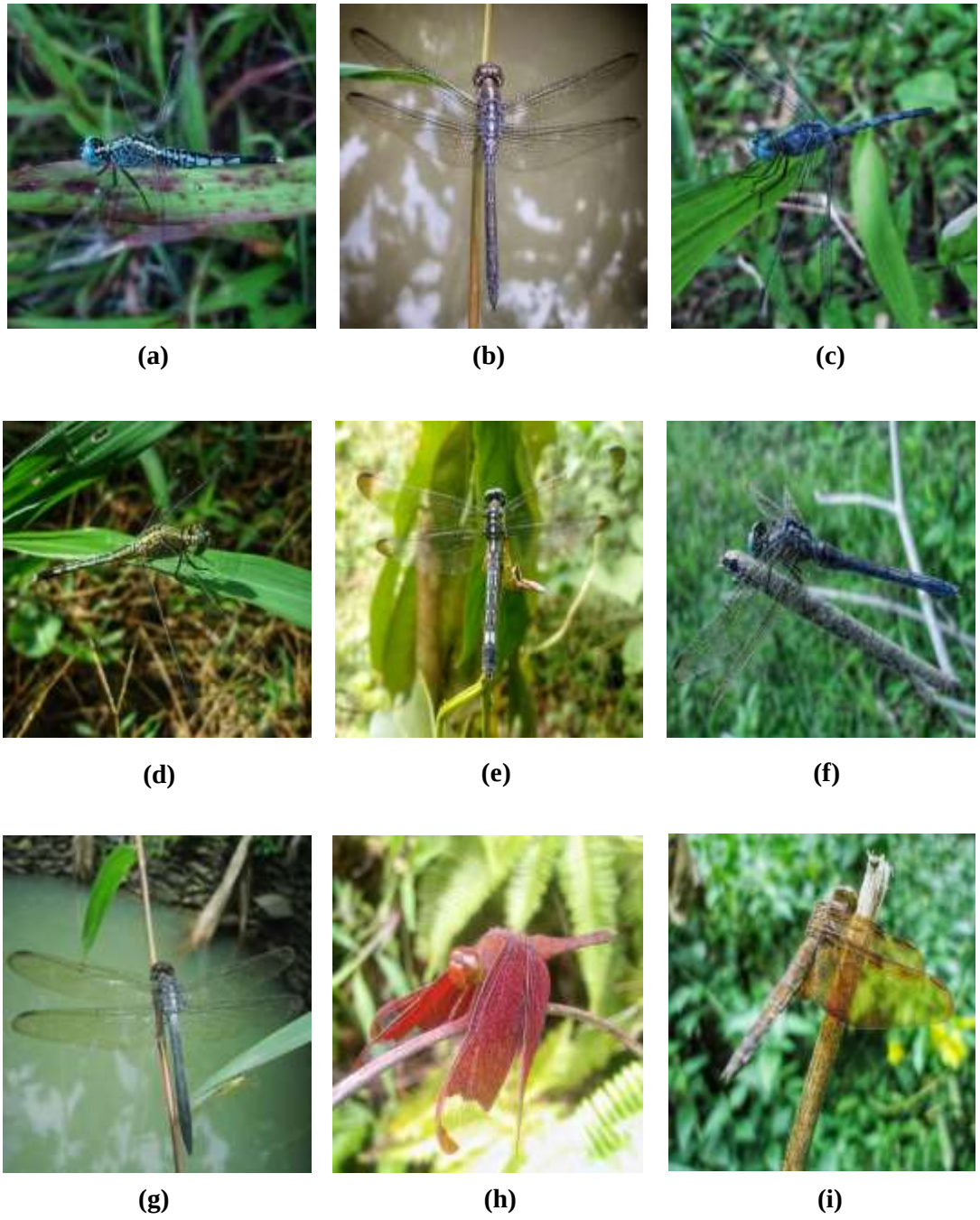
Serial number	Family	Scientific name	Common name
1	Libellulidae	*Acisoma panorpoides*	Asian pintail
2		*Cratilla lineata*	Line skimmer
3		*Diplacodes trivialis*	Chalky percher
4		*Hylaeothemis apicalis*	Blue hawklet
5		*Indothemis carnatica*	Black marsh skimmer
6		*Libellula incesta*	Slaty skimmer
7		*Neurothemis fulvia*	Fulvous skimmer
8		*Neurothemis tullia*	Pied paddy skimmer
9		*Neurothemis intermedia*	Paddy field parasol
10		*Orthetrum chrysostigma*	Epaulet skimmer
11		*Palpopleura sexmaculata*	Asian widow skimmer
12		*Trithemis aurora*	Crimson marsh glider
13		*Orthetrum chrysis*	Spine-tufted skimmer
14		*Orthetrum pruinosum*	crimson-tailed marsh hawk

5. GENERAL CHARACTERISTICS OF THE FAMILY LIBELLULIDAE :

The family libellulidae is known for its diversity and adaptability across various habitats (Bora Atanu and Meitei. L. R. (2014). [23]). The members of the family Libellulidae inhabit an extensive range of ecosystems, spanning from coastal plains at sea level to elevated terrains within dense forests. (Emiliyamma K. G. (2014). [24]). During the survey in total of 14 species were reported (Figure. Ia- Ii and Figure IIa- IIh) which also includes male and female of the same species. The family Libellulidae, commonly referred to as "pond hawks" encompasses a diverse group of dragonflies, boasting over 1,000 species globally, with the exception of Antarctica. These insects are characterized by their slender bodies, typically measuring between 2 to 5 cm in length, complemented by delicate wings that span between 3 to 6 cm in length. The bodies of Libellulidae dragonflies showcase a kaleidoscope of colours,

including yellows, oranges, reds, and browns, often adorned with striking patterns and markings. Their large, compound eyes, which occupy a significant portion of their head, are a notable feature. Libellulidae dragonflies are renowned for their agility and swiftness in flight, achieved through rapid wingbeats. *Diplacodes trivialis* belonging to the family Libellulidae, exhibited a pronounced presence in contaminated aquatic habitats. (Tiple Ashish, Sharma Vivek & Padwad Sonali V. (2022). [25]). They inhabit areas in proximity to still or slow-moving water bodies, such as ponds, lakes, and streams, where they actively hunt and feed on other insects, often capturing their prey in mid-air. Throughout their life cycle, which involves incomplete metamorphosis, Libellulidae dragonflies progress through three distinct stages: egg, nymph and adult, each marked by unique characteristics and developmental milestones.

Photographs of Dragonfly



(a) **(b)** **(c)**

(d) **(e)** **(f)**

(g) **(h)** **(i)**

Figure. I

Figure I: a) *Acisoma panorpoides*

b) *Cratilla lineata*

c) *Diplacodes trivialis* (♂)

d) *Diplacodes trivialis* (♀)

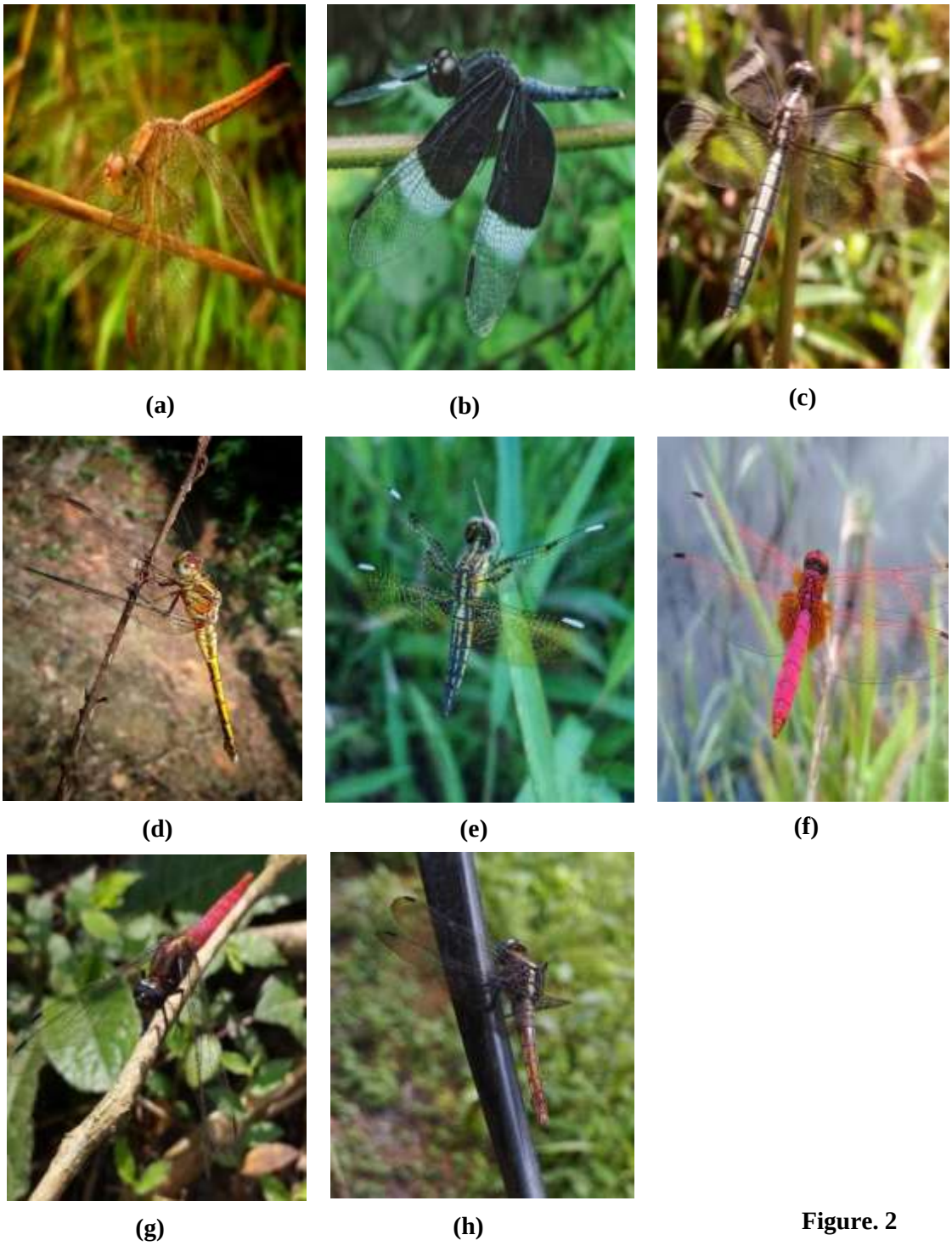
e) *Hyalaeothemis apicalis*

f) *Indothemis carnatica*

g) *Libellula incesta*

h) *Neurothemis fulvia* (♂)

i) *Neurothemis fulvia* (♀)



(a) **(b)** **(c)**

(d) **(e)** **(f)**

(g) **(h)**

Figure. 2

Figure 2: a) *Neurothemis intermedia*
b) *Neurothemis tullia* (♂)
c) *Neurothemis tullia* (♀)
d) *Orthetrum chrysostigma*
e) *Palpopleura sexmaculata*
f) *Trithemis aurora*
g) *Orthetrum chrysis*
h) *Orthetrum pruinosum*

Table 3: List of damselfly species documented during the survey

Serial number	Family	Scientific name	Common name
1	Coenagrionidae	*Agriocnemis pieris*	White dartlet
2		*Ischnura aurora*	Aurora blue tail
3	Platycnemididae	*Copera marginipes*	Yellow bush dart
4	Chlorocyphidae	*Rhinocypha bisignata*	Stream ruby
5	Calopterigidae	*Vestalis apicalis*	Black tipped glory

6. GENERAL CHARACTERISTICS OF THE FAMILIES OF DAMSELFLIES IDENTIFIED DURING STUDY :

Coenagrionidae:
The *Agriocnemis pieris* (Figure. III a and III b) and *Ischnura aurora* (Figure. III d) under Coenagrionidae family, comprising narrow-winged damselflies, is characterized by diminutive size (2-5 cm), slender bodies with vibrant coloration, and elongated, curved wings with dense venation. Large compound eyes dominate their cephalic region, enabling exceptional visual acuity. They inhabit stagnant or slow-moving aquatic environments, exhibiting complex reproductive behaviours. The prevalence of these species can be linked to the availability of large green trees and a small pond within the study area. (Sanap NP. (2020). [26].)

Platycnemididae:
The *Copera marginipes* (Figure. III c) belongs to Platycnemididae family is distinguished by their robust build, medium to large size (3-6 cm), and striking colour patterns. Their wings are broad and flattened, with a distinctive white or yellowish costa and a network of veins that impart a characteristic "lattice-like" appearance. The discoidal cell features costal and posterior sides that are roughly equal in length; the second segment of the antenna matches the third in size. The legs are distinctly citron-yellow, with the hind tibiae slightly expanded. Superior anal appendages reach at least half the length of the inferior ones, while the female's prothorax displays a pair of thin, divergent spines that point forward. (Radhakrishnan, C. & Emiliyamma K.G. (2003). [27]). The Platycnemididae are further characterized by their large, globular eyes, long and slender abdomen, and distinctive white or yellowish leg markings, which impart a striking contrast to their darker body coloration. These damselflies inhabit a range of aquatic environments, from slow-moving streams to vegetated ponds, where they exhibit complex territorial and mating behaviours. taxa from the families Chlorocyphidae and Platycnemididae were conspicuously absent in polluted waters, thriving solely in pristine wetland ecosystems.

Chlorocyphidae:
The Chlorocyphidae family, comprising the jewel damselflies, is a group of odonates distinguished by their striking coloration and robust build. These medium-sized damselflies (3-5 cm) exhibit a characteristic "jewel-like" appearance, with iridescent blues, greens, and yellows adorning their bodies

and wings. Their wings are broad and flattened, with a distinctive network of veins and a prominent costa. The Chlorocyphidae are further characterized by their large, globular eyes, long and slender abdomen, and distinctive leg markings. These damselflies inhabit fast-flowing streams and rivers, where they exhibit agile flight and complex territorial behaviours.

Calopterigidae:

The Calopterigidae family, comprising the broad-winged damselflies, is a group of odonates distinguished by their striking colour patterns and robust build. These medium to large-sized damselflies (4-6 cm) exhibit broad, flattened wings with a distinctive curvature and a prominent costa, imparting a "wing-pad" appearance. Their bodies are elongated, with vibrant coloration and distinctive markings on the thorax and abdomen. These damselflies inhabit a range of aquatic environments, from slow-moving streams to vegetated ponds, where they exhibit complex territorial and mating behaviours.

Photographs of Damselflies

Figure. III: a) *Agriocnemis pieris* (♂)
b) *Agriocnemis pieris* (♀)
c) *Copera marginipes*
d) *Ischnura aurora*
e) *Rhinocypha bisignata*
f) *Vestalis apicalis*

7. RESULT AND DISCUSSION :

A comprehensive survey of odonates identified a total of 17 species, comprising 12 dragonflies (Anisoptera) and 5 damselflies (Zygoptera), underscoring the remarkable biodiversity of the region. All 12 dragonfly species belong to the Libellulidae family, exhibiting characteristic traits such as robust bodies, broad wings, and predatory habits. Notably, some species displayed territorial behaviours and intricate mating rituals, suggesting a high degree of ecological specialization within this family.

In contrast, the damselflies demonstrated greater diversity, with five species spanning four distinct families. *Agriocnemis pieris* and *Ischnura aurora*, both from the Coenagrionidae family, exhibited slender bodies, delicate wings, and agile flight patterns typical of this group. *Copera marginipes*, belonging to the Platycnemididae family, showcased an elongated body shape and striking colour patterns. The *Rhinocypha bisignata* species from the Chlorocyphidae family displayed iridescent colours and complex wing venation patterns, while *Vestalis apicalis* of the Calopterigidae family featured broad wings and vibrant colour patterns, highlighting the unique characteristics of each family.

A particularly notable observation was *Rhinocypha bisignata*, a species endemic to South India, emphasizing the region's importance as a biodiversity hotspot. The presence of this species highlights the urgent need for conservation efforts to preserve the region's odonate fauna, especially in light of habitat destruction and climate change. The discovery of such biodiversity in a single region emphasizes the necessity of implementing effective conservation strategies to protect these species and their habitats.

8. SUGGESTIONS/RECOMMENDATIONS BASED ON ABOVE ANALYSIS :

Based on the analysis, it is recommended to implement habitat protection and restoration measures in areas identified as species-rich for dragonflies and damselflies. Establishing long-term monitoring programs will aid in tracking changes in species diversity. Public awareness campaigns should be developed to educate communities about the ecological importance of Odonata. Additionally, fostering collaboration among researchers, local authorities, and conservation organizations will enhance data collection. Promoting sustainable land-use practices and advocating for policies prioritizing biodiversity conservation will further support the protection of these species.

9. CONCLUSION :

In conclusion, this study underscores the rich biodiversity and ecological importance of dragonflies and damselflies in the Angod region of the Western Ghats. The presence of 17 distinct species, including endemic variety, highlights the area's significance as a biodiversity hotspot. The findings emphasize the crucial roles these odonates play in maintaining ecological balance and their sensitivity to environmental changes, making them vital bioindicators for habitat health. The detailed observations and photographic documentation provide valuable insights into the species composition and behaviour of odonates in this region. These results not only contribute to the broader understanding of their ecological roles but also underscore the urgent need for conservation efforts to protect these species and their habitats from the threats of habitat destruction and climate change.

Pollution is steadily rising, and its negative impact on animal diversity is becoming increasingly evident. Dragonflies serve as key indicators of freshwater habitat health due to their presence, population levels, and behaviours. Shifts in their numbers can reflect changes in water quality, habitat deterioration, or other environmental pressures, making them valuable bio-indicators for assessing ecosystem conditions. (Dolai Sayak et. al. (2023). [28]). Compiling an updated checklist of Odonata requires a dedicated effort to collect species occurrence data across a wide range of habitats. (Supanekar Santosh P. et. al. (2021). [29]). We firmly assert that continuous and concerted endeavours are imperative for the comprehensive documentation of the state's odonate diversity. (Rangnekar Parag et. al. (2014) [30]). Ongoing research and conservation initiatives are essential to safeguard the diverse odonate fauna of the Western Ghats. By fostering a deeper appreciation for these remarkable insects and their ecosystems, more effective conservation strategies can be promoted, ensuring the preservation of this vital aspect of our natural heritage.

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