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Diversity and Distribution of Ozonates (Insect: Odonata) as Bioindicators in Freshwater Habitats of Chintamani Taluk, Karnataka

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1. Abstract

Ozonates, encompassing dragonflies and damselflies, are widely recognized as excellent bioindicators of freshwater ecosystem health due to their aquatic larval stages and sensitivity to habitat quality. This study investigated the diversity and distribution of odonate species across three distinct freshwater habitats in Chintamani Taluk, Karnataka, during 2014. Time-constrained visual surveys and opportunistic netting were employed monthly from February to October. A total of 38 odonate species belonging to 7 families were recorded. Species richness and abundance were significantly higher in perennial tanks with diverse macrophytic vegetation compared to seasonal ponds and irrigation canals. Results indicated that habitat complexity, particularly the presence of emergent and submerged vegetation, was a key determinant of odonate diversity. The findings underscore the importance of maintaining diverse microhabitats within freshwater bodies for odonate conservation and highlight their utility in assessing the ecological integrity of these vital ecosystems in rapidly changing semi-arid regions.

2. Keywords

Odonata, dragonflies, damselflies, bioindicators, freshwater ecology, diversity, Chintamani, habitat complexity, conservation, Karnataka

3. Introduction

Freshwater ecosystems are among the most threatened habitats globally, facing intense pressure from anthropogenic activities such as agriculture, urbanization, and water abstraction. In semi-arid regions like Chintamani Taluk, Karnataka, small freshwater bodies (tanks, ponds, irrigation canals) are crucial for both human livelihoods and biodiversity sustenance. Understanding the health of these ecosystems is paramount for effective conservation and management.

Odonates (dragonflies and damselflies) are an order of carnivorous insects known for their two-phase life cycle: an aquatic larval (nymphal) stage and a terrestrial adult stage. This unique life history makes them highly sensitive to changes in aquatic and riparian habitat quality,

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positioning them as powerful bioindicators of freshwater ecosystem health (Corbet, 1999; Sahlén, 2004). Their relatively long lifespan, conspicuous nature, and ease of identification in the field further enhance their utility in ecological assessments.

Despite the recognized importance of odonates, studies focusing on their diversity and distribution in the small, often neglected, freshwater bodies of interior Karnataka are limited. These localized studies are vital for establishing baseline data against which future environmental changes can be measured and for informing regional conservation strategies.

This study was designed to:

- Document the species richness and composition of odonates across different freshwater habitat types in Chintamani Taluk.
- Assess the distribution patterns and relative abundance of odonate species in relation to specific habitat characteristics.
- Evaluate the utility of odonates as indicators of freshwater habitat quality in a human-modified landscape.

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4. Materials and Methods

4.1 Study Sites

Three representative freshwater habitats were selected in Chintamani Taluk, Karnataka, based on their accessibility, varying levels of anthropogenic disturbance, and typical representation of local water bodies:

1. **Kerehalla Tank:** A large perennial tank with significant macrophytic growth, used for irrigation and livestock.
2. **Gowribidanur Pond:** A medium-sized seasonal pond heavily influenced by agricultural runoff, drying up partially during summer.
3. **Irrigation Canal (Near Thippenahalli):** A man-made, frequently maintained canal with limited vegetation, primarily serving agricultural fields.

4.2 Sampling Period

Sampling was conducted monthly from February to October 2014, covering the pre-monsoon, monsoon, and early post-monsoon periods, which typically represent peak odonate activity in the region.

4.3 Odonate Collection and Identification

- **Sampling Method:** Time-constrained visual encounter surveys (VES) were primarily employed. At each site, a fixed 50-meter transect was walked slowly for 45 minutes by a single observer during peak activity hours (09:00 - 12:00 IST) on clear days. All

odonate species observed within approximately 5 meters on either side of the transect and overhead were recorded.

- **Opportunistic Netting:** A hand net was used opportunistically to capture individuals for closer examination and identification, particularly for cryptic species. Captured specimens were photographed and released unharmed after identification.
- **Identification:** Species identification was performed in the field using standard field guides and taxonomic keys (Fraser, 1933-1936; Subramanian, 2005). Unknown specimens were photographed for later verification by experts.
- **Data Recorded:** For each observation, the species, number of individuals, sex (if discernible), and specific microhabitat (e.g., emergent vegetation, open water, riparian zone) were noted.

4.4 Habitat Characterization

At each sampling site, environmental parameters were recorded concurrently:

- **Vegetation Cover:** Estimated percentage of emergent, submerged, and riparian vegetation using a 1m x 1m quadrat at 5 points along each transect.
- **Water Quality (Qualitative):** Visual assessment of turbidity, presence of algal blooms, and general odor.
- **Anthropogenic Disturbance:** Noted presence of solid waste, direct human interference (e.g., washing, fishing), and proximity to agricultural fields.

4.5 Data Analysis

- **Species Richness:** Total number of species recorded at each site.
- **Relative Abundance:** Calculated as the number of individuals observed per unit effort (e.g., per hour of survey).
- **Diversity Indices:** Shannon-Weiner Diversity Index (H') and Simpson's Diversity Index (D) were calculated for each site to compare species diversity (Magurran, 2004).
- **Non-parametric tests:** Kruskal-Wallis H-test was used to compare species richness and abundance across the three study sites, given potential non-normal distribution of ecological data.

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5. Results and Discussion

5.1 Odonate Diversity and Abundance

A total of 38 odonate species, comprising 26 Anisoptera (dragonflies) and 12 Zygoptera (damselflies), were recorded during the study period. These belonged to 7 families: Libellulidae (18 species), Coenagrionidae (9 species), Aeshnidae (3 species), Gomphidae (3 species), Lestidae (2 species), Platycnemididae (2 species), and Chlorocyphidae (1 species).

Kerehalla Tank exhibited the highest species richness (32 species) and abundance (mean 28 individuals/survey), with a Shannon-Weiner index of H'=2.87 and Simpson's D=0.91.

Dominant species included *Orthetrum sabina*, *Pantala flavescens*, and various *Crocothemis* species. The presence of diverse emergent and submerged macrophytes (e.g., *Typha*, *Nymphaea*, *Hydrilla*) provided ideal perching, breeding, and larval habitats.

Gowribidanur Pond showed moderate diversity (21 species) and abundance (mean 15 individuals/survey), with H'=2.21 and D=0.82. Species like *Ischnura senegalensis* and *Brachythemis contaminata* were common. The periodic drying and agricultural runoff likely contributed to lower diversity compared to Kerehalla Tank.

Irrigation Canal had the lowest diversity (11 species) and abundance (mean 7 individuals/survey), with H'=1.68 and D=0.70. Only widespread and tolerant species such as *Diplacodes trivialis* and *Pseudagrion microcephalum* were consistently observed. The lack of varied vegetation and frequent human maintenance limited available microhabitats.

The Kruskal-Wallis test revealed a significant difference in odonate species richness ($H=7.89$, $p<0.05$) and abundance ($H=9.12$, $p<0.01$) among the three study sites.

5.2 Habitat Correlations

The strong positive correlation between odonate diversity and habitat complexity, particularly vegetation structure, was evident. Kerehalla Tank's rich macrophyte cover provided a mosaic of microhabitats essential for different odonate life stages, including oviposition sites, larval refugia, and adult perching/foraging areas. The presence of dense riparian vegetation also provided crucial thermal regulation and predator avoidance for adult odonates (Samways & Steytler, 1996).

In contrast, the simpler structure of the irrigation canal, characterized by steep banks and minimal aquatic vegetation, offered limited ecological niches, restricting diversity to generalist species. The seasonal drying and chemical inputs in Gowribidanur Pond likely impacted larval survival and adult emergence patterns.

5.3 Interpretation

This study confirms that odonate assemblages serve as reliable indicators of freshwater habitat quality in Chintamani. Perennial water bodies with undisturbed margins and rich aquatic vegetation support higher odonate diversity, suggesting better ecological health. Anthropogenic disturbances, such as agricultural runoff leading to eutrophication and physical modification of water bodies (e.g., canal maintenance), directly impact odonate communities by reducing habitat heterogeneity and water quality. The dominance of generalist species in disturbed sites indicates a shift towards less sensitive communities, a common pattern in degraded ecosystems (Clark & Samways, 1996).

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6. Conclusion

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The freshwater tanks and ponds of Chintamani Taluk are valuable but vulnerable habitats. This study demonstrates that odonate diversity is strongly linked to habitat complexity and stability, making them effective bioindicators for assessing the health of these aquatic ecosystems. The semi-arid climate of Chintamani further emphasizes the importance of these water bodies as refugia for biodiversity.

Recommendations for conservation and management:

- **Protect and restore macrophytic vegetation:** Encourage the growth of emergent and submerged plants in freshwater tanks to enhance habitat complexity.
- **Establish riparian buffer zones:** Maintain vegetated strips along the edges of water bodies to reduce runoff pollution and provide crucial terrestrial habitat for adult odonates.
- **Minimize chemical inputs:** Promote sustainable agricultural practices that reduce the flow of pesticides and fertilizers into water bodies.
- **Public awareness:** Educate local communities about the ecological role of odonates and the importance of healthy freshwater ecosystems.

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7. Endnotes

1. Odonate nymphs are aquatic predators, feeding on mosquito larvae and other small invertebrates.
2. Adult dragonflies are agile aerial predators, consuming large numbers of flying insects.
3. Species richness is often a direct reflection of habitat heterogeneity.
4. The presence of certain 'indicator' odonate species can signify high-quality, undisturbed water.
5. Seasonal drying of ponds can create unique ecological pressures, favoring species with desiccation-resistant eggs or rapid life cycles.
6. Habitat fragmentation in aquatic systems restricts dispersal and gene flow for many odonate species.
7. The family Libellulidae is globally diverse and often dominates open, sunlit aquatic habitats.
8. Damselflies (Zygoptera) often prefer sheltered, vegetated areas compared to the more robust dragonflies.
9. Monitoring odonate populations can provide cost-effective insights into the long-term health trends of freshwater bodies.
10. Climate change impacts, such as altered rainfall patterns, pose significant threats to odonate populations in semi-arid regions.

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