International Journal of Zoology Studies
ISSN: 2455-7269
Impact Factor: RJIF 5.14
www.zoologyjournals.com
Volume 3; Issue 1; January 2018; Page No. 197-200

Species richness, diversity and conservation threats of Odonates in Dyamannana Lake (Kere), Bhadravathi Taluk, Shivamogga District, Karnataka, India

[1] MN Harisha, [2] BB Hosetti

[1] Department of Post Graduate Studies and Research in Wildlife & Management, Kuvempu University, Jnana Sahyadri, Shankaraghatta, Shivamogga, Karnataka, India

[2] Department of Post Graduate Studies and Research in Applied Zoology, Kuvempu University, Jnana Sahyadri, Shankaraghatta, Shivamogga, Karnataka, India

Abstract
The study was conducted to find out the status, diversity and conservation threats of Odonata at Dyamannana Lake, Shivamogga Disrtict during October 2015 to September 2016. Sampling was done by direct counts method and collected data were statistically analyzed to work out the magnitude of Odonate diversity. A total of 470 individuals of odonates belonging to 41 species in 29 genera under 6 families were recorded. The order- Anisoptera was found to be the most dominant with 76% (n=31) species, belonging to 3 families, followed by order- Zygoptera with 24% (n=10) species, under 3 families respectively. Among the order- Anisoptera, the family wise, abundance, richness, diversity and evenness indices was found to be maximum in Libellulidae (340, 4.1, 2.9, 0.72) followed by the Aeshnidae (38, 0.8, 1.3, 0.93) and minimum in Gomphidae (26, 0.3, 0.7, 1.0) respectively (Table 2). Similarly, among the order: Zygoptera, it was found to be maximum in Coenagrionidae (42, 1.6, 1.9, 0.92) and minimum in Platycnemididae (12, 0.5, 0.6, 0.94), however, it was least in Lestidae (12, but showed no significant indices value with only single species) respectively. The study revealed that, odonates and their habitats were under threat due to intensive anthropogenic activities, which are attributed to encroachment and loss of habitat. Also, addition of fertilizers and insecticides from the surrounding arecanut plantation lead to pollution and eutrophication of the lake, which not only affect the assemblage of Odonata population but also cause local extinctions.

Keywords: anisoptera, dragonflies, damselflies, diversity, Dyamannana Lake, zygoptera

1. Introduction
Globally 5740 species of odonates are known, of which 474 species under 142 genera and 18 families exist in India [1]. Dragonflies have been proposed as indicators to assess the health of freshwater wetlands [2] and also play a vital role as prey and predator to balance the tropic levels of food chain [3, 4]. Odonates serve as an umbrella species in biodiversity conservation [5, 6] and represent specific biotic wetland assemblages. Odonates, being important elements of the food chain; they predate on harmful insect pests of crops, orchards and forest, other small insects like mosquitoes, moths, butterflies and thus have a bio-control impact on agro-forestry [7, 8, 9, 10].
Odonates survive in a wide range of aquatic habitats i.e., lentic to lotic water bodies, some have adapted to urban areas and exploit man-made water bodies [8, 9]. Even though most species of odonates are highly specific to a habitat are susceptible to habitat alterations induced by human activities [7]. For the first time the hitherto study was to carried out on odonate species assemblages in Dyamannana Lake, Shivamogga District in order to understand the nature of odonate species assemblages with reference to the habitat characters.

2. Material and Methods
2.1. Study Area: The Dyamannana Lake (Kere) is a spectacular site located between 13°56'27"N latitude and 75°48'3"E longitude. The lake is spread in an area of about 120.3 acres, built before the independence of India. It is belonging to Arakere Gram Panchayat, Bhadravathi Taluk, Shimoga District of Karnataka. The lake is located just adjacent to the highway (State Highway 65 Bhadravathi-Channagiri) road, which cover the half of the study area and rest of the area is surrounded by the Joladal Range Forest. This wetland provides water for drinking to wildlife from the surrounding Joladal Range Forest as well as to cattle's from the nearby villages, irrigation to surrounding agricultural lands and for aquaculture practices. Most importantly the lake has ecological significance as an attracting sight for few wetland and wetland dependent, local and migratory birds.

2.2. Sampling Methods
Odonata sampling was carried out from October 2015 to September 2016. Adult Odonata sampling was done around the bank of the wetland and along transect by direct counts [11] made while observing habitats on hourly basis. The field work was conducted 4 days in every month and selection of days was not chronological but clear, windless and sunny days were selected. Data collection was conducted between 10:00 am and 01:00 pm [12], when insects activities found in peak to regulate body temperature in sunlight [13]. During the course of

the survey Odonates observed in the field were identified by using field guides [14, 15]. The taxonomic and nomenclature has been followed as per Subramanian [14]. The frequency of odonates were categorized into five groups such as, very common (80-100%), common (60-80%), occasional (40-60%), rare (20-40%) and very rare (below 20%) based on their abundance during the study period [16]. The collected data were statistically analyzed to work out the magnitude of Odonate diversity (OD) and odonate species richness (OSR), were measured by Shannon's index (H^1), Margalef's index (M) and Evenness index (E^1) respectively [17]. Biodiversity indices were calculated by Past software [18].

3. Results and Discussion

3.1. Odonata Species Composition

A total of 470 individuals of odonates belonging to 41 species in 29 genera under 6 families were recorded. The order-Anisoptera was found to be more diverse and predominant with 31 species under 23 genera belonging to 3 families, contributed 76%, followed by order-Zygoptera which was less diverse with 10 species under 6 genera belonging to 3 families, contributed 24% of total odonates recorded from study area. Among the Order-Anisoptera, the family Libellulidae dominated with highest number species and abundance (number of individuals) (81% (n=25), 340), followed by Aeshnidae (13% (n=4), 38) and least in the Gomphidae (6% (n=2), 26) respectively. Similarly, among the Order-Zygoptera, it was highest in the family Coenagrionidae (70 % (n=7), 42), followed by Platycnemididae (20% (n=2), 12) and least in Lestidae (10% (n=1), 12) respectively. The status of odonates based on the frequency of occurrence revealed that 39% (n=16) were common, 22% (n=9) were occasional, 17% (n=7) were rare, 15% (n=6) were very common and 7% (n=3) were very rare respectively (Table 1, Table 2).

3.2. Margalef's richness (M), Shannon Weiner Diversity (H^1) and Evenness index (E^1)

During the hitherto study, the order wise, species richness, diversity and evenness indices was found to be highest in Anisoptera (M=5.0, H^1=3.1, E^1=0.75) and least in the order: Zygoptera (M=2.1, H^1=2.2, E^1=0.91) (Table 2). Among the order: Anisoptera, the family wise, species richness, diversity and evenness indices was found to be highest in Libellulidae (M=4.1, H^1=2.9, E^1=0.72) followed by the Aeshnidae (M=0.8, H^1=1.3, E^1=0.93) and least in Gomphidae (M=0.3, H^1=0.7, E^1=1.0) respectively. Similarly, among the order: Zygoptera, it was found to be highest in Coenagrionidae (M=1.6, H^1=1.9, E^1=0.92), and least in Platycnemididae (M=0.5, H^1=0.6, E^1=0.94) however, the family Lestidae showed no significant value with only single species (Table 2).

It is revealed that Anisoptera (dragonflies) was found to be abundant in the study area and this similar pattern of predominance was also reported from other wetlands i.e., from Komaranahalli Lake [4], Kondajji Lake [9] and Kundavada Lake [19] of Davanagere district, Karnataka, this might be due to their high dispersal ability and adaptability to wide range of habitats [20, 21]. Less abundance of Zygoptera (damselflies) may be due to their limited dispersal ability and changing environment [20, 22, 23] and partial or absence of shade cover [24] afforded by the temporary water bodies. The encounter of damselflies in study area could be attributed to the existence of shade over the habitat from the trees present surrounding the water bodies and also to the occurrence of aquatic vegetation. The study also revealed that shade and aquatic vegetation could favour the Zygoptera more than the Anisoptera [14].

According to IUCN categorization, only one species namely, *Indothemis carnatica* fall under Near Threatened (NT) category (Table 1) was remarkable. During the present investigation, the record of abundant Libellulidae (Anisoptera) and Coenagrionidae (Zygoptera) might be due to their shorter life cycle and widespread distribution and tolerant to wide range of habitats [25, 26-27]. The large size of the water bodies also becomes an important factor to determine the species richness and diversity of Odonata [4, 9, 20, 28-29].

In the study it has been found that, the odonates and their habitats are under threat due to intensive anthropogenic activities, like, movement of heavy vehicles around the wetland, presence of predators, habitat alterations such as construction and widening of roads, encroachment of lake bed for agricultural and human settlements and the excavation of bed for clay and soil for making bricks lead to habitat fragmentation, and also leached fertilizers and insecticides from the surrounding arecanut plantation lead to pollution and eutrophication of lake. These activities might affect the assemblage of Odonata population and cause local extinctions [27, 30-31]. The data of present study works as a baseline data for assessing the changes of environmental conditions in the area, thereby helping in formulating future conservation measures to preserve the wetland habitats and to maintain the ecosystem health.

Table 1: Systematic list of Odonates along with their abundance and conservation status at Dyamanna Lake, Bhadravathi Taluk, Shivamogga District, Karnataka.

Sl. No	Common name	Scientific name	No. ind.	F	IUCN
	Order: Anisoptera (Dragonflies)				
	1. Family: Aeshnidae				
1	Blue-tailed Green Darner	*Anax guttatus* (Burmeister, 1839)	15	O	LC
2	Blue Darner	*Anax immaculifrons* (Rambur, 1842)	10	C	LC
3	Rusty Darner*	*Anaciaeschna jaspidea* (Burmeister, 1839)	8	O	LC
4	Parakeet Darner	*Gynacantha bayadera* (Selys, 1891)	5	O	LC
	2. Family: Gomphidae				
5	Common Clubtail	*Ictinogomphus rapax* (Rambur, 1842)	14	VC	LC
6	Common Hooktails	*Paragomphus lineatus* (Selys,1850)	12	O	LC
	3. Family: Libellulidae				

7	Trumpet Tail	*Acisoma panorpoides* (Rambur, 1842)	8	C	LC
8	Little Blue Marsh Hawk	*Brachydiplax sobrina* (Rambur,1842)	4	C	LC
9	Ditch Jewel	*Brachythemis contaminata* (Fabricius, 1793)	4	VC	LC
10	Ruddy Marsh Skimmer	*Crocothemis servilia* (Druey, 1773)	8	C	LC
11	Scarlet Marsh Hawk	*Aethriamanta brevipennis* (Rambur,1842)	18	C	LC
12	Granite Ghost	*Bradinopyga geminata* (Rambur,1842)	23	VC	LC
13	Ground Skimmer	*Diplacodes trivialis* (Rambur,1842)	16	VC	LC
14	Black-tipped Ground Skimmer	*Diplocodes nebulosa* (Fabricius, 1793)	10	C	LC
15	Blue Ground Skimmer	*Indothemis carnatica* (Fabricius, 1798)	16	R	NT
16	Pied Paddy Skimmer	*Neurothemis tullia* (Drury,1773)	12	O	LC
17	Brown-backed Red Marsh Hawk	*Orthetrum chrysis* (Selys, 1891)	14	VR	LC
18	Blue Marsh Hawk	*Orthetrum glaucum* (Brauer, 1865)	12	O	LC
19	Crimson-tailed Marsh Hawk	*Orthetrum pruinosum* (Rambur,1842)	18	C	LC
20	Green Marsh Hawk	*Orthetrum Sabina* (Drury,1770)	16	VC	LC
21	Wandering Glider	*Pantala flavescens* (Fabr.1798)	80	C	LC
22	Common Picture Wing	*Rhyothemis variegata* (Linn.1763)	14	O	LC
23	Crimson Marsh Glider	*Trithemis aurora* (Burmeister,1839)	6	C	LC
24	Long-legged Marsh Skimmer	*Trithemis pallidinervis* (Selys,1889)	8	O	LC
25	Black Stream Skimmer	*Trithemis festiva* (Rambur,1842)	12	C	LC
26	Black Marsh Trotter	*Tramea limbata* (Desjardins,1832)	7	C	LC
27	Red Marsh Trotter	*Tramea basilaris* (Kirby,1889)	6	VR	LC
28	Coral-tailed Cloud Wing	*Tholymis tillarga* (Fabr.1798)	6	R	LC
29	Emerald-banded Skimmer	*Cratilia lineata* (Foerster,1903)	10	C	LC
30	Fulvous Forest Skimmer	*Neurothemis fulvia* (Drury,1773)	8	R	LC
31	Asiatic Blood Tail	*Lathrecista asiatica* (Fabricius, 1798)	4	VR	LC
	Order: Zygoptera (Damselflies)				
	4. Family: Coenagrionidae				
32	Pigmy Dartlet	*Agriocnemis pygmaea* (Rambur,1842)	6	O	LC
33	Coromandel Marsh Dart	*Ceriagrion coromandelianum* (Fabr.1798)	10	C	LC
34	Rusty Marsh Dart	*Ceriagrion olivaceum* (Laidlaw,1914)	4	C	LC
35	Golden Dartlet	*Ischnura aurora* (Brauer,1865)	6	C	LC
36	Senegal Golden Dartlet	*Ischnura senegalensis* (Ramb.1842)	2	VC	LC
37	Elegant Sprite	*Pseudagrion decorum* (Rambur, 1842)	8	R	LC
38	Blue Grass Dartlet	*Pseudagrion microcephalum* (Rambur,1842)	6	C	LC
	5. Family: Lestidae				
39	Emerald Spreadwing	*Lestes elatus* (Selys, 1862)	12	R	LC
	6. Family: Platycnemididae				
40	Blue Bush Dart	*Copera vittata* (Selys,1863)	6	R	LC
41	Yellow Bush Dart	*Copera marginipes* (Rambur, 1842)	6	R	LC

F-Frequency: VC-Very common; C-Common; O-Occasional, R-Rare and VR-Very Rare, LC- Least concern, *- End emic to Western Ghats; **-Endemic to Peninsular India and Sri Lanka, No. ind.- number of individuals

Table 2: Family/order wise species richness, diversity, evenness and frequency of occurrence of Odonata at Dyamanna Lake, Bhadravathi Taluk, Shivamogga District, Karnataka.

Sl. No.	Family/Order	N S (with % composition)	Abd. (T. no. ind.)	M	H^1	E^1	Frequency of occurrence (% composition)				
							VC	C	O	R	VR
	Order: Anisoptera	31(76%)	404	5.0	3.1	0.75	5	12	8	3	3
1	Aeshnidae	4(13%)	38	0.8	1.3	0.93	-	1	3	-	-
2	Gomphidae	2(6%)	26	0.3	0.7	1.00	1	-	1	-	-
3	Libellulidae	25(81%)	340	4.1	2.9	0.72	4	11	4	3	3
	Order: Zygoptera	10(24%)	66	2.1	2.2	0.91	1	4	1	4	0
4	Coenagrionidae	7(70%)	42	1.6	1.9	0.92	1	4	1	1	-
5	Lestidae	1(10%)	12	0.0	0.0	0.00	-	-	-	1	-
6	Platycnemididae	2(20%)	12	0.5	0.6	0.94	-	-	-	2	-
	Over all	41(100%)	470	6.5	3.4	0.74	6 (15%)	16 (39%)	9 (22%)	7 (17%)	3 (7%)

NS-number of species, Abd-Abundance, T.no.ind.- Total number of individuals, M- Margalef's index, H^1-Shannon Wiener's Diversity Index, E^1-Evenness Idex, VC-Very common, C-Common, O-Occasional, R-Rare, VR-Very rare

4. Acknowledgements

We take this opportunity to thank authorities of Dept. of Wildlife and Management, and Kuvempu University, Shivamogga District, Karnataka for their support and facilities.

5. References

1. Subramanian KA. A checklist of Odonata of India.

Zoological Survey of India, Kolkata. 2014, 31.
2. Suhling F, Sahlen G, Martens A, Marais E, Schutte C, Dragonfly assemblages in arid tropical environments A case study from Western Namibia. Arthropod Diversity and Conservation. Top. in Biodiver. and Conserv. 2006; (1):297-318.
3. Corbet PS. A Biology of Dragonflies HF, Witherby G. London. 1962.
4. Harisha MN. Assessment of status, diversity and threats of odonates in Komaranahalli Lake, Komaranahalli Village, Harihar Taluk, Davanagere District, Karnataka, India. Intern. J. of Plan. Anim. and Environ. Sci. 2016 a; 6(3):122-127.
5. Noss RF. Indicators of monitoring biodiversity: A hierarchical approach. Conserv. Biol. 1990; 4:355-364.
6. Lambeck RJ. Focal species: A multispecies umbrella for nature conservation. Conserv. Biol. 1997; 11(4):849-856.
7. Prasad M, Varshney RK. A checklist of the Odonata of India including data on larval studies. Oriental Insects. 1995; 29:385-428.
8. Mitra TR. Geographical Distribution of Odonata (Insecta) of Eastern India. Memories of the Zoological Survey of India. 2002; 19(1):17.
9. Harisha MN. Evaluation of Status and Diversity of Odonates of Kondajji Lake, Kondajji Village, Harihar Taluk, Davanagere District, Karnataka, India. J. of Entomol. and Zool. Stud. 2016 b; 4(4):384-388.
10. Harisha M. Nijjavalli, Basaling B. Hosetti. Preliminary observations on Odonata fauna of Daroji Sloth Bear Sanctuary, Ballari District, North Karnataka (India). Biodiversity Journal. 2017a; 8(4):875-880.
11. Sutherland KA. Ecological census techniques. Cambridge University Press, Cambridge. 1996.
12. da Junior C, SM, SRM, Coucriro N, Hamada, Juen L. Effect of vegetation removal for road building on richness and composition of Odonata communities in Amazonia, Brazil. International Journal of Odonatology. 2013; 16:135-144.
13. Das SK, Sahoo PK, Dash N, Marathe S, Mahato S, Dashahare A, Mishra PS, Prasad A, Rana R. Odonates of three selected tiger reserves of Madhya Pradesh, Central India. Check List. 2013; 9:528-532.
14. Subramanian KA. Dragonflies and damselflies of Peninsular India-A field guide. Indian Academy of Sciences, Bangalore. 2005.
15. Subramanian KA. Dragonflies of India-A Field Guide, Vigyan Prasar, Department of Science and Technology, Offset Press, New Delhi. 2009, 118.
16. Adarsh CK, Arunraj R, Nameer PO. Odonata (Insecta) diversity of Chinnar Wildlife Sanctuary, the southern Western Ghats, India. J. of Threatened Taxa. 2015; 7(2):6910-6919.
17. Magurran A. Ecological Diversity and its Measurement. Princeton University Press, Princeton, NJ. 1988.
18. Hammer O, Harper DAT, Ryan PD. PAST: Paleontological Statistical package for education and data analysis. *Palaeontologia electronica*. 2001; 4:9.
19. Harisha MN, Hosetti BB. Status, diversity and conservation threats of Odonates in Kundavada Lake, Davanagere district, Karnataka, India J. of Entomol. and Zool. Stud. 2017b; 5(1):312-316.
20. Kadoya T, Suda S, Washitani I. Dragonfly species richness on man-made ponds: effects of pond size and pond age on newly established assemblages. Ecological Research. 2004; 19:461-467.
21. Suhling F, Schenk K, Padeffke T, Martens A. A field study of larval development in a dragonfly assemblage in African desert ponds (Odonata). Hydrobiologia. 2004; 528:75-85.
22. Weir JS. Odonata collected in and near seasonal pools in Wankie National Park, Rhodesia with notes on the physio-chemical environments in which nymphs were found. J. Entomol. Soc. South Africa. 1974; 37:135-145.
23. Williams DD. Temporary ponds and their invertebrate communities. Aquatic Conservation: Marine and Freshwater Ecosystems. 1997; **7**:105-117.
24. Clark TE, Samways MJ. Dragonflies (Odonata) as indicators of biotope quality in the Kruger National Park, South Africa. J. Appl. Ecol. 1996; 33:1001-1012.
25. Samways MJ. Taxon turnover in odonata across a 3000 m altitudinal gradient in Southern Africa. Odonatology. 1989; 18:263-274.
26. Gentry JB, Garten CT, Howell FG, Smith MH. Thermal ecology of dragonflies in habitats receiving reactor effluent, In: Environmental Effect of Cooling Systems at Nuclear Power Plants. International Atomic Energy Agency, Vienna. 1975, 563-574.
27. Norma-Rashid Y, Mohd-Sofian A, Zakaria-Ismail M. Diversity and distribution of odonata (dragonflies and damselflies) in the fresh water swamp lake, Tasek Bera, Malaysia. Hydrobiologia. 2001; 459:135-146.
28. Carchini G, Solimni AG, Ruggiero A. Habitat characteristics and odonate diversity in mountain ponds of central Italy. Aquatic Conservation: Marine and Freshwater Ecosystems. 2005; 15:573-581.
29. Suh AN, Samways MJ. Significance of temporal changes when designing a reservoir for conservation of dragonfly diversity. Biodiversity and Conservation. 2005; 14:165-178.
30. Clausnitzer V. Dragonfly communities in coastal habitats of Kenya: Indication of biotope quality and the need of conservation measures. Biodiversity and Conservation. 2003; 12:333-356.
31. Krishna Prasad K, Ramakrishna B, Srinivasulu C, Srinivasulu B. Odonate Diversity of Manjeera Wildlife Sanctuary with notes on Female Polymorphism of *Neurothemis tullia* (Drury, 1773) (Odonata: Libellulidae) and Some Species Hitherto Unreported from Andhra Pradesh, India. J. of Entomol. and Zool. Stud. 2013; 1(4):99-104.