

Evaluation of Community Composition of Dragonflies and Damselflies (Order: Odonata) in Nalsarovar Bird Sanctuary, Gujarat, India

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ABSTRACT: : A study was carried out in Nalsarovar Bird Sanctuary to evaluate community composition of Odonates (Dragonflies and Damselflies) in Nalsarovar Bird Sanctuary (Ramsar Site), Gujarat. Transects survey was carried out at Nalsarovar Bird Sanctuary covering all habitats. Each transect was repeatedly surveyed in all seasons. A total of 30 species of dragonflies and damselflies were encountered belonging to 5 families namely Libellulidae, Gomphidae, Aeshnidae, Coenagrionidae, and Lestidae during the entire study. During the study, percentage frequency of occurrence, abundance and density of Odonates were calculated based on data collected to evaluate community composition of Dragonflies and Damselflies in Nalsarovar Bird Sanctuary. During the entire survey, the percentage frequency of occurrence of 3 species namely *Brachythemis contaminata*, *Pantala flavescens* and *Trithemis pallidinervis* were recorded highest. The most abundant species encountered were *Pantala flavescens* followed by *Trithemis pallidinervis*, *Brachythemis contaminata*, *Ischnura aurora* and *Ischnura senegalensis* respectively among all species encountered during the survey. However, the density of Odonates species namely *Trithemis pallidinervis* were highest which was further followed by *Pantala flavescens* and *Brachythemis contaminata*, *Ischnura senegalensis* and *Ischnura aurora* respectively during the entire survey. This study can be used as a benchmark for future conservation and monitoring of Odonates in state and similar wetland worldwide.

Key Words: Odonata, Nalsarovar, Habitat, Damselfly, Density, Dragonfly, Abundance, Occurrence

INTRODUCTION

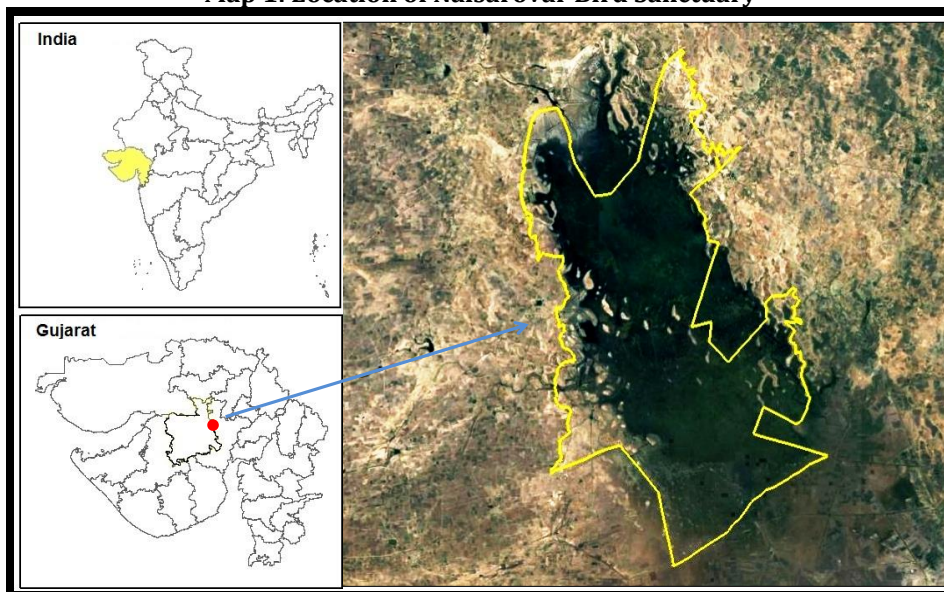
Odonata is one of the most ancient groups of insects. Odonates first appeared during the Carboniferous era, about 250 million years ago [1]. Dragonfly (Suborder-Anisoptera) and Damselflies (Suborder-Zygoptera) both belong to Order Odonata. Globally 5,952 species of Odonates that belonged to 652 genera have been reported [2]. India harbors 474 species and 50 subspecies belonging to 142 genera in 18 families [3]. Odonates have three stages in life eggs, nymphs (larvae) and adult. The Odonates are amphibiotic insects. They spend a major part of their life cycle in a freshwater ecosystem. Odonate nymphs are carnivores and voracious feeder whereas adults are a predator of other insect species [4, 5]. Anisoptera (dragonflies) are abundant in all waterbodies compared to Zygoptera may be due to their high adaptability and dispersal of dragonflies whereas damselflies have limited dispersal ability and adaptation to the environmental changes. The factors that mainly influence dragonflies and damselflies diversity and assemblage compositions are habitat structure and complexity predation, pollution and water chemistry [6,7,8,9]. Odonates larval (nymphs) and adult stage play a significant role as a predator in the wetland ecosystem as a biocontrol agent. However, Odonates also act as a biocontrol agent of many disease-causing species including mosquitoes i.e. a vector of malaria and dengue and helminths i.e. parasites of birds especially of poultry and wild ducks which thereby aid transmission of these diseases [1, 10,11,12,13,14, 15,16,17]

Nalsarovar Sanctuary is one of the important wetlands of India and Gujarat. It is internationally recognized as a Ramsar Site of Gujarat. It is also designated as a Sanctuary i.e. protected area and an Important Bird and Biodiversity Area (IBA) [18]. Studies on various aspect of Nal Sarovar is done in the past including birds and biodiversity study [18,19,20]. The entire study was carried out in Nalsarovar wetland. Studies on aquatic insects are limited within the Gujarat state. However, few studies focused on aquatic and semi-aquatic insects had been carried out in Gujarat State [21,22,23,24,25,26,27]. However, Odonata being such an important semi-aquatic insect, there is a gap of studies on dragonflies and damselflies within entire Gujarat including various protected area including Nalsarovar Bird Sanctuary. Considering the important role played by Odonata in terms of monitoring wetland health. An effort was made to study the current status of community composition of Dragonflies and Damselflies at Nalsarovar Bird Sanctuary. This study was can be used as a benchmark for future conservation and monitoring of odonate in state and similar wetland worldwide.

METHODOLOGY

Study Area: The study was carried out at Nal Sarovar Sanctuary. Nal Sarovar is located between 22°07' N and 22° 96' N latitude and 71° 92' E and 72° 64' E longitudes. The lake area is spread over two districts viz., Ahmedabad and Surendranagar. It has an area of 147 sq. km. [28] Biogeographically, the area falls in Gujarat-Rajwara Biotic Province (4B) of the Semi-Arid biogeographical zone [29]. Geologically it is the remnant - relict of an oceanic creek - locally called as Nal. This depressed portion had come into existence by tectonic uplift of an estuary and also by increased sedimentation and aeolian infill [30]. The natural and seasonal spread of wetland of Nal Sarovar, has an irregular configuration, though the basin is elliptical in shape. It is shallow with a maximum depth of 3m and in most parts muddy. Among the wetlands of Gujarat, Nal Sarovar is unique in characteristics. The change in water quality between fresh and brackish keeps the bio-cycles of organisms. Nal Sarovar provides adequate depression over a large area for the existence of submerged aquatic vegetation. It supports emergent hydrophytic vegetation in and around its shallow water near the shores and islets. Both the submerged and emergent vegetation, as well as algae, constitute primary producers of this aquatic ecosystem. They support large epiphytic macro-invertebrates and also provide cover to a variety of organisms [18,31,32]. The major habitats of Nal Sarovar wetland includes Open Water Habitat, Emergent Hydrophytic Cover, Muddy Habitat, Islets ('bet'), Shore-land, Agriculture fields surrounding the Lake, wasteland surrounding the Lake and Inlets and Outlets of Lake [32] (Map 1). There are about 12 villages located on the periphery of this wetland. They include Kayla, Vekaria, Meni, Darji, Digvijaygadh, Shiyal, Paraii, Mulbavla, Ranagadh, Bhagvnpur, Nani Kathechi, and Shahpur. The rainfall is erratic. During the good rainfall years, the total area under submergence swells to around 350 sq. km whereas submergence area is often 60 sq km during winter of normal rain year. The entire land of Nal Sarovar and its environs is salt-affected with saline/alkaline salts concentrated in the upper layer of clayey, medium black soil [33].

Map 1: Location of Nalsarovar Bird Sanctuary



Sampling Strategies: A study of odonates was carried out from February 2015 to February 2017 at Nalsarovar Bird Sanctuary. Transect survey was carried out. Fourteen sites were fixed using GPS for the odonate survey within the study area (from T1 to T14). All sites were regularly and repeatedly surveyed. Fixed belt transects of 500 m length and width of 5 m on both side of transect were followed for the study of Odonates between 7.00 a.m. and 11.30 a.m. Each transect was surveyed for 30 minutes. The survey was carried out covering all major habitats and different seasons. Individuals of Odonates were recorded during the survey, photographed and then released back to the field. Species were mainly photographed using digital photos by Powershot SX60 HS camera with 16.1 megapixels, ultrasonic, full HD 65X optical zoom. Species were identified using standard taxonomic literature [1,34,35,36]. The raw data of all the sites collected from the field were transferred in an electronic format. The data collected from all the sampling sites during field survey were calculate using M.S. office (Excel) and PASTsoftware.

RESULTS AND DISCUSSION

A total of 30 species of dragonflies and damselflies were encountered belonging to 5 families namely Libellulidae, Gomphidae, Aeshnidae, Coenagrionidae, and Lestidae during the entire study (Table 1). Out of total Odonate (30 species) encountered during the entire study, a total of 21 species of dragonflies (Suborder – Anisoptera) encountered that belonged to 16 Genera and 3 families. However, among Anisoptera, 18 species that belonged to 13 Genera and family Libellulidae, 1 species belonged to family Gomphidae, 2 species that belonged to family Aeshnidae were encountered during the survey. Similarly, a total of 9 species of Zygoptera (damselflies) encountered that belonged to 6 Genera and 2 families during the entire study. Among Zygoptera, 8 species belonged to 6 Genera and 1 family Coenagrionidae, a single species belonged to family Lestidae were encountered during the survey (Table 1).

During the study, percentage frequency of occurrence, abundance and density of Odonates were calculated irrespective of seasonality based on data collected to evaluate community composition/community structure of Dragonflies and Damselflies in Nalsarovar Bird Sanctuary. These analyses are important in determining the community composition/community structure. Details of each are given further

Percentage frequency of Occurrence (%): Percentage frequency of occurrence of each species recorded during this study was calculated and analyzed. Each species was distributed in the four different ranges including above 10 (Highest), from 5 to 10 (High), from 0 to 5 (Moderate) and below 0 ranges (Low). During the survey, the percentage frequency of occurrence of total 3 species namely *Brachythemis contaminata*, *Pantala flavescens* and *Trithemis pallidinervis* were recorded highest (above 10). The percentage frequency of occurrence of total 2 species namely *Ischnura aurora* and *Ischnura senegalensis* were recorded high (in the range between 5-10). Similarly, Percentage frequency of occurrence of total 9 species namely *Diplacodes trivialis*, *Agriocnemis pygmaea*, *Hemianax ephippiger*, *Rhyothemis variegata*, *Crocothemis servilia*, *Macrodiplax cora*, *Orthetrum sabina*, *Rhodischnura nursei* and *Pseudagrion decorum* were recorded moderate (in the range between 0-5). However, the percentage frequency of occurrence of 16 species namely *Brachydiplax sobrina*, *Indothemis carnatica*, *Bradinopyga geminata*, *Orthetrum glaucum*, *Enallagma cyathigerum*, *Ceriagrion coromandelianum*, *Tramea limbata*, *Acisoma panorpoides*, *Diplacodes lefebvrii*, *Tramea basilaris*, *Anax guttatus*, *Trithemis kirbyi*, *Ictinogomphus rapax*, *Pseudagrion microcephalum* and *Trithemis festiva* were recorded low (below 0) (Table 1, Figure 1).

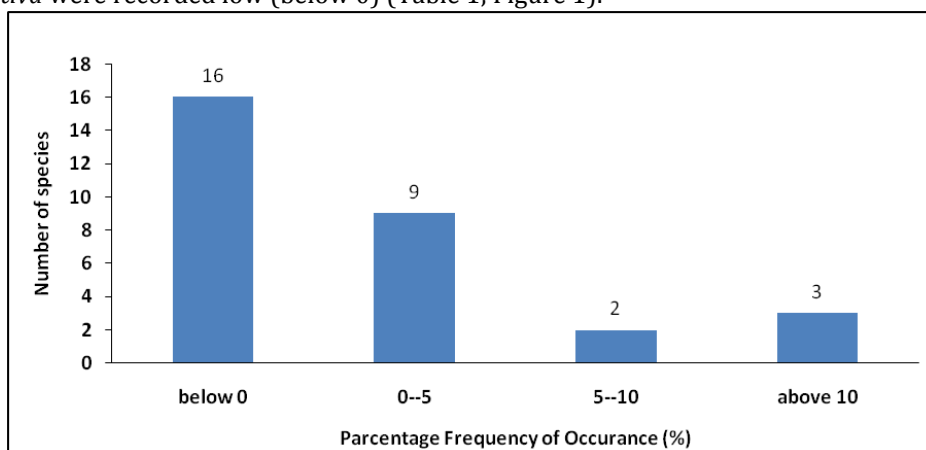


Figure 1: Odonata species encountered with similar Percentage Frequency of Occurrence (%) during the survey

Abundance of Odonates: Abundance of Odonate species recorded during the entire survey was calculated irrespective of seasonality. Among all Odonate species encountered during the survey, the most abundant species encountered were *Pantala flavescens* followed by *Trithemis pallidinervis*, *Brachythemis contaminata*, *Ischnura aurora* and *Ischnura senegalensis* respectively. However, Odonate species including *Enallagma cyathigerum*, *Ceriagrion coromandelianum*, *Bradinopyga geminata*, *Tramea limbata* and *Indothemis carnatica* were recorded with less abundance during study (Table 1).

Density of Odonates: The density of Odonate species recorded during the entire survey was calculated. The density of Odonates species namely *Trithemis pallidinervis* were encountered highest which was further followed by *Pantala flavescens* and *Brachythemis contaminata*, *Ischnura senegalensis* and *Ischnura aurora* respectively during the entire survey. However, the density of Odonates species namely *Bradinopyga geminata* were low and *Indothemis carnatica*, *Brachydiplax sobrina* were lowest (Table 1). All the remaining species recorded were recorded with moderate density during the study. Among Anisoptera species

(Dragonflies) belonging to family Libellulidae, the density of *Trithemis pallidinervis* were recorded highest. Density of dragonfly species belonging to family Aeshnidae namely *Hemianax ephippiger* were recorded highest followed by *Anax guttatus*. Among Zygoptera (Damselfly) species belonging to family Coenagrionidae, the density of *Ischnura senegalensis* and *Ischnura aurora* were recorded highest. However single species were encountered in Odonata family namely Gomphidae (Anisoptera) and family Lestidae (Table 1).

Table 1: Community Composition of Odonata (Dragonfly and Damselflies) in Nalsarovar Bird Sanctuary

Odonate Species	Percentage Frequency of Occurrence (%)	Abundance	Density (Individuals Per ha)
Family - Libellulidae			
<i>Trithemis festiva</i> (Rambur, 1842)	0.93	2.16	1.47
<i>Crocothemis servilia</i> (Drury, 1770)	3.80	4.62	6.03
<i>Brachythemis contaminata</i> (Fabricius, 1793)	14.55	18.7	23.11
<i>Macrodiplax cora</i> (Brauer, 1867)	3.83	8.94	6.08
<i>Diplacodes trivialis</i> (Rambur, 1842)	1.02	2.25	1.63
<i>Trithemis pallidinervis</i> (Kirby, 1889)	19.19	18.92	30.49
<i>Orthetrum sabina</i> (Drury, 1770)	3.94	5.06	6.25
<i>Pantala flavescens</i> (Fabricius, 1798)	16.98	33.48	26.97
<i>Tramea basilaris</i> (Rambur, 1842)	0.25	1.61	0.4
<i>Tramea limbata</i> (Desjardins, 1832)	0.11	1.08	0.18
<i>Rhyothemis variegata</i> (Linnaeus, 1763)	3.30	11.42	5.24
<i>Bradinopyga geminata</i> (Rambur, 1842)	0.05	1.2	0.08
<i>Acisoma panorpoides</i> (Rambur, 1842)	0.15	1.89	0.24
<i>Orthetrum glaucaum</i> (Drury, 1770)	0.07	1.6	0.11
<i>Brachydiplax sobrina</i> (Rambur, 1842)	0.04	2	0.06
<i>Trithemis kirbyi</i> (Kirby, 1889)	0.32	1.76	0.51
<i>Diplacodes lefebvrrii</i> (Rambur, 1842)	0.15	1.7	0.24
<i>Indothemis carnatica</i> (Fabricius, 1798)	0.04	1	0.06
Family - Aeshnidae			
<i>Hemianax ephippiger</i> (Burmeister, 1839)	2.17	4.35	3.44
<i>Anax guttatus</i> (Burmeister, 1839)	0.26	3	0.42
Family - Gomphidae			
<i>Ictinogomphus rapax</i> (Rambur, 1842)	0.39	6.29	0.61
Family - Coenagrionidae			
<i>Ischnura aurora</i> (Brauer, 1865)	8.15	14.79	12.94
<i>Ischnura senegalensis</i> (Rambur, 1842)	8.22	12.05	13.06
<i>Rhodischnura nursei</i> (Morton, 1907)	4.44	6.77	7.06
<i>Pseudagrion decorum</i> (Rambur, 1842)	4.86	9.11	7.72
<i>Agriocnemis pygmaea</i> (Rambur, 1842)	1.53	5.47	2.43
<i>Ceriagrion coromandelianum</i> (Fabricius, 1798)	0.11	1.5	0.17
<i>Pseudagrion microcephalum</i> (Rambur, 1842)	0.90	4.29	1.43

<i>Enallagma cyathigerum</i> (Charpentier, 1840)	0.10	1.57	0.15
Family - Lestidae			
<i>Lestes species</i>	0.17	1.73	0.26

Presence of adult species of Odonata and their distribution area generally depends on their daily activities during entire life. Odonate groups are known to associate with different abiotic and biotic factors. The analysis derived during this study determines the current scenario of community structure of odonates in Nalsarovar wetland. The distribution and occurrence of Odonates are known to be linked with its associated habitat including different vegetation life-forms and landscape [37]. This may be one of the reasons for variation in percentage frequency of occurrence, abundance and density of Odonates during the study. This species composition derived during study may be due to their requirements by each species recorded during survey. Odonates are known to be very susceptible to specific types of habitat changes as Odonates are known to associate with aquatic habitats, terrestrial landscapes and their associated habitat required for selection of egg laying sites which may further lead to future associated processes for larval life stage and its characteristic habitat. This makes Odonata susceptible to specific types of habitat changes [5,12,38,39,40]. Dragonflies and damselflies both being an aquatic insect and play an important role of environmental bio-indicator of water quality, this study can be used to evaluate physical and biological conditions in wetlands. Odonates also play a very important role as a bio-control agent of mosquitoes i.e. Vector of various vector-borne diseases including malaria and dengue. Some of the mosquito-voracious and bio-control agent dragonflies include *Bradinopyga geminata*, *Brachythemis contaminata* and *Pantala flavescens*. These mosquito-voracious and bio-control dragonfly species are encountered during this study. In ecological studies variation in biodiversity and number of species may occur as biotic and abiotic factors are linked within an ecosystem. This study can be considered as primary information about the composition of species as well as for controlling various vector-borne diseases including malaria and dengue in the future if wetland monitoring data related to Odonata are added regularly. The studies can also be used for better management of these species within a protected area in state and similar wetland worldwide.

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