



Odonata diversity in and around Vadodara, Gujarat, India

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ABSTRACT: Investigation on the diversity of Odonates revealed a total of 38 species belonging to two suborders, six families, and 24 genera in and around Vadodara, in Gujarat, which included 15 species of Zygoptera (damselfly) and 23 species of Anisoptera (dragonfly). Out of the 38 species, 10 species are new records for the Vadodara. Most number of species was found in water reservoirs as compared to urban ponds and area around Mahi River. Furthermore, it was observed that areas around the rivers were adversely affected because of nearby sand mining. Amongst damselflies and dragonflies the population of damselflies was richer. Renovation of Urban ponds leads to decrease in their diversity due to loss of vegetation indicating anthropogenic pressure on species diversity.

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KEY WORDS: Damselflies, dragonflies, conservation, reservoir, mine

INTRODUCTION

Dragonflies are amongst the most ancient of winged insects, dating back well into the Permian period (Grimaldi and Engel, 2005). Dolny and Asmera (1989) recognized them as good indicators of environmental change as the larvae and adult both are sensitive to habitat degradation and climate change. Diversity of the local Odonates fauna is determined by the overall ecological quality of water bodies and related land water ecotones (Chovanec *et al.*, 2004; Smith *et al.*, 2007). The eight super-families, 29 families and around 58 sub-families of Dragonflies for approximately 600 genera and 6000 named species have so far been described all over the world (Mitra, 2006). Odonate fauna of India is known by 3 sub-orders, 17 families, 139 genera and 499 species and subspecies (Subramanian, 2014). Very few studies have been carried out on the

diversity of Odonates in Gujarat. ZSI scientists during general survey of Gujarat enlisted 48 species (Prasad, 2004). Other than that Rathod *et al.* (2016) and Rohmare *et al.* (2015) had worked in Gujarat and described 80 species of Odonates from Gujarat. While working on total insect diversity in different habitats of Vadodara, 22 species of Odonates were reported (Naidu, 2008). During the working on terrestrial birds and their prey 45 species of Odonates from Vadodara were reported but identified only 28 up to species level (Gandhi, 2012). Rohmare *et al.* (2015) working in Central Gujarat described 42 species having a place with 27 genera from 6 district including 28 species of 21 genera from Vadodara. Dragonflies and damselflies are amongst the prominent and colourful insects in tropical landscapes. In addition to providing aesthetic pleasure, studying them could give us valuable insights about ecosystem health, especially of

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wetlands. Therefore, for a better understanding of ecology, diversity, distribution and conservation the work on the diversity of Odonate was started from June 2017 with the study of Ordinates of various sites of Vadodara.

MATERIALS AND METHODS

Study Area: Vadodara is situated at 22.30°N 73.19°E in western India at a rise of 39 meters on the banks of the Vishwamitri waterway, southeast of Ahmedabad. An observation review in and around Vadodara was made for site choices. Distinct habitats of living spaces were chosen based on natural components, vegetation, encompassing condition and anthropogenic pressure, to get an insight of the best possible Odonate diversity

Timbi Irrigation Reservoir (TIR: Plate 1) is situated around 15 km east of the Vadodara city. The water of the reservoir is utilized for the local reason, for example, agriculture fields, washing the garments and utensils and cleaning up while the drier side of the supply is utilized as grazing field by cattle.

Ajwa Reservoir (AR: Plate 1) situated 25 km from the Vadodara city, the water of the store is used for the neighbourhood region, for instance, washing of clothing and utensils and tidying up while the drier side of the supply is used as grazing field for cattle.

Urban Pond sites (Plate 1) Under the smart city project a great deal of advancement is going on like, development of new infrastructure and residential complexes, beautification of ponds, sculpture park and boating close to ponds. This demonstrates an anthropogenic weight on the ponds which influences the natural habitat of the ponds.

Mahi River Sites (Plate 1) study was conducted at two different locations of Mahi River which are: A) Sindhrot Check dam which is a picnic and religious spot for the locals of Vadodara City which brings about tossing loads of waste in the streaming water; B) Angadh Village where sand mining on the banks of Mahi River is prone.

Sampling Method

Systematic survey method was followed in which the observation time was from 9am to 1pm. For observation visual encounter method was followed in transect. Point count method was used for counting individual number of species. Odonates present on both the sides of the water bodies were watched while walking on transect and recorded. Adult Odonates were collected from all the sites by using a standard insect net. Live dragonflies were collected in transparent container with a wide mouth plastic bottle and were utilized to store them alive. Collected specimens were killed by putting the jar in deep freeze for 10 minutes. The Odonates were taken out from the jar and entomological pins were passed through the thorax and settled on the spreading board. The wings were then spread in such a manner that the inner margin of the forewing remained perpendicular to the body of the insect. The collected specimens of Odonates comprised of both dragonfly and damselfly. They were identified with the help of suitable guides (Subramanian 2009; Nair 2011; Kiran and Raju, 2013) and (Fraser, 1936).

RESULTS

During the study period, 38 species belonging to 24 genera, under 6 families, and 2 suborders were recorded from four different sites in and around Vadodara. A total 15 species of Zygoptera and 23 species of Anisoptera were identified. The highest number of Odonate species (34) was recorded in Timbi irrigation reservoir (21 species of Anisoptera and 13 species of Zygoptera) followed by Ajwa reservoir with 32 species (19 species of Anisoptera and 13 species of Zygoptera). 27 Species were recorded near banks of Mahi River (15 species of Anisoptera and 12 species of Zygoptera) and least species (16) recorded from urban ponds (11 species of Anisoptera and 5 species of Zygoptera) (Table 1).

The highest number of Odonates recorded belonged to family Libellulidae with 21 species (Table 3) followed by family Coenagrionidae with 10 species (Table 2) and least number were from family Aeshnidae just with one species (Table 3). Family



Reed Beds at Ajwa Reservoir



Reed Beds at Timbi Irrigation Reservoir



Periphery of Urban Pond (Gotri Pond)



Construction around Urban Pond (Harni Pond)



Mining near the Riparian Zone (Angadh)



Riparian Zone of Mahi River (Sindhrot)

Plate 1. Study sites



Ischnura senegalensis (resting on a twig)



Pseudagrion hypermelas (resting on a leaf)



Pseudagrion rubriceps (Mating pair)



Lestes viridulus (resting)



Paragomphus lineatus (hovering)



Diplacodes nebulosa (hovering)

Plate 2. Species of Odonata collected from three different habitats.

Lestidae (Table 2) represented by three species, families Platycnemididae (Table 2) and Gomphidae (Table 3) were represented by two species each. Ten species i.e. *Agriocnemis pygmaea*,

Ceriagrion coromandelianum, *Ischnura aurora*, *Ischnura senegalensis*, *Acisoma panorpoides*, *Brachythemis contaminata*, *Crocothemis servilia*, *Orthetrum sabina*, *Pantala flavescens*



Indothemiscarnatica (resting on a twig)



Orthetrum pruinosum (resting on a branch)



Tholymis tillarga (collected specimen)



Trithemis kirbyi (resting at rock)

Plate 3. Species of Odonata collected from three different habitats.

and *Trithemis aurora* were most common and widely distributed species as they were recorded from all sites (Table 2 and 3).

Fifteen species were recorded from at least three sites i.e. *Lestes thoracicus*, *Copera marginipes*, *Enallagma cyathigerum*, *Rhodoischnura nursei*, *Pseudagrion decorum*, *Pseudagrion hypermelas*, *Pseudagrion rubriceps*, *Anax guttatus*, *Bradinopyga geminata*, *Diplacodes trivialis*, *Neurothemis tullia*, *Orthetrum pruinosum*, *Tholymis tillarga*, *Trithemis kirbyi* and *Trithemis pallidinervis* (Table 2 and 3).

Timbi irrigation reservoir and Ajwa reservoir have 32 species as common. *Paragomphus lineatus* and *Bradinopyga geminate* were the species which

recorded from Timbi irrigation reservoir not from Ajwa reservoir and 8 species i.e. *Indothemis carnatica*, *Pseudagrion microcephalum*, *Ictinogomphus rapax*, *Brachydiplax sobrina*, *Diplacodes nebulosa*, *Orthetrum taeniolatum*, *Rhyothemis variegata* and *Trithemis festiva* were only recorded from these two sites and were absent from other sites (Table 2 and 3).

Although the habitat of both Timbi and Ajwa is almost similar in spite of that Timbi is slightly more diverse because of rocky substrate and also the construction of residential complexes near Timbi leads to a good roosting habitat for few urban species like *Bradinopyga geminate*. *Disparoneura quadrimaculata* and *Lestes umbrinu* species (Table 2) were only recorded

Table 1. Species richness of dragonflies and damselflies in and around Vadodara

Sr. No	Study Site	Dragonfly	Damselfly	Total
1	Timbi Irrigation Reservoir	21	13	34
2	Ajwa Reservoir	19	13	32
3	Mahi River	15	12	27
4	Urban ponds	11	5	16

Table 2. A comparison of damselflies collected from different sites in and around Vadodara

Taxon	Study Sites			
	Timbi	Ajwa	Mahi River	Urban Ponds
Suborder : Zygoptera				
Family: Lestidae				
<i>Lestes thoracicus</i> Laidlaw, 1920	Y	Y	Y	N
<i>Lestes umbrinus</i> Selys, 1891	N	N	Y	N
* <i>Lestes viridulus</i> Rambur, 1842	Y	Y	N	N
Family: Coenagrionoidea				
<i>Agriocnemis pygmaea</i> (Rambur, 1842)	Y	Y	Y	Y
<i>Ceriagrion coromandelianum</i> (F. 1798)	Y	Y	Y	Y
<i>Enallagma cyathigerum</i> (Charpentier 1840)	Y	Y	N	Y
<i>Ischnura aurora</i> (Brauer 1865)	Y	Y	Y	Y
* <i>Ischnura senegalensis</i> (Rambur 1842)	Y	Y	Y	Y
<i>Rhodischnura nursei</i> (Morton, 1907)	Y	Y	Y	N
<i>Pseudagrion decorum</i> (Rambur 1842)	Y	Y	Y	N
* <i>Pseudagrion hypermelas</i> Selys, 1876	Y	Y	Y	N
<i>Pseudagrion microcephalum</i> (Rambur 1842)	Y	Y	N	N
* <i>Pseudagrion rubriceps</i> Selys, 1876	Y	Y	Y	N
Family: Platycnemididae				
<i>Copera marginipes</i> (Rambur 1842)	Y	Y	Y	N
<i>Disparoneura quadrimaculata</i> (Rambur 1842)	N	N	Y	N

The Species marked with asterisk (*) are the first records from Vadodara City. **Y** denotes presence of Species and **N** denotes absence of species.

from the Mahi river site and *Diplacodes lefebvrii* species (Table 3) was absent at Timbi irrigation reservoir and Ajwa reservoir.

Generally, it is seen that flowing water bodies have more diversity but in the present study at two location of Mahi River the diversity was less. This could be because of anthropogenic pressure as the Sindhrot check dam is a tourist place and sand mining activities are very prevalent near Angadh

village so disturbance level is high at this places. Due to mining activities near the Angadh village it leads to channelling of river water and temporary water puddles around the riparian area which acts as microhabitat for Damselflies. This could be the reason for good diversity of damselflies at the riverine site.

Least diversity is recorded at Urban Ponds because of the loss of vegetation surrounding the ponds.

Under smart city project beautification of pond is going on which leads to removal of vegetation and concretization of the pond periphery. This affects the diversity as no suitable roosting site is available. Therefore only 5 species of damselflies belonging from a single family were observed and 11 species of Dragonfly from 2 families was recorded.

After the present study ten species (Plate 2 and Plate 3) from in and around Vadodara are being

reported for the first time. These are *Lestes viridulus* Rambur, 1842, *Ischnura senegalensis* (Rambur 1842), *Pseudagrion hypermelas* Selys, 1876 and *Pseudagrion rubriceps* Selys, 1876 (Table 2); *Paragomphus Lineatus* (Selys 1850), *Diplacodes nebulosa* (Fabricius 1793), *Indothemis carnatica* (Fabricius 1798), *Orthetrum pruinsum* (Burmeister, 1839), *Tholymis tillarga* (Fabricius 1798) and *Trithemis kirbyi* (Selys 1891) (Table 3).

Table 3. A comparison of dragonflies collected from different sites in and around Vadodara

Taxon	Study Sites			
	Timbi	Ajwa	Mahi River	Urban Ponds
Suborder : Anisoptera				
Family : Aeshnidae				
<i>Anax guttatus</i> (Burmeister 1839)	Y	Y	Y	N
Family: Gomphidae				
<i>Ictinogomphus rapax</i> (Rambur 1842)	Y	Y	N	N
* <i>Paragomphus Lineatus</i> (Selys 1850)	N	Y	N	Y
Family : Libellulidae				
<i>Acisoma panorpoides</i> (Rambur 1842)	Y	Y	Y	Y
<i>Brachydiplax sobrina</i> (Rambur 1842)	Y	Y	N	N
<i>Brachythemis contaminata</i> (Fab 1793)	Y	Y	Y	Y
<i>Bradinopyga geminate</i> (Rambur 1842)	Y	N	Y	Y
<i>Crocothemis servilia</i> (Drury 1770)	Y	Y	Y	Y
<i>Diplacodes lefebvreii</i> (Rambur 1842)	N	N	Y	Y
* <i>Diplacodes nebulosa</i> (Fabricius 1793)	Y	Y	N	N
<i>Diplacodes trivialis</i> (Rambur 1842)	Y	Y	N	Y
* <i>Indothemis carnatica</i> (Fab 1798)	Y	Y	N	N
<i>Neurothemis tullia</i> (Drury 1773)	Y	Y	Y	N
* <i>Orthetrum pruinsum</i> (Burmeister, 1839)	Y	Y	Y	N
<i>Orthetrum sabina</i> (Drury 1770)	Y	Y	Y	Y
<i>Orthetrum taeniolatum</i> (Schneider 1845)	Y	Y	N	N
<i>Pantala flavescens</i> (Fabricius 1798)	Y	Y	Y	Y
<i>Rhyothemis variegata</i> (Linnaeus 1763)	Y	Y	N	N
* <i>Tholymis tillarga</i> (Fabricius 1798)	Y	N	Y	Y
<i>Trithemis aurora</i> (Burmeister 1839)	Y	Y	Y	Y
<i>Trithemis festiva</i> (Rambur 1842)	Y	Y	Y	N
* <i>Trithemis kirbyi</i> (Selys 1891)	Y	Y	N	N
<i>Trithemis pallidinervis</i> (Kirby 1889)	Y	Y	Y	N

The Species marked with asterisk (*) are first records for Vadodara City. Y denotes presence of Species and N denotes absence of species

DISCUSSION

Wetlands are among the most impacted habitat because of land conversion (Reece and McIntyre, 2009) and their important biological resources can easily be lost through clearance and overuse (Clausnitzer, 2004). Wetlands are one of the major ecosystems that support the Odonate density and diversity. Hence to save Odonate species wetlands need to be conserved. Recent studies around the world have suggested that Odonates respond to anthropogenic pressures and thus may serve as useful indicators of habitat quality in terms of species occurrence and diversity (Sahlen, 2006; Suhling *et al.*, 2006).

Presence of reed beds at Timbi Irrigation Reservoir and Ajwa Reservoir is one of the most important factor behind the high diversity as reed beds are a type of grass which grows up to 4-6 feet and remain submerged in water throughout the year, as water from Narmada canal is present throughout the year so it acts as a perfect habitat for Odonates.

Along with reed beds Ipomoeas, Water lily, Hydrilla, Water hyacinth, Calotropis, Prosopis, were the major plants presents which Odonates uses for perching, resting and most importantly for egg laying.

During the present study Club tails were more abundant on the water reservoir whereas they were less on the riverine ecosystem (Subramanian, 2009) while working on ecology of Dragonfly in Western Ghats indicate that Club tail, Bamboo tail, Reed tails, Torrent hawk, Torrent darts are good indicators of health of riverine ecosystem. The investigation shows that Libellulids were most predominant on Mahi River and Urban ponds while Gomphids were in great number at Irrigation reservoirs. Presence of generalist Libellulids, particular species like *Brachythemis contaminata* clearly shows deteriorating habitats and contamination of water. The findings suggest that the diversity of Vadodara is quite good but there are many threats to Odonates of Vadodara like over construction and overcrowding by the birdwatchers near Timbi Irrigation Reservoir, even the release of water from Narmada River to reservoir all of a sudden

increases water level of the Reservoir and many anthropogenic activities like washing of clothes, utensils and grazing cattle around the reservoir also destruct the habitat.

Though riverine ecosystem have more diversity but our study reports that Mahi River has less diversity due to anthropogenic activities like picnic place near the riparian area, throwing of religious stuffs, garbage, plastic waste, burning of waste products etc. All this leads to the pollution at the riverine ecosystem. On the other side of Mahi River sand mining is prevalent which leads to fragmentation of habitats thus an overall decrease of the diversity even common species of riverine ecosystem like Club tails were very rarely observed.

Under the smart city project, beautification of ponds, development of Sculpture Park and renovation of gardens around the ponds is going on which leads to the removal of the vegetation in and around the ponds and the periphery of ponds being replaced by concrete. This disturbs the normal habitat of Odonates resulting in low population at urban ponds as only 16 species from 3 families which are very common and most adaptive species and even the individuals were very less. One of the biggest threats to Odonata is an unplanned urban development as it directly leads to the destruction of their habitat. To save the extinction of several Odonate species wetlands need to be conserved. Recent studies around the world have suggested that Odonates respond to anthropogenic pressures and thus may serve as useful indicators of habitat quality in terms of species occurrence and diversity (Sahlen, 2006; Suhling *et al.*, 2006). Conservation strategy needs to be developed and implemented to stop further deterioration of the Odonate species.

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