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**Ritu Chourasia**

Department of Zoology and  
Applied Aquaculture,  
Barkatullah University, Bhopal,  
Madhya Pradesh, India

**Deepika Bhargava**

Department of Zoology and  
Applied Aquaculture,  
Barkatullah University, Bhopal,  
Madhya Pradesh, India

**Vipin Vyas**

Department of Zoology and  
Applied Aquaculture,  
Barkatullah University, Bhopal,  
Madhya Pradesh, India

## Study on odonata as health indicator of riparian ecosystem of Betwa River, Bhojpur, Raisen

Ritu Chourasia, Deepika Bhargava and Vipin Vyas

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**Abstract**

An indicator species is an organism that serves as a measure of the environmental conditions. In the present study Odonates (Arthropoda: Insecta) are used as a health indicator of the riparian ecosystem of Betwa river, Raisen (Division: Bhopal). A total of 30 species including 22 species of Anisoptera and 8 species of Zygoptera were recorded in four different Sites during the study period from July to December 2019. 23 species recorded from Site A (Riparian zone adjoining to Forest), 22 species recorded from Site C (Bhojpur Ghat), 21 species from Site D (Riparian zone adjoining to Agriculture field), and 16 species from Site B (Jain Temple). Site A was the most abundant habitat with 582 individuals (379 Anisopterans and 203 Zygopterans), followed by Site C with 517 individuals (338 Anisopterans and 179 Zygopterans), followed by Site D with 435 individuals (318 Anisopterans and 117 Zygopterans) and Site B with 200 individuals (184 Anisopterans and 16 Zygopterans) was the least abundant.

**Keywords:** Anisoptera, Betwa river, indicator species, Odonata, Zygoptera

**Introduction**

Odonates are usually known as 'guardians of the watershed' [1]. Anisoptera (Dragonflies) and Zygoptera (Damselflies) are collectively called Odonates, are one of the most common insects flying over forests, fields, meadows, ponds, and rivers. About 6000 extant species are distributed all over the world. India is highly diverse with more than 500 known species [2]. Odonata are one of the ancient orders of insects. It first appeared during the Carboniferous period of the Palaeozoic Era [3]. Odonates are primarily aquatic in their pre-adult stages and their life is closely tied with flowing and stagnant water bodies. Even though species are usually highly specific to a habitat, some have adapted to urbanization and use man-made water bodies. Being primarily aquatic, their life history is closely linked to specific aquatic habitats. Naturally, these insects become a marker, an indicator of wetland health [4].

Madhya Pradesh is a landlocked State of India, it is completely surrounded by land, hence rivers are the dominant water sources of the state. Madhya Pradesh is also known as 'NADIYO KA MAYKA' meaning originating point of rivers, approximate 207 small and large rivers flow in Madhya Pradesh. Betwa is the 5<sup>th</sup> largest river of MP [5].

The Betwa or Betravati is a river in Northern India and a tributary of the Yamuna. The length of the Betwa is 480 km. It rises in the Vindhya Range (Kumrangaon; Raisen) just north of Hoshangabad in Madhya Pradesh and flows north-east through Madhya Pradesh and Orchha to Uttar Pradesh. In the present study the riparian ecosystem of Betwa river of Bhojpur region was studied using odonates as marker of its health, their Abundance, Richness, diversity and similarity between various sites were recorded during the study

**Material and Methods**

The present study was conducted in the Riparian zone of Betwa river in its Bhojpur region, District Raisen, Madhya Pradesh, India from July to December 2019.

**Study Area**

Bhojpur is situated on the Betwa River, 28 km from Bhopal, the state capital of Madhya Pradesh. The site is located on sandstone ridges typical of central India, next to a deep gorge through which the Betwa River flows. Two large dams, constructed of massive hammer-dressed stones, were built in the eleventh century to divert and block the Betwa, so creating a large lake. Bhojpur is located between 23°6'54"N latitude and 77°35'43"E longitude in the state of Madhya Pradesh, India.

**Corresponding Author:****Ritu Chourasia**

Department of Zoology and  
Applied Aquaculture,  
Barkatullah University, Bhopal,  
Madhya Pradesh, India

It is located at a height of 463m (1,519 fits) from the mean sea level. The average annual temperature is 26.10 °C and the average annual precipitation is 1560 mm.

The different types of habitats which were surveyed are as following:

#### Site A - Riparian zone adjoining with forest

Coordinates- 23°10'56"N and 77°57'92"E

It is spread in the northern and north west region of Bhojeshwar temple. This site has zero anthropogenic activities hence it has a calm and peaceful environment that provides natural habitat to Odonates. Fishing nets were laid for fishing. Riverside fencing protects unfortunate accidents with tourists and it also provides safeguarding to the riparian zone from human interferences. Social behaviour of wandering glider or Globe skimmer (*Pantala flavescens*) was recorded on this site during the study. Their copulatory calling by tail movements and wheel position was also spotted there.



Fig 1: Map showing different study sites of Betwa River in Bhojpur

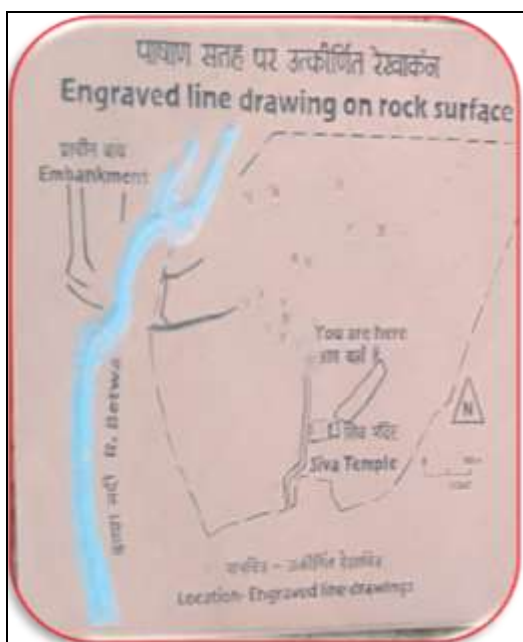


Fig 2: Engraved line drawing of study area on rock surface

#### Site B - Digamber Jain Atishay Kshetra (Jain Temple)

Coordinates- 23°10'56"N and 77°57'92"E

Bhojpur also has an unfinished Jain temple which is the worship place of Digambar Jain situated in the eastern part of Bhojeshwar temple. Restaurants and children's park established there for entertaining tourists. Plastic bags and other pollutants (cans, wrappers, glass, etc.) were dispersed here and there.

#### Site C - Bhojpur Ghat

Coordinates- 23°09'63"N and 77°57'87"E

Bhojpur Ghat is situated in the southwest of Bhojeshwar temple both the sides of Betwa river. People were spotted performing several religious practices there. Some people were bathing and washing clothes. Boating was also performing to entertain tourists. The egg-laying position of Zygopterans was recorded there.

#### Site D - Riparian zone adjoining to Agriculture field

Coordinates- 23°09'95"N and 77°57'61"E

A small farmhouse spotted there and caretaker was gardening in the field. The Agri area has black fertile soil. Bumblebee and honeybees spotted there in huge numbers. Farmers have laid fencing for limitation of their agricultural areas.

#### Survey Method

Adult Odonates were sampled for a period of 6 months (July to December 2019) in four different types of habitats across the study area. Data collection was done twice a week starting from July 2019 to December 2019 undertaken between 7:00 to 10:00 AM morning and 4:00 to 6:00 PM evening [4]. A sampling of adult odonates was done on days with fine weather conditions. Capturing of odonates was done along transects with a width of 50m perpendicular from the water systems to maximize the area along with water systems. The line transect method has been widely used for the quantitative sampling of Odonates [6]. The species were identified using various keys [8, 9, 10, 3]. Species that could not be identified in the field were collected and stored in 70% ethyl alcohol for identification [7]. Environmental parameters were recorded for the sample points which included the colour of the stream, type of immediate vegetation, etc. The abundance is determined by the number of individuals found during visual surveys, along transects. The total number of individuals of each species encountered during the study period (July to December 2019) is used for comparing their abundance.

#### Data Analysis

Margalef's richness ( $D_{Mg}$ ) index is used here to determine species richness. If 'S' is the number of species recorded and 'N' is the total number of individuals in the sample, the indices are calculated as follows:

$$D_{Mg} = (S-1)/\ln N$$

The Shannon-Weiner index is used here to calculate the diversity of species in different habitats. The Shannon-Weiner index ( $H'$ ) is given by the formula as follows:

where 's' is the number of species, and 'pi' is the proportion of individuals of each species belonging to the 'i<sup>th</sup>' species of the total number of individuals. The negative of this sum is taken as the index. The higher the index, the higher is the species diversity.

Jaccard's index ( $C_j$ ) was used to calculate the similarity of odonate species between two habitats among the different types of habitats studied. It is given by the following relation:

$$C_j = c/a + b + c$$

Where 'c' is the total number of species common in both sites, 'b' is the number of species unique to first site and 'c' is the number of species unique to second site.

## Results and Discussion

### Abundance

A total of 30 species were recorded during the study. The Infraorder Anisoptera is represented by 2 Families and 22 species and the Infraorder Zygoptera by 3 Families and 8 Species. 23 species were recorded from Site A (Riparian Adjacent To Forest) followed by 22 species were recorded from Site C (Bhojpur ghat) followed by 21 species from Site D (Riparian adjacent to Agriculture field) and 16 species from Site B (Jain Temple).

Site A was the most abundant habitat with 582 individuals (379 Anisoptera and 203 Zygoptera) followed by Site C with 517 individuals (338 Anisoptera and 179 Zygoptera) followed by Site D with 435 individuals (318 Anisoptera and 117 Zygoptera) and Site B with 200 individuals (184 Anisoptera and 16 Zygoptera) was the least abundant.

### Diversity and similarity index

The Shannon – Weiner index (Site A:  $H' = 1.345$ ; Site B:  $H' = 1.163$ ; Site C:  $H' = 1.2655$ ; Site D:  $H' = 1.23064$ ) as shown in table 2 does not vary much among the different sites.

Species richness or Margalef's richness index ( $DM_g$ ) was found to be 3.455 in Site A followed by 3.292 in Site D followed by 3.361 in Site C and it was 2.835 found to be least in Site B.

Jaccard's similarity index ( $C_j$ ) as shown in Table- 2 was highest (0.692) between Site A and Site C and it was lowest (0.4) between Site B and site D.

**Table 1:** Table showing Odonata species recorded, their Abundance, Margalef's Coordinates- 23°10'56"N and 77°57'92"E richness index ( $DM_g$ ) and Shannon- Weiner index ( $H'$ ) in different sites of study area

Sub Order	S. No.	Scientific Name	Common Name	No. of individuals encountered (Abundance)				
				Site A	Site B	Site C	Site D	
Anisoptera	<b>Family: Aeshnidae</b>							
	1.	<i>Anax immaculifrons</i>	Blue darner	-	23	-	81	
	2.	<i>Anax guttatus</i>	Lesser green emperor	6	5	12	-	
	<b>Family: Libellulidae</b>							
	3.	<i>Pantala flavescens</i>	Wandering glider	36	14	63	68	
	4.	<i>Acisoma panorpoides</i>	Trumpet tail	46	-	-	-	
	5.	<i>Orthetrum Sabina</i>	Green marsh hawk	43	15	91	-	
	6.	<i>Crocothemis erythraea</i>	Scarlet darter	18	21	31	-	
	7.	<i>Trithemis aurora</i>	Crimson marsh glider	47	-	40	21	
	8.	<i>Bradynopyga geminate</i>	Granite ghost	16	27	10	-	
	9.	<i>Potamarcha congener</i>	Yellow tailed ashy skimmer	23	21	-	23	
	10.	<i>Orthetrum cancellatum</i>	Black tailed skimmer	-	-	38	20	
	11.	<i>Orthetrum pruinosum</i>	Crimson tailed marsh hawk	-	14	-	19	
	12.	<i>Tramea onusta</i>	Red saddlebags	-	-	3	-	
	13.	<i>Neurothemis tullia</i>	Pied paddy skimmer	33	-	12	-	
	14.	<i>Trithemis pallidinervis</i>	Long legged marsh glider	24	-	-	18	
	15.	<i>Lathrecista asiatica</i>	Asiatic blood tail	11	-	3	5	
	16.	<i>Diplacodes nebulosi</i>	Black tipped ground skimmer	17	-	8	-	
	17.	<i>Neurothemis fulvia</i>	Fulvous forest skimmer	21	-	-	15	
	18.	<i>Diplacodes trivialis</i>	Chalky percher	13	9	12	4	
	19.	<i>Libellula saturate</i>	Flame skimmer	5	12	1	6	
	20.	<i>Brachythemis cantaminata</i>	Ditch jewel	5	6	9	18	
21.	<i>Rhyothemis variegata</i>	Common Picture wing	8	5	2	11		
22.	<i>Urothemis signata</i>	The greater crimson glider	7	12	3	9		
Zygoptera	<b>Family: Platycnemididae</b>							
	23.	<i>Nososticta solida</i>	Orange thread tail	-	-	12	32	
	<b>Family: Lestidae</b>							
	24.	<i>Lestes umbrinus</i>	Brown Spread wing	49	-	20	6	
	<b>Family: Coenagrionidae</b>							
	25.	<i>Ischnura elegans</i>	Common blue tail	41	1	41	2	
	26.	<i>Enallagma cyathigerum</i>	Common bluet	22	-	27	5	
	27.	<i>Ceriagrion coromandelianum</i>	Yellow wax tail	28	-	46	37	
	28.	<i>Ishnura aurora</i>	Golden dartlet	-	-	33	1	
	29.	<i>Agriocnemis pygmaea</i>	Pygmy dartlet	63	4	-	-	
30.	<i>Ceriagrion olivaceum</i>	Rusty marsh dart	-	11	-	34		
Total				582	200	517	435	
$DM_g$				3.455	2.835	3.361	3.292	
$H'$				1.345	1.163	1.265	1.230	

**Table 2:** Table showing Jaccard's similarity index ( $C_j$ )

	Site A	Site B	Site C	Site D
Site A	1	0.5	0.692	0.517
Site B	0.5	1	0.407	0.4
Site C	0.692	0.407	1	0.518
Site D	0.517	0.4	0.518	1



*Orthetrum pruinosum* (Crimson-tailed Marsh Hawk)



*Orthetrum Sabina* (Green marsh hawk)



*Trithemis/aurora* (Crimson marsh glider)



*Pantala flavescens* (Globe skimmer)



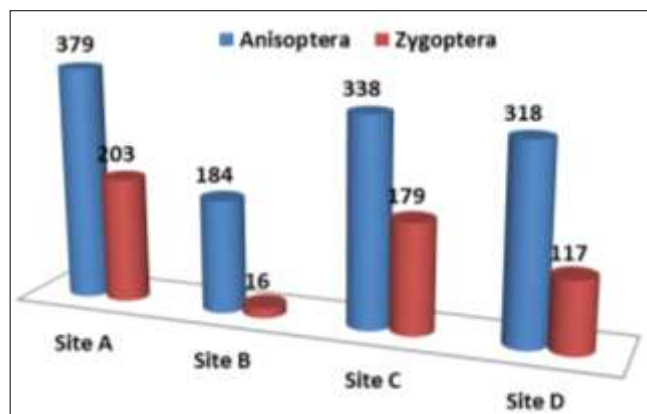
**Mating of Dragonfly on Study Site**



**Mating of Damselfly on study site**



Egg laying of Damselfly

*Brachythemis cantaminata* (Ditch jewel)*Crocothemis erythraea* (Scarlet darter)*Potamarcha congener* (Yellow tailed ash Skimmer)

**Fig 3:** Graph showing abundance of Anisoptera and Zygoptera in various sites.

Odonates are carnivore insects hence they also act as biological controllers of epidemics (Dengue, yellow fever, malaria etc.) by eating their vectors. Odonates are major components of the food chain of the riparian ecosystem and their role is important not only as predators of other insects but as prey of birds, frogs etc. many species of Odonates inhibit pest population in agricultural ecosystem.

Odonates are astonishing creature of nature that not only attracts humans by its large eyes and beautiful wings, but also helps humans in form of bio-indicators (indicates the health of riparian ecotone), biological controllers (by eating vectors of epidemics), and friends of farmers (controls pests' population in agricultural ecosystem).

### Conclusion

In the study presented, the observers found that the diversity of Odonates in the Bhojpur region of Raisen district, India is

adequate, but it has many anthropogenic activities that affect their habitat and threaten their diversity. In these activities, water pollution caused by dhobis, plastic spreaded by tourists, bathing of cattle by well-meaning villagers are prominent. Therefore, effective conservation efforts have to be made to eliminate this danger hovering over the diversity of Odonates in the region. These strategies include long-term and appropriate national level planning, fresh water conservation programs, public awareness to do so (for which nukkad plays can be resorted to) as well as it should also follow the sustainable development model to make development without any depletion of environment.

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