



Full Length Research Article

DIVERSITY ASSESSMENT AND EXPANSION OF ODONATA IN NARMADA BASIN OF JABALPUR REGION (M.P)

¹Arjun Shukla, ²Shivani Rai, and ²Bhoopendra Kumar Ahirwar

¹Research Scholar, Department of Zoology, Govt. Model Science College, Jabalpur (M.P.) India, 482001

²Research Scholar, Department of Zoology, Govt. M.H. College of Home Science, Jabalpur (M.P.) India, 482001

ARTICLE INFO

Article History:

Received 24th February, 2016

Received in revised form

24th March, 2016

Accepted 17th April, 2016

Published online 31st May, 2016

Key Words:

Odonata,
Conservation,
Diversity,
River Narmada,
Biological Indicator.

ABSTRACT

An opportunistic survey of Odonata diversity and distribution was done in along with river Narmada region of district Jabalpur to give updated list of species within the study. Odonata play crucial role in ecosystem functioning and can be used as biological indicators as well as potential bio-control agent of environmental quality whereas biodiversity protection and conservation is a national and international agenda and responsible for sustainable development of a region or a country. A total of 38 species are recorded belonging to two sub-orders Zygoptera with 16 species and Anisoptera with 22 species. In order Odonata, *Libellulidae* with 17 species is the most dominating families among dragonflies and *Coenagrionidae* with 13 species among damselflies while others have fewer representatives. Bargi dam shows the highest Regional diversity of Odonata in Jabalpur. The present study encourages the conservation of a wide range of dragonfly species in this area.

Copyright©2016, Arjun Shukla et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Biodiversity conservation and management are worldwide concern (Ramesh *et al.*, 2010), where determining the diversity levels of indicator groups of ecosystem should permit the prediction of other taxa to be present i.e., the importance and appropriateness of using invertebrate groups as indicator (Oliver and Beattie, 1993; Pearson, 1994). Biodiversity loss is one of the world's most pressing crisis and there is global concern about the biological resource on which so much human life depends. To focus on the conservation of biodiversity has recently received attention. Various studies and protocols have been proposed to test the apropos patterns of biodiversity (Wilson, 1988; Noss, 1990; Enlich and Wilson, 1991) and Vane Wright *et al.*, (1991) also classified a hierarchical composition of different level of organization as well as groups of taxonomically related species to test the patterns of biodiversity conservation. The use of indicator taxa in conservation efforts from pollution control to biodiversity has been the focus of attention (Landers *et al.*, 1988).

**Corresponding author: Arjun Shukla, Research Scholar, Department of Zoology, Govt. Model Science College, Jabalpur (M.P.) India, 482001.*

Ecological indicators can be defined as a taxon or community that reflects the biotic or abiotic state of an environment (Hodkinson and Jackson, 2005). Larval Odonata diversity and abundance was positively correlated with macroinvertebrates diversity and abundance and it was efficient bioindicators of intactness and diversity of overall macroinvertebrates (Foote and Rice, 2005). The river Narmada is the third holy and fifth longest west flowing river of India and the biggest west flowing river of the state of Madhya Pradesh. River Narmada covers large areas in the state of Madhya Pradesh (Armitage, 2012). Perennial river system with different habitat types provides good opportunities to Odonata, the wonderful insect groups to flourish and survive. Narmada basin in the Jabalpur region created an excellent habit and source of alteration for many faunal species like insects, reptiles, birds and mammals (Tiple *et al.*, 2010). Odonata is good indicator of environmental changes as their larvae and adult both are sensitive to habitat degradation and climate changes (Kunte, 2000). Different ecological requirements are linked to different dispersal capacities and their high diversity of aquatic habitats in tropical forests (Orr, 2006), especially in mountain areas (Oppel, 2005) as mountains not only provide a greater contemporary diversity of habitats, but also a greater potential for survival in refugia.

Species with narrow niches often disperse poorly, while pioneers of temporal habitats are excellent colonizers, making Odonata a particularly good group for evaluating habitat connectivity and easy-to-study group that is useful to monitor the overall biodiversity of aquatic as well as near-by terrestrial habitats and had been identified as good indicators of environmental health (Corbet, 1999; Kalkman *et al.*, 2008). Odonata is generally regarded as best taxonomically studied group of insects. With the exception of Antarctica, they are widespread and abundant in all continents, although centers of species richness typically occur in tropical forests (Kalkman *et al.*, 2008). It is highly specialized insect order shows total metamorphosis and passes through various stages such as egg, larva, pupa and adult stage. Among the invertebrates, Odonata include insects known as dragonflies or damselflies and are always attract the human beings for their, powerful flight, extraordinary sense of vision and variety of colours.

Silby, (2001) described about 6000 species of dragonflies and Schorr and Paulson, (2014) documented both the dragonflies and damselflies, about 5,952 species and subspecies of Odonata belonging to 652 genera world-wide, in all over the world. At present, the Indian subcontinent hosts 3 sub orders, 17 families, 139 genera and 499 species and subspecies of Odonata (Prasad and Varshney, 1995). Mitra, (2005) recorded 499 and later on 463 species were confirmed by Subramanian, (2009) till date. Odonata fauna from some protected areas of Madhya Pradesh such as 24 species in Pench National Park and 11 species in Satpura National Park (Ramkrishna *et al.*, 2006), 46 species in Kanha National Park (Raju and Narayanan, 2008) 32 species in Bandhavgarh Tiger Reserve (Mishra, 2009), 14 species Pachmarhi Biosphere Reserve (Prasad and Mishra, 2009) and 26 species in Singhori wildlife sanctuary (Talmale, 2011).

Table 1. The observed species of Odonata and their Relative Status in Jabalpur district around river Narmada basin

S.No.	Name of Species	Common Name	Status
Order: Odonata			
Sub order: Zygoptera (Damselflies)			
Family: Coenagrionoidae (13)			
1.	<i>Agriocnemis femina</i> (Brauer, 1868)	White-backed Wisp	Common
2.	<i>Agriocnemis pygmaea</i> (Rambur, 1842)	Pygmy Dartlet	Very Common
3.	<i>Agriocnemis pieris</i> (Laidlaw, 1919)	White Dartlet	Rare
4.	<i>Ceriatagrion coromandelianum</i> (Fabricius, 1798)	Coromandel Marsh Dart	Rare
5.	<i>Disparoneura quadrimaculata</i> (Rambur, 1842)	Black-winged Bamboo-tail	Rare
6.	<i>Amphiallagma parvum</i> (Selys, 1876)	Azure Dartlet	Rare
7.	<i>Ischnura aurora</i> (Brauer, 1868)	Golden Dartlet	Common
8.	<i>Ischnura senegalensis</i> (Rambur, 1842)	Senegal Golden Dartlet	Very Common
9.	<i>Lestes umbrinus</i> (Selys, 1891)	Brown spread-wing	Rare
10.	<i>Pseudagrion decorum</i> (Rambur, 1842)	Elegant Sprite	Common
11.	<i>Pseudagrion rubriceps</i> (Selys, 1876)	Saffron Faced Blue Dart	Very common
12.	<i>Pseudagrion spencei</i> (Fraser, 1922)	Brook Sprite	Very Common
13.	<i>Rhodischnura nursei</i> (Morton, 1907)	Pixie Dartlet	Rare
Family: Platynemididae (1 species)			
14.	<i>Copera marginipes</i> (Rambur, 1842)	Yellow Bush Dart	Common
Family: Lestidae (1 species)			
15.	<i>Lestes umbrinus</i> (Selys, 1891)	Brown Spread-wing	Very Common
Family: Chlorocyphidae (1 species)			
16.	<i>Libellago lineata indica</i> (Fraser, 1928)	Golden Gem	Rare
Sub-order: Anisoptera (Dragonflies)			
Family: Aeshnidae (3 species)			
17.	<i>Anax guttatus</i> (Burmeister, 1839)	Pale Spotted Emperor	Very Common
18.	<i>Gynacantha bayadera</i> Selys, 1891	Small Dusk hawker	Rare
19.	<i>Hemianax ephippiger</i> (Burmeister, 1839)	Vagrant Emperor	Rare
Family: Gomphidae (2 species)			
20.	<i>Macrogomphus annulatus</i> (Selys, 1854)	Keiser's Forktail	Common
21.	<i>Paragomphus lineatus</i> (Selys, 1850)	Lined Hooktail	Common
Family: Libellulidae (17 species)			
22.	<i>Acisoma panorpoides</i> (Rambur, 1842)	Grizzled Pintail	Rare
23.	<i>Brachythemis contaminata</i> (Fabricius, 1793)	Ditch Jewel	Very Common
24.	<i>Bradinyopyga geminate</i> (Rambur, 1842)	Granite Ghost	Rare
25.	<i>Crocothemis servilia</i> (Drury, 1770)	Scarlet Skimmer	Very Common
26.	<i>Diplacodes trivialis</i> (Rambur, 1842)	Blue-Ground Skimmer	Common
27.	<i>Neurothemis intermedia</i> (Rambur, 1842)	Paddy Field Parasol	Rare
28.	<i>Neurothemis tullia</i> (Drury, 1773)	Pied Paddy Skimmer	Very Rare
29.	<i>Orthetrum luzonicum</i> (Brauer, 1868)	Slender Blue Skimmer	Rare
30.	<i>Orthetrum pruinosum</i> (Burmeister, 1839)	Crimson-tailed Marsh Hawk	Common
31.	<i>Orthetrum sabina</i> (Drury, 1773)	Slender Skimmer	Very Common
32.	<i>Orthetrum taeniolatum</i> (Schneider, 1845)	Small Skimmer	Very Rare
33.	<i>Pantala flavescens</i> (Fabricius, 1798)	Globe Skimmer	Common
34.	<i>Rhyothemis variegata</i> (Linnaeus, 1763)	Common Picture Wing	Rare
35.	<i>Tholymis tillarga</i> (Fabricius, 1798)	Coral Tailed Cloud-wing	Rare
36.	<i>Trithemis aurora</i> (Burmeister, 1839)	Crimson Mars Glider	Very Rare
37.	<i>Trithemis festiva</i> (Rambur, 1842)	Black stream glider	Very Common
38.	<i>Trithemis pallidinervis</i> (Kirby, 1889)	Long-legged Mars Glider	Very Common

MATERIALS AND METHODS

Study area

The findings presented here are based on random surveys carried out January 2015 to December 2015 in Jabalpur region of river Narmada. Jabalpur is located between 23°10'N latitude and 79°56'E longitude. The study area of river Narmada basin is surrounded with a very large variety of trees, mini forest, vast grassland and small hill; these are the elements for architecting a preferred habitat or such species. Four study sites were selected for the investigation these were Bargi dam, Gwarighat, Tilwaraghat and Bhedaghat.

Data Collection

The sites were visited early in the morning from 5 to 9 am, and evening from 5 to 7 pm hours to note maximum possible species of dragonflies and damselflies to record their activities. The study has been carried out and in such a way there should be least one visit in a week. Observations were made through walking in a wide area of the site with the aid of binocular and digital cameras.

Data Treatment, Analysis and Identification

Organisms were primarily identified directly in the field by observation and the difficult cases followed capture or photography of the organism. In critical conditions, specimens were collected only with handheld aerial sweep nets. Each specimen was placed in a plastic bottle and carried to the laboratory for further identification with the help of a field guide (Wynter-Blyth, 1957 and Kuntem 2000). In the present study, all scientific names of Odonata were followed Varshney, (1983) guidelines. The observed dragonflies and damselflies were categorized in four categories on the basis of their abundance in Gwarighat region of river Narmada i.e., Very common, Common, Rare, Very rare (Tiple *et al.*, 2008).

Observation

The present study was started to examine the diversity of dragonflies and damselflies from surrounding of river Narmada in Jabalpur region. 38 observed species were tabulated family wise (Table 1.) according to the regional diversity (Table 2.) of the various sites.

Table 2. Regional diversity of Odonata species in four sites in Jabalpur district around river Narmada basin

S. no.	Name of species	Bargi Dam	Gwarighat	Tilwaraghat	Bhedaghat
Zygoptera (Damselflies)					
1.	<i>Agriocnemis femina</i>	+	-	+	+
2.	<i>Agriocnemis pygmaea</i>	+	+	+	+
3.	<i>Agriocnemis pieris</i>	+	-	-	+
4.	<i>Ceriagrion coromandelianum</i>	-	-	+	+
5.	<i>Disparoneura quadrimaculata</i>	-	-	+	+
6.	<i>Amphiallagma parvum</i>	+	-	-	+
7.	<i>Ischnura aurora</i>	+	+	-	+
8.	<i>Ischnura senegalensis</i>	+	+	+	+
9.	<i>Lestes umbrinus</i>	-	+	-	+
10.	<i>Pseudagrion decorum</i>	+	-	+	+
11.	<i>Pseudagrion rubriceps</i>	+	+	+	+
12.	<i>Pseudagrion spencei</i>	+	+	+	+
13.	<i>Rhodischnura nursei</i>	+	-	-	+
14.	<i>Copera marginipes</i>	+	+	+	-
15.	<i>Lestes umbrinus</i>	+	+	+	+
16.	<i>Libellago lineata indica</i>	-	+	+	-
Anisoptera (Dragonfly)					
17.	<i>Anax guttatus</i>	+	+	+	+
18.	<i>Gynacantha bayadera</i>	+	-	+	-
19.	<i>Hemianax ephippiger</i>	+	-	+	-
20.	<i>Macrogomphus annulatus</i>	+	+	+	-
21.	<i>Paragomphus lineatus</i>	+	+	+	-
22.	<i>Acisoma panorpoides</i>	+	-	-	+
23.	<i>Brachythemis contaminata</i>	+	+	+	+
24.	<i>Bradinyopyga geminate</i>	+	-	-	+
25.	<i>Crocothemis servilia</i>	+	+	+	+
26.	<i>Diplacodes trivialis</i>	+	+	-	+
27.	<i>Neurothemis intermedia</i>	+	+	-	-
28.	<i>Neurothemis tullia</i>	-	-	+	-
29.	<i>Orthetrum luzonicum</i>	+	-	+	-
30.	<i>Orthetrum pruinosum</i>	+	-	+	+
31.	<i>Orthetrum sabina</i>	+	+	+	+
32.	<i>Orthetrum taeniolatum</i>	-	-	-	+
33.	<i>Pantala flavescens</i>	+	+	-	+
34.	<i>Rhyothemis variegata</i>	+	+	-	-
35.	<i>Tholymis tillarga</i>	+	-	+	-
36.	<i>Trithemis aurora</i>	-	-	-	+
37.	<i>Trithemis festiva</i>	+	+	+	+
38.	<i>Trithemis pallidinervis</i>	+	+	+	+

RESULTS AND DISCUSSION

Diversity

This study of Odonata was too primarily to identify the different specimen at different habitats and different representative fields. The specimens were categorized into four groups based on their occurrence during the study period on the basis of frequency of sightings. During the intensive survey of Insects in Jabalpur district, 38 species were revealed among these a total of 7 families belonging to order Odonata recorded from selected sites. A total of 38 species of order Odonata, where suborder Zygoptera have 16 species under 4 families out of which *Coenagrionoidae* with 13 species is consisting of maximum number of species followed by *Chlorocyphidae*, *latynemididae* and *Lestiae* with 1 species each. Anisoptera were comprise of 22 species under 3 families out of which *Libellulidae* or Skimmers are the most diverse and dominating family of dragonflies with 17 species that was followed by others such as *Aeshnidae* with 3 species and *Gomphidae* with 2 species (Figure 1.).

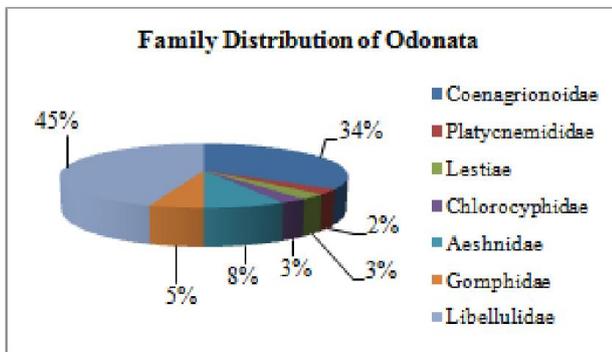


Figure 1. Families distribution of Odonata in Jabalpur region of river Narmada

Regional Diversity

Regional diversity of Anisoptera was considered as the most dominating group in compiling species of all four study sites (Fig. 2). Anisoptera was most abundant in Bargi Dam with 19 species as compared to Tilwaraghat (14 species), Bhedaghat (13 species) and the least abundant in Gwarighat (12 species). Similarly Zygoptera constitute of 16 species of total 38 Odonata species in Jabalpur region of river Narmada basin while highest in Bhedaghat (14 species) than Bargi Dam (12 species), Tilwaraghat (11 species), and Gwarighat (9 species).

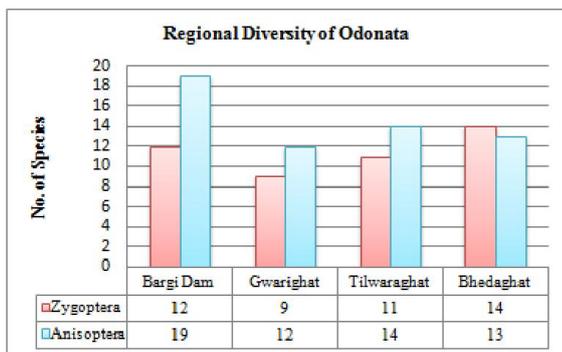


Figure 2. Regional Diversity of Odonata in Jabalpur region of river Narmada

Relative Abundance

The relative abundance showed that among the 38 species of Odonata were recorded, 11 species were found to be very common, 9 species were common, 15 species were rare and 3 species were very rare were found to the study areas. (Figure 3.) These 39% species of Odonata from the study area were designated rare and 8% species as very rare, suggesting the need for strict conservation. Sharma and Shukla, (2015) reported total 25 species of Odonata in southeast region of river Narmada during January 2015 to August 2015 where *Libellulidae* family was the most diverse with 10 species than *Coenagrionoidae* with 7 species but in further study of that same site 5 more species i.e., 30 species were found from Jabalpur region and highlighted the presence of pollution.

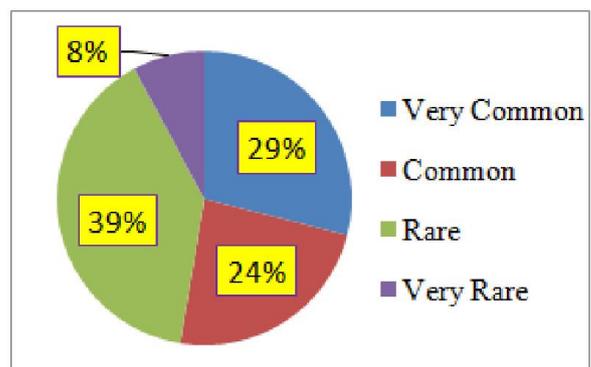


Figure 3. Relative Abundance of Odonata

They revealed the relative abundance among the 25 species of Odonates recorded 9 species very common, 4 species common, 10 species rare and 2 species very rare. Similarly in present study the numbers of rare species (15) were generally high. Odonata are biological indicators as their species composition and abundance changed in response to human disturbance. Bhandari et al., (2015) studied the diversity of Odonata of river Sone in the surroundings of Bansagar dam and revealed 22 species of Odonata from the catchment of reservoir. Subramanian, (2009) reported 11 dragonfly families, of which 972 species with *Libellulidae* and 958 species with *Gomphidae* are major families throughout the world followed by 436 species in *Aeshnidae*, 249 species in *Corduliidae* and 123 species in *Macromiidae*. Manwar et al., (2012) in Maharashtra (India) recorded 22 species of dragonflies and damselflies of 4 families and 17 genera of which 50% species are of family *Libellulidae*. Tijare and Patil, (2012) were observed 21 species of dragonflies from Nagpur district and *Libellulidae* family has high species richness. Urbanization also is associated with habitat degradation including decreased plant species diversity, reduced water quality, and increased air and soil pollutions. In terrestrial ecosystem, insect fauna represent more than 70% and also play an important role in food chain for the natural balance. Insects are extremely important components of the bioindicators of the world. They further demonstrated that most of the species were noticeably absent in the disturbed and human impacted sites (gardens, plantation and grassland) and there was no occurrence of unique species in moderately disturbed areas comparable to those of less disturbed wild areas.

The present study site is in constant disturbance due to the cutting of grasses, shrubs and trees for landscaping which may be the reason for the overall reduction of the number of species. The rich diversity of Odonata, especially the *Libellulidae* in Jabalpur region of river Narmada indicates a varied assemblage of floral species as well as terrestrial area. The flora in studied site is of mixed type with herbs and shrubs dominating the vegetation in the tropical climate. Dragonflies and damselflies serve as an environmental indicator. Owing to habitat destruction for developmental activities in urban environment and unscientific management of natural resources, much of our native Odonata is fast disappearing and at present, their survival is under threat. For our next generation we can save wonderful attractive creature on our surrounding garden & forest.

Conclusion

The summary reports the status and diversity of Odonata. Odonata is biotope characterization that shows different types of habits have characteristic species assemblages. Many species of Odonata as birds, but receive much less research and conservation attention. Many species have disappeared from water bodies worldwide. The group features prominently in nature management and they are often used as indicators for environmental health and conservation management. Odonata is insect group that is highly rich in fat and protein and provide essential amino acids which lack in plants and seeds, so they are eaten by birds, fishes, amphibians, reptiles and mammals including human. Large scale and multi-taxa conservation plans for river systems are needed in order to establish a balance between agriculture, development and nature conservation and Development of a sustainable network of local experts and volunteers is needed to facilitate the conservation and monitoring of dragonfly and damselfly species and habitats. We suggest that a varied assemblage of floral species as well as terrestrial area that is flora in studied site is of mixed type with herbs and shrubs in the tropical climate was the most important environmental variables of River Narmada in periods of January to December in 2015.

Recommendation concern for conservation

- Research-notably taxonomy and studies of the distributions and biological requirements of species.
- Pollution Control
- Legislation-notably to provide protected areas, to control development and to control pollution.
- Education and raising public awareness

REFERENCES

- Armitage, S. 2012. Water quality assessment of river Narmada at M.P., India, *American journal of soil and water*, 2(4): 7-9.
- Bhandari, R., Choubey, V. and Shukla, A. 2015. Diversity and Abundance of Odonata in Catchments of Bansagar Dam, Shahdol (M.P) *International Journal of Current Research*, 7 (12): 24034-24037.
- Corbet, P.S. 1999. Dragonflies: Behaviour and Ecology of Odonata. Harley Books, Colchester.
- Enrlich, P.R. and Wilson, E.O. 1991. Biodiversity studies: science and policy. *Science*, 253: 758-762.
- Foote, A. L. and Rice, C.L. 2005. Odonata as biological indicators Canadian prairie wetlands. *Ecological Entomology*, 30: 273-283.
- Hodkinson, I.D. and Jackson, J.K. 2005. Terrestrial and Aquatic Invertebrates as Bioindicators for Environmental Monitoring, with Particular Reference to Mountain Ecosystems. *Environmental Management*, 35(5): 649-666.
- Kalkman, V.J., Clausnitzer, V., Dijkstra, K.D.B., Orr, A.G., Paulson, D.R. and van Tol, J. 2008. Global diversity of dragonflies (Odonata) in freshwater. *Hydrobiologia* 595: 351-363.
- Kunte, K. 2000. Butterflies of Peninsular India. Universities Press (Hyderabad) and Indian Academy of Sciences (Bangalore), 254pp.
- Landres, P.B., Verner, J. and Thomas, J.W. 1988. Ecological uses of vertebrate indicator species: a critique. *Conservation Biology* 2: 316-328.
- Manwar, N.A., Rathod, P.P. and Raja, I.A. 2012. Diversity and abundance of dragonflies & damselflies of Chatri Lake Region, in Pohara-Malkhed Reserve Forest, Amravati, Maharashtra (India). *International Journal of Engineering Research and Applications*, 2(5): 521-523
- Mishra, S.K. 2009. Insect: Odonata. In: *Fauna of Bandhavgarh Tiger Reserve (Madhya Pradesh)*. *Conservation Area Series, Zool. Surv. India*, 40: 25-38.
- Mitra, T.R. 2005. Evolutionary Adaptations in Morphology and Ecology of *Tholymis Tillyard* (Faricius) and *Bradino pygageminata* (Rambur) (Insecta: Odonata). *Records of Zoological Survey of India*; 104(1-2): 300pp.
- Noss, R.F. 1990. Indicators for monitoring biodiversity: a hierarchical approach. *Conservation biology*, 4: 355-364.
- Oliver, I. and Beattie, A. 1993. A possible method for the rapid assessment of biodiversity. *Conservation Biol.*, 7: 562-568.
- Oppel, S. 2005. Habitat associations of an Odonata community in a lower montane rainforest in Papua New Guinea. *International Journal of Odonatology*, 8: 243-257.
- Orr, A.G. 2006. Odonata in Bornean tropical rain forest formations: diversity, endemism and implications for conservation management. In Cordero Rivera, A. (ed.), *Forest and Dragonflies*. Pensoft Publishers, Sofia.
- Pearson, D.L. 1994. Selection of Indicator taxa for the quantitative assessment of biodiversity; *Phil. Trans. R. Soc. Lond.*, 345: 74-79.
- Prasad, M. and Mishra, S.K. 2009. Insect: Odonata, In: *Fauna of Pachmarhi Biosphere Reserve*. *Conservation Area Series, Zool. Surv. India*, 39: 203-212.
- Prasad, M. and Varshney, R.K. 1995. A checklist of the Odonata of India including data on larval studies. *Oriental Insects* 29: 385-428.
- Raju, D.V. and Narayanan, S.P. 2008. Odonata fauna of Kanha National Park area in central India. *Fraseria* (N.S.), 7: 5-9.
- Ramesh, T., Hussain, K.J., Satpathy, K.K., Selvanayagam, M. and Prasad, M.V.R. 2010. Diversity, Distribution and Species Composition of Ants fauna at Department of Atomic Energy(DAE) Campus Kalpakkam, South India; *World J. Zoology, IDOSI Publication*, 5(1): 56-65.
- Ramkrishna Chandra, K., Nema, D.K., Ahirwar, S.C. and Alfred, J.R.B. 2006. Faunal Resources of National Parks of

- Madhya Pradesh and Chhattishgarh. *Conservation Area Series, Zool. Surv. India*, 30: 1-123.
- Schorr, M. and Paulson, D. 2014 World Odonata List. www.pugetsound.edu/academics/academicresources/slater_museum
- Sharma, S. and Shukla, A. 2015. Preliminary Study of Odonates in Southeast Region of Narmada Valley, Jabalpur, *International Journal of Recent Scientific Research*, 6(10): 7038-7040.
- Spencer, M., Schwartz, S.S. and Blaustein, L. 2002. Are there fine-scale patterns in community similarity among temporary freshwater pools? *Global Ecol. Biogeogr.* 11: 71-78.
- Subramanian, K.A. 2009. *A Checklist of Odonata of India*. Zoological Survey of India, 36pp.
- Talmale S.S. 2011. A Preliminary list of Odonata from the Singhori Wildlife Sanctuary, Madhya Pradesh. *Bionotes* 13(4): 159-160pp.
- Tijare, R.V. and Patil, K.G. 2012. Diversity of Odonets in and around Gorewada National Park, Nagpur MS. (India). *Bionano Frontier Special Issue*, 9: 182-183.
- Tiple, A.D., Khurad, A.M. and Andrew, R.J. 2008. Species Diversity of Odonata in and around Nagpur City, Central India. *Fraseria* (Proceeding of the 18th International Symposium of Odonatology, Nagpur) 7: 41-45.
- Tiple, A.D., Kulkarni, N., Paunikar, S. and Joshi, K.C. 2010. Avian fauna of tropical forest research institute Jabalpur, Madhya Pradesh, India. *Indian Journal of Tropical Biodiversity* 18(1): 1-9.
- Van Wrigh, R.I., Humphries C.J. and Williams P.H. (1991) What to protect? systematics and the agony of choice. *Biological Conservation* 55: 235-254.
- Varshney, R.K. 1983. Index *Rhopalocera indica* part II. Common names of butterflies from India and neighbouring countries. Records of the Zoological Survey of India. Occasional Paper no. 47: 1-49.
- Wilson, K.D.P. 1995. Hong Kong dragonflies. Urban Council.
- Wynter-Blyth, M.A. 1957. Butterflies of the Indian Region. Bombay Natural History Society, 523pp.
