IJART- Vol-2, Issue-1, February, 2017 Available online at http://www.ijart.info/
DOI: https://doi.org/10.24163/ijart/2017/2 (1):1-15

INTERNATIONAL JOURNAL OF APPLIED RESEARCH AND TECHNOLOGY
ISSN 2519-5115
RESEARCH ARTICLE

Diversity and Current Status of Ecological Markers in Narmada Valley of Jabalpur Region (M.P.)

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Received: January 05, 2017
Revised: January 17, 2017
Published: February 28, 2017

ABSTRACT

Biodiversity encompasses the variety of all life on earth. Jabalpur is major city of Madhya Pradesh, India which is rich in biodiversity. The present study was carried out from January 2014 to December 2016. The whole Narmada valley of Jabalpur region including river, forest, grassland and urban area were selected as study site for the collection of sample. In the study total 155 Bio indicator species of various classes were recorded viz., Fungi 12 species (1 Groups), Zooplankton 42 species (4 groups), Odonata 37 species (7 Families), Butterflies 25 Species (5 Families), Spiders 26 Species (10 Families) and Mollusca 13 Species (2 Class). This study aimed to promote habitat recovery and biodiversity restoration in studied region and development of management strategies so as to ensure sustenance of all the recorded species and ecosystem services derived from them. The content of this paper will be useful step for future studies.

Keywords- Narmada, Fauna, Diversity, Pollution, Biomarker.

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INTRODUCTION

Water is one among the prime necessities of life required for growth and daily activity of all living organism in the globe. The river Narmada valley is one of the major hot spot for aquabiodiversity in India.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). The use of indicator taxa in conservation efforts from pollution control to biodiversity has been the focus of attention (Landers *et al.*, 1988). A food web and some measure of its complexity and connectivity is one way to depict the functional diversity of a community. Worldwide there are more than 28,000 species of butterflies, with about 80% found in tropical regions (Robbins and Oplar, 1997) while Silsby (2001) described about 6000 species of dragonflies and Schorr and Paulson (2014) documented 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 about 1,504 species of butterflies (Tiple, 2011) and Odonata of India is known by 3 sub orders, 17 families, 139 genera and 499 species and subspecies (Prasad and Varshney, 1995). Mitra (2005) recorded 499 and later on 463 species were confirmed by Subramanian, (2009) till date.

Bhandari and Shukla, (2015) Studied on benthic macro invertebrate community of river Narmada and their correlation with Physico-Chemical parameters from the water body. They recorded, a total of Forty two species of benthic macro-invertebrates fauna belonging to three phyla (Annelida, Arthropoda and Mollusca), five classes (Oligochaeta, Crustacea, Hexapoda, Gastropoda, Pelecypoda) and five families (*Baetidae*, *Caenoidae*, *Ephemeridae*, *Heptagenidae*, and Chironomidae) in the river Narmada during which Mollusca was dominating group with 47% species constitution.

In Madhya Pradesh and Vidarbha of central India 177 species of butterfly species have been documented (D'Abreu, 1931). Chandra *et al.*, (2007) recorded 174 species of butterflies belonging to eight families from Madhya Pradesh and Chhattisgarh. Mishra (2007) documented 70 species belonging to 40 genera and 9 families. Odonata of some protected areas of Madhya Pradesh have been revealed before; 24 species of Odonata were found in Pench National Park, 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 in Pachmarhi Biosphere Reserve (Prasad and Mishra, 2009) and 26 species in Singhori wildlife sanctuary (Talmale, 2011).

Spiders form the seventh largest order among all organisms in the world (Coddington and Levi, 1991) which is estimated as world's total 170,000 spider species. Spiders generally have humidity and temperature preferences that limit them to areas within the range of their "physiological tolerances" which make them ideal candidates for land conservation studies (Riechert and Gillespie, 1986). The ecological development of these types is attributed to various climatic, edaphic, and topographic factors. However biotic factors play a significant role depending upon their frequency and intensity. Therefore spider can consider as indicator in case of change in environmental condition or interference

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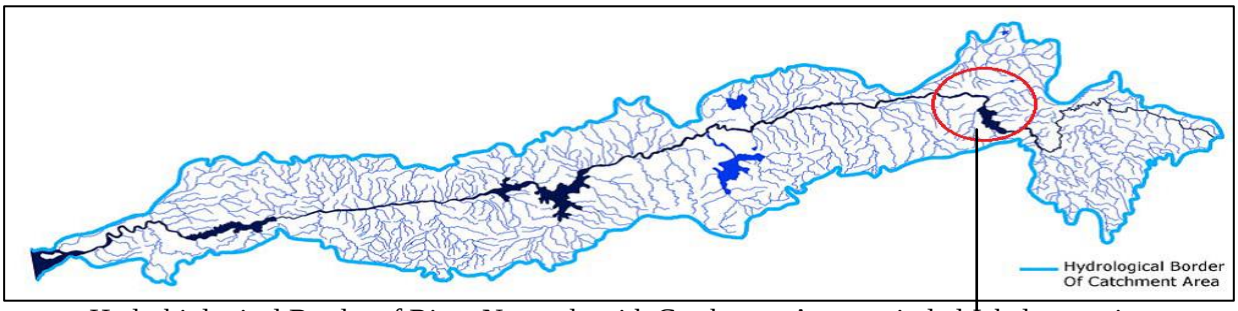
of human activities. Ironically, the spider diversity in central India is still not fully explored or understood. Here we provide a comprehensive account of the diversity of bio indicators in the Narmada Basin, Jabalpur region based on fresh field studies and past records. Thus the present study aimed to explore the species richness, abundance and diversity of ecological indicators in river Narmada of Jabalpur region, which might be helpful to improve the habitat, pave the way for future research and formulate an effective strategy for conservation of these important groups.

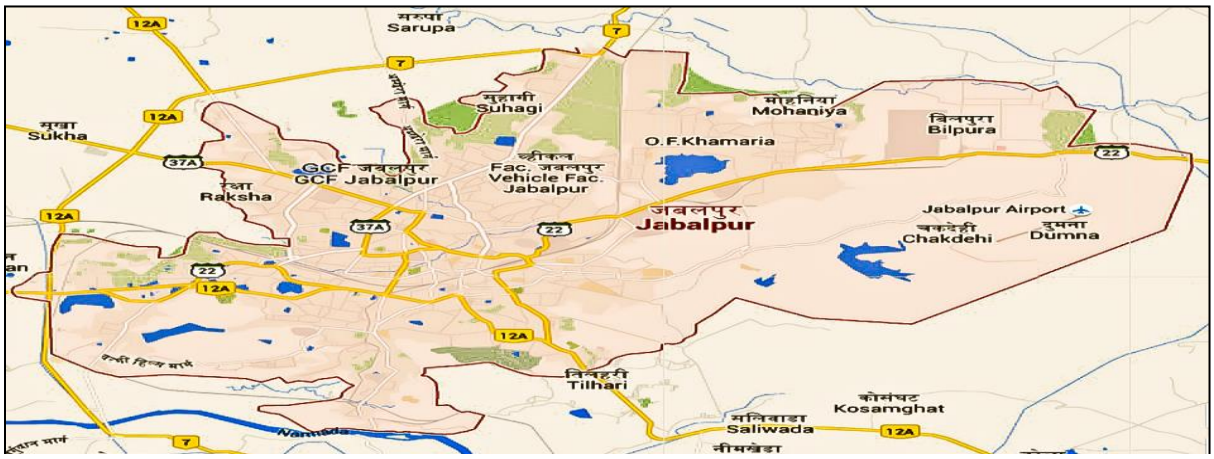
MATERIAL AND METHODS

Study Site

The present study was carried out for two year from January 2014 to December 2016 due to which include all four seasons. Different species reproduce in different season hence, we choose whole year for study. The Narmada basin lies in the central India between 70° 20" E to 81°45" E longitude and 21°20" N to 23°45" N latitude with a drainage area of 98,796 sq. km and mean elevation of 760 meters (Sharma and Shukla *et al.*, 2015) while Jabalpur is located at 23°10'N 79°57'E and 23.17°N 79.95°E. The city has an average elevation of 411 meters from sea level. The whole Narmada valley of Jabalpur region including river, forest, grassland and urban area were selected as study site for the collection of samples which is rich in all the taxa of animals. Four study sites were selected for the investigation namely, Bargi dam, Gwarighat, Tilwaraghat and Bhedaghat.



Hydrobiological Border of River Narmada with Catchment Area encircled Jabalpur region



Jabalpur Narmada Valley Map

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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 to record their activities. The study has been carried out in such a way that there should be at 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. Collected specimens were photographed in live condition identified and then released to their natural habitat. Few specimens were observed under microscope for identification and study of some morphological characteristics. The plankton samples were collected by filtering 20 Liters of water through plankton net having pore size 64 µm and following the guidelines of Lind(1979); Welch (1953) and Wetzel (1983).The biological samples of fungi were collected from the Submerged decaying, Skeletonized, and dark brown to black leaves and twigs from barriers of water flow and litter bed of water bodies in pre-sterilized polythene bags and brought to laboratory.

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.

1. **Fungi**

   Plant Residue analysis: The leaves and twigs were washed thoroughly in tap water and then distilled water individually to remove adhering mud invertebrates and any other debris and placed in separate bottles containing 100 ml of distilled water and a pinch of antibiotic (Chloramphenicol) to control bacterial growth. They were incubated at room temperature 25±2^{o}C five to seven days. The bottles were continuously aerated using Aerator. Starting from the beginning day, the water samples and incubated plant materials were examined regularly under a low power compound microscope.

   Preparation and Maintenance of culture: Isolated fungi were aseptically transferred to agar slants and by repeated sub-culturing of different pure cultures individual fungi species were obtained. The stock culture of the micro-organisms were maintained on the PDA slants and stored at low temperature in the refrigerator. The other slants were kept in the incubator (BOD) at 28 ± 1°C and were routinely transferred into the fresh slants for experimental purposes.

   Identification: The identification was done after studying the morphological and cultural characteristics with the help of manuals, monographs and various literatures of some workers Subramanium (1971); Ellis (1976); Sutton (1980); Corol (2007) and Upadhya *et al.*, (2012). Slides were prepared by mounting the culture in lacto-phenol and cotton - blue reagent.

2. **Zooplankton:** The concentration plankton samples were fixed in 4% formalin and Lugal's solution for zooplankton and phytoplankton study respectively. Zooplanktons were identified with the help of keys' provided by Needham and Needham (1962); Tonapi (1962) and APHA (2005).

3. **Odonata:** In the present study, all scientific names of Odonata were followed by Fraser (1933, 1934 and 1936); Mitra (2006); Subramanian

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(2005); Andrew *et al.*, (2009) and Subramanian (2009) guidelines.

4. **Lepidoptera:** The collected adult specimens of Lepidoptera were identified with the help of identification keys provided by Wynter-Blyth (1957); Kunte (2000) and Varshney (1983).
5. **Spider:** The specimens were preserved in 70% alcohol and labeled. Bushes, tree trunks, ferns, forest floor, foliage and grass lands were all searched for spiders and collected by hand picking method as suggested by Tikader (1987). Identification was done on the basis of Morphometric characters of various body parts with the help of keys and catalogues provided by Kaston (1978); Tikader (1962,1973,1982); (Biswas and Biswas, 1992); Gajbe (1987) and Platnick (2004).
6. **Mollusca:** Mollusca was collected from Profundal zone by using Ekman grab and at shallow Profundal zone by using surber sampler following Wetzel (2001) in the river. All the samples were preserved in field with 5% formalin solution. Organisms were identified by using standard keys, such as Tonapi (1980); Adoni *et al.*, (1985) and Rao (1993).

The observed fauna were categorized in four categories on the basis of their abundance in Jabalpur region of river Narmada i.e., Very common, Common, Rare, Very rare (Tiple *et al.*, 2008).

RESULT AND DISCUSSION

In the study total 155 species of Bio indicators of various fauna were recorded viz., Fungi 12 species (1 Groups), Zooplankton 42 species (4 groups), Odonata 37 species (7 Families), Butterflies 25 Species (5 Families), Spiders 26 Species (10 Families) and Mollusca 13 Species (2 Class).

Fungi: Over a period of two years, 12 species of water borne fungi were recorded. It was followed by foam and twig litters. 10 fungi were found in Gwarighat reason while 11 were found in Bhedaghat represented in (Table-1). Similar observation were also recorded by (Shearer and Webster, 1985b; Gunhild *et al.*, 2009 and Pires *et al.*, 2008).The leaves having soft tissue can easily be degraded in comparison to twig having hard tissue. The presence of wood in stream may be important in long term maintenance of population of these fungi (Hageskal *et al.*, 2007 and Hayette *et al.*, 2010). According to Hedayati *et al.* (2011) and Kanzler *et al.*, (2008), the foam analysis technique is believed to give reasonable complete list of water fungi occurring in a given stream.

Table-1: Water borne conidial fungi of river Narmada Jabalpur.

S/No.	Name of Fungi	Gwarighat	Bhedaghat
1.	*Anguillosporacrassa*	+	+
2.	*A.fragementans*	Absent	+
3.	*Chaetocladia*	+	+
4.	*C.aquatica*	+	+
5.	*Asp. terreus*	Absent	+
6.	*Pericorniadiospyrae*	+	+
7.	*Ceratosporella deviate*	+	Absent
8.	*Asp. fumigates*	+	+

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9.	*Asp. Nidulans*	+	+
10.	*Phomasp.*	+	+
11.	*Rhizopus sp.*	+	+
12.	*Monilia sp.*	+	+

Zooplankton

Zooplankton is good indicator of the changes in water quality because they are strongly affected by environmental conditions and due to their short life cycle, these communities often respond quickly to environmental change and water quality. Total 35 species were found in 2014 from all three sampling stations. Among these, Copepods were dominating group comprise of 14 species (33%), Rotifera comprise of 12 species (29%), Cladocera of 9 species (21%) while Protozoan is the least diverse group comprise of only 7 species (17%) as shown in Fig-1.In the report of year 2015 total 42 species were found in the study sites in which Protozoan were dominating group with 17 species (42%), Rotifera with 13 species (31%), Copepods with 7 species (14%) and Cladocera with 5 species (13%) represented in Fig-2. This study gives a preliminary knowledge on the diversity and productivity of Zooplankton, so the information can be utilized during the formulation of management measures (Pandey *et al*., 2015).

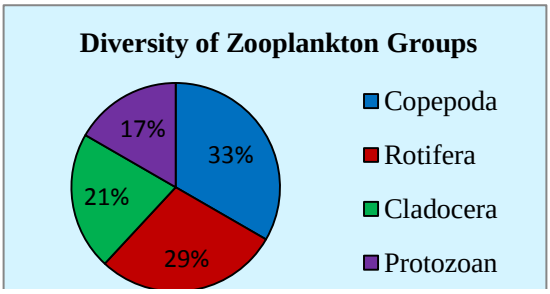

Fig-1: Population Density of Zooplankton, January 2014 to December 2014

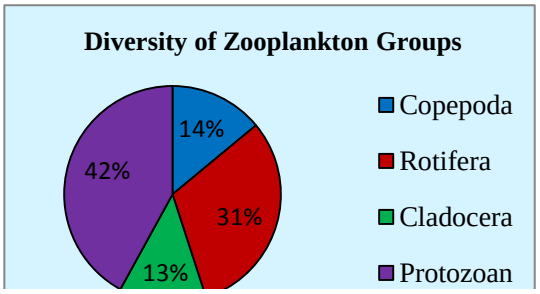

Fig-2: Population Density of Zooplankton, January 2015 to December 2015

Odonata

The preliminary study of Odonata was carried out to identify the different specimen at different habitats and different representative fields. During the intensive survey of Insects in Jabalpur district, 37 species of 7 families belonging to order Odonata recorded from selected sites. Total 37 species of order Odonata categorized in two suborders namely Zygoptera and Anisoptera. 15 species of Zygoptera (damselfly) comprise of 4 families out of which *Coenagrionoidae* with 12 species was consisting of maximum number of species followed by *Chlorocyphidae*, *Platycnemididae* and *Lestiae* with 1 species each. Another suborder Anisoptera (dragonfly) was comprise of 22 species under 3 families out of which family *Libellulidae*or Skimmers were the most diverse and dominating family of dragonflies with 17 species that was followed by other families such as *Aeshnidae* with 3 species and *Gomphidae* with 2 species (Fig-3).

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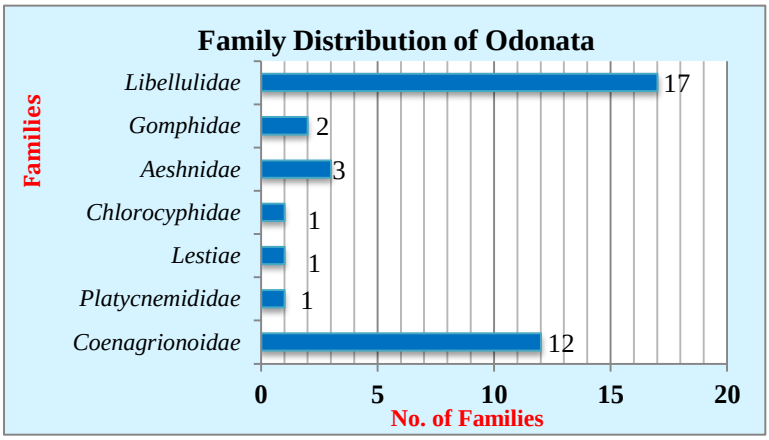

Fig-3: Families distribution of Odonata

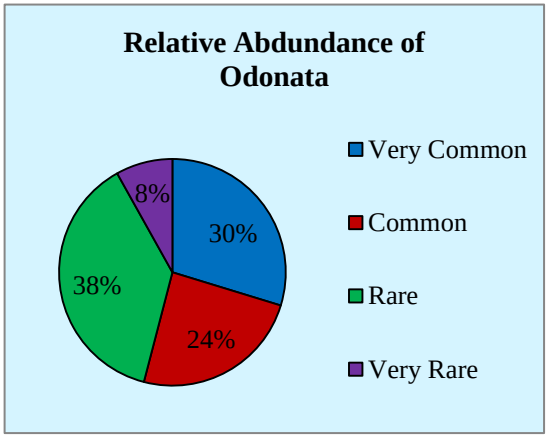

Fig-4: Relative Abdundance of Odonata

The relative abundance showed that, among the recorded 37 species of Odonata, 12 species were found to be very common, 9 species were common, 14 species were rare and 3 species were very rare were found to the study areas (Fig-4). These 38% rare species and 8% very rare species of Odonata were suggesting the need for strict conservation.

Lepidoptera

Total 25 species of Lepidoptera belonging to 19 Genus under 5 families viz., *Nymphalidae, Papillionidae, Pieridae, Hesperiidae and Lycaenidae* were recorded in the survey. Among the species recorded from the valley area, 44% are belonging to the family *Nymphalidae* showed the maximum species richness, comprising of 11 species, followed by 4 species (16%) of *Lycaenidae*, 4 species (16%) of *Pieridae*, 3 species (12%) of *Papillionidae* and also 3 species (12%) of *Hesperiidae* shown in Fig-5.

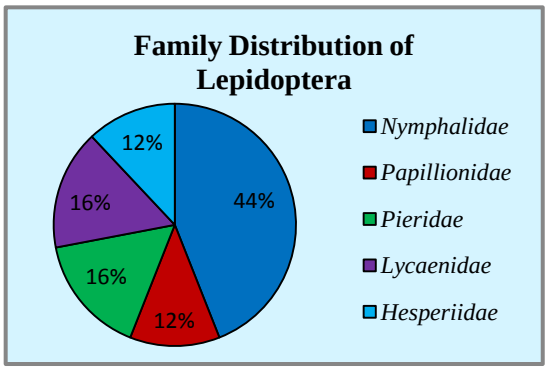

Fig-5: Distribution of families of Lepidoptera in Narmada Valley

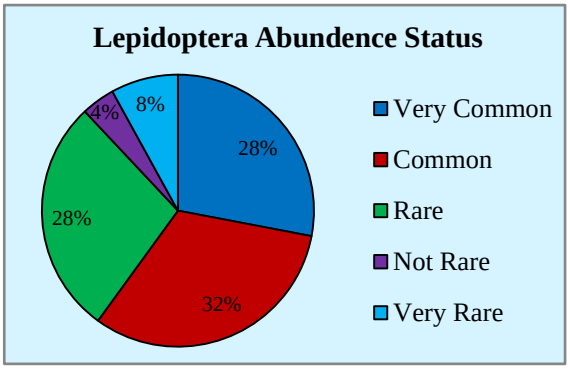

Fig-6: Abandence Status of Lepidoptera in Narmada Valley

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Among these 25 species 2 (8%) were very rare, 7 (28%) were rare, 1 (4%) were not rare, 8 (32%) were commonly occurring and 7 (28%) were very common (Fig-6). A total of seven species of Lepidoptera from the study area are designated rare, needs conservation. The preference of Lepidoptera for particular habitats is associated with the availability of larval host plants and adult nectar plants.

Spider

Total 26 species under 20 genera and 10 families were recorded in Jabalpur division of Narmada valley. This area is rich in floral diversity. In our observation *Araneidae* (34%) is the most represented family with 9 species subsequently *Salticidae* (15%) with 4 spcies, *Lycosidae* (8%) with 2 species, *Tetragnathidae* (8%)with 2 species, *Theridiidae* (8%) with 2 species, *Thomisidae* (8%) with 2 species, *Erasidae* (7%) with 2 species while *Clubionoidae*, *Oxyopidae*and *Pholcidae* each contributed below 5% with 1 species shown in Fig-7.

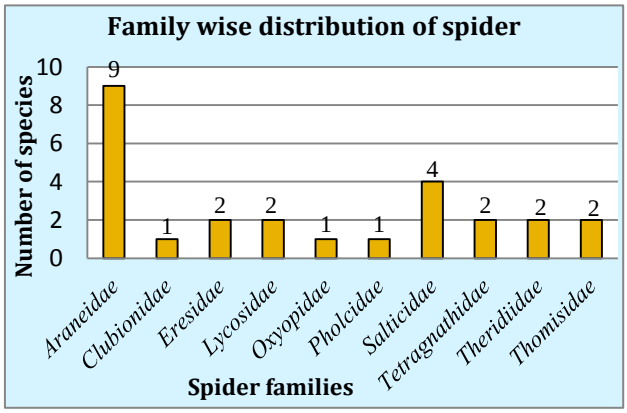

Fig-7: Distribution of species diversity at Narmada valley

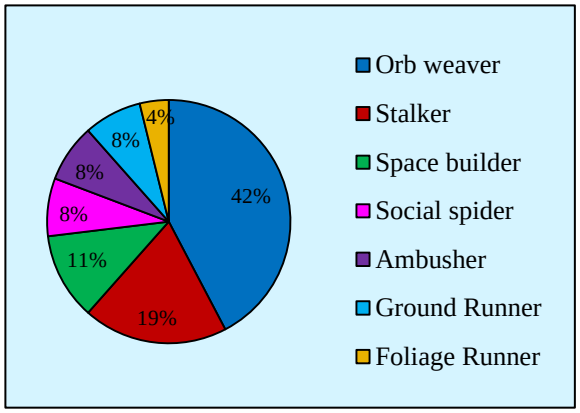

Fig-8: Guild-wise distribution of species spider

About 1442 species reported from India. Siliwal *et al.*, (2005), recorded 29 species from, central India. The spiders sampled belonged to 7 functional groups (guilds) based on their foraging behavior in the field where Orb Weaver (42%) was dominating, subsequent Stalker (19%), Space Builder (11%), Social Spider (8%), Ambusher (8%), Ground Runner (8%) and Foliage Runner (4%) shown in Fig-8. The peak population densities of spiders coincide with an increase of insect pests (Kiritani, 1972). An increase in the spider population depends on prey availability and, if the density of prey becomes higher, spiders are expected to increase proportionally to some extent. Diversity generally increases when a greater variety of habitat types are present (Ried and Miller, 1989). Holloway, (2003), observed that conversion of forest to plantation and other man-induced disturbances lead to reduction in the diversity of invertebrates. (Downie*et al.*, 1999) and New (1999), have demonstrated that spiders are extremely sensitive to small changes in the habitat structure; including habitat complexity, litter depth and microclimate characteristics.

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Mollusca

The relative abundance of 13 recorded species of Mollusca was figured out, in which 15% species comprise of *Pila* and *Bellamya* species were found to be very common belong to class Gastropoda. 31% species were common that are comprise of 4 species namely *Potamopyrgus*, *Lymnea* (Gastropoda), *Perreysia*and *Margaritifera* (Bivalvia). 31% species were found to be rare which comprise of *Lamellidens* species belongs to class Bivalvia, and *Valvatapiscinalis*, *Cremnoconchus*and *Physellaacuta* belongs to Gastrapoda, 8% species was not rare and 15% species were very rare found to the study areas. Dominance of *Pila* species was seen from the study site (Fig-9 and Fig-10).

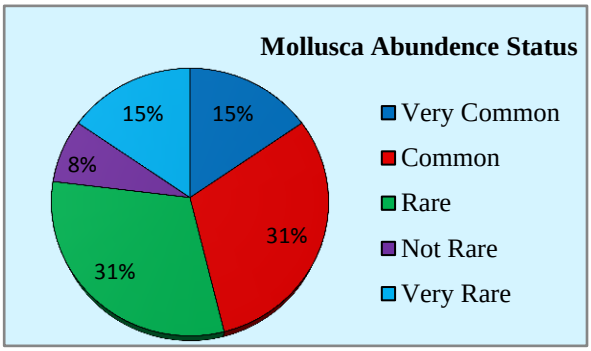

Fig-9: Abandence Status of Mollusca in Narmada River Jabalpur (M.P.)

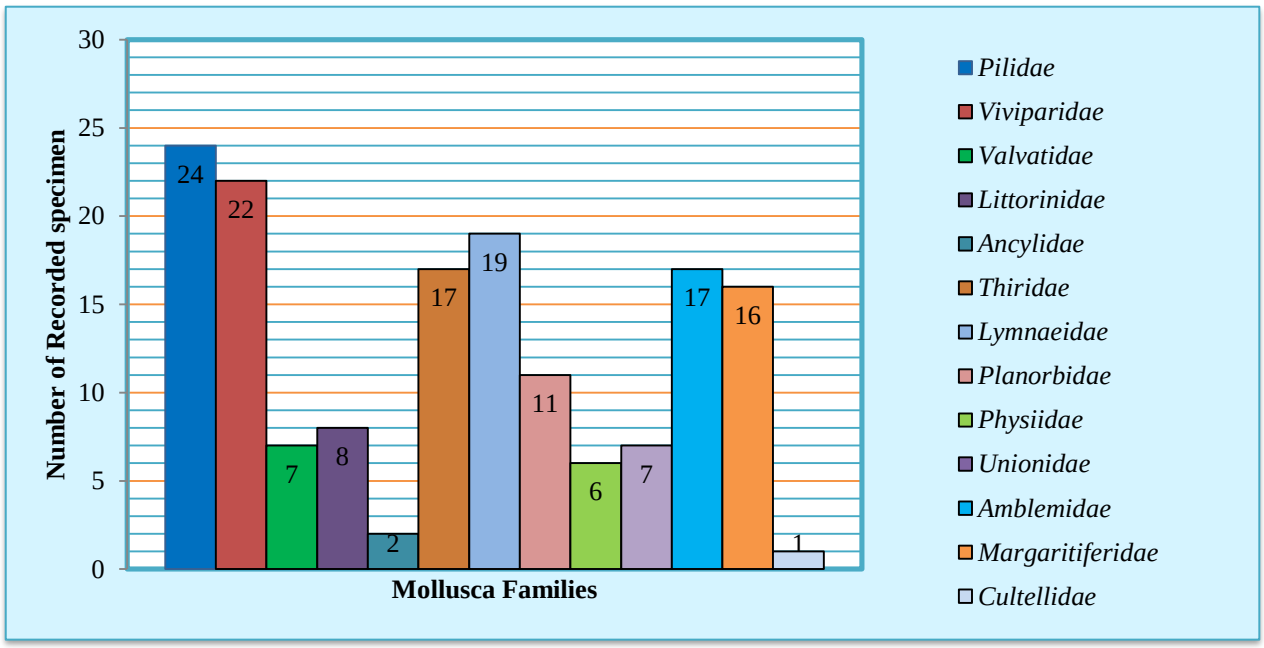

Fig-10: Species wise distribution of Mollusca in Pariyat River at Panagar region of Jabalpur (M.P.).

Complete fauna: Faunal diversity that comprise of Zooplankton, Fungi, Odonata, Spiders Lepidoptera and Mollusca shows a large abundance in river Narmada at central India.

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Table-2: List of 155 recorded species of various phyla from Jabalpur region.

Fauna of Jabalpur Recorded (2014-16)	No. of Species	No. of Groups
Fungi	12	1 Groups
Zooplankton	42	4 Groups
Odonata	37	7 (Families)
Lepidoptera (Butterfly)	25	5 (Families)
Spider	26	10 (Families)
Mollusca	13	2 (Class)
TOTAL	155	

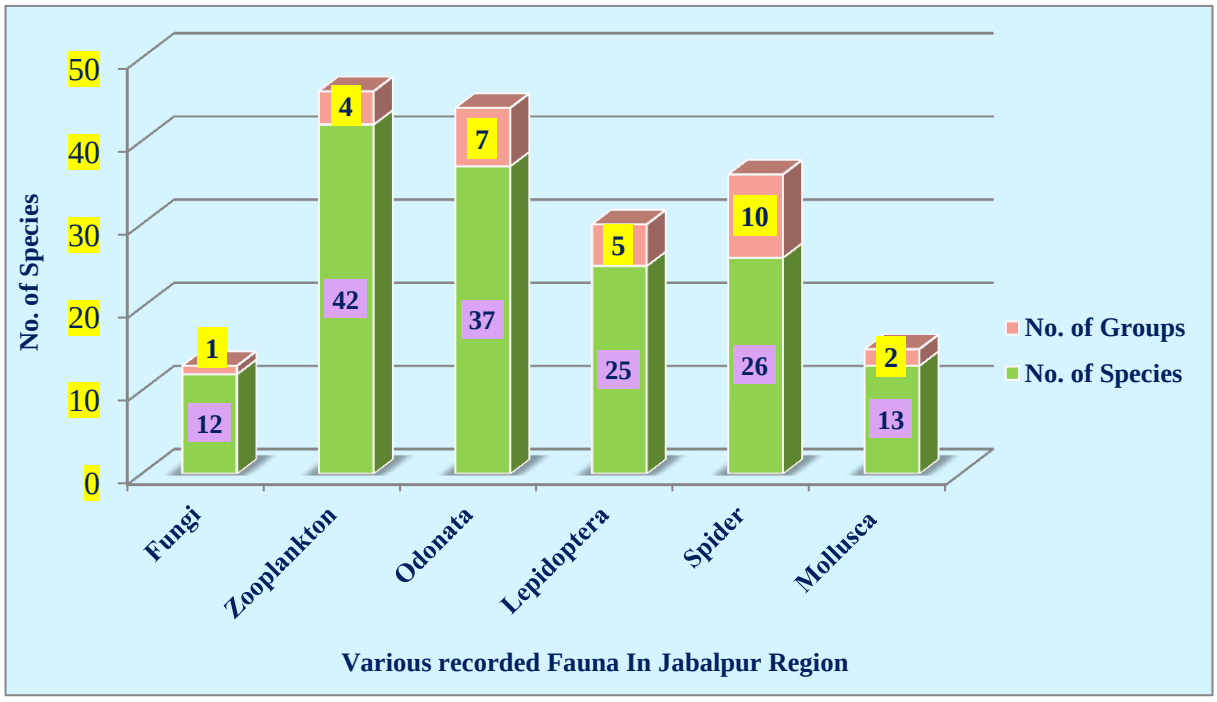

Fig-11: Recorded species of various phyla from Narmada Valley Jabalpur region.

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Total 155 species of various ecological indicators were found in Narmada valley. From the recorded fauna 12 species of Fungi belong to 1 group, 42 species of Zooplankton belong to 4 groups, 37 species of Odonata belong to 7 groups, 25 species of butterfly with 5 groups, 26 species of spiders belong to 10 groups and 13 species belong to 2 groups were found in the study sites of Narmada valley represented in Table-2 and Fig-11.Various papers show a drastic decrement caused by climatic changes, insufficient attempts in preservation and uncontrolled human interference throughout the river track. The eradicated animal population followed by disturbed ecological stigma will tend to lead local and distant human beings to compromise with economically countable productivity from the same natural resource.

CONCLUSION

The relative taxonomic report summarizes to reveal the studies during 2014-2016 works on various fauna of Jabalpur around river Narmada. This report provides knowledge of diversity of various species for further detailed study. Conservation of biodiversity is necessary for a healthy environment so we can use bio indicator species in place of chemical for pollution assessment as well as anthropogenic activities. Hence there is an urgent need to create awareness among local peoples on the importance of the riverine habitat as well as its fauna and the need to conserve them for future generations.

In river Narmada the biological heterogenecity loss driven by local, regional, global and climatic factors which is a major threat to the future of our generation directly or indireclty. River water is less satisfactory for drinking purposes with an increasing awareness in the field of water pollution and the desire of river maintenance at their highest quality level is required. Strict environmental compliance is required to check the pollution load.

To return on megadiversity of the river Narmada human being have to recognize the overwhelming significance of habitat destruction and over exploitation of aquatic resources. Also apply an addresable strategy of three R's, Rethink; Redefine; and React on fundamental cause of climate change as furthersome identify, catalog, and reverse the unpredictable human evisceration of aquabiodiversity. Every developing city produces heavy pollution and to reduce the pollution status, we have to increase the use of more biological resources for the treatment of environment and also reduce chemical treatments which enhance biodiversity in Jabalpur region.

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