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Arjun Shukla *et al.* published work on the fauna of River Narmada, Jabalpur region: A review

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Abstract

The current review intends to provide an overview of species richness of river Narmada according to Arjun Shukla *et al.*, during 2014-2015. With his colleagues he worked on various sites of river Narmada at Jabalpur region and recorded 260 species of river Narmada at Jabalpur region of various fauna viz., Fungi, Zooplankton, Annelida, Odonata, Butterflies, Spiders, Mollusca, Fishes, Reptiles and Birds. The content of this review will be useful step for future studies.

Keywords: Narmada, Complete Fauna, Diversity.

1. Introduction

Water is one of the prime necessities of life required for growth and activity of all living beings in world. The river Narmada is third holy and the fifth longest westward flowing river of central India as well Madhya Pradesh state. It originates from Amarkantak of eastern M.P. and it flows towards West and joins Arabian Sea at Bharuch in Gujarat. It enters the structural trough between Vindhya and Satpura ranges at marble rocks gorge and flows westward across Madhya Pradesh entering the Gulf of Khambhat through an estuary thirteen miles wide. The river has numerous waterfalls and tributaries. Narmada River flows from numerous big cities of Madhya Pradesh including Jabalpur (Shukla and Bhandari, 2015) ^[1, 2, 5, 12].

Jabalpur is one of the most important cities of Madhya Pradesh and is located at the center of the State. The city is situated in the 'Mahakaushal' region within the Narmada valley, which here runs over a rocky ledge. It consists of a long narrow plain running north-east and south-west, and shut in on all sides by highlands. The Narmada basin lie 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) ^[7, 8, 11] 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 river Narmada velly is one of the major hot spot for aqua biodiversity in India. Jabalpur region of Narmada velly 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. The species diversity of an ecosystem is often related to the amount of living and non-living organic matter present in it. The climate of Jabalpur is humid subtropical which is typical of North-Central India favor species richness. The fauna of Jabalpur district is quite rich and diverse, comprising of 532 invertebrate species pertaining to numerous animal groups from microscopic protozoa to the large sized Mammalia. Further, species diversity is a property at the population level while the functional diversity concept is more strongly related to ecosystem stability and stress, physical and chemical factors for determining population dynamics in the lentic ecosystem. Life on Earth is diverse at many levels, beginning with genes and extending to the wealth and complexity of species, life forms, and functional roles, organized in spatial patterns from biological communities to ecosystems, regions, and beyond. Within biological communities and ecosystems, functional diversity refers to the variety and number of species that fulfill different functional roles. A food web and some measure of its complexity and connectivity is one way to depict the functional diversity of a community.

Over the last century, riverine ecosystems have suffered from intense human intervention resulting in habitat loss and degradation and as a consequence, many fish species have become

highly endangered, particular in rivers where heavy demand is placed on freshwaters. The main causes are habitat destruction and defragmentation, water abstraction, industries and private use exotic species introduction, pollution and global climate change impacts (Azad and Shukla, 2015) [9]. The content of this review was the result and recommendation given by Arjun Shukla *et al.*, which provide further scope for study and betterment of river Narmada.

2. Study of Material and Methods

In this review we have studies the sites selected by Arjun Shukla *et al.*, during 2014-2015 of river Narmada in Jabalpur region. Some of the studies have been conducted by Arjun Shukla *et al.*, on the faunal diversity of the river Narmada during 2014-2015 that we are going to discuss here. (Fig. 1 and 2).

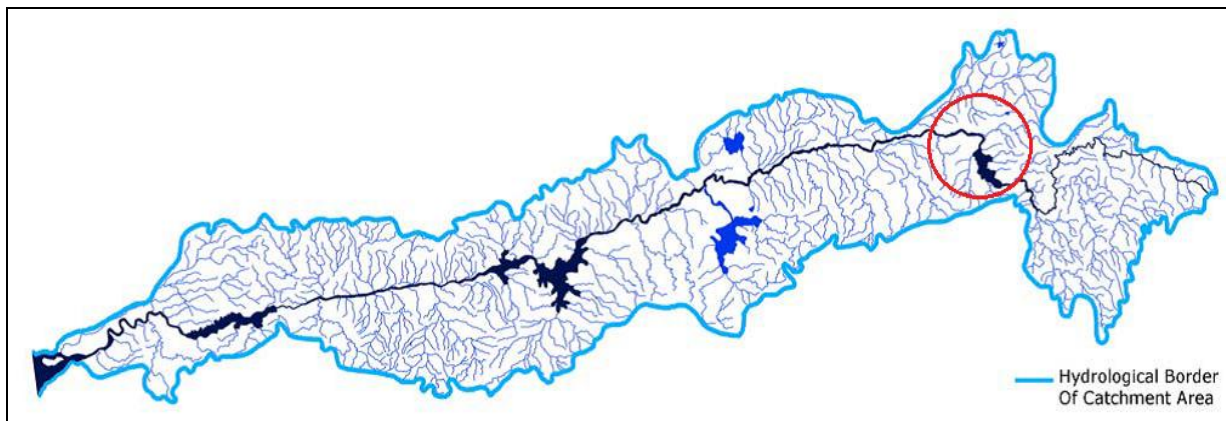


Fig 1: Hydrobiological Border of River Narmada with Catchment Area encircled Jabalpur region

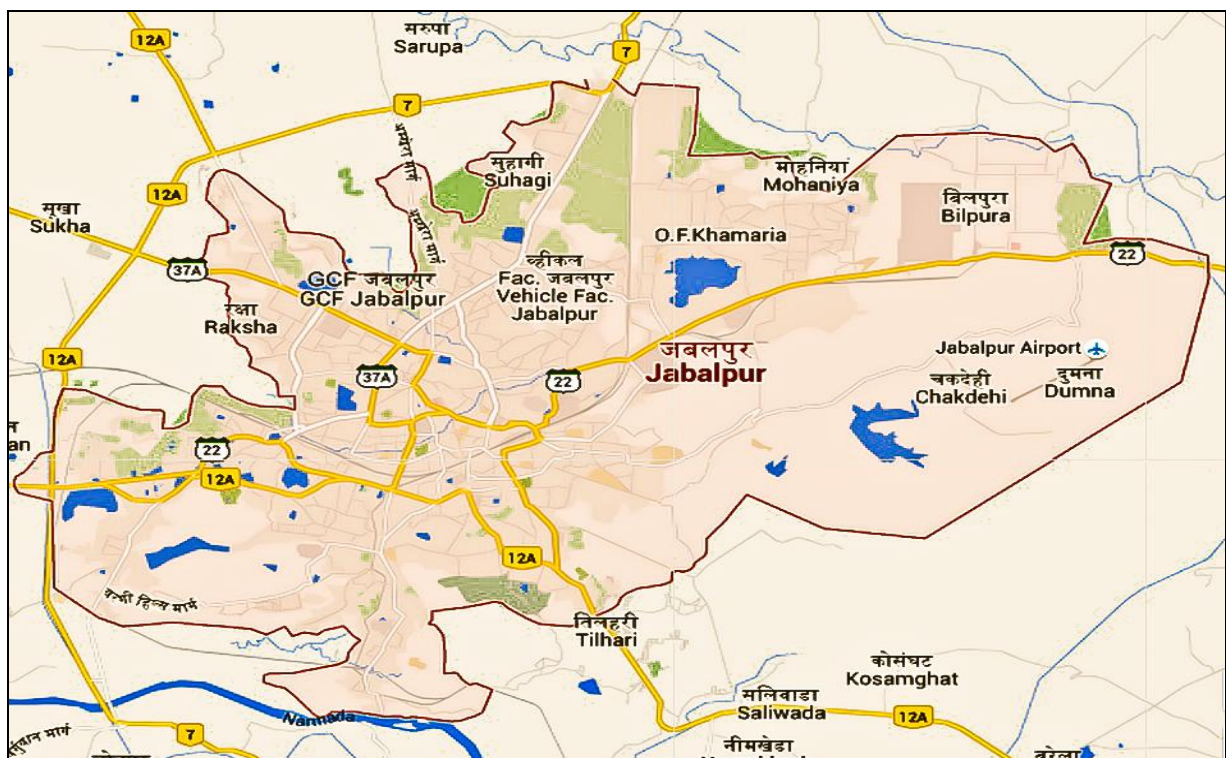


Fig 2: Area of Jabalpur Narmada Valley region, Where Arjun Have Conduct Research.

2.1 List of Site, Duration and Related fauna

| S. No. | Study Site | Duration | Related Fauna |
|--------|---------------------------------|---------------------------------|---------------|
| 1. | Narmada River, Jabalpur | December 2014 to May 2015 | Fungi |
| 2. | Narmada River, Madhya Pradesh | January 2014 to December 2014 | Zooplankton |
| 3. | Narmada valley Jabalpur | January 2015 to August 2015 | Odonata |
| 4. | Narmada valley Jabalpur | February 2015 to September 2015 | Lepidoptera |
| 5. | Narmada river Jabalpur Division | February 2015 to August 2015 | Spider |
| 6. | Narmada River, Jabalpur region | June 2014 to December 2014 | Mollusca |
| 7. | Narmada River, Jabalpur region | June 2015 to December 2015 | Fish |
| 8. | Narmada River, Jabalpur region | 2014-2015 | Reptile |
| 9. | Narmada River, Jabalpur region | 2012 to 2014. | Birds |

2.2 Fungi

Fungi are native inhabitants of water and some species behave as opportunistic pathogens in man. All above, all filamentous fungi can occur almost everywhere. Shukla *et al.*, (2015)^[1, 2, 5, 12]. Have conducted a 6 month study and recorded 12 species of water borne conidial fungi in river Narmada at Jabalpur region from foam, leave and twigs analysis. Fungi can enter in drinking water distribution systems through several contamination pathways, including water treatment breakthrough, deficiencies in cross-connections of water storage and water supply facilities, breakage of main pipelines during installation and maintenance. Once introduced, fungal species can become established on the inner surfaces of pipes, including interaction and reaction with sealing and coatings, and biofilms within distribution systems, or can be suspended in the water.

2.3 Zooplankton

Pandey and Shukla *et al.*, (2015)^[13]. have studied on zooplankton during January 2014 to December 2014 in which they communicated about the species richness of zooplankton in river Narmada at Jabalpur region. Zooplankton diversity is one of the most important ecological parameters in water quality assessment. 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. They occupy an intermediate link between phytoplankton and fish. Hence qualitative and quantitative studies of zooplanktons are of great importance. Zooplankton form an important quantitative component of net plankton of the four parts; Copepoda dominantly contributed to their abundance while Rotifera > Cladocera > Protozoan were sub-dominant groups. They collected sample from river Narmada and recorded 42 species belonging to four groups in which copepod was the most diverse one. Their study aimed to conserve the zooplanktons which are declining day by day. Their study gives a preliminary knowledge on the diversity and productivity of zooplankton and the reasons for the variation in river Narmada and the information can be utilized during the formulation of management measures to improve the productivity the reservoir. This is in turn, helps in planning exploitation, antipollution or conservation strategies.

2.4 Benthic Macroinvertebrates

Arjun Shukla and Rita Bhandari (2015)^[1, 2, 5, 12]. have reviewed on benthic macroinvertebrates which are important part of river system that lives on or inside the deposited at the bottom of a water body. They suggested macroinvertebrates, as biological indicators of stream water quality, can be utilized to identify impaired waters, determine aquatic life stressors, set pollutant load reductions, and indicate improvement. Macroinvertebrates formed an important constituent of an aquatic ecosystem and had functional importance in assessing the trophic status as the abundance of benthic fauna mainly depends on physical and chemical properties of the substratum and thus the benthic communities respond to changes in the quality of water and available habitat. In their review they have discussed on the species composition and distribution of macroinvertebrates in lakes and river. Also, analysis of the benthic community helped in the determination of pollution status of river and concluded that benthic macroinvertebrates are used in the bio-monitoring of stream and river ecosystems for various environmental stress types, such as organic pollution, heavy metals, hydro morphological degradation,

nutrient enrichment, acidification and general stressors and are also an important component of trophic level.

Rita Bhandari and Arjun Shukla (2015)^[1, 2, 5, 12]. have studied on benthic macroinvertebrate 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*, *Caenidae*, *Ephemeriidae*, *Heptageniidae*, and *Chironomidae*) in the river Narmada during the study where Mollusca was dominating group with 47% species constitution. They revealed species diversity show positive correlation of temperature while negative correlation with pH, DO, BOD, alkalinity, chloride & phosphate. They revealed that the weak correlation of some fauna to the water quality parameter that can attribute to their physicochemical parameter to the unfavorable environmental condition.

Arjun Shukla (2016)^[3, 4]. have reviewed on the use on macroinvertebrates to check the pollution status of river Narmada which shows very low pollution level to very high pollution level for its sustainable development. The importance of macroinvertebrates as bio-assessment tools is widely recognized because of their limited mobility, comparatively long life cycles and differential sensitivity to pollution of various types and they reflect the impact of cultural eutrophication on aquatic habitats quite satisfactorily. The implementation of sustainable development principles often comes into conflict with government driven needs for greater economic growth where they concluded that for sustainable development of water supply in Jabalpur to assess the Health of river Narmada without using chemicals that is done by Biological monitoring and for this purpose people have to research on importance of macroinvertebrates in pollution control.

2.5 Aquatic Beetles

Arjun Shukla *et al.*, (2016)^[3, 4]. have revealed on water beetles and their importance in aquatic ecosystem. Insects has many potential representatives that can be used as environmental bioindicators, among which are from the Coleoptera, Diptera, Lepidoptera, Hymenoptera. Water insects or aquatic beetles are biological indicator. Their study deals with diversity and importance of aquatic beetles in fresh water ecosystem and their role in water quality assessment as pollution indicator. They concluded that beetle involved in transmission of disease and an important bio control agent.

2.6 Odonata

Sunita Sharma and Arjun Shukla (2015)^[7, 8, 11] have reported the assemblage of 25 species of Odonata in southeast region of river Narmada during January 2015 to August 2015 where family Libellulidae is the largest family with 10 species carrying maximum number of species and dragonflies are amphibiotic insects found all around the freshwater bodies than Coenagrionidae with 7 species, highlighted the presence of pollution. They concluded that Odonates have little economic value, although they are used as food and as magical or medicinal resources at a local scale and to an unknown extent may influence populations of disease vectors. The group features prominently in nature management and they are often used as indicators for environmental health and conservation management. 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.

2.7 Lepidoptera (Butterfly)

Arjun Shukla and Haninder Maini (2015) ^[10], have preliminary studied the status of butterfly from southeast region of Narmada valley Jabalpur which is part of an extensive study of biodiversity. They presented the aggregation of up to 25 species belonging to 5 families and categories on the basis of their status from the study area and aimed to plan the biodiversity restoration in studied region and development of management strategies so as to ensure sustenance of butterflies and ecosystem services derived from them. They concluded the pressing needs of the growing human population in India, natural greeneries are being clear-felled giving way to urbanization, pollution and overgrazing. Loss of prime habitat is the major threat to all wildlife including butterflies. In addition to these, a variety of threats from human recreational activities, trampling, run-off from roads, litter deposition and weeds are common factors which affect butterfly populations. Although ill effects of urbanization and development cannot be completely nullify the, but they support for reduction of ill effects by planting endemic trees and plants supporting the local wildlife. This will make sure that at least the common species will not go on to the verge of extinction.

2.8 Spider

Arjun Shukla *et al.*, (2015) ^[9], have conducted six month pioneer study to reveal the spider diversity in surroundings of river Narmada in central India which exhibits good number of spiders and remarkable diversity in guilds of spider fauna. The main aim of their study was to explore the diversity and abundance of spider fauna at different habitats. During the study they observed 26 species of spiders belonging to 10 families, where Araneidae was the dominant family. The Narmada Valley area is home to several species rich endemic flora and harbors different species of fauna. The area prevail humid and moderate rainfall and climate. The high species diversity of spiders in river Narmada surrounding can be attributed to the high diversity of plants and insects. Their serves as a baseline for future study of spiders in the ecosystem of Narmada valley and further studies also required to confer the diversity of spider and to clarify the usefulness of spiders as indicators; relevance to high taxon surrogacy and to develop standardized sampling techniques.

2.9 Mollusca

Rita Bhandari and Arjun Shukla (2015) ^[1, 2, 5, 12], have studied diversity of Mollusca in river Narmada at Jabalpur region from June 2014 to December 2014 and also diversity indices of Mollusca. They recorded 9 species of class Gastropoda and 4 species of class Pelecypoda throughout the study duration and determined Shannon-Weiner diversity indices that indicate a rich diversity and good variation of Mollusca in river Narmada. They did not find significant differences in the frequency of species occurrences at sites while saw a moderate trend indicating a decrease in endemic species and an increase of widespread species. They recommended the protection as well as maintenance of forest area because snail depends on herbs as food, especially in the tropical rain forests which support rich snail diversity.

2.10 Ichthyofaunal

Arjun Shukla and Sunita Sharma (2015) ^[7, 8, 11] have studied on fish diversity of river Narmada during post-monsoon season to spring season. The fish is one of the most important vertebrate provide rich protein source in human diet and several animals and important elements in the economy of many countries. They attempt a successful study on river Narmada at Jabalpur region and recorded 25 species of fishes where they noticed abundance of major carp, minor carp and cat fishes. The species belonging to order Cypriniformes was the dominating throughout their investigation. At last they suggested enrichment of fish diversity through conservation planning and management program. Their analysis will provide a useful step for future studies in the same subject.

Zubair Azad and Arjun Shukla (2015) ^[9], have studied that biodiversity is essential for stabilization of ecosystem. Fish diversity of river essentially represents the fish faunal diversity and their abundance. River conserves a rich variety of fish species which supports to the commercial fisheries. They study for 6 month during 2015 in river Narmada at Jabalpur region and observed 23 species belonging 10 families. Their study revealed that *Cyprinidae* was the most diverse family among all and attempted to reveal the study and status of fish diversity for better conservation action plans and their modern management. Sustainable consumption of edible fishes and application of legal protection in pollution and harvesting aspects will be key methods to ensure the healthy density of fishes for human and ecological use.

2.11 Reptiles

Rita Bhandari, Vivek Sharma and Arjun Shukla (2015) ^[7, 8, 11], have studied the on the reptilian diversity of central India which is the region of significant diversity of major and minor fauna of dry deciduous forests, scrubs and wetlands in low to moderate elevations. This region is also rich in widespread snake diversity by having maximum number of common snakes of India. Venomous snakes of Central India are also widespread across the country or Indian subcontinent. Out of about 50 species only 7 snakes found to be medically significant which may cause fatalities. In their article they have given an introduction on venomous snakes of Central India and their relation with human beings. Such knowledge can help people to recognize snake especially venomous snakes when encountered. Four most widespread and common venomous snakes viz. Common Krait, Spectacled Cobra, Russell's viper and Saw-scaled Viper are responsible for more than 80% fatalities due to snake bites in Indian Subcontinent. In many parts of their range they are actually the only occurring set of venomous snakes.

2.12 Avian Fauna

Bird's population is frequently used as an indicator of environment quality. They are thought to be a useful proxy for assessing the impact of human influence of on biodiversity. The diversity and richness of avian fauna in a community indicated diversity and richness of other flora and fauna of the habitat. Sunita Sharma and Arjun Shukla (2015) ^[7, 8, 11], have surveyed Gwarighat region of river Narmada for two years and observed 77 Species of birds belong to 34 families and 13 orders where order, Passeriformes was diversified group. Urban ecosystem has been largely ignored throughout many decades of ecological research. They concluded that the structural heterogeneity of forest trees within the study area was a fundamental aspect supporting high level of species

abundance of birds. The conservation of species diversity in urban areas should be based on the knowledge on one or more

indicators species having different habitat requirements in terms of vegetation and trees' structure.

Table 1: List of 260 recorded species of various phyla by Arjun Shukla *et al.* from Jabalpur region.

| Fauna recorded by Arjun Shukla <i>et al.</i> , from Jabalpur | No. of Species | No. of Groups |
|--|----------------|---------------|
| Fungi | 12 | 1 Groups |
| Zooplankton | 42 | 4 Groups |
| Annelida | 9 | 1 Groups |
| Odonata | 25 | 7 (Families) |
| Lepidoptera (Butterfly) | 25 | 5 (Families) |
| Spider | 26 | 10 (Families) |
| Mollusca | 13 | 2 (Class) |
| Fish | 25 | 6 (Orders) |
| Reptile | 6 | 2 (Families) |
| Birds | 77 | 13 (Orders) |

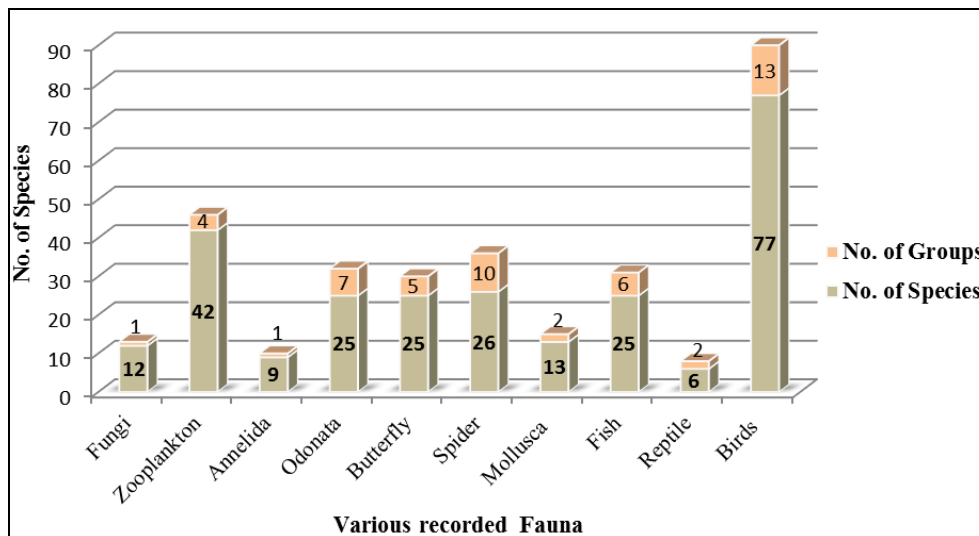


Fig 1: Arjun Shukla *et al.*, recorded 260 species of various phyla from Jabalpur region

2.3 Complete fauna

Arjun Shukla and Shivani Rai (2015) [9]. have reviewed many literatures and provided the significance of aqua faunal diversity of river Narmada at central India that comprise of plankton, macrozoobenthic, fungi and Pisces. 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. They give the strategy of rethink, redefine and react to recognize the overwhelming significance of habitat destruction and over exploitation of aquatic resources.

3. Conclusion

The review summarizes to reveal the studies of Arjun Shukla during 2014-2015. With his colleagues he worked on various fauna of Jabalpur around river Narmada. This review provides knowledge of diversity of various species for further detailed study. He suggests conservation of biodiversity for a healthy environment and use of bioindicators species in place of chemical for pollution assessment as well as anthropogenic activities. There is hence an urgent need to create awareness among local peoples on the importance of the riverine habitat and its fauna and the need to conserve them for future generations.

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