International Journal of Fauna and Biological Studies
Available online at www.faunajournal.com

IJFBS
International Journal of Fauna And Biological Studies

E-ISSN 2347-2677
P-ISSN 2394-0522
www.faunajournal.com
IJFBS 2022; 9(3): 35-40
Received: 22-02-2022
Accepted: 17-04-2022

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Assessment of macrozoobenthic diversity in Parbati River, Madhya Pradesh, India

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DOI: https://doi.org/10.22271/23940522.2022.v9.i3a.902

Abstract
The present study was aimed to assess the diversity, distribution and abundance of macrozoobenthos in Parbati River (Madhya Pradesh). During the present investigation, 5 sampling stations were selected to collect the samples. Shannon diversity index and Margalef's richness index was used on benthic data obtained during the survey. A total of 50 taxa of macrobenthic fauna were recorded from different sampling stations of Parbati River. The phylum Arthropoda was found dominant followed by mollusca and annelida. The maximum diversity and richness were recorded during winter season while minimum diversity was recorded during monsoon. Among the EPT, Ephemeroptera were reported only at the reference site, while Plecoptera and Trichoptera were absent at all the stations.

Keywords: Macrozoobenthos, diversity index, EPT, Parbati River

Introduction
Macrozoobenthos are aquatic organisms that live in the bottom of any water body, having ability to respond environmental changes which is useful in assessing the quality of surface water (Hallawell, 1986) [3]. Macroinvertebrates are important in ecological systems as their presences or absences reveal the nature of water body by being the primary bioindicator of fresh water bodies besides serving as food for fishes and also acting as a vector of pathogens to both humans and animals (Ganie *et al*., 2018; Foil, 1998) [18, 2]. Release of hazardous materials and urban expansion activities deteriorate the water quality of rivers and accordingly lead to a change in the benthic macroinvertebrates community structure (Patang *et al*., 2018; Suriawiria, 2003; Setiawan, 2009) [17, 8, 20]. Measuring the physicochemical properties of water gives estimation of its quality but cannot exactly represent the actual state of the reasons for polluted waters. To overcome this, biological evaluation along with other monitoring methods are used to provide a comprehensive picture of ecological quality of the waters (Sciortino & Ravikumar, 1999) [7]. Biological monitoring using macroinvertebrates has been found accurate and advantageous compared with other organisms because macroinvertebrates are extremely sensitive to organic pollutants, widely distributed, easy and economical to sample (Setiawan, 2009) [20]. So, macroinvertebrate diversity is one of the most effective and inexpensive way to determine the ecological status in aquatic ecosystems.

Material and Methods
Study Area
Parbati River originates from at a height of 610 m in the Vindhya Range at 76°35'40.75"E longitude and 22° 50'09.63"N latitude from Pithapura Lake near village Siddiqueganj in Sehore district, Madhya Pradesh, India. Being 471 km long it runs through various districts, of Madhya Pradesh and finally joins with Chambal River in Sawai Madhopur District of Rajasthan at District at 76° 33'58.86" E longitude and 25° 50'56.86'' N latitude. It is one of the Chambal River's three main tributaries, along with the Banas River and the Kali Sindh River.
For the study, samples were collected from 5 selected sites. Selection of the sampling stations was based on the possible pollutant loads and the magnitude of human activities along the rivers. Detailed location information of these sampling sites, and the latitude and longitude of all stations, is presented in Table 1 and Fig 1.

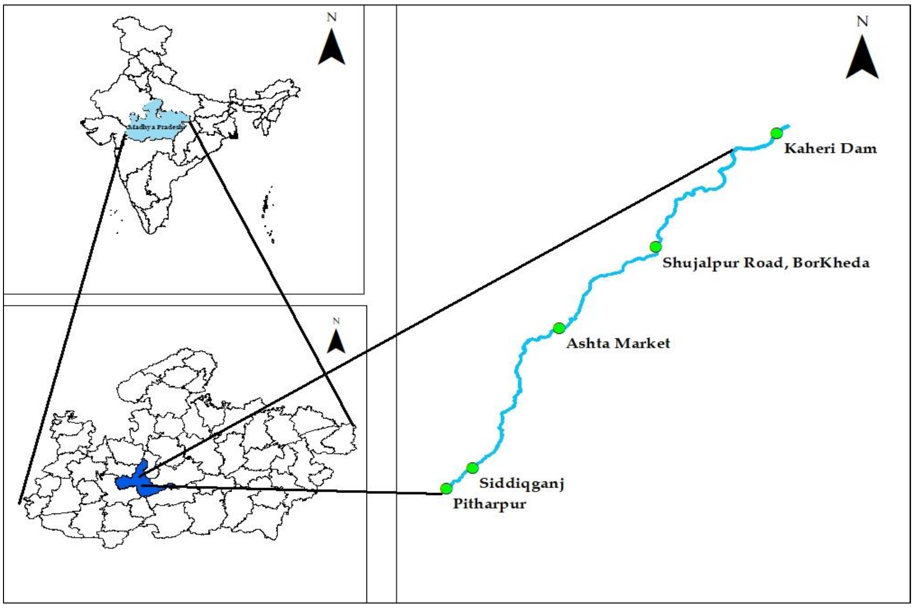

Fig 1: Map showing position of Parbati River

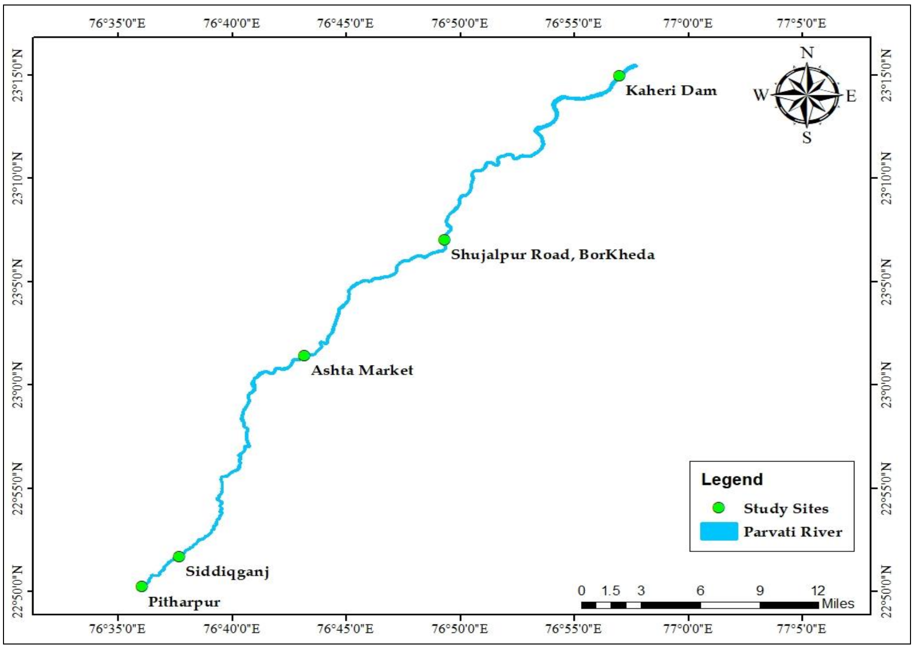

Fig 2: Map showing study area

Table 1: Showing the geographical locations of sampling stations

S. No.	Sampling station	Station code	Longitude E	Latitude N
1	Pitharpur	P 1	76^{0}36’2.41’’E	22^{0}50’13.96’’ N
2	Siddiqganj	P 2	76^{0}37’0.41.53’’E	22^{0}51’41.60’’N
3	Ashta Market	P 3	$76^{0’}$47’42’’E	23^{0}3’35’’ N
4	Shujalpur Road Borkheda	P 4	76^{0}49’18.11’’ E	23^{0}7’0.72’’ N
5	Kaheri Dam	P 5	76^{0}55’49’’E	23^{0}13’55’’N

Collection, Sieving, Sorting, Preservation and Identification of Macrozoobenthos

Firstly, the habitat of macrozoobenthos were identified in the river to collect benthic samples. Different gears were used to collect macrozoobenthos from different types of habitats *viz*., where the depth was less than 1 meter, Surber sampler is used; from macrophytes where macrozoobenthos fauna is found attached, the D- Frame net is used; the areas where large stones, pebbles were found, Kick net is used to collect the macrozoobenthos fauna (Barbour *et al*., 1999) [1]. The collected samples were sieved from sieve having mesh size of 0.5 to 0.6 micron. The macrozoobenthos were washed properly and sorting was made on the field using forceps and brushes. Separate screw cap wide mouth plastic containers were used for collecting macrozoobenthos followed by 95% alcohol as preservative. After completion of field procedure samples were transferred to the laboratory with utmost care. The macrozoobenthos fauna were identified to the lowest possible taxonomic levels as per requirement of the study. Stereo microscope and hand lens with 6x zoom capacity were used to observe the finest details about the organisms. In this process, macrozoobenthos were identified up to the genus or species level using different monographs and identification keys (Subramanian and Sivaramakrishnan, 2005; Subramanian and Sivaramakrishnan, 2007) [15, 14].

Result and Discussion

A total of 50 macrobenthic species were recorded during the present study from Parbati River belonging to three phylum's *viz*., Mollusca, Arthopoda and Annelida. During the present study the maximum number of species were recorded from phylum Arthopoda (30 species), followed by Mollusca (16 species) and Annelida (4 species) (Table-2). Phyllum arthropoda was dominant followed by mollusca and annelida (Fig-3). Similar results were revealed for (Vyas *et al*., 2012) [13] they found 20 species of class insect, 11 of mollsaca and two of Annelida. The dominance of Arthopoda was attributed due to favorable habitat conditions and food availability. (Sharma *et al*., 2013 and Ishaq and Khan, 2013) [21, 19] are also of the opinion that favorable habitat conditions and food availability results in the dominance of arthropoda diversity. At Class level Insecta (Arthropoda) and class Gastropoda (Mollusca) were main representatives of macrozoobenthos from the Parbati river. Similar observations were recorded from Ganjal River (Sharma *et al*., 2013) [21], Ken River (Nautiyal and Mishra, 2013) [11] and Streams of Yedigoller National Park (Turkmen and Kazanci, 2010) [9].

During the present study, the maximum species were recorded in winter season (Table-3). The maximum taxa richness and density of benthic fauna observed during winter season which favors low temperature (Yusuf, 2020) [12] and more dissolved oxygen (Negi and Sheetal, 2013) [6] for the benthic population. Also, density is more due to the availability of phytoplankton population in the form of food source (Joshi *et al*., 1996) [4]. The decline in the density of benthic fauna during rainy season was due to surface runoff containing inadequately treated sewage, dilution factor and other contaminants which increased load of suspended solids, reduced transparency and increased water flow that in turn affected the distribution of benthos in the Parbati River. Similar conclusions were drawn by many experts (Joshi *et al*., 1996, Duffield and Nelson, 1993) [4, 22].

Table 2: Showing diversity of macrozoobenthos in Parbati River

Taxa	Winter					Summer					Monsoon					Postmonsoon				
	p1	p2	p3	p4	p5	p1	p2	p3	p4	p5	p1	p2	p3	p4	p5	p1	p2	p3	p4	p5
Gastropoda																				
Bellamya bengalensis	+	+	-	+	+	+	+	+	-	+	+	-	-	-	-	+	-	-	-	+
Bellamya dissimilis	+	+	+	-	-	+	+	-	+	-	+	+	-	-	-	+	+	-	-	-
Thiara scabra	-	+	-	-	+	+	+	-	-	-	-	-	-	-	+	+	+	+	-	+
Thiara tuberculata	-	+	-	-	+	-	+	-	-	+	+	+	-	-	+	+	-	-	-	-
Tarebia lineate	+	+	-	-	-	+	+	-	-	-	+	-	-	-	+	+	-	-	-	-
Tarebia graiffera	-	-	-	-	+	-	-	-	-	+	-	-	-	-	+	+	-	-	-	+
Pila globosa	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	+
Lymnaea acuminate	-	+	-	-	+	+	+	-	-	+	-	+	-	-	+	-	+	-	+	+
Gyraulus convexiusculus	-	-	+	+	+	-	-	+	+	+	-	-	+	-	+	-	-	+	+	-
Indoplanorbis exustus	-	-	+	-	-	-	-	+	+	+	-	-	-	+	+	-	-	+	+	+
Gyraulus labiatus	+	-	+	+	-	-	-	+	-	+	+	-	+	+	-	+	-	+	+	-
Bivilvia																				
Radiatula oocata	-	+	-	-	+	-	+	-	-	+	-	+	-	-	-	-	+	-	-	+
Corbicula striatella	-	-	-	-	+	-	-	-	-	+	-	+	-	-	-	-	+	-	-	+
Pisidium nevillianum	-	-	-	+	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-
Lamellidens corrianus	+	-	-	-	+	+	-	-	-	-	+	-	-	-	+	+	-	+	+	+
Lamellidens marginalis	+	+	-	-	+	+	+	-	-	-	+	+	-	-	-	+	+	-	-	+
Annelida																				
Limmodrilus hoffmeisteri	-	+	+	+	+	-	+	+	-	+	-	+	+	+	+	-	+	+	+	+
Tubifex tubifex.	+	-	+	+	+	+	+	+	+	+	-	+	+	+	-	+	+	+	+	-
Tubifex albicola	-	-	-	+	-	-	+	-	-	+	-	+	-	-	+	-	+	+	-	-
Hirudiniaria sp	-	-	+	+	-	-	-	+	+	+	-	-	+	+	-	-	-	+	+	+
Diptera																				
Chironomus chironomus	-	-	+	+	+	-	-	+	+	+	-	-	+	+	-	-	-	+	+	+
Chaoborus chaoborus	-	-	+	+	-	-	-	+	+	-	-	-	+	+	+	-	-	+	+	+
Culex sps.	+	+	-	-	+	+	+	-	-	+	+	+	-	-	+	+	+	-	-	+
Simuluim sp.	-	+	-	-	-	+	+	-	-	-	-	+	-	-	-	-	+	-	-	-
Tabanus sp.	-	-	-	-	+	+	-	-	-	+	-	+	-	-	-	-	+	-	-	+
Odonata																				
Aphylla *sps.*	+	-	-	-	+	+	-	-	-	+	-	-	-	-	+	+	-	-	-	+
Gomphus sps.	+	+	-	-	+	+	+	-	-	+	-	+	-	-	+	+	+	-	-	+
Cordulegaster sps.	-	+	-	-	+	-	+	-	-	+	-	+	-	-	+	-	+	-	-	+
Anax sps.	+	+	+	-	+	+	+	-	-	+	+	+	-	-	+	+	+	-	-	+
Hagnius sp.	-	+	-	-	-	-	+	-	-	-	-	+	-	-	-	-	+	-	-	-
Argia sp.	+	-	-	-	-	+	-	-	-	-	+	-	-	-	-	+	-	-	-	-
Enallagma sps.	-	+	-	-	+	-	-	-	-	+	-	-	+	-	+	-	-	-	-	+
Hemiptera																				
Water Boatmen sps. Sigara sp	-	+	-	-	+	-	+	-	+	+	-	+	-	-	-	-	+	-	-	+

Ranatra sps.	+	-	-	-	+	+	-	-	-	+	-	-	-	-	+	+	-	-	-	+
Nepa sps.	+	-	-	+	+	+	-	-	-	+	+	-	-	-	+	+	-	+	+	+
Notoneta sps.	+	+	-	-	+	+	+	-	-	+	+	+	-	-	+	+	+	-	-	+
Gerris sp.	+	+	-	-	+	+	+	-	-	-	+	+	-	-	+	-	+	-	-	+
Rhagovelia sp.	+	-	-	-	+	-	-	-	-	+	+	-	-	-	+	+	-	-	-	+
Pelocoris sp.	-	-	-	-	+	-	-	-	-	+	-	+	-	-	-	-	-	-	-	+
Ephemeroptera																				
Caenis sps.	-	+	+	-	+	-	+	+	-	+	-	-	-	-	+	-	+	-	-	+
Ephemerella sp.	+	+	-	-	+	+	+	-	-	+	+	+	-	-	-	+	+	-	-	-
Baetis sp.	+	+	-	+	+	+	+	-	-	+	-	+	-	-	+	+	+	-	-	+
Coleoptera																				
Dineutus sps.	+	-	-	-	-	+	-	-	-	-	+	-	+	-	-	+	-	-	-	-
Peltodytes sps.	-	+	-	-	+	-	+	-	+	-	-	+	-	-	-	+	-	-	-	-
Hydraena sp.	-	+	-	-	+	-	+	-	-	-	+	-	-	-	+	+	-	-	-	+
Dytiscus sp.	+	+	-	-	+	-	+	-	-	+	-	+	-	-	+	-	+	-	-	+
Bembidium sp.	+	+	-	-	-	+	+	-	+	-	+	-	-	-	-	+	+	-	+	-
Stenelmis sp.	-	-	-	-	+	-	-	+	-	+	-	-	-	-	+	-	-	-	-	-
Berosus sps.	+	+	+	+	-	+	+	-	-	-	+	+	-	-	-	+	+	+	-	-
Decapoda																				
Palaemonetes sps.	+	+	-	-	+	+	+	-	-	+	-	+	-	-	+	+	+	-	-	+

Table 3: Shannon and Margalef index of the sampling sites

	Sampling stations	Taxa_S	Individuals	Shannon_H	Margalef
Winter	P1	24	158	2.972	4.543
	P2	29	197	3.222	5.3
	P3	12	73	2.208	2.564
	P4	13	72	2.263	2.806
	P5	35	234	3.392	6.314
Summer	P1	25	148	3.02	4.803
	P2	30	202	3.242	5.463
	P3	12	67	2.22	2.616
	P4	10	54	2.08	2.256
	P5	33	218	3.347	5.866
Monsoon	P1	19	87	2.721	4.031
	P2	26	112	3.029	5.298
	P3	9	52	2.062	2.025
	P4	8	34	1.933	1.985
	P5	28	131	3.111	5.538
Post monsoon	P1	27	146	3.068	5.217
	P2	26	147	3.065	5.01
	P3	13	64	2.313	2.885
	P4	13	63	2.336	2.896
	P5	33	212	3.274	5.974

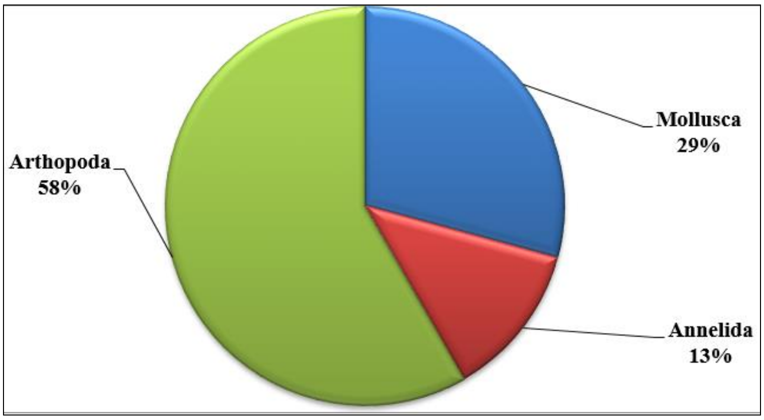

Fig 3: Percent Composition of Taxonomic Group of macrozoobenthos

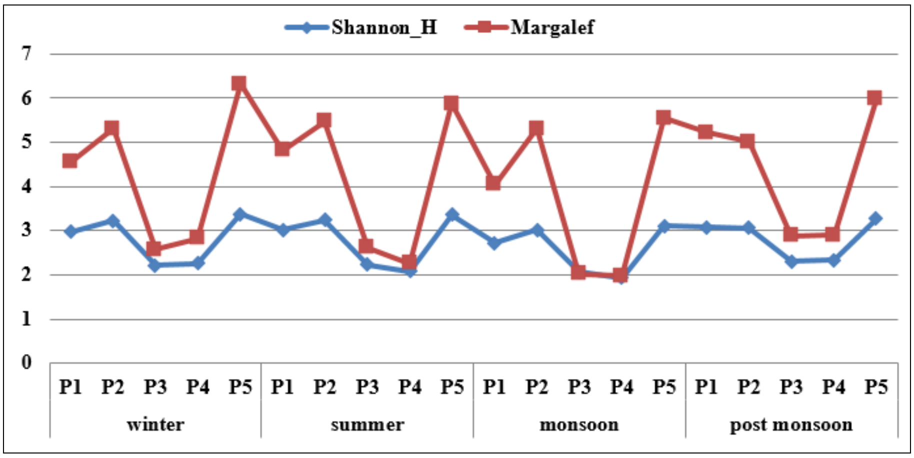

Fig 4: Graphical presentation of Shannon and Margalef Diversity index of sampling sites

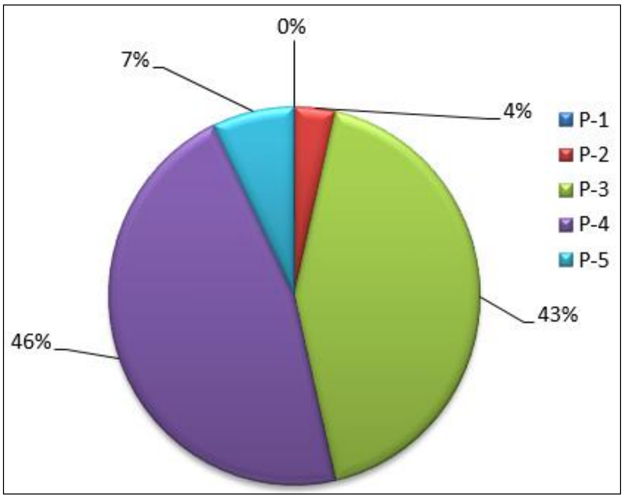

Fig 5: Graphical presentation of chironomidae at sampling sites

In the present study, the Shannon diversity index ranged from 1.933 to 3.392 (Table-3). The diversity value of site 5 was highest during winter season and lowest value of index was noted at site 4 during monsoon season. During all the four seasons maximum taxa richness and diversity were recorded at site P5 and P2 (Table 3 and Fig-4) due to good riparian vegetation, found on the banks of the river which provide high nutrient sources for macroinvertebrates (Legendre, 1998) [5] while as the minimum richness and diversity which were recorded at P4 and Site P3 (Table 3 and Fig-5) due to intense human activities (bathing, washing, urban location and highway road connectivity) which produces the high pollution load. Dominance of Chironomus sp. at site P4 and P3 indicates the increase of nutrients enrichment such as nitrates, and phosphate, because under such conditions, only certain types of organism like Chironomus sp. can survive because of their ability to tolerate the high organic contamination (Mariantika & Retnaningdyah, 2014) [16]. Further During our study sensitive species like Ephemeroptera was limited only in the reference site (Table-2) but Plecoptera and Trichoptera were totally absent in all of the sites these results are in agreement with the findings of (Sultana & Seshi Kala 2012) [10].

Conclusion

This study provides information about diversity, distribution and abundance of macrozoobenthos of Parbati River (Madhya Pradesh). The maximum taxa richness and diversity were recorded at site P2 and P5 throughout the study period which was mainly due to good riparian vegetation whereas the minimum richness and diversity were recorded at site P3 and P4 which is due to intense human activities as these sites producing high pollution load. Further, (EPT) Ephemeroptera was reported only at the reference site, while Plecoptera and Trichoptera were absent at all stations, thus confirming disturbances along the Parbati River. The Parbati River is rich in benthic diversity and measure should be taken to prevent anthropogenic pressure nearby river.

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