ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 5, Issue, 02, pp.254-257, February, 2013

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

Diversity of Mayflies (Insecta: Ephemeroptera) in river Narmada India

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ARTICLE INFO

Article History:
Received 10th November, 2012
Received in revised form
14th December, 2012
Accepted 21th January, 2013
Published online 14th February, 2013

Key words:
Biodiversity,
Ephemeroptera,
Mayfly,
River.

ABSTRACT

Ephemeroptera is an important group of insects used in the bioassessment and monitoring of freshwater bodies worldwide because of their relative abundance in a wide variety of substrates and their increasing chances of detecting pollution impacts. In present study limnological studies on various sampling sites of river Narmada were carried out from August 2009 to July 2010 to enumerate the diversity of mayfly fauna. Four sampling sites viz; Punasa dam (Narmada Nagar), Omkareshwar, Khalgat and Koteshwar (Barwani) were sampled quantitatively. During present investigation, 17 species comprising of 6 families were recorded including Baetidae, Ephemerdae, Heptageniidae and Leptophlebiidae.

INTRODUCTION

Among the Macroinvertebrates Epemeroptera (Mayflies) are truly the 'ballerians' of the insect world. Ephemeroptera is an ancestral order of insects, dating from the late Carboniferous – early Permian, about 290 million years ago (Brittain 1980, Brittain and Sartori, 2003; Barber-James *et al*., 2008). Mayflies have a complex life cycle, involving both aquatic and terrestrial phases. Such life cycles create evolutionary dichotomy with selection pressures operating in two, more or less independent environments (Wilbur 1980). Mayflies are distributed in nearly all lentic and lotic water bodies and are especially abundant in rivers and streams. They contribute significantly to ecological processes (You and Gui 1995). Mayflies are extremely impotant in the ecology of fresh water streams. Both immature and adult mayflies are an important part of the food web, particularly for carnivorous fish such as trout in cold water streams or bass and catfish in warm water streams. Their presence is an indication of good water quality given their sensitivity to pollution (PSERIE 2003). Mayflies are highly susceptible to pollution and thus are important indicators of water quality.

Most mayfly species are known as sensitive to pollution (Bauernfeind and Moog 2000). Mayflies requires high quality water for their existence, thus biologists have used their presence or absence, in conjunction with the numbers present at a particular location in a stream or river, to develop several indices of water quality. Numerous studies demonstrate that mayfly community structure effectively reflects the environmental situation of water courses (Gupta and Michael 1992, Bauernfeind and Moog 2000, Medina and Vallania 2001, Ogbogu and Akinya 2001, Baptista *et al*., 2001, Rueda *et al*., 2002, Nelson and Roline 2003). In some cases, low mayfly diversity is the result of extreme ecological conditions in the natural environment (Aagaar *et al*., 2004).

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MATERIALS AND METHODS

Study site

The Narmada basin, hemmed between Vindya and Satpuda ranges, extends over an area of 98,796 km^2 and lies between east longitudes 72 degrees 32' to 81 degrees 45' and north latitudes 21 degrees 20' to 23 degrees 45' lying on the northern extremity of the Deccan Plateau. The basin covers large areas in the states of Madhya Pradesh (86%), Gujarat (12%) and a comparatively smaller area (2%) in Maharashtra. The river Narmada receives 41 principal tributaries (Alvares and Ramesh 1988), each with a catchments area exceeding 500sq. kms. Out of these 22 (21 in MP and 1 in Gujarat) joins the river from left bank and 19 (18 in MP and 1 in Gujarat) from right bank (Ghosh *et al*., 2004). The total length of these principal tributaries is 3387 Kms. Sampling Stations. The water and biological samples were collected from selected sampling stations in the Narmada river which are as under.

Punasa Dam

The Indirasagar Dam (Punasa Dam) is a multipurpose key project of Madhya Pradesh on the Narmada river at Narmada Nagar in Khandwa (Tehsil of West Nimar district) Madhya Pradesh in India.

Omkareshwar

Omkareshwar is a famous place of pilgrimage located in Khargone Tehsil of East Nimar district of Madhya Pradesh, on the Mandhata hill on the banks of the Narmada river**.** Millions of pilgrims of both local and foreigners use to visit the place every year.

Khalghat

Khalghat is a small town and a Municipality of Dhar district in the state of Madhya Pradesh, India. It is located on the banks of

Narmada river and national Highway 3 Agra- Indore – Dhule – Mumbai. It is 76 kilometer away from Indore.

Koteshwer

Koteshwer is a holy place in Barwani district of Madhya Pradesh in Central India. It is located 17 kilometer from Barwani district and 160 kilometer from Indore.

Biological Analysis

Different methods were employed to sample aquatic insects from the target habitats. The samples were collected with surber sampler at shallow profundal zone (Wetzel, 1983), various types of nets and by random sampling. The samples were preserved in 75% alcohol solution and transported to the laboratory for further investigation. In the laboratory, samples were rinsed thoroughly with pure water to remove preservative through a sieve (100 µm mesh size). Samples were then poured in a white-bottomed tray of the appropriate size for good visualisation and the sorted mayflies were then identified. Collected samples were examined under microscope (10X and above) and identified using standard taxonomic literature. Samples were assigned to a family or genus using taxonomic keys like; Dudgeon (1999); APHA (2002); Pennak (2004); Tonapi (1980), and Barber-James and Lugo- Ortiz (2003).

Physico-chemical analysis

In the analysis of the physico-chemical properties of water, standard methods prescribed in limnological literature were used. The Physico- Chemical parameters were determined as per standard methods of APHA (2002).

Statistical Analysis

The numerical relationship between the species population and whole communities often provides better reliable indications of pollution than single species (Datta and Datta 1995). These relationships are represented by "Diversity Indices". In the present study Simpson's Index and Shannon and Weiner diversity index (H) were used.

minimum in August 2009 at Khalagat and maximum at Punasa and Koteshwar in May 2010. The Dissolved oxygen varied between 6.3 mg/l to 9.0 mg/l. Minimum dissolved oxygen was recorded at Punasa in June 2010 and maximum dissolved oxygen was recorded at Punasa and Omkareshwar in January 2010. The biological oxygen demand varied between 0.28 mg/l to 1.30 mg/l with minimum in January 2010 at Omkareshwar and maximum at Khalghat in May 2010. The value of total hardness fluctuated between 73 mg/l to 210 mg/l. Minimum total hardness value was recorded at Punasa in October 2009 and maximum total hardness was recorded at Omkareswar in June 2010. In the present study 17 species of Ephemeroptera (Mayflies) belonging to 6 families were recorded from river Narmada (Table 2). The population of Mayflies fluctuated in different seasons and months. The dominant family was Baetidae of which Baetis simplex was the most common species. Batidae showed high diversity almost at all sampling stations.The Mayfly diversity was maximum in post monsoon and summer and was very low in monsoon season. In the present study, the value of Shannon diversity index (H) varied from 0.000 to 2.626 with minimum value in July and maximum value in September at Omkareshwar. The value of Simpson dominance index varied from 0.00 to 0.94 with minimum in July and maximum in December. The distribution of the Mayfly nymphs is dependent on the availability and distribution of preferably food items and the quality of water.

Table 1. Range of variation, mean and standard deviation of water quality parameters of Narmada river during August 2009to July 2010.

Parameters	Min	Max	Mean±SDV
Temperature	17	35	27.25±3.93
pH	7.3	9.1	8.18±0.53
Dissolved Oxygen	6.3	9	7.91±0.64
Biochemical Oxygen Demand	0.28	1.3	0.70±0.27

DISCUSSION

In the present study 17 species of Ephemeroptera (Mayflies) belonging to 6 families were recorded from river Narmada. The population of mayflies fluctuated from season to season. The mayfly

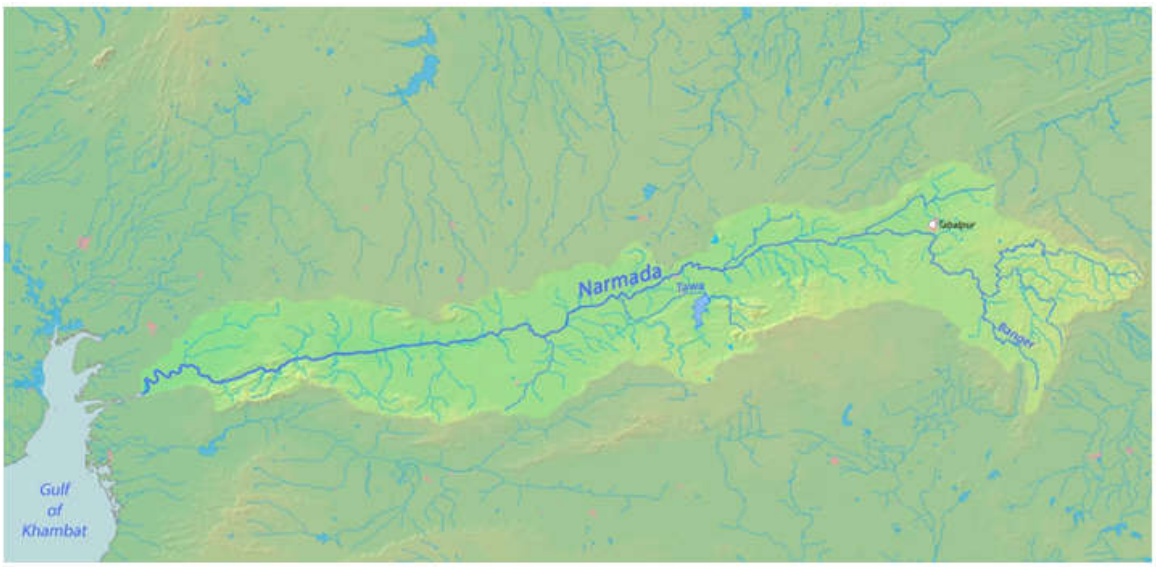

Figure 1. Showing Map of Narmada river

RESULTS

The physico- chemical parameters showed wide variations throughout the study period (Table 1). The water temperature varied between 17 ^{o}c to 35 ^{o}c. Minimum water temperature was recorded at Khalgat in January 2010 and maximum temperature was recorded at Punasa in May 2010. The value of pH varied from 7.3 to 9.1 with

diversity was maximum in post monsoon season and during summer and was very low in monsoon season. This is consistent with the observations made by Arimoro and Ikomi (2009), that numbers of taxa and the mean abundance of mayflies increased in the dry season and decreased in the wet season in the upper reaches of river Warri, Niger Delta. The diversity of mayfly nymphs was very low in monsoon season due to the heavy floods and poor water quality in the

Table 2. Relative composition (in percent) of Ephemeroptera density in river Narmada from August 09 to July 2010

Families	Species	Stations			
		Punasa	Omkareshwar	Khalgat	Koteshwar
Baetidae	Baetiella ladakae	6.72	8.29	6.96	6.88
	Baetis solangensis	5.17	8.92	6.81	3.79
	Baetis simplex	10.43	11.59	12.28	4.01
	Baetis festivus	8.66	6.98	8.88	3.27
Caenidae	Caenidae picea	6.46	6.89	10.00	3.92
	Clypeocaenis bisetosa	3.79	5.17	4.87	4.18
Ephemeridae	Ephemera nadinac	5.34	7.58	8.49	3.15
	Ephemera fulvata	2.15	7.76	7.45	3.40
	Ephemera indica	2.71	7.88	5.99	2.50
	Eatonigenia trirama	5.30	7.76	3.92	2.97
Ephemerellidae	Ephemerella indica	4.39	6.81	7.20	4.27
Heptageniidae	Epeorus gilliesi	7.71	7.20	8.36	2.54
	Epeorus psi	8.96	7.76	8.49	3.15
	Heptagenia nubila	5.95	5.60	5.04	0.00
	Heptagenia solangensis	2.67	2.84	6.94	2.67
Leptophtebiidae	Atalophlebia chialhnia	6.55	5.95	7.63	2.15
	Thraulus gopalani	7.02	5.82	10.99	1.85

river. Pupilli and Puig (2003) also reported that floods especially those with a long return time can have a catastrophic effect on mayfly communities. Maldonado *et al*., (2001) while studying four non-Andean streams in central Venezuela reported that the rainfall to be a determining factor in the temporal fluctuation of density and composition of mayfly communities. According to Mccabe and Gotelli (2000) and Lytle (2001) that the effect of rainfall on nymph abundance is not direct but occurs by means of disproportionate and sudden rises of flow. According to Hartman *et al*. (2005) and Pond *et al*. (2008) the loss of mayfly taxa depends more on the exceptionally high chemical loading to the recieving water than on the total area of watershed disturbed.

Francis and Muller (2010) while studying mayfly community as an indicator of the ecological status of a stream in the Niger Delta area of Nigeria stated that Ephemeroptera diversity was influenced by substrate heterogeneity which in turn was influenced by catchment processes such as flooding and anthropogenic activities especially abattoir effluent. Mayfly community in streams with seasonal rainfall is affected by direct anthropogenic impacts (like source pollution) during dry season (Dudgeon 2000) and by indirect anthropogenic impacts (entrophication, non-source pollution) in the wet season. In the present study, Shannon diversity index was recorded higher in post monsoon and summer months which may be attributed due to the breeding season in nutrient rich and oxygenated habitat and the diversity index was recorded lower in monsoon season which may be attributed due to the heavy floods and poor water quality. Savic *et al*. (2010) observed the values of Shannon diversity index (H) between 0.00 to 4.92 in river Nisava, Serbia with maximum values in the months of summer. In the present study, the value of simpson index showed wide variation. The pattern of lower Simpson's diversity during monsoon and higher diversity values in post monsoon recorded in the present study, is in conformity with the earlier observations made by Shukla and Shrivastava (2004) at Gandhi sagar reservoir MP. Sharma and Chowdhary (2011) observed the values of Simpson's index between D= 0.00 to 0.917 in river Tawi, Jammu and Kashmir.

Acknowledgement

The financial assistance of the Department of Science and Technology, New Delhi, for the Ph. D. research of Zahoor Pir is highly acknowledged.

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