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The Influence Of Water Parameters On The Distribution Of Aquatic Insects In Narmada River, India

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Abstract

The Aquatic Insects are helpful in purification of water in their capacity to act as scavengers. Narmada river is one of the most important river of India, which covers 98,796 sq. km of total water shed area. Narmada is considered to be life line and west flowing river of state Madhya Pradesh. Limnological study was carried out for a period of Twelve months from Oct 2019- Sep 2020 in selected stations of Narmada river. In present study various four Families of Ephemeroptera, 1 families of Odonata, 1 families of Plecoptera, 6 families of Hemiptera were recorded. In the present study the value of Shannon Weaver index varies from 2.7 to 3.1 indicating that the water is less polluted. Besides that the values of Simpson's diversity index varies from 0.92 to 0.94 showing higher diversity of Aquatic Insects species. The result of the present study emphasizes the importance of conserving the world's Aquatic Insects population, which are declining at an alarming rate through habitat destruction and pollution.

Key words: - Insect diversity, diversity index, Narmada river, Biomonitoring.

Introduction-

Aquatic biodiversity has enormous economic and aesthetic value and is largely responsible for maintaining and supporting overall environmental health. Humans have long depended on aquatic resources for food, medicines, and materials as well as for recreational and commercial purposes such as fishing and tourism. Aquatic organisms also depend upon the great diversity of aquatic habitats and resources for food, materials, and breeding grounds.

Phylum Arthopoda is a large assemblage of animal groups having diverse shapes, size, habits and occupy different habitats (Subba Rao 1993). The Insects are helpful in purification of water in their capacity to act as scavengers. In addition to this they provide food for fishes, birds (Preston 1915). George (1976) reported that the Insects for the major food item of murrels and cat fishes. Aquatic insects have scientific importance as they are used in Biomonitoring and risk assessment (Barbour et al 1999, Salanki et al 2003). Anthropogenic activities, especially involving chemical contaminants that pollute the environment, can also affect Insects ecological and physiological parameters (Morley 2010). Dias et al (2011), Javanshir (2008) conclude that the Insects Population are declining at an enormous rate due to habitat destruction. Yilmaz (1998) concluded that due to intensive land use, the ecological diversity of Insects is threatened.

Aquatic insects have tackled the problem of living in aquatic environment by evolving various morphological and physiological modifications. These include air-tubes to obtain atmospheric oxygen, cutaneous and gill respiration, the extraction of air from plants, haemoglobin pigments, air bubbles and plastrons. Air-tubes are present in aquatic bugs (Hemiptera) and files (Diptera) restricting their activity to water surface. Cutaneous and gill respiration is widespread in the immature stages of most of the aquatic insects. This helps them to live among submerged substrates. Adult beetles and bugs often respire by the use of an air bubble. Some species use plastron (a system of microhairs or papillae) that hold an air film. Plastron respiration helps these insects to stay longer under water. Chironomid (Diptera) larvae living in eutrophic aquatic habitats survive in low oxygen levels through the use of hemoglobin pigments.

The loss of biodiversity worldwide has been well documented for decades, and while much of the attention of the media and scientific community has been focused on terrestrial ecosystems, other biomes such as freshwater rivers and streams have received less consideration (Myers et al., 2000). As human populations continue to develop aquatic resources to maximize a few of these anthropogenically beneficial services such as water storage, generation of electricity, and fish production, other environmental services that are less directly important to humans are being reduced or lost (Bennett et al. 2009). The reduction of these ecosystem functions can significantly alter an ecosystem's natural character. Cardenes and Hidalgo (2006), Leppakoski (1999), Guo and Gan (2002) observed that the eutrophication serves as the main threat to the aquatic environment.

Material and Method: -

Description of Narmada River

The Narmada also called Rewa is a river in central India and the fifth largest river in the Indian subcontinent. It is the third largest river that completely flows within India after Ganga and Godavari. The Narmada River Basin lies in the central part of India, between 72_ 20 E to 81_450 E long. and 21_200 N to 23_ 450 N lat. with a drainage area of 98,796 sq. km and a mean elevation of 760 m. Narmada River originates in the Maikal Mountain Ranges in Amarkantak in Madhya Pradesh State, and flows through

west for a distance of 1312 km into the Gulf of Cambay, west of Bharuch District in Gujarat State (NIH, 1999). The catchment area of the river exists in the States of Madhya Pradesh (86.18%), Gujarat (11.6%), Maharashtra (1.5%), and Chattisgarh (0.72%). During its course, the river drops from an elevation of 1051 m to sea level, and flows through narrow gorges in the head reaches. The basin is bounded on the north by the Vindhya Ranges, on the east by the Maikal Range, on the south by the Satpura Ranges, and on the west by the Arabian Sea. Deep black soil covers the major portion of the basin. The river has 41 tributaries, of which 22 are on the left bank and 19 are on the right bank. The Barna, Tawa, Kolar, and Sukta dams have been constructed on the tributaries. The Bargi is constructed on the mainstream, while the Indirasagar, Omkareshwar, Maheshwar, and Sardar Sarovar dams are under construction.

Sampling Sites

OMKARESHWAR (S-I)

Omkareshwar is situated 77 km from Indore in Khandwa District, Madhya Pradesh. Omkareshwar is visited by pilgrims from all over the country to seek blessing at the temple of Shri Omkar Mandhata. This station has more anthropogenic activities and all the time the large numbers of people are seen bathing, washing clothes at this station. Less number of Insects species were observed from this station. (Figure 1)

MANDLESHWAR (S-II)

Mandleshwar is a town and a Nagar Panchayat in Khargone district of Madhya Pradesh situated on the bank of Narmada river, 8 km east of Maheshwar and 99 km south of Indore. A good number of Aquatic Insect species were observed. (Figure 1)

Biological Analysis:

Insects Samples were collected from the deeper profundal zone by using Ekman grab and at shallow profundal zone by using Surber sampler following Wetzel (2001), APHA (2002). Qualitative samples were also collected by hand picking organisms from immersed stones. Water samples were filtered in the field with pre-rinsed cellulose nitrate Sartorius filters, 0.45mm pore diameter, and were analyzed within a period of 5 days after collection. pH was measured in the field using a combined glass electrode compensated for temperature. The Physico- Chemical parameters were determined as per standard methods of APHA (2002), Welch (1998).

The Number of Aquatic Insects per unit area was calculated as follows;

$$\text{Aquatic Insects No. /cm}^2 = \frac{N \times 104}{A}$$

Where as N = No. of organisms per sample.

A = Area of the sampler (20 x 20 cm).

The samples were preserved in 4% Formalin solution and transported to the laboratory for further investigation. Samples were assigned to a family or genus using taxonomic keys like; APHA (2002); Pennak (2004); Tonapi (1980), Welch (1998) and

Needham and Needham (1998). The graphs was calculated by using software's like Microsoft Excel 2010, SPSS and Manitab-16 (academic addition).

Diversity Index:

The numerical relationship between the species population and whole communities often provides better reliable indications of pollution than single species (Datta et al 1995). These relationships are represented by "Diversity Indices". Several types of indices are used. In the present study Margalef Richness Index, Simpson's Index and Shannon and Weaver diversity index (1963) (H) was used. Shannon and Weiver diversity index has been calculated as:

$$H = \sum_{i=1}^{S} (p_i \ln p_i)$$

Where as

H = Shannon and Weiver Index.

Pi = ni / N (ni = number of individuals of the species.

N = Total number of individuals in the sample.)

The value of Shannon and Weiver Index theoretically range from 0.00 to 4.00. Value less than 1.00 indicates poor water quality, value from 1.00 to 3.00 indicates moderate water quality and value above 3.00 indicates good water quality.

Results:-

In the present study four families of Ephemeroptera consisting of 13 species were recorded. Among the recorded species the dominant was *Ephemerella indica* in the station I (Omkareshwar) through the year. Moreover Ephemerellidae was also found in good proportion in the Station I. In the present study the maximum population of Ephemeroptera and Odonata were recorded in the month of March-April and minimum in August. The reason for maximum population was the enough food availability during the rainy seasons and less anthropogenic activities. *Ephemerella indica* was dominant followed by *Epeorus psi* in both station I (Graph -1) and station II (Graph -2) throughout the study period. Population of *Trithemis kirbyi* was recorded highest in May and June months in both stations. Among Odonata the species *Orthetrum pruinosum* was recorded maximum during May June Month month and minimum in October at station II (Graph -2).

The Pearson's correlation coefficient (r) was calculated between Physico-chemical parameters and Aquatic Insects in both stations. Aquatic Insects showed strong negative correlation with pH, Dissolved Oxygen, Sulphate, Nitrate, phosphate and Calcium at all the five stations, while strong positive correlation was observed between Insect species and Biological oxygen Demand. A moderate positive correlation was observed between transparency, Total Hardness and insects species. This indicates that increase in temperature and pH has a significant effect on the diversity of Insects (Graph 3 & 4).

The Insects fauna was analysed for species diversity, species richness and dominance described in Table 1. The value of species diversity of Insect fauna thus obtained varied considerably during the entire sampling. The index ranged from H= 2.70 to H= 3.10 in station I and from H= 2.70 to H= 3.0 in station II. The minimum value was observed in August month and maximum in March 2020. The Simpson's index varied from 0.93 to 0.95 in station I and from 0.92 to 0.94 in station II. (Table 1). The values for all the indices used (diversity, species richness and dominance) were maximum in the month of March as abundance of food available for the benthic organisms.

Discussion:-

The Aquatic insects like Baetidae are highly resistant to pollution and were recorded dominant in station I, as the station I was highly influenced by anthropogenic activities. Such abundance was also recorded by Pir Z. et al (2010).

In the present study among Coenagrionidae family the diversity of *Ceriagrion cerinorubellum* and Enallagma were recorded dominant from month Nov- Jan and among Ephemerellidae family the species like *Ephemerella indica* was dominant from Nov- Jan. such dominancy was also recorded by Chhetry (2011) in Betna wetlands of Nepal.

The distribution and diversity of Insects depend on their abilities of colonization in a habitat and survival. That is related by physico-chemical parameters like temp., hardness and pH. During the present study the pH ranges from 7.6 to 9.0 and the Aquatic Insects species showed strong Negative correlation with pH. Michel et al (2003) and Guerold et al (2000) also observed negative correlation between pH and Insects species. Dissolved oxygen ranges from 7.1 to 9.0 and Insects species show slightly negative correlation with DO. Robert (1988) also observed negative correlation between Insects fauna and DO.

The total Hardness range from 110 to 180 mg/l in both the stations and it was observed that Aquatic insects were slightly Positive correlated with total Hardness. Bhat (2011) observed the positive correlation between Aquatic Insects fauna and total solids in Florentino Ameghino Dam. Pip (2006) reported positive correlation between Aquatic Insects species richness and total hardness.

The Shannon and Weaver index (H) in shallow zone ranged from 2.7 to 3.0 in Omkareshwar station and from 2.7 to 3.0 in Mandleshwar station. The highest value was observed during the month of March. Such dominance value was also observed by Laura et al (2002). The value of "H" indicates that station I and II are slightly polluted. Sinha et al (1995) observed diversity index ranged from 1.74 to 3.69 and found habitat slightly polluted in Feb, Mar and April months. Simpson's dominance value ranged from 0.93 to 0.95 in station I and from 0.92 to 0.94 in station II. The values indicate that the station II is more dominant than station I. Similar observations have been reported by Bernhard et al (2007) giving the community diversity and the species diversity indices of macro invertebrate.

The biological status of water body is expressed in terms of diversity indices. The number of species in a community increases in complexity of food webs and with the extent of niche overlap and species packing (Sugihara 1980). Wilhm and Dorris

(1966) suggested species diversity indices to be >3 in clean water, 1-3 in moderately polluted water and <1 in heavily polluted water.

As the Aquatic Insects form an important link in the food chain and serve as an important protein diet of fishes. Our results raise an important point concerning the regular monitoring of physico-chemical as well as biological parameters of the Narmada river which will be useful in maintaining the productivity of the river. This study shows that the diversity of Aquatic Insects fauna alters with the change in Physico-chemical characteristics and flow of water.

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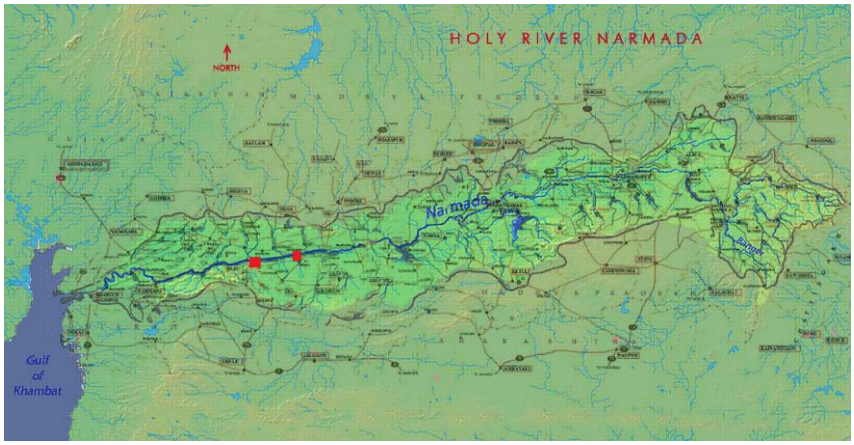
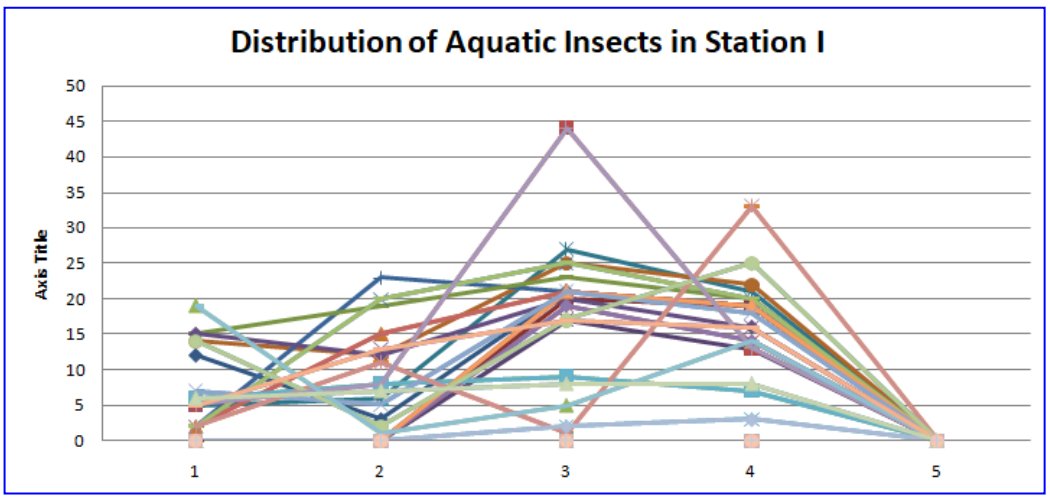
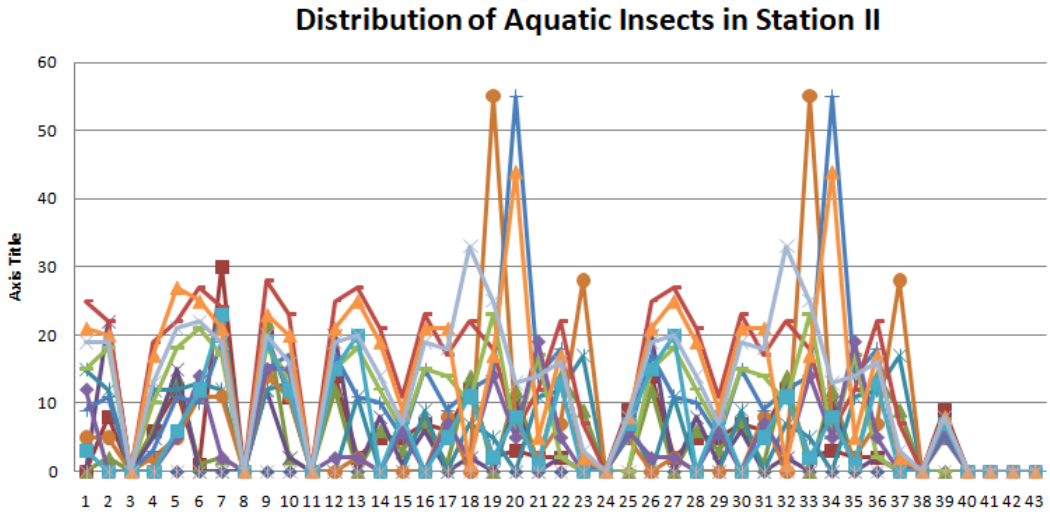
Figure 1. Map of Narmada river showing sampling stations.



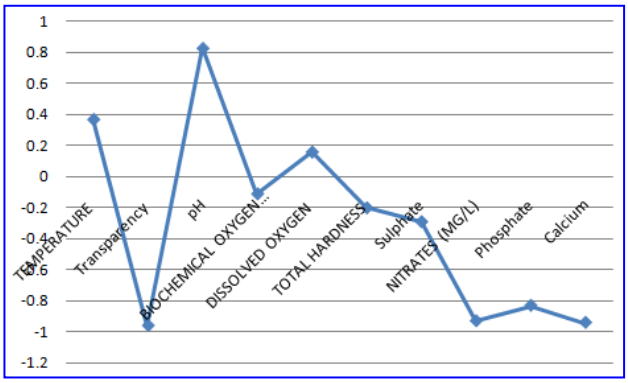
Graph-1. Monthly variation of Aquatic Insects fauna at Omkareshwar (Station I)



Graph-2. Monthly variation of Aquatic Insects fauna at Mandleshwar (Station II)



Graph 3. Correlation coefficient (r) between physico-chemical parameters and Insects fauna of Station I



Graph 4. Correlation coefficient (r) between physico-chemical parameters and Insects fauna of Station II

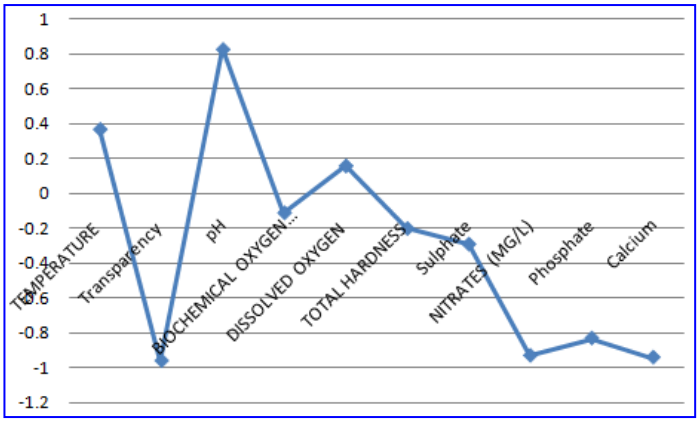


Table 1. Diversity, species richness and dominance for Insects fauna in station I and Station II

Months	**Shannon & Weaver Index**		**Simpson's diversity Index**	
	S-I	**S-II**	**S-I**	**S-II**
Oct.	**2.7**	**2.8**	**0.93**	**0.93**
Nov.	**3.0**	**2.9**	**0.95**	**0.94**
Dec.	**3.1**	**3.0**	**0.95**	**0.94**
Jan.	**3.1**	**3.0**	**0.95**	**0.94**
Feb.	**3.1**	**3.0**	**0.95**	**0.94**
Mar.	**3.1**	**3.0**	**0.95**	**0.94**
Apr.	**3.1**	**3.0**	**0.95**	**0.94**
May.	**3.1**	**3.0**	**0.95**	**0.94**
June.	**3.1**	**3.0**	**0.95**	**0.94**
July.	**3.1**	**3.0**	**0.95**	**0.94**
Aug.	**2.9**	**3.0**	**0.93**	**0.94**
Sep.	**2.8**	**2.7**	**0.93**	**0.92**