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Correlation coefficient between physico-chemical parameter and benthic macro-invertebrates of Omkareshwar to Barwani in Narmada River M.P. India

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Abstract
River Narmada is one of the 13 prominent rivers of India, which covers 98,797 sq km of total water-shed area. Narmada is considered to be the lifeline of Madhya Pradesh and most important west flowing river of India. The monitoring of water quality of Narmada River was carried out for One year August 2015 to July 2016. Omkareswar station-I, Maheshwer Station-II, Mandleshwer Station-III and Barwani station-IV, Four sampling stations were selected at downstream of Narmada River. The main objectives of practice on direct mixing of domestic sewage in to the river and Regular monitoring of physic-chemical as well as biological parameters of the Narmada river. During the study period (2015-2016), temperature showed low negative correlation with annelid at all the station. Moderate negative correlation with arthopoda at station I, II, IV and low negative correlation at station III, pH and other parameter was showed low positive correlation with annelid at station I and II, moderate positive correlation at station III and IV. Low positive correlation with arthropoda at station I and IV, low negative correlation at station II, and Moderate positive correlation at station at station III. Moderate positive correlation with mollusca at station I, III and IV, and low positive correlation at station II.

Keywords: Narmada river, benthic macro invertebrates, annelid, mollusca, arthropods, temperature

1. Introduction
Macro-invertebrates are most frequently used in bio-monitoring studies because the responses of macro-invertebrates to organic and inorganic pollution have been extensively documented (Thorne., Williams., 1997; Kazanci., Dugal., 2000) [28, 6]. They have sensitive life stages that respond to stress and integrate effects of both short-term and long-term environmental stressors (EPA., 1998) and they are important areas for maintaining biodiversity (Meyer *et al*., 2007; Richardson., Danehy., 2007) [12, 20]. The study of benthic macro-invertebrates provides a method to determine the water quality of a stream based on collection and identification of stream-bottom (benthic) macro-invertebrates. This study has been done to water quality assessment using benthic macro-invertebrates. Benthic study in Malwa region of Madhya Pradesh is scare except that of Govindan K., Kashinathan R., Desai BN., 1976 [5], Rao KS *et al*., 1985 [19], Sunny A., Diwan AP., 1991 [27] Sharma S.,and Barkale S 2016 [23], Sharma S *et al*., 2007 [25], Khichi Y and Sharma S., 2017 [9]. The main purpose of this study is to assess the water quality of Narmada river and to suggest the conservative measures to increase the quality of the river.

Materials and Methods
Description of Study Area: The Narmada river is considered as the life line of Madhya Pradesh. The catchment area of the river exists in the States of Madhya Pradesh (86.18%). Benthic Macro invertebrates from four study sites Omkareswer, Mandleshwer, Maheshwer and Barwani of narmada river were studied in every first week of each month for a period of one year that is August 2015 to July 2016.

A Collection, Handling and Preservation of Benthic Fauna:
Collection of sample:- Different methods were employed to collect benthic macro invertebrates from the target habitat. Samples were collected from the deeper profundal zone by using EKman grab and at shallow profundal zone by using Surber sampler following Wetzel (2001) [32]. Quantitative sampling was done by Kick net, Cast net, Gill net and Surber sample.

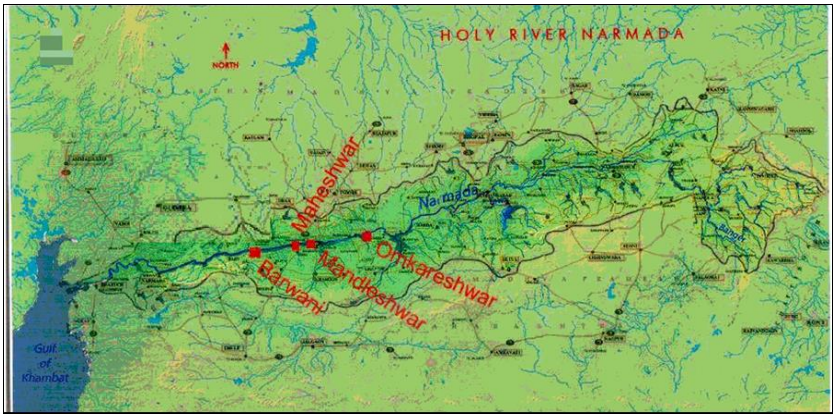

Fig 1: Map of Narmada river showing sampling stations

Identification of Samples

Collected samples were examined under a standard microscope with proper resolution and the fauna was identified using cited taxonomic literature. Samples were assigned to a family /species using taxonomic keys; APHA (2005) [3], Pennak (2004), Welch (1998), Tonapi (1980) and Needham & Needham (1969).

Correlation analysis

The relation ship between the physico-chemical parameter and fresh water macro- in vertebrate species was calculated by Pearson's correlation coefficient(r) by the help of various software's.

The planktons, macrophytes used as food by macro in vertebrates were studied at the sampling site by using HKH protocol of benthic macroinvertebrate version 15-02-2006. Habitat study was carried out with the help of protocol multi habitat sampling of benthic invertebrates version Nov-2005.

Observations and result

During the study period (2015-2016), temperature showed low negative correlation with annelid at all the station. Moderate negative correlation with arthopoda at station I,II,IV and low negative correlation at station III. Low negative correlation with mollusca at all the stations. (Table 1, 2, 3, 4).

During the study period (2015-2016), pH showed low positive correlation with annelid at station I and II, moderate positive correlation at station III and IV. Low positive correlation with arthropoda at station I and IV, low negative correlation at station II, and Moderate positive correlation at station at station III. Moderate positive correlation with mollusca at station I,III and IV, and low positive correlation at station. II(Table 1, 2, 3,4).

During the study period (2015-2016), transparency showed moderate positive correlation with annelid at station I,II and IV and low positive correlation at station III. Moderate positive correlation with arthopoda at station I, and high positive correlation at station II,III and IV. High positive correlation with molusca at station I,II and III, and moderate positive correlation at station IV.(Table 1,2,3,4).

During the study period (2015-2016), total dissolved solids showed low positive correlation with annelid at station I,II and IV and moderate positive correlation at station III. Moderate negetive correlation with arthopoda at station I, and low negetive correlation at station II, and IV. High positive correlation at station III. Low negative correlation with mollusca at station I and II.(Table 1,2,3,4).

During the study period (2015-2016), biochemical oxygen demand showed low positive correlation with annelida at station I and II, moderate positive correlation at station III and IV. Moderate positive correlation with arthopoda at station I and II, higher posetive correlation with mollusca at station I,III and IV, while higher positive correlation at station II.(Table 1,2,3,4).

During the study period (2015-2016), dissolved oxygen showed low negative correlation with annelida at station I and III and low positive correlation at station II and IV. Moderate positive correlation with arthopoda at station I and low posetive correlation at station II,III and IV.Low positive correlation with mollusca at station I,II and III and low negative correlation at station IV.(Table 1,2,3,4).

During the study period (2015-2016), chemical oxygen demand showed low positive correlation with annelida at station I and II, moderate positive correlation at station III and IV. Moderate positive correlation with arthopoda at station I and II, higher posetive correlation with mollusca at station I,III and IV, while higher positive correlation at station II.(Table 1, 2, 3, 4).

Table 1: Karl Pearson`S coefficient of correlation between physico-chemical parameter and benthic macro-invertebrates at station–I (Omkareshwar) 2015-2016

Serial no.	Parameters	Annelida (Oligochata and Hirudinea)	Arthopoda (Crustacian and Insecta)	Mollusca (Gaatropoda and Pelecypoda)
1.	Temperature	-0.102	-0.057	-0.23
2.	pH	0.239	0.320	0.323
3.	Transparency	0.659	0.730	0.323
4.	Total Dissolved Solids	-0.244	-0.023	0.538
5.	Biochemical Oxygen Demand	0.509	0.610	0.705
6.	Dissolved Oxygen	-0.765	-0.702	-0.162
7.	Total Hardness	-0.534	-0.101	0.636
8.	Alkalinity	0.744	0.690	0.345
9.	Total Calcium Hardness	0.606	-0.519	0.065
10.	Chloride	0.804	0.751	0.277
11.	Nitrate	0.174	-0.011	0.346
12.	Phosphate	-0.288	-0.575	-0.589
13.	Sulphate	0.512	0.086	0.529
14.	Free Carbon Dioxide	0.445	0.460	-0.318
15.	Total Suspended Solids	0.354	0.082	0.523
16.	Chemical Oxygen Demand	-0.503	0.039	0.674

Table 2: Karl Pearson`S coefficient of correlation between physico-chemical parameter and benthic macro-invertebrates at station–II (Mandleshwar) 2015-2016

Serial no.	Parameters	Annelida (Oligochata and Hirudinea)	Arthopoda (Crustacian and Insecta)	Mollusca (Gaatropoda and Pelecypoda)
1.	Temperature	-0.159	-0.181	-0.165
2.	pH	0.305	0.298	0.446
3.	Transparency	0.388	0.225	0.628
4.	Total Dissolved Solids	0.160	0.279	0.257
5.	Biochemical Oxygen Demand	0.722	0.130	0.255
6.	Dissolved Oxygen	0.568	0.516	0.359
7.	Total Hardness	0.174	-0.038	0.372
8.	Alkalinity	0.580	0.535	0.419
9.	Total Calcium Hardness	0.428	0.578	0.380
10.	Chloride	0.539	0.610	0.384
11.	Nitrate	0.094	0.158	0.153
12.	Phosphate	0.315	0.267	0.573
13.	Sulphate	0.108	0.251	0.219
14.	Free Carbon Dioxide	0.368	0.369	0.502
15.	Total Suspended Solids	-0.321	0.311	0.464
16.	Chemical Oxygen Demand	0.485	0.477	0.310

Table 3: Karl Pearson`S coefficient of correlation between physico-chemical parameter and benthic macro-invertebrates at station–III (Maheshwar) 2015-2016

Serial no.	Parameters	Annelida (Oligochata and Hirudinea)	Arthopoda (Crustacian and Insecta)	Mollusca (Gaatropoda and Pelecypoda)
1.	Temperature	-0.053	-0.002	-0.028
2.	pH	0.039	0.122	0.141
3.	Transparency	0.610	0.340	0.461
4.	Total Dissolved Solids	0.104	0.050	0.142
5.	Biochemical Oxygen Demand	0.570	0.110	0.178
6.	Dissolved Oxygen	-0.050	0.156	0.187
7.	Total Hardness	0.160	0.312	0.109
8.	Alkalinity	0.712	0.523	0.503
9.	Total Calcium Hardness	0.066	0.141	0.147
10.	Chloride	0.099	0.010	-0.157
11.	Nitrate	0.500	0.339	0.475
12.	Phosphate	0.381	0.235	0.128
13.	Sulphate	0.168	0.467	0.299
14.	Free Carbon Dioxide	0.324	0.375	0.447
15.	Total Suspended Solids	-0.309	0.606	0.090
16.	Chemical Oxygen Demand	0.461	0.328	0.426

Table 4: Karl Pearson`S coefficient of correlation between physico-chemical parameter and benthic macro-invertebrates at station–IV (Barwani) 2015-2016

Serial no.	Parameters	Annelida (Oligochata and Hirudinea)	Arthopoda (Crustacian and Insecta)	Mollusca (Gaatropoda and Pelecypoda)
1.	Temperature	-0.134	-0.136	-0.076
2.	pH	0.583	0.528	0.509
3.	Transparency	0.048	0.079	0.054
4.	Total Dissolved Solids	0.104	0.178	0.3
5.	Biochemical Oxygen Demand	0.685	0.636	0.598
6.	Dissolved Oxygen	-0.715	0.659	0.641
7.	Total Hardness	0.596	0.690	0.592
8.	Alkalinity	0.747	0.614	0.592
9.	Total Calcium Hardness	0.495	0.515	0.440
10.	Chloride	0.225	0.257	0.139
11.	Nitrate	0.091	0.103	0.066
12.	Phosphate	-0.470	0.462	0.410
13.	Sulphate	0.192	0.250	0.242
14.	Free Carbon Dioxide	0.536	0.616	0.525
15.	Total Suspended Solids	0.357	0.245	0.320
16.	Chemical Oxygen Demand	-0.367	0.128	0.117

Conclusion

Benthic macro-invertebrates are ecologically important organisms in food webs and are integral in establishing trophic structure of an aquatic ecosystem. They mix the sediments allowing exchange of oxygen, nutrients and pollutants between the water column and the bottom. Because of their inability to escape exposure to changing conditions (relative to more motile aquatic fauna), benthic macro-invertebrates are often used to assess the condition of an aquatic system since they integrate numerous environmental factors over time exceeding those of typical water quality monitoring.

During the study period August 2009 to July 2012, in each station Omkareshwar S-I, Mandleshwar S-II, Maheshwar S-III and Barwani S-IV are collected a several species of benthic macro invertebrates. Most dominant species was Tubifex Tubifex (Oligocheta), Tubifex albicola was less sensitive, Ephemara nadinae (Insecta), Thiara scabra (Gastropoda) was less sensitive.

Recommendation

1. A continuous monitoring of the physico-chemical, biological, and microbiological parameters of this river is needed for in -situ conservation of aquatic biodiversity.
2. A definite impact on the water mass for increase in the development of submerged saprophytes and aquatic weeds which promote eutrophication must be prevented by taking advance precaution in this record.

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