

WATER QUALITY ASSESSMENT OF SHAHPURA LAKE, BHOPAL (M.P.) INDIA USING BENTHIC MACRO-INVERTEBRATES

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Received : 25.01.18; *Accepted* : 22.03.18**ABSTRACT**

Shahapura Lake is manmade perennial situated in Bhopal (M.P.) India. The main source of water to this lake is rain water and sewage water from residential colonies. Samples were collected and analyzed to check the pollution status of Shahapura Lake. Present study deals with quantitative and qualitative analysis of macro-zoobenthic invertebrates of the lake together with the assessment of physicochemical parameters. The water quality was assessed by using BMWP and ASPT scoring index and physicochemical parameters as per APHA. During investigations total 34 genera were found belonging to 24 families respectively. The presence of higher number of oligochaetes and chironomids (pollution indicating species) alongwith the scores obtained by BMWP and ASPT index indicated that the water body was polluted. The detailed study was further carried out and correlated with the findings of physicochemical parameters like DO, BOD, COD, TDS, Alkalinity, Chloride, Carbonate, Bicarbonate, Calcium and Total hardness etc.

Figure : 00

References : 16

Tables : 05

KEY WORDS : ASPT scores, Benthic macro-invertebrates, Bio-indicators, Bio-monitoring, BMWP.

Aim and Objectives

To study the impact of seasons on biodiversity and provide information, regarding the effect of pollution on biodiversity, alongwith study of macro-zoobenthic invertebrates in two different seasons in relation to its physicochemical parameters.

Introduction

Benthic macro-invertebrates are used as bio-indicators for water quality assessment. These bottom dwelling aquatic organism without back bone, are easily collected and generally visible with naked eye. They generally hide under rocks, cobbles and green grasses found at the shore as well as at the centre of water body. Macro-zoobenthic invertebrates include many common insect such as Ephemeroptera, Dragon flies, damsel flies and crane flies. The abundance of macro-zoobenthos varies across different habitat's which depends upon the provisions suitable for breeding, hiding, sheltering, egg laying and oxygen supply criteria⁴. These invertebrates can constitute the benthic fauna of water bodies and their presence or absence can provide reliable assessment for long term ecological changes in the quality and rapidly changing physico-chemical characteristics of water

bodies. The assessment done by studying the benthic organisms is known as Bio-assessment *i.e.* systematic use of living organisms for monitoring and analysis of water quality is known as Biomonitoring. Biomonitoring is feasible in aquatic ecosystem to obtain a quick assessment of water quality¹⁰. So these organisms can be used as Bio-indicators to assess the water quality. Their presence or absence can predict the physico-chemical conditions defining the status of given water body, *e.g* presence of numerous families of highly intolerant species is usually an indication of good water quality and presence of highly tolerant species is the indicator of poor water quality. Ecological functioning and water quality of these ecosystems is affected by anthropogenic activities along the catchment areas^{5,8,15}. Introduction of human activities in the water bodies can alter the habitat structure of macro-zoobenthic diversity¹¹. The diversity and abundance of macro-zoobenthic fauna in the dry season were higher than that of the rainy season and the water quality was more polluted during rainy season as compared to the dry season⁵.

Materials and Methods

Study Area: Shahpura Lake is having longitude

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TABLE-1: Physico-chemical parameters of water during summer and monsoon season.

Names of physicochemical Parameters.	Summer (2015)		Monsoon (2015)	
	PCB**	BANSAL*	PCB**	BANSAL*
	Site 1st	Site 2nd	Site 1st	Site 2 nd
pH	8	8.3	7.6	7.8
water temp(0°C)	38.5	38.7	30.4	30.7
Air temp(0°C)	40.8	41.2	34.6	34.8
Conductivity(ms/cm)	0.78	0.74	0.45	0.39
Total dissolved solids(mg/l)	475.8	451.4	274.5	237.9
Dissolved oxygen(mg/l)	3	4	3.2	3.8
Free Co ₂	8	6	10	8
Turbidity(FNU)	45	43	55	52
Total alkalinity(mg/l)	182	176	168	164
Carbonate alkalinity(mg/l)	0	0	0	0
Bicarbonate alkalinity(mg/l)	182	176	168	164
Total hardness(mg/l)	156	150	160	156
Calcium hardness(mg/l)	132.3	128.1	128.1	121.8
Magnesium hardness(mg/l)	23.7	21.9	31.9	34.2
Chloride(mg/l)	58.94	56.94	47.95	45.95
Nitrate(mg/l)	2.76	2.32	2.55	2.31
Orthophosphate(mg/l)	2.84	2.28	2.65	2.18
BOD(mg/l)	32	28	28	24
COD(mg/l)	100	84	92	88

**PCB = Pollution Control Board, *BANSAL= near Bansal Hospital.

77.4229°E and latitude 23.2031°N receiving untreated sewage and waste water from the eastern northern and southern part of the lake. The other main stream which joins the lake comes from Shahapura hillocks and Shahapura residential colony. The lake is surrounded by hillock and forms a depression or valley. The western part of the lake is covered by MACT hill while southern part is occupied by the Shahapura hillock. The water

samples were collected from two stations viz., near P.C.B. (pollution control board) site 1st and BANSAL (near BANSAL hospital) site 2nd in two seasons. (summer and monsoon).

Methodology: The sampling was done using net of 500 µm mesh size for collecting the macro-invertebrates. Each pickable large boulder or cobble in the area was picked up and organisms washed vigorously by hand into

TABLE -2 : Macrozoobenthic invertebrates recorded during summer and monsoon season.

S.No.		Taxa	Summer season		Monsoon season	
			P.C.B.**	BANSAL*	P.C.B.**	BANSAL*
			Site 1st	Site 2nd	Site 1st	Site 2nd
	Phylum	MOLLUSCA				
	Class	Gastropoda				
	Order	Caenogastropoda				
	Family	Viviparidae				
1		<i>Bellamyia bengalensis</i>	+	+	+	+
2		<i>Bellamyia dissmilis</i>	+	-	-	-
3		<i>Viviparus viviparus</i>	+	+	+	-
4		<i>Viviparus connectus</i>	-	-	+	+
5		<i>Viviparus manull atus</i>	-	-	-	+
	Order	Hygrophila				
	Family	Planorbidae				
6		<i>Indoplanrobis exustus</i>	+	-	-	-
	Order	Basommatophore				
	Family	Lymneidae				
7		<i>Lymnaea auricularia</i>	+	+	-	+
8		<i>Lymnea ovate</i>	-	-		+
	Order	Littorinimorpha				
	Family	Bithyniidae				
9		<i>Bithynia tenticulata</i>	-	+	-	-
	Family	Hydrobiidae				
10		<i>Peringa ulvae</i>	-	+	-	-
	Phylum	ARTHROPODA				
	Class	Insecta				
	Order	Diptera				
	Family	Chironomidae				
11		<i>Chironomous sps.</i>	+	+	+	+

	Family	Culicidae				
12		<i>Culex Sp.</i>	+	-	-	-
	Order	Odonata				
	Family	Gomphidae				
13		<i>Gomphus Sp.</i>	+	-	+	-
	Family	Libellulidae				
14		<i>Libellule</i>	-	+	-	+
	Family	Aeshinidae				
15		<i>Anax junix</i>	+	-	+	-
	Family	Coenagrionidae				
16		<i>Argia Sp.</i>	-	-	+	-
	Order	Ephemeroptera				
	Family	Cordulegastridae				
17		<i>Cordulegaster</i>	-	+	+	-
	Family	Caenidae				
18		<i>Caenis Sp.</i>	+	-	-	-
	Order	Coleoptera				
	Family	Hydrophilidae				
19		<i>Berosus Sp.</i>	+	+	+	-
	Order	Hemiptera				
	Family	Notonectidae				
20		<i>Notonecta</i>	+	-	+	-
21		<i>Buenoa burtsa</i>	-	-	+	+
	Family	Corixidae				
22		<i>Sigara Sp.</i>	+	+	-	-
23		<i>Micronecta scholtzi</i>	-	+	+	+
	Family	Belostomatidae				
24		<i>Abedus herberti</i>	+	-	+	-
	Family	Naucoridae				

25		<i>Pelcoris Sp.</i>	+	+	+	+
	Family	Nepidae				
26		<i>Nepa Sp.</i>	-	+	+	+
27		<i>Ranatra Sp.</i>	-	-	+	+
	Phylum	ANNELIDA				
	Class	Oligocheata				
	Order	Haplotaxida				
	Family	Tubificidae				
28		<i>Tubifix Sp.</i>	-	+	+	+
29		<i>Limnodrilus Sp.</i>	-	+	-	+
30		<i>Branchura Sp.</i>	-	+	-	+
31		<i>Stylaria lacustris</i>	-	+	-	+
	Family	Megascolecidae				
32		<i>Pheretima Sp.</i>	-	-	-	+
	Class	Clitellata				
	Order	Rhynchobdellida				
	Family	Glossiphoniidae				
33		<i>Glossiphonia</i>	+	-	+	+
	Order	Arhynchobdellida				
	Family	Hirudidae				
34		<i>Hirudinea</i>	+	+	+	-

**PCB = Pollution Control Board,*BANSAL= near Bansal Hospital

the net. Finally, the substrate with smaller boulders was disturbed by kicking by feet 3 – 4 times such that the organisms were collected into the net. The organisms were carefully picked up from the net and finally preserved immediately in 70% ethanol for further identification. The samples were collected in plastic containers and analyzed for physicochemical parameters using standard methods³. The samples for microbiological examination were collected in sterilized and dried non-reactive Borosilicate glass bottles.

Results and Discussion

1. Physico-chemical parameters:

Physico-chemical parameters for water quality were analysed as per Standard methods^{2,3}. Physico-chemical parameters on investigation showed variations in different aquatic habitats. Fluctuations in physico-chemical characteristics can affect the biological diversity of water bodies⁹. The water temperature ranged from minimum mean value 30.55 °C, to maximum mean value 38.6°C and air temperature varied from minimum mean

value 34.7°C to maximum mean value 41°C during the present study.

The highest temperature was recorded at site 2nd (near BANSAL hospital) during summer season and lowest temperature was recorded at site 1st (near P.C.B.) during monsoon season. Conductivity of water varied with catchment characteristics of the concerned water body. The highest conductivity 0.78 ms/cm was recorded at Site 1st (near PCB) during summer season and lowest conductivity 0.39 ms/cm at Site 2nd (near BANSAL hospital) during monsoon season. The value of T.D.S. ranged between maximum mean values 463.2 ppm in summer to minimum mean value 256.4 ppm in monsoon season. This is an indication of concentration of dissolved electrolyte ions in the water which indicated that polluting effluents had entered the water body. The pH of the water varied between 7.6 to 8.3 with maximum mean values 8.15 during summer season and minimum mean value 7.7 during monsoon season. pH is a function of amount of Ca, Mg, carbonate and CO₂ in water¹. The alkalinity of Shahpura Lake ranged from a minimum mean value 166 in monsoon to maximum mean value 179 mg/l in summer season. Alkalinity was due to presence of bicarbonate of calcium and magnesium. Carbon-dioxide was the main component of buffer system in the lakes. The carbon dioxide ranged from a minimum mean value of 7mg/l in summer season and maximum mean value 9 mg/l in monsoon season. Comparatively when the ratio of carbon dioxide during monsoon season increased, at the same time the ratio of alkalinity decreased in the water body. While during summer season the decrease in the carbon dioxide concentration results an increase in the alkalinity. The value of D.O. was observed ranging from a minimum mean value 4 mg/l in monsoon and maximum mean value 4.6 in summer. The total hardness of Shahpura Lake ranged between the minimum mean value 153 mg/l during monsoon season and maximum mean value 158 mg/l. During monsoon season increase in hardness was due to the addition of domestic sewage with rain water from the surrounding areas during monsoon season. Calcium hardness recorded between minimum mean value 124.95 during monsoon season and maximum mean value 130.2 during summer season and magnesium hardness depicted mean value 22.8 during summer season and maximum mean value 33.05 during monsoon season. Chloride concentration showed fluctuations minimum mean value 46.95 mg/l during monsoon season and maximum mean value 57.94 mg/l. Turbidity varied from minimum mean value 44 FAU during summer season turbidity and maximum mean value 53.5 FAU during monsoon season. Temperature plays vital role in aquatic ecosystem, it regulates aquatic biological process. Water temperature showed close relationship with air temperature. Increase or decrease of water temperature

TABLE -3 : BMWP and ASPT scores for site 1st (PCB) and site 2nd (BANSAL hospital) of Shahpura Lake in Summer season.

S. No.	Invertebrate Families	BMWP Scores	BMWP Scores
		Site 1 st	Site 2 nd
01	Aeschnidae	8	-
02	Cordulegasteridae	-	8
03	Gomphidae	8	-
04	Libellulidae	-	8
05	Caenidae	7	-
06	Bithynidae	-	6
07	Viviparidae	6	6
08	Naucoridae	5	5
09	Nepidae	-	5
10	Notonectidae	5	-
11	Belostomatidae	5	-
12	Corixidae	5	5
13	Hydrophilidae	5	5
14	Culicidae	5	-
15	Hydrobiidae	-	3
16	Hirudidae	-	3
17	Lymnaeidae	3	3
18	Planorbidae	3	-
19	Glossiphonidae	3	-
20	Chironomidae	2	2
21	Tubificidae	-	1
	BMWP SCORE	70	60
	ASPT SCORE	5	4.6

depends upon variations done in the atmospheric temperature in different seasons of that area. The pH of Shahpura lake indicated the impact of domestic sewage and decomposing organic matter on the water body which resulted in the decrease of pH value and increase in the carbon dioxide and bicarbonate contents of the water. Higher the value of alkalinity during summer season indicates the accumulation of bicarbonates of calcium and magnesium and less the value of alkalinity in monsoon season might be due to the dilution by addition of rain water to this water body from surrounding. Hardness seems to be influenced by the anthropogenic activities along the catchment area⁵. Turbidity increases in the monsoon season due to the excessive flow of mud and silt along with sewage water into the water body. B.O.D. ranging from minimum mean value 26 mg/l during monsoon season and maximum mean value 30 mg/l during summer season. C.O.D. value varies from minimum mean value 90 mg/l during monsoon season and maximum mean value 92 mg/l during season. These variations in the physico-chemical parameters cause direct impact on the biotic components of water body¹².

2. Biological data:

In present survey a total of 34 generas belonging to 24 families and 12 orders were identified. (Table -2) Identification of the obtained macrozoobenthic invertebrates was carried out with the help of keys¹³⁻¹⁴.

Total number of families observed at site 1st (near PCB) were having 10 orders and 16 generas out of which 10 families belong to phylum arthropoda, 3 families belong to phylum mollusca and 1 family belong to phylum annelida. Here the dominating species were of phylum arthropoda. Number of families observed at site 2nd (near BANSAL hospital) were 13 having 10 orders and 18 generas out of which 7 families belong to phylum arthropoda, 4 families to phylum mollusca and 2 families to phylum annelida.

Number of families observed at site 1st (near PCB) during monsoon season were 15 having 10 orders and 19 generas out of which 10 families belongs to phylum arthropoda, 2 families belong to mollusca and 3 families belong to phylum annelida. The families observed at site 2nd (near BANSAL hospital) during monsoon season were 11 having 8 orders and 18 generas, out of these families 6 belong to phylum arthropoda, 2 families belong to mollusca and 3 families belong to phylum annelida. Presence of oligochaetes and chironomids and molluscans were higher than arthropoda which clearly indicate that water was polluted.

The BMWP score is an index for measuring the biological quality of water body by using species of macro-invertebrates as biological indicators⁷. Biological

TABLE-4 : BMWP and ASPT scores for site 1st (PCB) and site 2nd (BANSAL hospital) of Shahpura lake in Monsoon season

S. No.	Invertebrate Families	BMWP Scores	
		Site 1 st	Site 2 nd
01	Aeschnidae	8	-
02	Cordulegastridae	8	-
03	Gomphidae	8	-
04	Libellulidae	-	8
05	Coenagrionidae	6	-
06	Viviparidae	6	6
07	Notonectidae	5	5
08	Nepidae	5	5
09	Naucoridae	5	5
10	Belostomatidae	5	-
11	Corixidae	5	5
12	Hydrophilidae	5	-
13	Lymnaeidae	-	3
14	Glossiphonidae	3	3
15	Hirudidae	3	-
16	Chironomidae	2	2
17	Tubificidae	1	1
18	Megascolicidae	1	1
	BMWP SCORE	75	44
	ASPT Score	5	4

monitoring by using biotic scores along with physico-chemical analysis of water quality can display the total health of the water body¹³. The BMWP score calculated for site 1st was 70 and the ASPT value obtained was 5. The BMWP score for site 2nd was 60 and ASPT value was 4.6 (Table-3). The obtained score of BMWP and ASPT

TABLE-5 :. The BMWP and ASPT score table showing biological quality and water quality¹⁶

BMWP		ASPT	
BMWP Score	Biological Quality	ASPT Score	Water Quality
Over 130	A. Very good biological quality (natural)	Over 7	Very good (Natural)
81 – 130	B. Good biological quality	6.0 – 6.9	Good
51 – 80	C. Fair biological quality	5.0 – 5.9	Fair
11 – 50	D. Poor biological quality	4.0 – 4.9	Poor
0 – 10	E. Very poor biological quality	3.9 or less	Very poor

revealed that water was moderately polluted at site 1st (inlet near PCB) and belong to class C, *i.e.* Fair water quality and more polluted at site 2nd (outlet near BANSAL hospital), which belongs to class D, *i.e.* poor water quality during summer season (Table-3 & 5). The calculated BMWP and ASPT scores for site 1st during monsoon season was 75 and 5 While at site 2nd BMWP and ASPT scores was 44 and 4 respectively.(Table-4). The obtained score of BMWP and ASPT indicates that water was moderately polluted at site 1st (near PCB) and belongs to class C, *i.e.* fair water quality, and heavily polluted at site 2nd (near BANSAL hospital). Which belongs to class D *i.e.*, poor water quality during monsoon season (Table-4 & 5). Thus the result of physico- chemical and biological

parameters both confirms the pollution status of Shahpura Lake during summer and monsoon season.

Conclusion

The biological study of water of Shahpura Lake shows that the use of macro-invertebrates as bioindicators is a valuable monitoring tool in comparison to the physico-chemical analysis in accessing quality of water, as it provides the cumulative assessment of water body. The biological assessment reflects that the Shahpura Lake is having an impact of pollution from the surrounding areas. The need of the hour is to create environmental awareness among the nearby inhabitants regarding quality of water and effect of pollution on water bodies.

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