

Original Research Article

Comparative study of macrozoobenthic invertebrates of upper lake and Shahpura lake (district Bhopal, M.P.), in relation to its water quality

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Abstract

Present study was conducted on the Upper lake and Shahpura lake of Bhopal (M.P), during monsoon season 2016. The main sources of water to Upper lake is river Kolans and river Uljhawan along with the rain water during monsoon season from its catchment area. The water of upper lake is fresh and utilized for domestic purposes. Whereas the main source of water to Shahpura lake is rain water and sewage water from the surrounding residential colonies. The water of Shahpura lake is polluted and not utilized for domestic purposes. During observation 27 families and 12 orders were found, which belongs to phylum annelida, arthropoda and mollusca, respectively. Physico-chemical and biological parameters were analyzed to check the pollution status of both the water bodies. Physico-chemical parameters of water quality and biological parameters along with the BMWP and ASPT score's can help us to correlate the pollution status of both the water bodies.

Key Words: Macrozoobenthos, physico-chemical parameters, bio-monitoring, BMWP and ASPT scores.

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INTRODUCTION

Fresh water is most precious gift of nature to mankind and all other living organisms on earth for sustenance of life. So water bodies needed to be conserved. Lakes are good source of fresh water in various parts of world. Human interference like setting of industries, factories and residential buildings near the catchment areas of water bodies, and permanent disposal of all types of wastes, viz. sewage water, laundry water, kitchen house hold water and garbage's which comes directly in contact with these water bodies. Due to human interference the water quality of these water bodies are deteriorating day by day¹. Therefore fresh water bodies are subjected to

increasing degradation by anthropogenic activities regarding their biological, physical and chemical conditions²⁻³⁻⁴⁻⁵⁻⁶⁻⁷. The changing water quality of aquatic environment can be identified by the presence or absence of benthic macro-invertebrates. Aquatic macro-invertebrates used to check the water quality condition is known as biomonitoring. The diversity and short life cycle of these macro-invertebrates can present the ideal image of wet land's ecology⁸. The present study is focused on two tropical wetland's (locally called Barra Tallab and Shahpura lake) named Upper lake and Shahpura lake in M. P., District Bhopal, India. The aim of the study is to find out the water quality of both the wetlands using physico-chemical parameters and aquatic insects as bioindicators.

MATERIAL AND METHODS

Study Area: The Upper lake is an irregular shaped water body having deposits of avifaunal, macrophytic and zoobenthic diversity. The lake is having longitude 77⁰ 3382 E and latitude 23⁰ 2532 N was formed till 11th century by constructing earthend dam (Kamla park) on river kolans near Retghat having catchment area of 361 km². Maximum depth at the centre of lake is 13 m and

minimum depth 0.35 m. The lake receives water mainly from river Kolans and river Uljhawan and from catchment area during rainy season. Samples were collected from two Stations viz., point where Kolans river meet with the Upper lake near Itkhedi gaon and 2nd station at Bhadbada near Sairsapata park, in monsoon season 2016. Shahpura lake is having longitude 77.4229⁰E and latitude 23.2031⁰N 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, Inlet) station 1st and BANSAL (near BANSAL hospital- outlet) station 2nd in monsoon season 2016.

Methodology: The sampling was done by using net of 500 µm mesh size for collecting the macro-invertebrates. Each pick able large boulder or cobble in the area was picked up and organisms washed vigorously by hand into the net. Finally, the substrate with smaller boulders was disturbed by kicking by feet 3 – 4 times such that the organisms are 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 container and analyzed for physicochemical parameters using standard methods suggested by American Public Health Association (APHA)⁹. The samples for microbiological examination were collected in sterilized and dried non-reactive Borosilicate glass bottles.

RESULTS AND DISCUSSION

Physico chemical parameters: Physico-chemical parameters for water quality were analyzed as per APHA⁹ and ADONI¹⁰. Physico-chemical parameters on investigation showed variations in different aquatic habitats. Fluctuations in physico-chemical characteristics can affect the biological diversity of water bodies¹¹. Table-1 shows that the water temperature ranges between 25.2 to 26.8 °C and air temperature varied between 27°C to 29°C during the present study. The highest water temperature was recorded at station 2nd (BANSAL) of Shahpura lake and lowest water temperature was recorded at station 1st (Kolans) of Upper lake during monsoon season. Highest air temperature was recorded at station 2nd (BANSAL) of Shahpura lake and lowest air temperature was recorded at station 1st (Kolans) of Upper lake. Conductivity of water varies with catchment characteristics of the concerned water body. The highest conductivity 0.68 ms/cm was recorded at Station 2nd (near

BANSAL) of Shahpura lake and lowest conductivity 0.3 ms/cm at station 2nd (Bhadbada) of Upper lake during monsoon season. The T.D.S. ranges from minimum value 134.2 ppm at station 1st (Kolans) of Upper lake to maximum value 414.8 ppm at station 2nd (BANSAL) of Shahpura lake. This is an indication of concentration of dissolved electrolyte ions in the water which indicate that polluting effluents have entered more in Shahapura lake than that of the Upper lake. The pH of the water varies between 7.4 to 7.8 with maximum value 7.8 at 2nd station (Bhadbada) of Upper lake and minimum value 7.4 at station 1st (Kolans) of Upper lake during monsoon season. The pH is a function of amount of Ca, Mg, carbonate and CO₂ in water¹². The highest alkalinity 164 mg/l was recorded at station 2nd (Bhadbada) of Shahpura lake and lowest alkalinity 70 mg/l was recorded at station 1st (Kolans) of Upper lake. Alkalinity is due to presence of bicarbonate of calcium and magnesium. The carbon dioxide ranges from a minimum value of 2 mg/l at station 2nd (Bhadbada) of Upper lake to maximum value 16 mg/l at station 1st (P.C.B.) of Shahpura lake. D.O. was observed ranging from a minimum value 2.6 mg/l and 3.2 mg/l at station 2nd (BANSAL and Bhadbada) of both the lakes, and maximum value 6.2 mg/l at station 1st (Kolans) of Upper lake.

Table 1: Physico-chemical parameters of water of Upper lake and Shahpura lake during monsoon season 2016.

Physicochemical Parameters.	UPPER LAKE		SHAHPURA LAKE	
	KOLANS Station 1 st	BADHBADA Station 2 nd	PCB* Station 1 st	BANSAL** Station 2 nd
pH	7.4	7.8	7.5	7.6
Water temp(0°C)	25.2	26	26	26.8
Air temp(0°C)	27	28.3	29	28
Conductivity(ms/cm)	0.22	0.3	0.6	0.68
Total dissolved solids(mg/l)	134.2	183	366	414.8
Dissolved oxygen(mg/l)	6.2	3.2	4.6	2.6
Free CO ₂	6	2	16	10
Turbidity(FAU)	86	52	152	114
Total alkalinity(mg/l)	70	80	138	164
Carbonate alkalinity(mg/l)	0	0	0	0
Bicarbonate alkalinity(mg/l)	70	80	138	164
Total hardness(mg/l)	44	76	150	180
Calcium hardness(mg/l)	42	73.5	126	130.2
magnesium hardness(mg/l)	2	2.5	24	49.8
Chloride(mg/l)	7.99	14.99	38.99	41.99
nitrate(mg/l)	1.75	1.42	2.66	2.28
Orthophosphate(mg/l)	1.23	1.18	1.45	1.65
BOD(mg/l)	2.4	3.6	24	86
COD(mg/l)	6	12	64	224

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

The total hardness of both the lakes ranges between the minimum value 44 mg/l at station 1st (Kolans) of Upper lake and maximum value 180 mg/l at station 2nd (BANSAL) of Shahpura lake. During study increase in hardness is more in water of Shahpura lake than that of Upper lake is due to addition of domestic sewage with rain water from the surrounding areas into these water bodies. Due to excess water holding capacity and large size of upper lake the effect of domestic sewage effluents is low as compared to that of Shahpura lake, having less water holding capacity and size. Calcium hardness ranges from minimum value 42 mg/l at station 1st (Kolans) of Upper lake to maximum value 130.2 at station 2nd (BANSAL) of Shahpura lake. Minimum magnesium hardness value depicted 2 mg/l at 1st station (Kolans) of Upper lake and maximum value 49.8 mg/l depicted at the 2nd station (BANSAL) of Shahpura lake. Chloride concentration shows minimum value 7.99 mg/l at station 1st (Kolans) of Upper lake and maximum mean value 41.99 mg/l at station 2nd (BANSAL) of Shahpura lake. Turbidity varies from minimum value 52 FAU at station 2nd (Bhadbada) of Upper lake and maximum value 152 FAU at station 1st (P.C.B.) of Shahpura lake. 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 depends upon variations done in the atmospheric temperature during monsoon season in tropical region. The pH of Upper lake and Shahpura lake indicates the impact of domestic sewage and decomposing organic matter on the water bodies which results in the decrease of pH value and increase in the carbon dioxide and bicarbonate contents of the water. Higher the value of alkalinity during monsoon season in Shahpura lake indicates the accumulation of bicarbonates of calcium and magnesium from the surrounding sewage and garbage fed catchment area and less the value of alkalinity in Upper lake might be due to the dilution by addition of excess of rain water to this water body from surrounding catchment area. Hardness seems to be influenced by the anthropogenic activities along the catchment area⁴⁻⁵⁻⁶⁻⁷. Turbidity increases in the monsoon season due to the excessive flow of mud and silt along with sewage water into the water bodies. B.O.D. ranging from minimum value 2.4 mg/l at station 1st (Kolans) of Upper lake and maximum B.O.D. value 86 mg/l at station 2nd (BANSAL) of Shahpura lake. C.O.D. value varies from minimum value 6 mg/l to 224 mg/l value at 1st station (Kolans) of Upper lake and 2nd station (BANSAL) of Shahpura lake. These variations in the physico-chemical parameters causes' direct impact on the biotic components of water body¹³.

Biological data: In present survey a total of 36 generas belonging to 27 families and 12 orders were identified (Table -2). Identification of the obtained macrozoobenthic invertebrates was carried out with the help of keys¹⁴⁻¹⁵.

Table 2: Macrozoobenthic invertebrates recorded during monsoon season in Upper lake and Shahpura lake.

S.No.	Taxa	UPPER LAKE		SHAHPURA LAKE	
		KOLANS	BHADBADA	P.C.B.**	BANSAL*
		Station 1 st inlet	Station 2 nd outlet	Station 1 st inlet	Station 2 nd outlet
Phylum	MOLLUSCA				
Class	Gastropoda				
Order	Caenogastropoda				
Family	Viviparidae				
	Bellamyia bengalensis	-	-	-	+
	Viviparus connectus	-	+	+	+
	Viviparus manullatus	-	-	-	+
Family	Ampullarioidae				
	Pila virens	-	+	+	+
	Pila globossa	-	-	+	-
Family	Thiaridae				
	Melonides tuberculata	+	-	-	-
	Melanoides granifera	+	-	-	-
	Thiara scraba	+	-	-	-
	Thiara tuberculata	+	-	-	-
Order	Heterobranchia				
Family	Orthalicidae				
	Bulimulinae	-	+	-	-
Family	Physidae				
	Physella acuta	+	+	-	+
Order	Basommatophora				
Family	Lymneidae				
	Lymnaea auricularia	-	+	-	+
	Lymnaea ovata	-	+	-	+
Order	Littorinimorpha				
Family	Hydrobiidae				
	peringa ulvae	-	+	+	-
Class	Bivalvia				
Order	Unionoida				
Family	Unionoidae				
	Unio tigridis	+	-	-	-
Phylum	ARTHROPODA				
Class	Crustacea				
Order	Decapoda				
Family	Palaemonidae				
	Palaemonetes	+	+	-	-
Class	Insecta				
Order	Diptera				
Family	Chironomidae				
	Chironomous sps.	+	+	+	+

18	Family	Ephemerellidae			
		Ephemerella	+	-	-
19	Family	Tipulidae			
		Tipula	-	+	-
	Order	Odonata			
20	Family	Gomphidae			
		Gomphus sps.	+	-	+
21	Family	Libellulidae			
		Libellule	-	+	-
22	Family	Aeshnidae			
		Anax junix	-	+	-
23	Family	Coenagrionidae			
		Argia sps.	-	-	+
	Order	Ephemeroptera			
24	Family	Cordulegastriidae			
		Cordulegaster	+	+	+
25	Family	Caenidae			
		Caenis sps.	+	-	+
	Order	Coleoptera			
26	Family	Hydrophilidae			
		Berosus sps.	-	-	+
	Order	Hemiptera			
27	Family	Notonectidae			
		Notonecta	-	-	+
28		Buenoa burtsa	-	+	+
29	Family	Corixidae			
		Sigara sps.	-	-	+
30		Micronecta scholtzi	+		
31	Family	Dytiscidae			
		Dytiscus sps.	-	-	+
32	Family	Gerridae			
		Gerris sps.	-	-	+
33	Family	Belostomatidae			
		Abedus herberti	-	+	-
34	Family	Naucoridae			
		Pelcoris sps.	-	-	-
35	Family	Nepidae			
		Ranatra sps.	-	+	+
	Phylum	ANNELIDA			
	Class	Oligocheata			
	Order	Haplotaxida			
36	Family	Tubificidae			
		Tubifix sps.	-	-	+

In Upper lake (Table -2) the families observed at station 1st (near Kolans river) during monsoon season was 12, having 6 orders and 13 genera's, out of these 9 families belongs to phylum arthropoda, 3 families belongs to mollusca. Number of families observed during monsoon season at station 2nd (near Bhadbada) was 16, having 7 orders and 17 genera's out of which 10 families belongs to phylum arthropoda, 6 families belongs to phylum mollusca. Number of arthropod species is more than that of mollusca. The presence of chironomids indicates that water of Upper lake is good but slightly impacted. In Shahpura lake (Table -2) total number of families

observed during monsoon season at station 1st (near PCB) was 15, having 8 orders and 17 genera's out of which 11 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 station 2nd (near BANSAL hospital) was 11, having 8 orders and 14 genera's out of which 6 families belong to phylum arthropoda, 4 families to phylum mollusca and 1 family to phylum annelid. Arthropod species are dominant and presence of chironomids, oligocheats indicate that water of Shahpura lake is moderately polluted. The BMWP score is an index for measuring the biological quality of water body by using species of macro-invertebrates as biological indicators¹⁶. Biological monitoring by using biotic scores along with physico-chemical analysis of water quality can display the total health of the water body¹⁷. BMWP (Biological Monitoring Working Party) is a family level scoring system which represents pollution tolerance capacity of an organism. The greater their tolerance towards pollution, lower the BMWP score¹⁸. Table-3 and 4, showed the BMWP (Biological Monitoring Working Party) and ASPT (Average Score per Taxon) scores for station 1st and station 2nd during monsoon season 2016 of Upper lake and Shahpura lake. The BMWP score calculated for station 1st (inlet near KOLANS) of Upper lake was 73. The obtained BMWP score indicates that water is (Acceptable) clean but slightly impacted. The BMWP score for station 2nd (outlet near Bhadbada) of Upper lake was 87 i.e. (Acceptable) clean but slightly impacted (Table -3 and 5). The obtained scores of BMWP reveals that water is good biological quality and belongs to class B. ASPT (Average Score Per Taxon) is also a family level scoring system for the average tolerance level of all the taxa within the community and was calculated by dividing the BMWP by the number of families represented in the sample¹⁹. The ASPT score at station 1st (KOLANS, inlet) of Upper lake was 6.0 i.e., good water quality while ASPT score at station 2nd (BHADBADA, outlet) of Upper lake was 5.4 i.e., fair water quality. From these observations it is clear that wetland (Upper lake) is subjected to pollution by anthropogenic activities from the surrounding residential area. So, the water quality at the inlet is (Acceptable) good and water quality at the outlet is (Questionable) moderately impacted or of fair quality (Table - 5).

Table 3: BMWP and ASPT scores for station 1st (kolans) and station 2nd (Bhadbada) of Upper lake in monsoon season

S.no.	Invertebrate Families	BMWP Scores	BMWP Scores
		Station 1 st KOLANS	Station 2 nd BHADBADA
01	EphemereIIDae	10	-
02	Aeshinidae.	-	8
03	Cordulegasteridae.	8	8
04	Gomphidae	8	8
05	Libellulidae	-	8
06	Nemouridae	7	-
07	Caenidae	7	-
08	Ampullarioidae	-	6
09	Bulimulidae	-	6
10	Palaemonidae	6	6
11	Thiaridae	6	-
12	Unionidae	6	-
13	Viviparidae	-	6
14	Belostomatidae	-	5
15	Corixidae	5	-2
16	Tipulidae.	-	5
17	Nepidae	-	5
18	Notonectidae	5	5
19	Hydrobiidae	-	3
20	Lymnaeidae	-	3
21	Physidae	3	3
22	Chironomidae	2	2
	BMWP Score	73	87
	ASPT Score	6.0	5.4

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

S. no.	Invertebrate Families	BMWP Score	BMWP Score
		Station 1 st (PCB)	Station 2 nd (BANSAL)
01	Cordulegasteridae	8	-
02	Gomphidae	8	8
03	Caenidae	7	-
04	Ampullarioidae	6	6
05	Coenagrionidae	6	-
06	Viviparidae	6	6
07	Dytiscidae	5	-
08	Gerridae	5	5
09	Naucoridae	-	5
10	Notonectidae	5	5
11	Nepidae	5	-
12	Corixidae	5	-
13	Hydrophilidae	5	5
14	Hydrobiidae	3	-
15	Lymnaeidae	-	3
16	Physidae	-	3
17	Chironomidae	2	2
18	Tubificidae	1	1
	BMWP Score	77	49
	ASPT Score	5.1	4.4

In Shahpura lake at station 1st (near PCB, inlet), the BMWP (Biological Monitoring Working Party) score was found 77 and 49 at station 2nd (near BANSAL hospital) in

monsoon season 2016. The BMWP score (77) at station 1st reflects (Acceptable) clean but slightly impacted water. In station 2nd BMWP score (49) represents the (Questionable) moderately impacted water condition according to BMWP score (Table- 4 and 5). Overall we can say, according to BMWP score of this wetland was moderately polluted. Similar studies at other parts of the world assessed moderate pollution in various wetlands according to BMWP score [20-21]. The Shahpura lake in case of ASPT score, at station 1st (PCB, inlet) had score 5.1 i.e., fair water quality and in station 2nd (KOLANS, outlet) had score 4.4 i.e. poor water quality. From this it is clear that water of Shahpura lake is moderately polluted at inlet and impacted at outlet. Over all we can say that this wet land is moderately polluted. The Previous studies also revealed moderately polluted or doubtful quality for ASPT scores¹⁹⁻²⁴.

Table 5: The BMWP and ASPT score table showing biological quality and water quality (adapted from Armitage et. al., 1983^[22] and Alba-Trecedor, 1996^[23]).

BMWP Score	BMWP		ASPT	
	Category	Interpretation	ASPT Score	Water quality
101-150	A Good	Very clean water	Over 7	Very good
61 – 100	B. Acceptable	Clean but slightly impacted	6.0 – 6.9	Good
36– 60	C. Questionable	Moderately impacted	5.0 – 5.9	Fair
16– 35	D. Critical	Polluted or impacted	4.0 – 4.9	Poor
0 – 15	E. Very critical	Heavily polluted	3.9 or less	Very poor

Thus the result of physico-chemical and biological parameters both confirms that water of Upper lake was (Acceptable) clean but slightly impacted according to BMWP score. According to ASPT score water at 1st station (KOLANS, inlet) was of good quality and at station 2nd (BHADBADA, outlet) was of fair quality (Table-5). The water of Shahpura lake is (Questionable) moderately impacted according to BMWP score and according to ASPT score the water at 1st station (near PCB, inlet) comes under fair quality and at station 2nd (near BANSAL hospital, outlet) water falls under poor quality.

CONCLUSION

The biological study of water of Upper lake and 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 Upper lake and 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 these water bodies. The municipal authorities have to take the necessary action for curbing the pollution.

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