Jr. of Industrial Pollution Control 30(2)(2014) pp 207-20

www.envirobiotechjournals.com

IMPACT OF SEWAGE DISCHARGE ON WATER QUALITY AND BENTHIC DIVERSITY OF KOTA BARRAGE, KOTA, RAJASTHAN, INDIA

N. SARANG[1] AND L.L. SHARMA[2]

[1]Chhattisgarh Kamdhenu Vishwavidyalaya, College of Fisheries
Kawardha (Kabirdham) 491 995, Chhattisgarh, India
[2]Maharana Pratap University of Agriculture and Technology, College of Fisheries
Udaipur 313 001, Rajasthan, India

Key words : Water quality, Benthic diversity, Sewage discharge, Kota Barrage Dam, Rajasthan

(Received ..... February, 2014; accepted ....., 2014)

ABSTRACT

The water of Kota Barrage is mainly used for domestic uses and bathing, besides irrigation and aquaculture. Seasonal variations in benthic fauna and selected Physico-chemical parameters of Kota Barrage Dam have been studied on the basis of the samples collected during monthly surveys for a period of one year (November, 2004 to October, 2005) which revealed interesting interrelationship among various factors. This Dam is affected by pollution (industrial specially Thermal Power Plant effluents and domestic) as indicated by low dissolved oxygen. Based on depth of visibility values Kota Barrage Dam could be categorized as "Moderately eutrophic" whereas nitrate nitrogen values of Kota Barrage dam indicated "Mesotrophic" status. On the other hand hardness values of this Dam were "Moderately hard". The species diversity was found to influence due to water pollution in Kota Barrage. Despite this the biodiversity of macroinvertebrates was appreciably high with recorded 27 species. Most dominant benthic species encountered were *Melanoides tuberculata, Bellamya bengalensis, Gyraulus convexiusculus*, *Indoplanorbis exustus* and *Lymnaea acuminata*. The seasonal abundance of benthos in Kota Barrage During investigation period varied between 869 to 1100 No./m^2. *Lymnaea acuminata* and *Chironomus* larvae may be used as pollution indicators in Kota Barrage. Richness of organic matter in this water body might have favoured the species composition and abundance of benthic fauna. Discharge of large quantities of waste causes thermal pollution and it affects the ecology of the ecosystem of Kota Barrage Dam.

INTRODUCTION

The benthic biota provides a method of biomonitoring of pollution and acts as a bioindicator. In aquatic system the macrobenthic invertebrate community is more often investigated due to absence of mobility and sensitivity towards physicochemical stress. Several workers have pointed out that benthic organism provide a valuable indicator of past and present condition of the water quality and prone to be the most useful in assessment of pollution Hynes (1965). Thus the pollution ecology of macrobenthic community

***Corresponding authors email:** Saranglimno@yahoo.com, sarangfish@gmail.com

becomes a very important biological tool for environmental impact assessment and management. In India the studies on macrobenthos had earlier been carried out by Anitha (2005). The studies on the use of this biotic component as bioindicator of aquatic pollution had been carried over Krishnamoorthi and Sarkar (1979). In the lakes of Rajasthan similar studies were conducted by Saxena (2007) and Sharma *at el*. (2007). The bottom fauna play important role in the mineralization and recycling of organic matter. They also serve as the good indicators of water pollution since they form an important food item for fishes.

Disruption of study area

The Kota Barrage reservoir located near Kota city is the last structure in the cascade development pattern of Chambal Velly. Kota Barrage Dam is the forth dam in the series of Chambal Velly project, located about 0.8 km upstream of Kota City in Rajasthan. Water released after power generation at Gandhi Sagar, Rana Pratap Sagar and Jawahar Sagar Dam is diverted by Kota Barrage Dam. Ecologically Kota Barrage Dam is different from other reservoirs as there is regular warm water discharge from the adjoining thermal power plant deposition of coal dust all the water levels. The total catchment area of Kota Barrage is 10, 6000 m^2 of which the free catchment area below Jawahar Sagar Dam is just 137 km^2. The live storage is 99 Mm^3. It is an earth filled Dam with a concrete spillway. The dam was completed in 1967 with the primary objective of establishing that Kota thermal power plant. The water of Kota Barrage Dam is used for domestic and public supply, irrigation, industrial supply and thermal power generation. Further details of this dam pertaining to morphometeric feature are indicated in (Table 1).

MATERIAL AND METHODS

The sampling frequency was kept monthly for a total period of over 12 months (From November, 2004 to November, 2005). Water samples were collected from station using a plastic bucket (Plates 1). For the collection and analysis of below stated water quality parameter standard methods such as APHA (1989) were followed. For qualitative analysis of macroinvertebrates standard keys were used Needham and Needham (1962). However, for quantitative analysis animals were counted individually species wise in the whale sample or sub samples. The number of benthos per unit area was calculated as follows.

$$\text{Benthos No./ m}^2 = \frac{N}{A} \times 10^4$$

N = Number of organism per sample
A = biting area of samples (15 x 15 cm)

RESULTS AND DISCUSSION

The results on physicochemical parameters of surface water of Kota Barrage dam are presented in (Table 2). During the study period the temperature of water ranged between 21°C to 39°C minimum in the month of February and maximum in the month of June. In Kota Barrage Dam pH of water indicated alkaline condition with variations between 7.0 (winter) to 9.1 (summer). The mean values of EC representing the total ionic load of water in different seasons varied between 0.222 (winter) to 0.604 mS (summer). The average values for depth of visibility of Kota Barrage Dam were 138.7, 176.0 and 212.5 cm in monsoon, summer and winter respectively (Table 2). Dissolved Oxygen is another vital parameter regulating survival of aquatic life. It was found to be maximum in the month of January (9.2 mg/L) and minimum (4.0 mg/L) in the month of September (Table 2). During the study period on 4 occasions dissolved oxygen was found below 5 ppm which is indicative of distressed condition for fish and aquatic biota. Total alkalinity ranged between 84.0 to 190 mg/L (Table 2). The maximum total hardness was observed in the month of February and minimum in the month of June (Table 2). The important nutrients nitrate nitrogen showed the range of 0.001 to 0.020 mg/L. The higher value was observed in July. Orthophosphate recorded in Kota Barrage Dam was fairly high with variations between o.283 (December) to 1.227 mg/L (May). It is interesting to note that the biodiversity of macrobenthic fauna in Kota Barrage Dam was appreciably high with 27 species (Table 3). Most dominant benthic species encountered were *Melanoides tuberculata, Bellamya bengalensis, Gyraulus convexiusculus, Indoplanorbis exustus* and *Lymnaea acuminata* (Fig. 2). The average density of these benthos respectively showed following order of dominance at Kota Barrage Dam (Table 3):

Average density (No./m^2): 121 > 117 > 88 > 77 > 70

The seasonal abundance of macroinvertebrates in Kota Barrage Dam during investigation period varied from 869 to 1100 No./m^2 (Table 3). Thus, under the pre-

Table 1. Morphometeric features of Kota Barrage, Rajasthan

S. No.	Items	Kota Barrage
1.	Locations: Latitude Longitude	24°18.892N 76°42.069E
2.	Catchment area	10, 6000 sq.m.
3.	Average rainfall (inch)	32
4.	Maximum depth (m)	18.0
5.	Mean depth (m)	10.0
6.	Length of dam (m)	603.0
7.	Height of dam (m)	40.0
8.	Nature of dam	Earth dam and rock fill
9.	Year of impoundment	1960
10.	Purpose	Thermal Power Generation & irrigation
11.	Power units in MW	6 units of Power Generation
12.	Tehsil and district	Kota district

vailing environmental condition the observed species composition of these benthos could be considered bio-indicators of organic pollution.

It seen true that the fluctuation brought about by these processes in that water body study, create a very conducive micro as well as macro environment for the healthy growth and multiplication of the molluscan fauna higher abundance of molluscs with increased water temperature and decomposed organic matter has been also reported by Bath et al. (1999). PH is another important parameter affecting species diversity and distribution in an ecosystem. The pH value of the water in Kota barrage Dam in the present investigation was alkaline. The alkaline pH was found to be associated with more number of species. However, with increasing pH the number of species has been reported to decrease (Venkateswarju, 1969). The richness of molluscs presently observed may be attributed to the cumulative effect of alkaline nature of water, high calcium contents and macrophytic vegetation which provide both food and shelter, because some of these from are of periphytic in nature as it has earlier been documented by Tonapi (1980). As per Rawson (1960) criterion Kota Barrage Dam with electrical conductance well above 0.222 mS could be considered eutrophic.

The present findings as regard water clarity values could be mainly assigned for biomass, suspended organic matter and other physical disturbances such as boating , bathing and washing in Kota Barrage Dam which keep the fine particles in suspension. A close perusal to depth of visibility of Kota

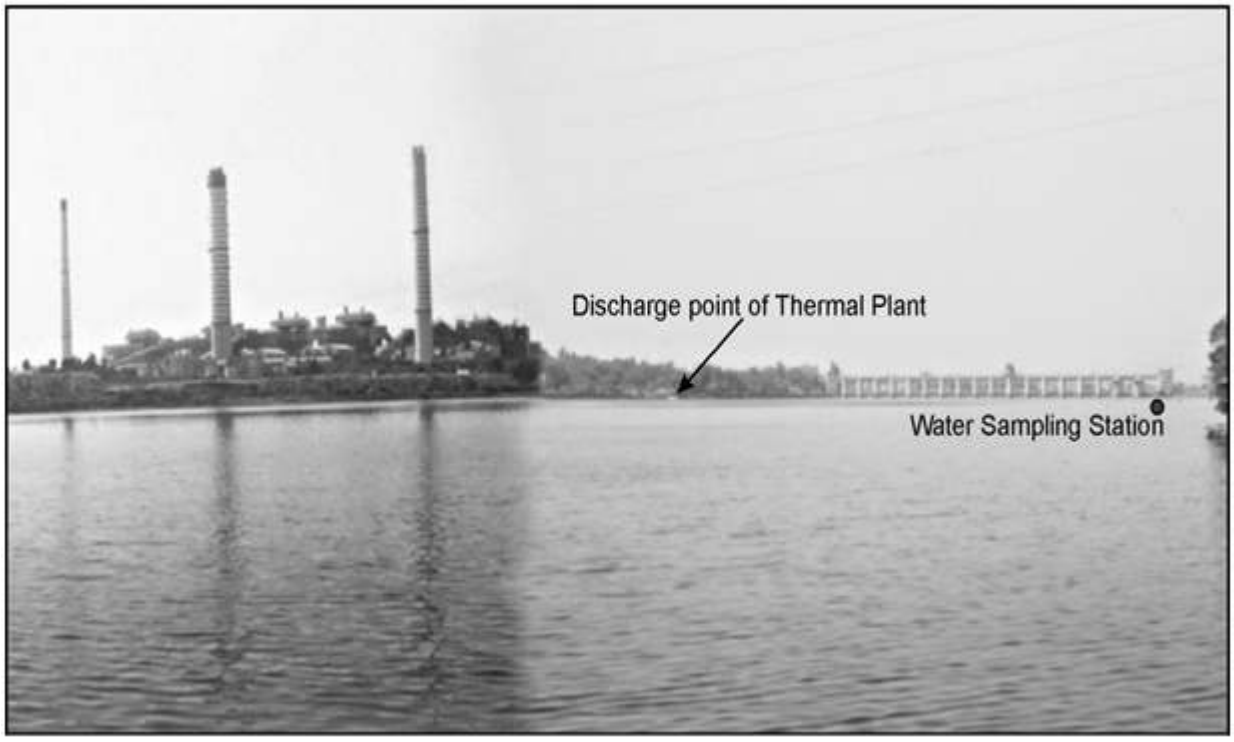

Fig. 1 Location of sampling station of Kota Barrage Dam, Rajasthan

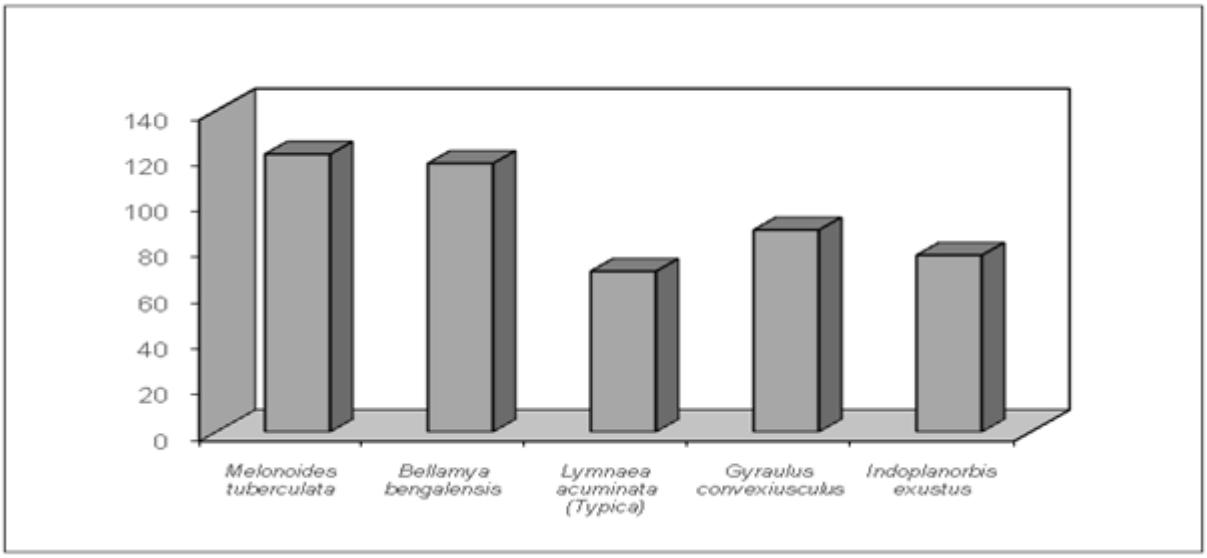

Fig. 2 Average density of five prominent benthos (No./m2) in Kota Barrage Dam, Rajasthan

Table 2. Seasonal variations in physico-chemical analysis of water quality parameters of Kota Barrage during Nov. 2004 to Nov. 2005

S. No.	Parameters	Winter		Summer		Mansoon	
		Seasonal range	Average range	Seasonal range	Average range	Seasonal range	Average range
1.	Temperature (°C)	21.0-27.0	23.5	26.0-39.0	33.5	31.0-38.0	34.2
2.	pH	7.0-8.5	7.8	8.0-9.1	8.4	7.3-8.3	7.7
3.	Electric conductivity (mS)	0.222-0.239	0.231	0.22-0.604	0.250	0.228-0.268	0.251
4.	Depth of visibility (cm)	150-300	212.5	100-300	176.0	60.0-260	138.7
5.	Dissolved oxygen (mg/L)	5.2-9.2	7.0	6.0-8.0	7.2	6.0-7.6	6.1
6.	Free carbon dioxide (mg/L)	10.0-32.0	19.5	0.0-14.0	7.0	4.0-16.0	10.0
7.	Carbonate alkalinity (mg/L)	Nil	Nil	6.0-12.0	4.5	0.0-2.0	0.5
8.	Bicarb. alkalinity (mg/L)	90.0-140	116.5	84.0-124	110.0	106-190	132.5
9.	Total alkalinity (mg/L)	90.0-140	116.5	84.0-146	117.0	108-190	133.0
10.	Nitrate nitrogen (mg/L)	0.001-0.006	0.003	0.003-0.014	0.007	0.001-0.020	0.007
11.	Orthophosphate (mg/L)	0.283-0.957	0.690	0.786-1.227	1.017	0.740-0.867	0.806
12.	Calcium Hardness (mg/L)	520-70.0	59.0	12.0-54.0	41.0	48-56	50.6
13.	Magnesium Hardness (mg/L)	30.0-36.0	32.0	26.0-46.0	36.5	20.0-38.0	30.0
14.	Total Hardness (mg/L)	88-100	91.0	40.0-94.0	78.0	76.0-86.0	80.5

Barrage Dam indicates that in general, Occurrence of high algal biomass coincided with low clarity values. Sharma and Durve (1991) proposed a regional classification for assigning trophic status to water bodies using average secchi disc values. On the basis of depth of visibility values Kota Barrage Dam could be categorized as "Moderately eutrophic". Zhang and Chang (1994) studied oligotrophic, mesotrophic and eutrophic lakes and reported that in oligotrophic lake phosphorus and nitrogen levels were 0.01 and 0.21 mg/L respectively. Sawyer (1960) have classified water of the basis of hardness as follows: Soft water (up to 75 mg/L), moderately (75 to 150 mg/L), hard water (150 to 300 mg/L) and very hard water (above 300 mg/L). Based on this classification also Kota Barrage Dam could be categorized "Moderately hard" water body.

The analysis of adverse affect of sewage on the structure of communities of aquatic organisms was among the first environmental assessment methods popularly adopted. These organisms are able to tolerate sewage discharge were categorized as saprobic,

Table 3. Seasonal quantitative analysis of macroinvertebrates (No./m²) of Kota Barrageduring Nov., 04 to Nov., 05

S. No	Species of Checklist of Macroinvertebrates	Winter		Summer		Monsoon		Average density
		Seasonal range	Average	Seasonal range	Average	Seasonal range	Average	
1.	*Melanoides tuberculata*	88-440	209	132-264	99	0.0-220	55	121
2.	*Bellamya bengalensis*	0.0-264	132	88-132	132	0.0-176	88	117
3.	*Lymnaea acuminata* (T.)	88-132	55	176-308	121	0.0-132	33	70
4.	*Gyraulus convexiusculus*	396-440	209	0.0-88	22	0.0-132	33	88
5.	*Lymnaea acuminata* (G.)	0.0-88	22	0.0-220	55	0.0	0.0	26
6.	*Goniobasis virginica*	0.0-176	88	0.0	0.0	0.0-88	22	37
7.	*Indoplanorbis exustus*	0.0-88	22	88-352	154	88-132	55	77
8.	*Parreysia caerulea*	0.0-88	22	0.0-132	33	0.0-132	33	29
9.	*Corbicula striatella*	44-132	44	0.0-176	44	0.0	0.0	29
10.	*Parreysia favidens*	0.0	0.0	0.0-132	66	0.0-264	66	44
11.	*Scaphula deltae*	0.0	0.0	0.0-132	33	0.0-88	22	18
12.	*Bithynia pulchella*	0.0-88	22	0.0	0.0	0.0-176	44	22
13.	*Lamellidens marginalis*	0.0-132	33	0.0-176	44	132-264	99	59
14.	*Physa acuta*	0.0-88	22	0.0	0.0	88-176	66	29
15.	*Diplonychus annuletus*	0.0-44.0	11	0.0	0.0	0.0	0.0	4
16.	*Diplonychus rusticus*	0.0	0.0	0.0-88	22	0.0-176	44	22
17.	*Cybister tocipunetatus*	0.0-88	22	0.0-176	44	0.0	0.0	22
18.	*Sternolophus rcufipes*	0.0	0.0	0.0-88	44	0.0	0.0	15
19.	*Berosus dolerosus*	0.0-132	33	0.0	0.0	0.0	0.0	11
20.	*Chironomus larvae*	0.0-176	44	88-308	99	0.0-88	22	55
21.	*Tabanus larvae*	0.0	0.0	44-88	33	0.0-88	22	18
22.	*Psychoda larvae*	0.0-132	33	0.0	0.0	0.0	0.0	11
23.	*Helocordulia uhleri*	0.0-44	11	0.0-88	22	88-132	55	29
24.	*Sympetrum*	0.0-88	22	0.0	0.0	0.0-88	22	14.6
25.	*Erythrodiplax* sp.	0.0	0.0	0.0-132	33	0.0-132	33	11
26.	*Heropobdelloidea lateroculata*	0.0-44	11	0.0	0.0	0.0-88	22	11
27.	*Barbronia weberi*	0.0-44	11	0.0	0.0	0.0-132	33	15
	Total	660-1496	1078	1012-1364	1100	440-1320	869	1015

these that could only survive in relatively pristine conditional were labeled as oligotrophic and those somewhere in between were know mesotrophic. Ample evidence exists that the macro benthic community acts as a bio-indicator and has become a very important biological tool for the assessment of water quality (Kumar, 1997). From the results of present study it is clearly evident that the macrobenthic community is dominated by *Chironomus* larvae population in Kota Barrage Dam. *Chironomus* larvae have also been used as pollution indicators by number of workers (Curry, 1962). Thus, the abundance of Chironomus in the benthic population is due to impact of altered nature of substrate due to organic pollution. These indicator properties of benthos can be used to identify different physical and chemical gradients or eutrophic increases in Kota Barrage Dam and can therefore be employed in environmental monitoring programmes.

ACKNOWLEDGEMENT

The authors are much grateful to Dr. H.C.L. Gupta, Dean, R.C.A. and College of Fisheries for providing necessary facilities. Thanks are also due to Dr. P.C. Verma, OIC/SO-G, ESL, (BARC), RAPS, Rawatbhata, Kota, India for his kind encouragement and consistent support. We are also indebted to the Director, Zoological Survey of India, Kolkatta and his associates namely Dr. P. Mukhopadhyay, Dr. Animesh Bal, Dr. K. Karmakar, Dr. R. Venkitesan and Dr. A. Misra for identification of aquatic fauna. We are also grateful to Dr. (Mrs) K. Mitra, Principal Scientist, CICFRI, Barrackpue, Kolkatta for the generous cooperation in identification of fauna.

REFERENCES

Anitha, G., Chandrsekhar, S.V.A. and Kodarkar, M.S. 2005. Hydrography in relation to macroinvertebrates in Mir-Alam Lake, Hyderabad, A.P. *Res. Zool. Surv. India.* Occ. Paper No. :235 : 1-148.

APHA-AWW-WPCF 1989. *Standard Methods for Examination of Water and Waste Water* (17th ed.). American Public Health Association, Washington, D.C.

Bath, K.S., Kaur, H. and Dhillon, S.S. 1999. Correlation of mollusks with physicochemical factors at Harike Reservoir (Punjab). *India J. Environ. Sci.*3 : 159-163.

Curry, L.L. 1962. A survey of environmental requirements for the midge (Diptera, Tendipedidae). In: *Biological Problems in Water Pollution. Transactions of 3rd Seminar* (Ed. Tarzwell), USDHEW, PHS, Robert, A. raft Sanitary Engineering Centre, Cincinnati.

Kumar, A. 1997. Role of species diversity of aquatic insects in the assessment of pollution in wetland of Santhan Paragnas (Bihar). *Journal of Environmental Pollution.* 1:117-120.

Krishnamoorthi, K.P. and Sakar, R. 1979. Macroinvertebrates as indicators of water quality. *Proc. Symp. Environ. Biology. Academy of Environmental Biology*, Muzaffarnagar, India. S.R. Verma, A.K. Tygi and S.K. Bansal (eds.) pp133-138.

Needham, J.G. and Needham, P.R. 1962. A*Guide of the Study of Freshwater Biology*. Holden Day Inc., San Francisco, p.108.

Pennak, R.W. 1978. *Freshwater Invertebrates of the United Sates*. 2nd edition, John Wiley and Sons Inc., New York pp.803.

Rawson, D.S. 1960. A limnological comparison of twelve large lakes in northern Saskatchewan. *Limnology and Oceanography.* 5 : 195-211.

Sawyer, C.H. 1960. *Chemistry of Sanitary Engineers.* McGraw Hill Book Co., New York.

Saxena, M.M. 2007. Trophic sate indices in water quality monitoring. *Proc. of NSL 2007* pp. 24-30.

Sharma, L.L. and Durve, V.S. 1991. Water clarity of 26 waters of Rajasthan in relation to phytoplankton. In: *Proceedings of the Second Asian Fisheries Forum. Asian Fisheries Society, Manila, Philippines.* pp.915-918.

Sharma, L.L., Sarang, N. and Sharma, B.K. 2007. Occurrence of macroinvertebrates in relation to water & sediment characteristics in three seasonal ponds of southern Rajasthan. *J. Aqua. Biol.* 22 (2) : 49-54.

Tonapi, G.T. 1980. *Freshwater Animals of India* (an ecological approach). Oxford and IBH Publishing Co., New Delhi pp.341.

Venkateswarju, V. 1969. An ecological study of the algae of river moosi, Hyderabad (India) with special reference to water pollution-1 physico-chemical complexes. *Hydrobiologia*. 33 : 117-143.

Zhang, H. and Chang, W.Y.B. 1994. Management of inland fisheries in shallow eutrophic, mesotrophic and oligotrophic lakes in China. *International Verein Limnology*. 24 : 228-229.