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Assessment of Water Quality of Some Selected Ponds of Burdwan, West Bengal, India by Abundance of Larval Chironomids (Diptera: Chironomidae)

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ABSTRACT

The present investigation was arranged to examine the status of water qualityof selected sites of Burdwan area in terms of density and abundance of chironomid population in correlation with physico-chemical parameters of water. Seven physico-chemical water quality parameters were measured in four selected sites along with abundance of chironomid population. Present investigation pointed out that chironomid larvae were abundant in agricultural pond throughout the study period.

Keywords : Chironomid, Diptera, Diversity, Water quality.

INTRODUCTION

Water is the universal solvent on world of the total amount of global water only 2.4 % is distributed on terrestrial region. Lakes and ponds are became a threat to those ecosystem which were continuously exploited. Population explosion, industrialization and urbanization created problems of water pollution. Direct discharges of effluents, domestic sewage and agricultural runoff may lead to the production of compounds and hence increase the toxicity. I addition to the chemical and physical measurements, biological indicators may be considered as potential tools for the assessment of the effect of various contaminants due to their functional role in water bodies (Warwick 1988).

Some benthic species are very sensitive to physical and chemical variations in the water due to their short lifecycles and sedentary habits (Wu *et al.* 2004). For this reason, these organisms have been used to evaluate the degree of changes of environments. Non-biting midges are one of the most potent groups for assessing the condition of waters due to their characteristic features (Saether1979, Saether 1980, Ruse and Wilson1984, Bazzanti and Seminara 1987, Kawai *et al.*1989, Bisthoven *et al.* 1992, Gerhardt and Bisthoven 1995). In particular, chironomids (Diptera: Chironomidae) larvae have been used as bioindicators of toxic materials in aquatic ecosystems.

Chironomids are very abundant, diversified and widely distributed (Coffman and Ferrington 1996) that can live wide range of aquatic habitats (Real *et al.* 2000, Higuti *et al.* 2005) which in turn influence the abundance of non-biting midges (Oliver 1971, Callisto 1997). These properties make them potential indicator in determining water for the presence of pollution. Chironomids are one of the most abundant aquatic insects in fresh water environments (Epler 2001) due to their adaptability to extreme environmental conditions (Armitage 1995). Species composition differs among microhabitats as the larvae are selective in the choice of site (Maasri *et al.* 2008). Midge populations are influenced to alterations in

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physico-chemical parameters and adding of nutrients (Lim 1990) and abundance are also affected by available food,the deposition of detritus and organic matter at the bottom (Galdean and Callisto 2000). The objective of this study is the measurement of various responses of chironomid population to characteristics of aquatic bodies in the vicinity of Burdwan.

MATERIALS AND METHODS

Study area

Four sites were selected for the study. Out of them two sites were at Kaligram. They were designated as Site-I (a pond adjacent to paddy field) and Site-II (domestic sewage canal). A canal carrying effluents from cast iron industries at Palitpur was taken as Site-III for this study. Finally, a pond located at the campus of University of Burdwan was taken as Site-IV which is free from any kind of pollutants.

Sampling of water samples and quality analysis

Water samples were collected from the four sites for a period of three year from January 2013 to December 2015. The water samples were collected with the aid of samplers. The temperature of the water was recorded using a thermo probe (Model TL1-A), pH was recorded using a portable pen pH meter (Hanna®, Mauritius). Calcium and magnesium hardness (APHA 234^{0}C) were determined using complex metric titration. Chloride was determined by argentometric titration method. Analysis of water samples was done following the standard methods of APHA (1998).

Determination of chironomid larval population density

To determine chironomid larval population density, three 15×15×15 cm Ekman dredge samplers were used for sampling at each sampling site (Kar *et al.* 2011). Then samples were processed, identified and counted following (Ali *et al.* 1977, Ali and Baggs 1982).

Statistical analysis

Physico-chemical parameters were studied through correlation analysis (Zar 1999) followed by correlation index (Kar *et al.* 2011).

RESULTS AND DISCUSSION

The water parameters for detection of water quality for 3 years (from January 2013 to December 2015) of four different study sites were presented in Fig. 1.

In the present investigation, higher level of conductivity value of water samples were recorded during the monsoon for study areas I and III and pre-monsoon periods for studied sites II and IV. In the present investigation, observations reveal that the values of

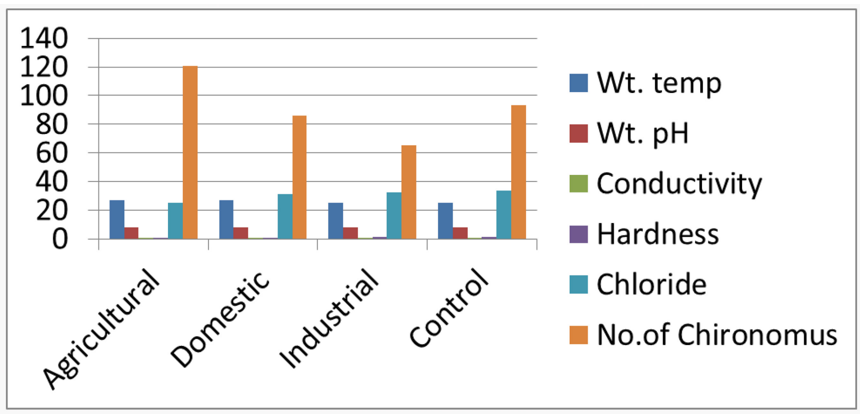

Fig. 1. Mean value of water parameters for 3 years (from January 2013 to December 2015) at four different study sites.

Table 1. Correlation between different physico-chemical factors of water and chironomid larvae in site-I (Agriculture) at different season. (* WT-Water temperature, pH-Water pH, CON-Conductivity, HARD-Total Hardness, CH- Chloride, Chiro- Number of chironomid larvae).

Pre monsoon	AT	WT	WpH	Con	Ch	Hard	Chiro
AT	1.0						
WT	0.849	1.0					
WpH	1.0	0.849	1.0				
Con	-0.933	-0.982	-0.933	1.0			
Ch	-0.984	-0.929	-0.984	0.982	1.0		
Hard	-0.984	-0.984	-0.929	0.982	1.0	1.0	
Chiro	0.629	0.945	0.629	-0.866	-0.756	-0.756	1.0
Monsoon	AT	WT	WpH	Con	Ch	Hard	Chiro
AT	1.0						
WT	0.756	1.0					
WpH	-0.023	-0.672	1.0				
Con	0.954	0.918	-0.322	1.0			
Ch	-0.839	-0.277	-0.525	-0.636	1.0		
Hard	-0.500	-0.945	0.877	-0.737	-0.052	1.0	
Chiro	0.996	0.693	0.068	0.923	-0.885	-0.419	1.0
Post monsoon	AT	WT	WpH	Con	Ch	Hard	Chiro
AT	1.0						
WT	0.961	1.0					
WpH	0.866	0.693	1.0				
Con	-0.327	-0.577	0.189	1.0			
Ch	0.500	0.240	0.866	0.655	1.0		
Hard	0.721	0.885	0.277	-0.891	-0.240	1.0	
Chiro	0.721	0.885	0.277	-0.891	-0.240	1.000	1.0

hardness are in decreasing order from site III > site IV > site II> site I. During the present investigation, the values of chloride content of water samples of sites I and III were found to be higher in monsoon comparison to other seasons where sites II and IV were found to be higher in pre-monsoon. Abundance and distribution of midge larvae were poor in sites I and III while higher values were recorded at sites II and IV. Number of chironomid population were found to higher during the post-monsoon for study sites I, III and IV and throughout the study period in site II, Tables 1-4.

From the correlation study, it is observed that water temperature, water pH and conductivity were positively correlated with larval population at all three season of agricultural pond. In domestic pond water temperature,water pH and conductivity were negatively correlated with number of chironomids at pre-monsoon where positively correlated at post-monsoon and monsoon.

For industrial pond, water temperature was negatively correlated with larval abundance at monsoon and post-monsoon but positively correlated at pre-monsoon. In control pond, chloride and water temperature were negatively correlated with larval population at post-monsoon. At monsoon, hardness is negatively correlated with abundance of chironomids. Water pH and conductivity were negatively correlated with number of chironomids at post-monsoon Fig. 2, Table 5.

PC-1 shows 69.256% of variance and Eigen value 693.67, while PC-2 shows 19.349% of variance and Eigen value 193.799. Number of chironomids very significantly loaded in both factor 1 and 2 as reported by Konar (2018). Except, number of chi-

Table 2. Correlation between different physico-chemical factors of water and chironomid larvae in site-II (Domestic) at different season. (* WT-Water temperature, pH-Water pH, CON-Conductivity, HARD-Total Hardness, CH- Chloride, Chiro- Number of chironomid larvae).

Pre monsoon	WT	WpH	Con	Ch	Hard	Chiro
WT	1.0					
WpH	0.444	1.0				
Con	0.982	0.605	1.0			
Ch	0.721	-0.301	0.577	1.0		
Hard	0.866	-0.064	0.756	0.971	1.0	
Chiro	-0.581	-0.987	-0.724	0.145	-0.096	1.0
Monsoon	**WT**	**WpH**	**Con**	**Ch**	**Hard**	**Chiro**
WT	1.0					
WpH	0.866	1.0				
Con	0.982	0.945	1.0			
Ch	-0.575	-0.907	-0.719	1.0		
Hard	-0.655	-0.189	-0.500	-0.242	1.0	
Chiro	0.277	0.721	0.454	-0.946	0.545	1.0
Post monsoon	**WT**	**WpH**	**Con**	**Ch**	**Hard**	**Chiro**
WT	1.0					
WpH	0.945	1.0				
Con	0.756	0.500	1.0			
Ch	-0.997	-0.918	-0.803	1.0		
Hard	0.997	0.918	0.803	-1.000	1.0	
Chiro	0.996	0.910	0.814	-1.000	1.000	1.0

ronomids other components are inversely correlated against PC-1, where components are correlate directly in PC-2.

CONCLUSION

In this present survey temperature showed significant level of seasonal variation. According to the fluctuations in water temperature has relationships with the air temperature. As reported by Sharma and Jain (2000) earlier, the deviation in water temperature in this study may be due to the regular climatic fluctua-

Table 3. Correlation between different physico-chemical factors of water and chironomid larvae in site-III (Industrial) at different season. (* WT-Water temperature, pH-Water pH, CON-Conductivity, HARD-Total Hardness, CH- Chloride, Chiro- Number of chironomid larvae).

Pre monsoon	WT	WpH	Con	Ch	Hard	Chiro
WT	1.0					
WpH	-0.968	1.0				
Con	0.999	-0.953	1.0			
Ch	-0.997	0.984	-0.992	1.0		
Hard	-0.994	0.989	-0.987	0.999	1.0	
Chiro	0.993	-0.931	0.998	-0.981	-0.974	1.0
Monsoon	**WT**	**WpH**	**Con**	**Ch**	**Hard**	**Chiro**
WT	1.0					
WpH	0.832	1.0				
Con	0.971	0.941	1.0			
Ch	-0.778	-0.996	-0.906	1.0		
Hard	0.866	0.998	0.961	-0.988	1.0	
Chiro	-0.866	-0.998	-0.961	0.988	-1.000	1.0
Post monsoon	**WT**	**WpH**	**Con**	**Ch**	**Hard**	**Chiro**
WT	1.0					
WpH	-0.997	1.0				
Con	0.929	-0.896	1.0			
Ch	-0.983	0.994	-0.844	1.0		
Hard	-0.971	0.949	-0.991	0.910	1.0	
Chiro	-0.982	0.964	-0.982	0.930	0.999	1.0

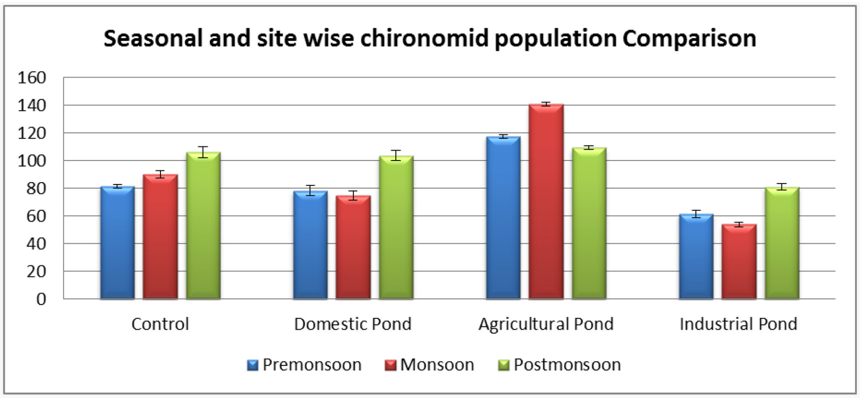

Fig. 2. Abundance of chironomid larvae within four sites in monthly variation.

Table 4. Correlation between different physico-chemical factors of water and chironomid larvae in site-IV (Control) at different season. (* WT-Water temperature, pH-Water pH, CON-Conductivity, HARD-Total Hardness, CH- Chloride, Chiro- Number of chironomid larvae).

Pre-monsoon	WT	WpH	Con	Ch	Hard	Chiro
WT	1.0					
WpH	-0.376	1.0				
Con	0.038	0.911	1.0			
Ch	0.554	-0.980	-0.811	1.0		
Hard	-0.240	0.990	0.961	-0.941	1.0	
Chiro	-0.350	1.000	0.923	-0.974	0.993	1.0
Monasoon	WT	WpH	Con	Ch	Hard	Chiro
WT	1.0					
WpH	0.397	1.0				
Con	0.500	0.993	1.0			
Ch	0.721	0.923	0.961	1.0		
Hard	-0.596	-0.974	-0.993	-0.986	1.0	
Chiro	0.327	0.997	0.982	0.891	-0.954	1.0
Post monsoon	WT	WpH	Con	Ch	Hard	Chiro
WT	1.0					
WpH	0.240	1.0				
Con	-0.721	0.500	1.0			
Ch	-0.037	-0.979	-0.666	1.0		
Hard	-0.178	-0.998	-0.554	0.990	1.0	
Chiro	0.059	-0.955	-0.735	0.995	0.972	1.0

Table 5. Principal component analysis (2 components counted) for physico-chemical parameters of water in site- I, II, III, IV.

	PC 1	PC 2
Water Temp.	-0.01194	0.12663
Water pH	-0.00593	0.009286
Conductivity	-0.00058	0.001845
Chloride	-0.11172	0.3022
Hardness	-0.01394	0.007023
No. of Chironomids	0.89755	0.40719
Eigenvalue	693.67	193.799
% of Variance	69.256%	19.349%

tions and outcome of seasons and time of collection or due to the atmospheric temperature as stated by Jayaraman *et al.* (2003), Tiwari *et al*. (2004), Zingade (1981), Kar *et al*. (2011) respectively.

The alkaline nature of water samples of the four studied areas indicate towards the anthropogenic influence in terms of on-farm inputs as well as industrial and domestic discharges as well as due to the buffering capacity of water (Datta *et al.* 2009, Kar *et al*.2011). Surface water pH was alkaline at all four sites with maximum value in post-monsoon and summer and minimum in monsoon. Probably it is due to the removal of CO_2 by photosynthesis through bicarbonate degradation, low primary productivity, reduction of temperature and salinity, decomposition of organic matter (Bragadeeswaran *et al*.2007, Kar *et al*. 2011). High pH in summer is due to high biological and photosyntheti cactivity (Govindasamy *et al.* 2000,Sridhar 2006, Saravanakumar *et al.* 2008).

Conductivity was high in summer resulting from concentration of organic matter and human intervention (Clymo 1983, Dakshini and Soni 1979, Kar *et al.* 2011, Koshy and Nayar 2000, Mahadavan and Krishnaswami 1983).

Higher level of hardness in water in site-I is due to the natural accumulation of salts from contamination with the soil and geological formations or it may enter from the anthropogenic effects. In all sites pre-monsoon exhibit higher hardness, may be due to influx of water and lower hardness during monsoon result from heavy rainfall (Kar *et al*. 2011).

Chloride content of water is one of the important ecological factors as well as an indicator of pollution. It influences the functional physiology and reproductive activityof organisms there by during summer months may be attributed towards continuous evaporation of water especially during summer season (Kar *et al.* 2011).

Seasonal differences in the density and abundance could be explained by the different amounts of allochthonous material entering these systems (Kar *et al.* 2011). Increased input of allochthonous matter makes a decline in organism density. The higher values of chironomid larvae during the winter and post winter period may be attributed towards increase in nutrient inputs and organic materials, primarily domestic sewage, agrochemicals which increased the amount of benthic surface area by increasing the three dimensional aspect of the four study sites and by providing an increase in food supply for the chironomids (Kar *et al*. 2011).

As the population of chironomids were higher in site I were significantly higher throughout the study period it therefore indicates towards higher nutrient enrichment and organic material concentration and therefore the water quality of study site-I is deteriorating at fast rate due to anthropogenic inputs where site II, III and IV were less vulnerable with respect to deterioration of water quality due to anthropogenic influence (Kar *et al.* 2011). Least density of chironomid population in site II, III and IV may be the effect of water pH, presence of toxic substances and low nutrient inputs.

From the overall experiment it can be decided that impairment of the water quality of the studied sites has contributed significantly towards distribution and abundance of chironomid population among different seasons. Among the study sites the water quality of site-I are deteriorating at fast rate in compare to other studysites. Therefore, abundance of chironomid population shows considerable promisetowards indicating the status of water parameters of four study areas.

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REFERENCES

Ali A, Baggs RD (1982) Seasonal changes of chironomid populations in as hallow natural lake and in a man-made water cooling reservoir in central Florida. *Mosquito News* 42: 76–85.

Ali A, Mulla MS, Federici BA, Pelsue FW (1977) Seasonal changes in chironomid fauna and rainfall reducing chironomids in urban flood control channels. *Environm Entomol* 6: 619–622.

American Public Health Association (APHA) (1998) Standard methods for the examination of water and wastewater. 20th ed. Washington DC.

Armitage P, Cranston PS, Pinder LCV (1995) Chironomidae–Biology and ecology of non-biting midges.Chapman and Hall, London. 572.

Bazzanti M, Seminara M (1987) Environmental stress in a **reg**ulated Eutrophic lake indicated by the profounded benthic community. *Bull Institute Zool* 54: 261-266.

Bisthoven LGJ, Timmermans KR, Ollevier F (1992) The concen tration of cadmium, lead, copper and zinc in Chironomust hummi larvae (Diptera: Chironomidae) with deformed versus normal menta. *Hydrobiologia* 239: 141-149.

Bragadeeswaran S, Rajasegar M, Srinivasan M,Kanagarajan U (2007) Sediment texture and nutrients of Arasalar estuary, Karaikkal, southeast coast of India. *J Environm Biol* 28: 237-24.

Callisto M (1997) Larvasbentônicas de Chironomidae (Diptera: Insecta) emquatroecossistemaslóticosamazônicos sob influência das atividades de umamineração de bauxita. Anais do 8 Seminário Regional de Ecologia, pp 89—98.

Clymo RS (1983) Peat In: Ecosystem of the world: Bog, Swamp, Moor and Fen (eds). Gore AJP, Elsevier, Amsterdam 4A : 159-—24.

Coffman WP, Ferrington LC Jr. (1996) Chironomidae. In:Merritt RW, Cummins KW (eds). An Introduction to the Aquatic Insects of North America.2nd edn. Kendall/Hunt Publishing Company, Dubuque, Iowa, pp 551—652.

Dakshini KMM, Soni JK (1979) Water quality of sewage drains entering Yamuna in Delhi. Ind J Environm Hlth 21(4): 354—361.

Datta JK, Layek S, Banerjee A, Mondal NK, Gupta S (2009) Physico-chemical characterization of water quality of eutrophied surface water body and ground water around the field crop research station, Burdwan, West Bengal.Asian *J Water Environ Poll* 7 (3): 69—75.

Epler JH (2001) Identification manual for the larval Chironomidae (Diptera) of North and South Carolina.NC Dept. Environment and Natural Resources, Raleigh, NC: 526.

Galdean N,Callisto M (2000) Barbosa FAR. Lotic ecosystems of Serra do Cipo, Southeast Brazil: Water quality and a tentative classification based on the benthic macroinvertebrate community. *Aqua Ecosyst Hlth Manag* 66 : 545—552.

Gerhardt A, Bisthoven LGJ (1995) Behavioral development and morphological response of *Chironomus thummi* larvae (Diptera: Chironomidae) to aquatic pollution. *J Aqua Ecosyst Hlth* 4 : 205—214.

Govindasamy C, Kannan L, Azariah J (2000) Seasonal variation in physico-chemical properties and primary production in the coastal water biotopes of Coromandel Coast. *Ind J Environm Biol* 21(1) : 1—7.

Higuti J, Zviejkovski IP, Takahashi MA, Dias VG (2005) Chironomidae indicadora de estadotróficoem reservatórios. In-Rodrigues L, Thomaz SM, Agostinho AA, Gomes LC (eds). Biocenosesemreservatórios: Padrõesespaciais e temporais, São Carlos: Rima, pp 137—145.

Jayaraman PR, Ganga Devi TT,Vasudevan N (2003) Water quality studies on Karamana River, Thiruvananthapuram district, South Kerala, India. *Poll Res* 22 (1): 89—100.

Kar D, Banerjee A, Palit D (2011) Assessment of water quality of some selected sites of Durgapur Industrial belt, West Bengal, India through distribution and abundance of Chironiodae in relation with physico-chemical characterinotics of water. *Int J Lakes and Rivers* 4 (2): 177—198.

Kawai K, Yamaagishm T, Kuba Y, Konishi K (1989) Usefulness of Chironomid larvae as indicator of water quality. *Jap J Sanitary Zool* 40: 269—283.

Konar S (2018) Estimation of water quality of different types of Ponds of Burdwan, West Bengal, India through distribution and abundance of larval chironomidae in relation with physico-chemical characteristics of water.*The Pharma Innov J* 7 (7) : 162—168.

Koshy M, Nayar TV (2000) Water quality of river Pamba at Kozhencherry. *Poll Res* 19 (4) : 665—668.

Lim RP (1990) Effects of pesticides on the aquatic invertebrate community in rice fields. In: Proceedings of the International Conference on Tropical Biodiversity. In Harmony with Nature, 12-16 June 1990, Kuala Lumpur, Malaysia, pp 336—352.

Maasri A, Fayolle S, Gandouin E, Garnier R, Franquet E (2008) Epilithicchironomid larvae and water enrichment: Is larval distribution explained by epilithon quantity or quality? *J North Am Benthol Soc* 27 (1): 38—51.

Mahadavan and Krishnaswami (1983) Self-purification capacity of river Vaigai (S. India). India. *J Environm Hlth* 25 (A) : 288—299.

Oliver DR (1971) Life history of the Chironomidae. *Annl Rev Entomol* 12: 211—230.

Real M, Rieradevall M, Prat N (2000) *Chironomus* species (Diptera: Chironomidae) in the profundal benthos of Spanish reservoirs and lakes: Factors affecting distribution patterns. *Freshwater Biol* 43 (1): 1—18.

Ruse LP, Wilson RS (1984) The monitoring of river quality in the great Quse basin using Chironomid Exuvial analysis technique.*Water Poll Control* 83: 116—136.

Saether OA (1979) Chironomid communities as water quality indicator. *Holarctic Ecol* 2: 66-74.

Saether OA (1980) The influence of eutrophication on deep lake benthic invertebrate communities. Proceeding of Seminar on Eutrophication of Deep Lakes, Norway 1978, pp 161—180.

Sharma D, Jain R (2000) Physico -chemical analysis of Gopalpura Tank of Guna District, MP *Ecol Environ Conserv* 6 (4): 441—445.

Sridhar R, Thangaradjou T, Kumar SS, Kannan L (2006) Water quality and phytoplankton characteristics in the Palk Bay, southeast coast of India .*J Environm Bio*l 27: 561—566.

Saravanakumar A, Rajkumar M, Serebiah JS, Thivakaran GA (2008) Seasonal variations in physico-chemical characteristics of water, sediment and soil texture in arid zone mangroves of Kachchh-Gujarat. *J Environm Biol* 29 : 725—732.

Tiwari S, Dixit S, Gupta SK (2004) An evaluation of various physico - chemical parameters in surface waters of Shahpura Lake, Bhopal. Poll Res 23 (4) : 829—832.

Warwick WF (1988) Morphological deformities in Chironomidae (Diptera) larvae as bioindicators of toxic stress. In: Evans M.S. (ed). Toxic contaminants and ecosystem Health, A Great Lake focus,Wiley and Sons, New York pp. 281—320.

Wu J, Fu C, Liang Y, Chen J (2004) Distribution of the meiofaunal community in a eutrophic lake of China.Arch Hydrobi ol159 (4) : 555—575.

Zar JH (1999) Biostatistical analysis. 4th edn .Prentice Hall, New Jersey, USA.

Zingade MD (1981) Base line water quality of river Narmada Gujrat, India. *J Marine Sci Engg* 1: 161.