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BIOMONITERING OF MACROZOOBENTHOS IN A TROPICAL LAKE (UPPER LAKE BHOPAL)

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Abstract- Biomonitering is recognized as a valuable tool to predict the environmental condition and to maintain the water quality. Biomonitering has surpassed the chemical screening in maximum number of water bodies. Thus, Biomonitering is the use of living organisms to predict the water quality. Upper Lake of Bhopal (Latitude 23º12' to 23º16' N and Longitude 77º18' to 77º23' E), build in the 11th century AD, is a multiple use water body supports various activities and is supermarket of biodiversity itself and offers shelter to thousands of migratory and local aquatic birds. It is about 503 meters above mean sea level with catchment area of 361km and having maximum depth of 13m and minimum depth of 0.34m, on hard pink red sand stones of Vindhya region. The wetland was constructed by former king, Raja Bhoj of Dhar to be a source of drinking water which later emerged as a new source of income to farmers and fishermen community. The lake has been facing serious problems mainly of sewage inflow and siltation of man-made nature which helps in profuse growth of macrophytes which on death and decomposition releases tremendous nutrients resulting in eutrophication in many parts of water body. The lake having an area of 32 sq. km receives water from a vast catchment with urban and rural parts. The maximum portion of the catchment area of rural has great impact on lake ecology while the urban catchment is mainly responsible for entry of untreated sewage. The cultivation of *Trapa bispinosa* and *Nelumbo nucifera* in the shoreline and the fish (major carps) available in this lake has a direct and indirect impact on the economic conditions of the people. The present study was carried out to know the macro invertebrate diversity of Upper Lake with changing environment due to anthropogenic pressure and changing climatic conditions, total of 21 families and 33 species were recorded during the one year study period. Phylum Arthropod was represented by 12 families, Phylum Annelida was constituted by 4 families, and Phylum Mollusca comprises 5 families. The collective number of individual species was 639nos/m^2 .The species and sub-species with highest population were represented by Chironomous with 137nos/$m^{2.}$ A massive restoration plan has been completed on the lake with the assistance of JBIC. Desilting, Deweeding, diversion and treatment of sewage, catchment area treatment and afforestation were the main components of the project. Hence conserving this precious resource from contamination for sustainable water use is of immense significance as an issue of policy.

Keywords: wetland, biodiversity supermarket, conservation, macrophytes

1. INTRODUCTION-

The systematic use of living organism for monitoring and analysis of water quality originated in Europe early in this century and is widely used (Cairns and Pratt, 1993; Metcalfe-Smith, 1994). Dudgeon et al., (1994) stresses the importance of Biomonitering and identifying areas of riverine biodiversity for long term accountability and conservation. Around the world, freshwater habitats are being subjected to increased levels of human disturbance (Saunders et al., 2002).Wetland ecosystems are inhabited by wide variety of organisms and are considered richest sources of biological diversity. Zoobenthos is characterized as a group of invertebrates, which spend at least part of their life cycle at the bottom substrate in the water bodies. The biotic environment of the water body, directly affect in the distribution of population density and diversity of the macro benthic community. Due to Anthropogenic pressure and rapid urbanization these water bodies acts as reservoirs to organic wastes. (Pani and Misra, 2000). The climate of Bhopal is tropical. According to the distribution of rainfall and variation in the temperature, four seasons can be recognized in the central India viz. winter (Dec. to Feb.), summer (March to May), monsoon (Jun to Aug,) and Post monsoon (Sept. to Nov.) The benthic communities

are composed of a wide array of flora and fauna, links all levels of food web and inhabit different types of habitat such as mud, sand attached to rocks , stones, macrophytes and other solid organic matter. Freshwater benthic macro-invertebrates, or more simply "benthos", are animals without backbones that are larger than ½ millimetres (the size of a pencil dot). These animals live on rocks, logs, sediment, debris and aquatic plants during some period in their life. The benthos includes crustaceans such as crayfish, molluscs such as clams and snails, aquatic worms and the immature forms of aquatic insects such as stonefly and mayfly nymphs.

Benthos is an important part of the food chain, especially for fish. Many invertebrates feed on algae and bacteria, which are on the lower end of the food chain. Some shred and eat leaves and other organic matter that enters the water. Because of their abundance and position as "middlemen" in the aquatic food chain, benthos plays a critical role in the natural flow of energy and nutrients. Some organisms serve as indicators of water pollution (organically or nutrient enriched waters) such as Oligochaeta, some Syrphidae (Diptera). Often, the greater the density of these organisms, the greater the degree of organic pollution. The lower species diversity index in general shows a more polluted water body. Tolerance to pollution is important for understanding the distribution of species. Benthic organisms take a great part in trophic relations, fluctuations and abundance of biomass, and water quality evaluation.

2. MATERIAL AND METHODS:-

Description of study area:

The present study was conducted on upper Lake Bhopal, the picturesque capital of the state of MP. It is also known as "city of lakes" on the account of large numbers of water bodies present in and around Bhopal. Upper lake and lower lake which is jointly known as Bhoj wetland are very important for citizens of Bhopal. The upper lake with abundance of macrophytes is an east – westerly elongated shallow lake with irregular margins. The latitude location of lake is between 23º10' – 23º – 20'N and longitude 77º 15' – 77º25'E with catchment area of 361 km and having maximum depth of 13 m and minimum depth 0.34 m. Upper lake is surrounded by Van Vihar National Park on the South, Human settlement on the north and east and agriculture field on the west. Whereas, lake is surrounded by human settlement on all sides. Bhoj wetland has been designated as Ramsar in November 2002. The water of the upper lake was used for drinking purpose up to year 1947 without any treatment, which proves that water quality was very good. The samples were collected between 8:30 am – 6pm and five sampling stations were selected, based on the depth profile, habitat and nutrient supply to the lake. One site was selected at central point of the urban zone with 4 m depth (S1) it is the central point of the water body with no pollution interference. Site second was selected at Hamidea with 4.5 m depth (S2) it is the offshore point of the water body with frequent bathing and washing of cloths. It also receives sewage from hospital and other drains. Site third was selected at Boat club with 1.5 m depth (S3). Mazar this site also receives organic as well as inorganic waste from its catchment area and also receives sediment from the Van Vihar during rainfall (S4). Site five was selected from koifiza designated as (S5).It receives water from sewage treatment plant. For biological analysis ,sediments were collected from all the five sampling stations(between 9am-5:30pm) with the help of Petersons grebe mud sampler and the collection was sieved with the help of 0.5mm sieve(Ankar and Elmgreen 1976).Similarly samples were collected from stones and Macrophytes by laying down50 x 50 cm^2 quadrant .Stones were hand- picked and attached Macrobenthos were collected by using brush and poured into the 70 percent ethanol for fixing Macrophytes present in the quadrant are uprooted with the help of a hook and collected in a white finished tray . The substrate collected is washed and punched against the floor of tray. The water retained in tray is sieved through 0.5mm sieve .Filtrate is sorted out with the help of forceps and brush and then collected in plastic bottle, containing 70 percent alcohol as preservative(Adoni 1985)and subsequently shifted to laboratory for identification.

Macrofaunal were identified under the Metzer light microscope and highly magnified hand lens with the help of standard keys and manuals, Needham and Needham (1962), Mike et al. (2005), Pennak (1989), Subba Rao, (1989) and Chandra (1991).

Population of organisms were counted species wise i.e., no. of individuals of a species per sample and were expressed as number / m^2. During one year study period, seasonal samplings were carried out, in which five samples were collected from each sampling session.

From each sample the number of individuals of different species and group percentage were calculated per meter square (Welch, 1948) according to following formula:

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Number of benthos per unit area was calculated as follows:-

$$N = O/AS \times 10^4$$

Where N = Number of organisms per sample /m^2,
O = number of individuals actively encountered.
A = area of sampler (Ekman's Dredge in m^2).
S = number of samples taken at one sampling point.

Modified Family Biotic Index,

Tolerance values range from 0 to 10 for families and increase as water quality decreases. The index was developed by Hilsenhoff(1988) to summarize the various tolerances of the benthic arthropod community with a single value. The Modified Family Biotic index (FBI) was developed to detect organic pollution and is based on the original species-level index (BI).The formula for calculating the Family Biotic Index is:

$$FBI = \frac{x_i t_i}{n}$$

Where,
xi = number of individuals within a taxon
ti = tolerance value of a taxon
n = total number of organisms in the sample (100)

3. RESULTS AND DISCUSSION:

Biological properties

Species diversity is a measure of the number of different kinds of organisms that occupy a defined geographical area e.g. Stream and Lake Etc. Biological diversity relates to the wealth of variety life forms of microorganisms, plants and animals that exists and the complex ecosystem they make up. Biological diversity is of fundamental importance to the functioning of all natural and manmade ecosystems as each species is important component of food chains and food webs which helps in transfer of energy to trophic levels and cycling of nutrients in any ecosystem. The present study was carried out to know the macro invertebrate diversity of Upper Lake with changing environment due to anthropogenic pressure and changing climatic conditions, total of 21 families and 33 species were recorded during the one year study period. Phylum Arthropod was represented by 12 families, Phylum Annelida was constituted by 4 families, and Phylum Mollusca comprises 5 families. The collective number of individual species was 639nos/m^2 .The species and sub-species with highest population were represented by Chironomous with 137nos/$m^{2.}$ Benthic animals which occur in massive numbers on and in sediment have received little attention. These organisms include coelenterates, flat worms, nematodes, aquatic worms, ostracoda, other crustaceans, mollusca and aquatic insects, these organisms have a tendency to concentrate in various niches of the aquatic environment. The response of benthic fauna can be profitably utilized to study the effects of waste outfall, self-purification, recycling of mineralization and recovery in lakes receiving pollution in general and organic pollution in particular.

Depending upon the reactivity of benthos to the environment benthic macro-invertebrates is described into three categories.

A. Sensitive benthos:
B. Moderately tolerant benthos:
C. Tolerant benthos:
A. Sensitive benthos:
1. Stone flies,
2. Water penny beetle,
3. May flies,
4. Dobsonsflies (intolerant to pollution)
5. Alderflies,
6. Stuperflies,
7. Mussles,
8. Riffle Battles

B. Moderately tolerant benthos:
1. Damselflies,
2. Dragonflies,
3. Crayflies(class crustadiea, order Decapoda)
4. Amphipods (class crustacia, Amphipoda
4. Blackflies,
5. Cranefly (Worm like thick skinned and brownish-green to somewhat transparent, length up to 3 inches).

Isopods (Class Crustaciea)
6. Crane fly larva,
7.Caddis flies (vary from yellow to brown, but usually green, larva are known for construction of hollow cases that they either carry with them or attached to rocks. Cases rebuild form sand and twigs).

C. Pollution Tolerant benthos:
1. Caddis flies,
2. Midge flies (Poor water quality indicator, class insect, Bloodworm Chironomous)
3. Leeches (Phylum annelida *Erpobdella Puntata*)
4. Pouch snail,

The distribution of macro-invertebrates in fresh water bodies been described by Krishnamurthy (1966), Gupta (1976), Kaul and Pandit (1981), Rosas et al.(1985), and Oommachan (1981).

During Sep. Mollusca shows highest diversity of 4 families after that Diptera shows 3 families, except Odonata and Oligochaeta all the orders show 2 families each.

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Table 1. Diversity of Macrozoobenthos in Upper Lake Bhopal.

Species S.No.	Family S.No.	PHYLUM ARTHOPODA	S 1	S 2	S 3	S 4	S 5
	1	**Family - Atydae**					
1		*Atydae sp*	-	-	-	**4**	**7**
	2	**Family- Chironomidae**					
2		*Chironomous sp*	**26**	**31**	**24**	**12**	**3**
3		*. Spaniotoma sp.*	**3**	**14**	**11**	**3**	-
	3	**Family- Caenidae**					
4		*. Caenidae sp.*	**6**	**4**	-	**1**	-
	4	**Family- Gomphidae**					
5		*Gomphous vulgatissinus*	-	**8**	-	-	-
	5	**Family- Gammeridae**					
6		*Gammarus pulex*	-	**3**	-	-	-
	6	**Family- Hydropsychadae**					
7		*Namamyia plutonia*	-	-	**3**	-	**1**
	7	**Family- Hydrophilidae**					
8		*Sternolophus rufipes*	-	-	**6**	**3**	-
	8	**Family- Hydrometidae**					
9		*Hydrometra latreille*		**6**			**4**
	9	**Family- Philopotamidae**					
10		*Philopotamus mantamus*	-	**4**	-	-	-
	10	**Family - Polycentropidae**					
11		*Polycentropus flavomaculatus*	-	-	**9**		-
	11	**Family- Psephenidae**					
12		*Psephenus herricki*	**30**	-	-	**14**	-
	12	**Family- Psychomyiidae**					
13		*Tinodes waenesi*	-	-	**5**	-	**7**
		PHYLUM- ANNELIDA					
	13	**Family- Glassiphonidae**					
14		*Glassiphonia complanata*	-	-	**5**	-	-
15		***Hemiclepsis viridis***	**3**	-	-	-	-
16		*Batracobdella hardingi*	**9**	-	-	-	-
	14	**Family- Hirudidae**					
17		*Poecilobdella granulose*	**10**	-	**6**	-	-

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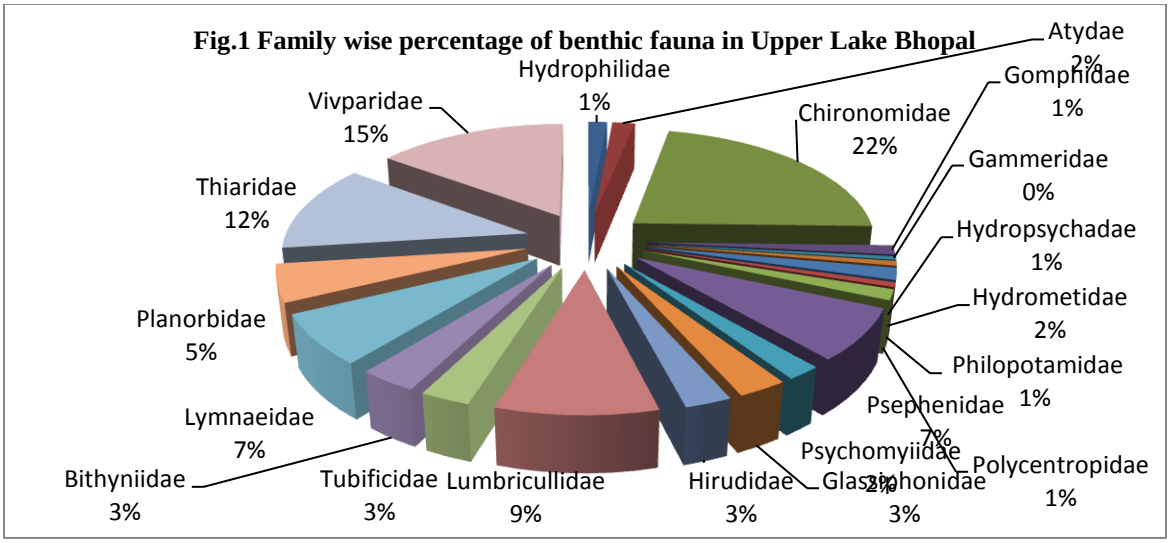
	15	**Family- Lumbricullidae**					
18		*Lumbriculus sp.*	**31**	**-**	**-**	**14**	**10**
	16	**Family-Tubificidae**					
19		Tubifix tubifix	**6**		**4**		**7**
	17	**Family - Bithyniidae**					
20		*Digoniostoma pulchella*	-	-	20	-	-
	18	**Family - Lymnaeidae**					
21		*Lymnaea luteola*	7	-	-	-	-
22		*L. biacuminata*	17	-	-	-	-
23		*L acuminate*	10	9	-	-	-
	19	**Family - Planorbidae**					
24		*Gyraulus rotula*	-	7	-	-	-
25		*G. velifer*	-	-	-	-	-
26		*Planorbis velifer*	-	25	-	-	-
	20	**Family - Thiaridae**					
27		*Thiara pyramis*	27	21	-	-	-
28		*T. tuberculata*	-	-	-	-	-
29		*T. crebra*	28	-	-	-	-
30		Paludomous andersoniana	20	-	-	-	-
	21	**Family- Vivparidae**					
31		*Bellamya bengalensis*	30	26	22	-	-
32		*B. colairensis*	-	-	-	-	-
33		*B. crassa*	-	14	-	-	-

Fig.1 Family wise percentage of benthic fauna in Upper Lake Bhopal



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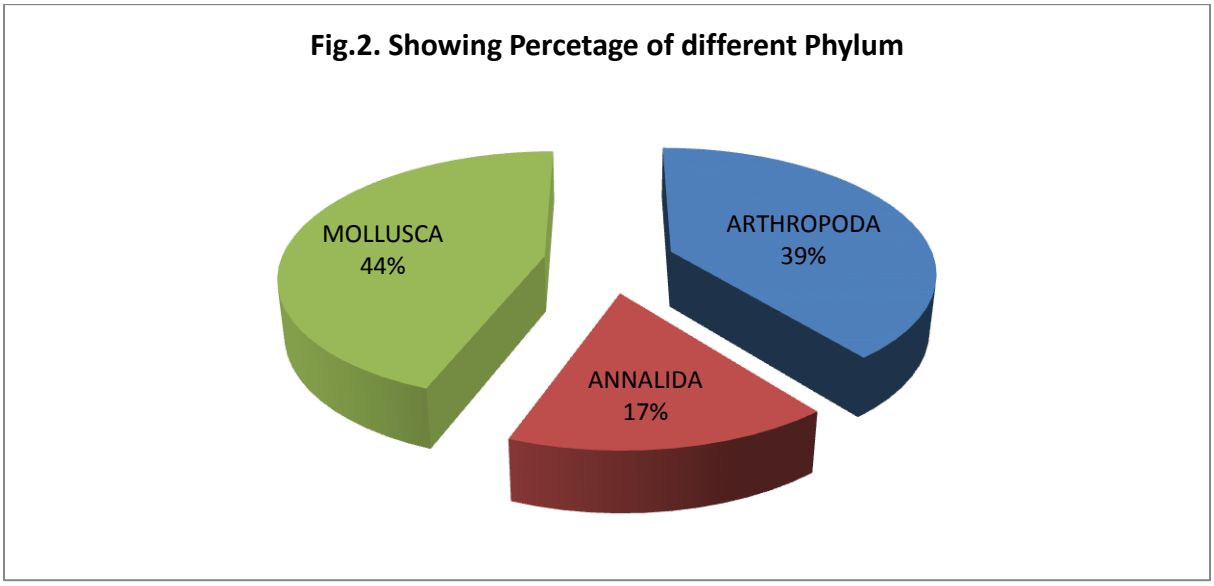

Table 2. Family wise comparison of current study to three other surveys.

S. No.	Taxonomic Status	Survey I	Survey II	Survey III	Survey 1V
		1999-2000	2001	2007-2008	2013-2014
	PHYLUM ARTHROPODA				
	FAMILIES				
1	Chironomidae	+	+	+	+
2	Tanabidae	+	-	-	-
3	Culicoidae	+	-	-	-
4	Tipulidae	-	+	-	-
5	Notonectidae	+	-	-	-
6	Hydrometridae	+	-	-	-
7	Hydropsychidae	+	+	-	+
8	Philopotamidae	-	-	+	+
9	Polycentropidae	-	-	+	+
10	Hydroptiladae	-	-	-	-
11	Nepidae	+	+	-	-
12	Psychomyiidae	-	-	+	+
13	Leptophlebiidae	-	+	-	-
14	Heptogenidae	-	+	-	-
15	Hygrobidae	-	+	-	-

16	Dytiscidae	-	+	-	-
17	Sialidae	-	+	-	-
18	Ephemerellidae	-	+	-	-
19	Pothaminthidae	-	+	-	-
20	Baetidae	-	+	-	-
21	Lestidae	-	+	-	-
22	Atydae	-	+	+	+
23	Palaemonidae	-	+	-	-
24	Psephenidae	-	-	+	+
25	Libelluidae	-	+	-	-
26	Hydrometidae	+	+	-	+
27	Aeschnidae	-	+	-	-
28	Haliplidae	-	+	-	-
29	Hydrophilidae	-	+	+	+
30	Hydroptilidae	+	-	-	-
31	Caenidae	-	-	+	+
32	Gomphidae	-	-	+	+
33	Gammaridae	-	-	+	+
	PHYLUM ANNALIDA				
34	Glassiphonidae	-	+	+	+
35	Hirudidae	-	-	+	+
36	Nanididae	-	-	+	-
37	Tubificidae	+	-	+	+
38	Lumbriculidae	-	-	+	+
39	Dendroceolodae	+	+	-	-
	PHYLUM MOLLUSCA				
40	Vivparidae	+	+	+	+
41	Thiaridae	+	+	+	+
42	Lymnaeidae	+	+	+	+
43	Bithyniidae	-	+	+	+
44	Planorbidae	-	+	+	+
	Total	**14**	**27**	**20**	**21**

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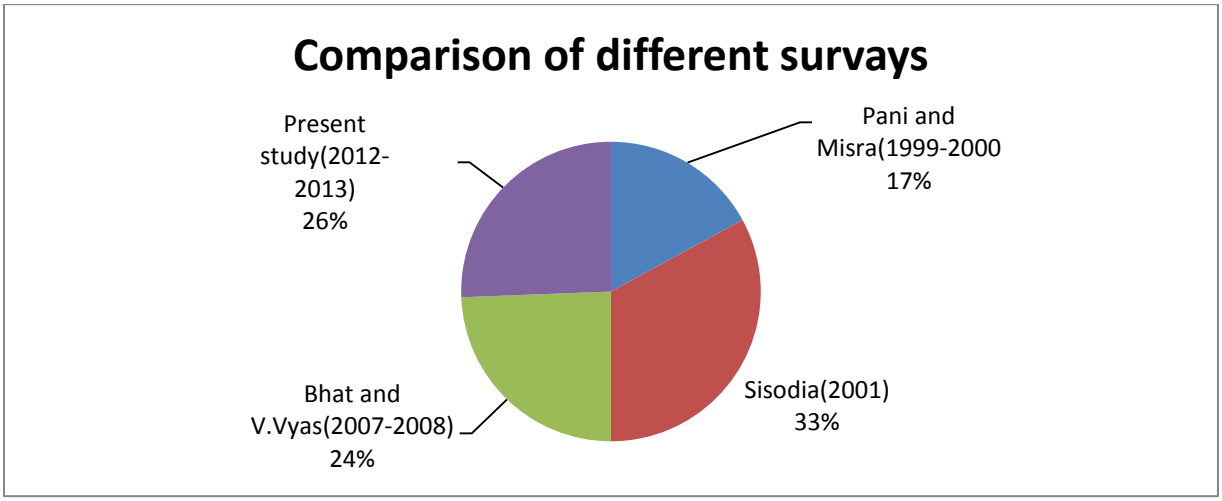

4. CONCLUSION:-

As depicted by results the vigorous growth of Chironomous larva with tolerance value 8 Hilsenhoff (1988) indicates the increased level of pollution which ultimately confers that the water body is under stress of organic and inorganic pollution .Chironomous being the pollution tolerant species and grows in abundance in polluted water bodies. Percent Model Affinity deviates from reference Central site (S1) to other selected sites. By following the trend in different surveys there is a reduction in the number of species of sensitive Benthos and significant Community Loss index which results in the extinction of few species from different families. Although, moderately tolerant species are showing increase in their density and new species have shown their appearance. There is a substantial difference between the survey conducted by Pani and Misra in 1999-2000 to Sisodia, Bhat and V.vyas, and present study. Emergence of new species are either tolerant or moderately tolerant.so, water body is under anthropogenic pressure and needs special attention. Site first (S1) represents the central point which is assumed as little pollution interference and hence, shows greater diversity of species for maximum number of families. Site fourth (S4) is Mazar which receives rich organic and inorganic wastes, silt as well boulders from catchment area which forms succession of the lake. Macrophytes grow abundantly in the shallow portion of the lake and Benthos remains attached to these macrophytes, so the rich diversity is also shown by this site after central point.

5. REFERENCES:

1. **Adoni, A.D. (1985).** Work book of Limnology, pratibha publication Sagar, M. P. India.
2. **Cairns,** J. Jr. and Pratt, J.R (1993). A history of biological monitoring using benthic macroinvertebrates. Pages.10-27.In: Freshwater Biomonitoring and Benthic Macroinvertebrates (eds.Rosenberg, D.M and Resh, V.H.). *Chapman and Hall*, New York.
3. **Bhat and V. VYAS. (2010).**Macrozoobenthic Diversity of tropical water Body (upper Lake) Bhopal.Department of Environment science and Limnology, Barkatullah University, Bhopal.The ecoscan 4(1):69-72**,** 2010.
4. **Chandra, M. (1991).** The leeches of India – A handbook. Zoological survey of India, Calcutta. pp 8 – 110. Conservation. *Cons.Biol*. 16 (1): 30-41.
5. **Dudgeon, D** (1994). Research strategies for the conservation and management of tropical Asian.
6. **Gupta, S. D. (1976).** The macrobenthic fauna of Loni Reservoir (India). *J. Inland Fish. Soc. India*, 8:49-59.
7. **Hilsenhoff, W. L,1988.** Rapid field assessment of orjanic pollution with a family-level biotic index. J.N.Am.Benthol. SOC. 7(1):65-68.
8. **Kaul, V. and Pandit, A. K. (1981).** Benthic communities as indicator of pollution with reference to wetland ecosystem of Kashmir, Cent. *Bd. Proc. Cont. water poll*. Osm. Univ. Hyderabad- India.
9. **Krishnamurthy, K. N. (1966).** Preliminary studies on the bottom macrofauna of the Tungabhadra Reservoir, *Proc. Ind. Acad. Sci, Sect*. B 63 (2): 96 – 103.

10. **Needham, J. G. and Needham, P. R (1962).** A guide to study the freshwater biology Holden – Rey Inc Francisco 1 – 108 pp.
11. **Mike, B. Dennis, H. Todd, H. Ken, K. Richard, L. Jim, L. Jacklyn, N. Brian, S. and Tom, W. (2005).** Benthic macroinvertebrate key. Revised may 2005 pp 1 – 23.
12. **Oommachan, L. (1981).** Ecological studies on lower lake of Bhopal (M.P.0 with special reference to benthic fauna PhD thesis, Bhopal University, Bhopal.
13. **Pani S.and Misra, S.M. 2000**. Biodiversity and trophic status of two tropical lakes of Bhopal. Proc. of Nat. Sem. p. 247-255.
14. **Pennak, R. W. (1989).** Fresh invertebrates of the United States. Protozoan to mollusca. *Johan wilx and scns, Inc*.
15. **Rosas, M. Mazari, J. S. and Baez, A. P. (1985).** Benthic organisms as indicator of water quality in lake Patzcuaro, Mexico *Abstract hydrobio.* vol.278.
16. **Saunders, D.L., Meeuwig, J.J and Vincent, A.C.J (2002).** Freshwater protected areas: Strategies for Streams and rivers. *Int.J.Ecol.Envi.*20:255-285.
17. **Subba Rao**, **N.V. and Dey A. (1989).** Handbook of freshwater molluscs of India. *ZSI, Calcutta*. pp 1- 289.
18. **Sisodia, S 2001.**Rapid assessment protocol for evaluation of biological water quality of upper lake, Bhopal.Msc. dissertation report submitted to Deptt. Of Limnology Barkatullah University Bhopal (M.P).
19. **Welch, P. S. (1948).** Limnological Methods. McGraw Hill Book Co., New York, London. pp 471.