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Trophic status of a tropical water body during a decade.

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Abstract: The present study accesses the trophic status in relation to aquatic insect diversity of the Upper Lake of Bhopal. The results revealed an increase in the physico-chemical parameters viz., Total dissolved solids (TDS), electrical conductivity (EC), calcium hardness, total hardness, nitrate and orthophosphate when related with earlier studies (Wanganeo *et al.*, 2011 and Bhat *et al.*, 2012). The lake was found to be alkaline with pH ($\bar{x}$ = 8.14 units) and can be categorized as alkaliphilous. Moderate electrical conductivity ($\bar{x}$=279.5 µScm-1) puts the water body under Mesotrophic status. Higher average alkalinity values (78.90 mgl-1) categorizes the water body into nutritionally rich. Higher nitrate values ($\bar{x}$ =1.24 mgl-1) puts the water body into the eutrophic condition. The overall study predicts the mesotrophic nature of Upper Lake of Bhopal. A total of 39 genera of aquatic insects belonging to 6 orders were recorded from the upper lake during the present study.

Key words: Trophic status, Aquatic insects, Upper Lake.

Introduction

Trophic status is a way of classifying lakes and describing lake processes in terms of the productivity of the system. It is an important aspect that needs to be monitored frequently as it is directly related with the incoming sewage and other wastes in the aquatic systems. The quality of the water and the health of the aquatic ecosystem of lakes are very sensitive issues and lakes in different regions of the world particularly in developing countries are facing a variety of problems associated with anthropogenic activities and unsustainable use of their resources. The chemical parameters play a prominent role in predicting the trophic status of a water body. The most important parameters that describe the trophic status of a water body are pH, conductivity, total alkalinity, phosphorus and nitrate · nitrogen. The dynamic nature of the productivity and eutrophication as a result of natural and anthropogenic factors leaves no single assessment variable as a true measure of the eutrophication status of a given water body (Xu *et al*., 2001 and Padisak *et al*., 2009). Continuous monitoring and assessing the aquatic environment for eutrophication is essential to mitigate adverse environmental and economic impacts (Devlin *et al*., 2005).

Study area

Bhopal, the capital city of Madhya Pradesh and popularly known as the city of lakes is famous for its numerous lakes, out of which Upper lake is most popular. Upper Lake is placed within the geographical coordinates of 23.25°N and 77.34°E. The lake was known as the **Upper Lake** or Bada Talab (Big Pond) until March (2011). It was renamed as Bhojtaal in honour of the Great King Raja Bhoj who built it. The lake was created by constructing an earthen dam across the Kolans river, formerly a tributary of the Halali river. The Bhojtal (Upper Lake) spans an area of 31 km², and drains a catchment of 361 km².It is the beauty queen of Bhopal and an important source of potable water that meets the demand of drinking water for almost 40% (30 million gallons per day) for the growing population of the Bhopal city. Upper Lake being wetland in nature is a hotspot of biodiversity and provides economic benefit to number of riparian owners in terms of fish production.

Methodology

The various physico - chemical parameters were analysed following the standard procedures as documented by (Adoni *et al*., 1985) and (APHA 2005). The collection of aquatic insects was done mainly during the early hours of the day. Sampling was done using various nets such as D hand net (30 × 30 cm frame), 250 µm and 20 µm mesh size nets. The nets were scooped through the water within an area of $1m^2$ for quantitative analysis. For qualitative enumeration of insects net was hauled throughout the sampling station. Then the material collected through nets was sieved (mesh size: 10 µm and 25 µm). During sieving water was sprinkled on the sample. The aquatic insects were then collected with the help of forceps and brush using a 10X magnifying lens. Aquatic insects were identified upto the genera level following the works of (Pennak 1978 and Subramanian 2005).

Results and discussions:

The physico- chemical characteristics as given in Table 1 depict the considerable variation during a period of 10 years.

Location map of Upper lake (Sour: **Google Earth**)

Table 1: Variation in the Physico- chemical parameters of the Upper Lake from 2007.

Parameters	Bhat *et al*., 2012 during 2007	Wanganeo *et al.*, 2011	Present study (2016-2018)
Air temperature	21-41	-	24-36 ($\bar{x}$= 30.1)
Water temperature	18-31	-	20-33 ($\bar{x}$= 25.65)
pH	6.7-9.2	7.36-7.56	7.4-8.9 ($\bar{x}$= 8.14)
Electrical conductivity	120-200	241.66-247.66	138-431 ($\bar{x}$= 296)
Total dissolved solids	80-150	95-96.33	105-280 ($\bar{x}$= 184.4)
Dissolved Oxygen	1.9-14	7.46-8	2-8.8 ($\bar{x}$= 6.4)
Total alkalinity	88-158	98.33-125	60-105 ($\bar{x}$= 78.90)
Total hardness	62-94	99.66-113.66	80-160 ($\bar{x}$= 106)
Calcium hardness	38-72	52-54.66	50-98 ($\bar{x}$=74.04)
Magnesium hardness	3.4-10.2	10.93-14.98	1-30 ($\bar{x}$= 9.22)
Chlorides	13.99-30.99	24.30-29.30	15-65 ($\bar{x}$= 35.02)
Nitrate	-	0.460-0.523	0.38-2.54 ($\bar{x}$= 1.2)
Nitrite	-	-	0.003-0.04 ($\bar{x}$= 0.01)
Orthophosphate	-	0.056-0.057	0.005-0.127 ($\bar{x}$= 0.054)

Atmospheric temperature during the present study ranged between 24-36 °C which was found be in accordance with the earlier studies (Bhat *et al*., 2012). According to (Welch 1952) both atmospheric and water temperature play an important role on the physico-chemical and physiological behavior of the aquatic system. Bhoj wetland experiencd a steady increase in maximum water temperature from the year 1975 till 1996 which remained within the limit of 10 °C during a period of more than two decades (Wanganeo and Wanganeo (2011)). Water temperature during the present investigation ranged from 20 -33 °C which was found to be coinciding the value recorded by (Bhat *et al.,* 2012).

In general there has been no significant change in pH during the decade as revealed by different authors (Table I). pH during the present study ranged between 7.4- 8.9 units which was found to be in accordance with both the findings of (Wanganeo *et al*., 2011 and Bhat *et al*., 2012). (Venkateshwarlu 1983) has classified reservoirs into five categories, viz., acidiobiontic (pH less than 5.5 units), acidophilus (pH between 5.5 units and 6.5 units), indifferent pH (between 6.5 units and 7.5 units), alkaliphilous (pH between 7.5 units and and 9.0 units), and alkalibiontic (pH more than 9.0 units). Following this category the Upper lake of Bhopal is categorized under alkaliphilous nature.

Total Alkalinity values during the present study ranged from 60-105 mgl^{-1} which is slightly lesser than the earlier records (Wanganeo *et al*., 2011) and (Bhat *et al*., 2012) from the same water body. As per (Spence (1964)) water bodies having alkalinity upto 15 mgl^{-1} are nutrient poor, those having alkalinity upto 60 are considered as moderately rich while the water bodies with alkalinity values higher than 60 are considered nutrient rich, Upper lake of Bhopal also comes under this category. The higher alkalinity values of a water body suggest higher pollution load (Bath and Kaur (1999)). Total hardness varied from 80-160 mgl^{-1} which was found to be 62 mgl^{-1} higher than the earlier studies conducted by (Wanganeo *et al*., 2011). As per (Sawyer (1960)) water can be classified into three categories as soft (0.00 - 75 mgl^{-1}), moderately hard (75.00 - 150.00 mgl^{-1}) and hard (151.00 -300.00 mgl^{-1}) on the basis of hardness. As per (Sawyer (1960)) classification **Upper Lake** is categorized among moderately hard water type of waterbody. During the present study Magnesium Hardness value ranged between 1-30 mgl^{-1}. The present values are higher than earlier values recorded by (Wanganeo *et al*., 2011 and Bhat *et al*., 2012) (Table 1).

During the present study Chloride values ranged from 15-65 mgl^{-1} which is higher than earlier records (Wanganeo *et al*., 2011 and Bhat *et al*., 2012). Electrical conductivity during the present study recorded an average value of 279.5 mg/l which was found to be higher than the values recorded by earlier works (Table 1). As per (Alikunhi (1957)) classification Upper Lake is categorized among the productive while as per (Lee *et al.,* 1981) classification Upper Lake is categorized among eutrophic lakes. Calcium, an important mineral for organisms, regulating various physiological functions also plays a vital role in antagonizing the toxic effects of various ions and neutralizing surplus acid produced (Munawar (1970)). A slight increase in Calcium has been reported during the present investigation, varying from 50-98 mgl^{-1} with respect to earlier observations (Wanganeo *et al*., 2011 and Bhat *et al*., 2012). According to Ohle (1934) water bodies having calcium more than 25 mg/l are rich while those having 10-25mg/l are medium. Following the above classification Upper Lake tends to be again in the medium to rich nature.

Dissolved oxygen acts as an indicator of trophic status and the extent of eutrophication (Edmondson (1996)). Dissolved oxygen is vital and very often a limiting factor for maintaining aquatic life whose diminution in water is probably the most frequent result of certain forms of water pollution (Srivastav *et al*., 2009). During the present study DO values ranged from 2 mgl^{-1} – 8.8 mgl^{-1} which was in consonance with the earlier studies by(Wanganeo *et al*., 2011) and lesser by 6 mgl^{-1} values from the earlier studies by (Bhat *et al*., 2012) from the same water body. The main nitrogen sources in the wetland are the domestic sewage, agricultural runoff and decomposition of autochthonous matter. During the present study Nitrate Nitrogen values varied from 0.38 - 2.54 mgl^{-1} which was found to be higher than the earlier studies (Wanganeo *et al*., 2011) who reported nitrate in the range of 0.460-0.523 mgl^{-1} .Wetzel (1975)) has classified water bodies on the basis on nitrate content into Oligotrophic (0.2 mgl^{-1}) mesotrophic (0.2-0.4 mgl^{-1}) and eutrophic (0.5-1.5 mgl^{-1}. Following this classification Upper Lake is categorized under the eutrophic nature type. On the basis of phosphate content (Wetzel 1975) classified lakes into the Oligotrophic (0.005 mgl^{-1}), mesotrophic (0.005-0.01 mgl^{-1}) and eutrophic (0.03-0.1 mgl^{-1}). During the present study the orthophosphate content ranged from (0.005-0.127 mgl^{-1}). Following this classification on the overall average basis Upper Lake is again categorized under the mesotrophic to eutrophic type.

During the present study 39 species of aquatic insects belonging to 6 orders were recorded from the Upper Lake. Of the 6 orders, Odonata contributed maximum number of species (12 spp.), which was followed by Hemiptera contributing a total of 11 species. This in turn was followed by order Diptera and Coleoptera contributing 7 species and 5 species respectively. However, order Ephemeroptera and Trichoptera contributed least number of 2 species each.

Table 2 : The orders recorded in the present investigation followed the following sequence of dominance: **Odonata = Hemiptera > Diptera > Coleoptera > Ephemeroptera = Trichoptera**

Order	**Genera**
Coleoptera	*Berosus* sp., *Cybister* sp., *Gyrinus* sp., *Haliplus* sp. and *Psephenus* sp.
Diptera	*Chironomous* sp., *Choborous* sp., *Culex* sp., *Limnophora* sp., *Stratiomys* sp., *Tendipes* sp. and *Tipula* sp.
Ephemeroptera	*Caenis* sp. and *Ephemera* sp.
Hemiptera	*Anisops* sp., *Buenoa* sp., *Diplonychus* sp., *Gerris* sp., *Lethocerus* sp., *Mesovelia* sp., *Naucorinae* sp., *Nepa* sp., *Notonecta* sp., *Ranatra* sp. and *Sigara* sp.
Odonata	*Anax* sp., *Brachythemis* sp., *Ceriagrion* sp., *Crocothemis* sp., *Enallagma* sp., *Gomphus* sp., *Ictinogomphus* sp., *Ischnura* sp., *Libellula* sp., *Orthetrum* sp., *Pseudagrion* sp. and *Tachopteryx* sp.
Trichoptera	*Hydropsyche* sp. and *Polycentropus* sp.

In the present study species such as *Chironomous* sp., *Culex* sp., *Berous* sp., *Brachythemis* sp., *Diplonychus* sp., *Cybister* sp., *Libellula* sp. and *Ephemera* sp. were resistant to high organic load, thus acting as indicators of pollution. *Chironomous* sp. has beenreported as a pollution indicator (Paine and Gaufin (1956) and Servia *et al*., 1998) while (CPCB (2017)) reported *Chironomous* sp. to be inhabiting less to moderate polluted waters. High abundance of chironomids in aquatic systems is also an indicative of eutrophic nature of the waterbody. Chironomids species diversity and their sensitivity to eutrophic conditions have been used in classification of lakes into oligotrophic, mesotrophic and eutrophic category (Saether (1975) and Langdon *et al*., 2006). Following the classification the present water body is categorized among eutrophic category. *Culex* sp. has been reported to be inhabiting polluted waters (Paine and Gaufin (1956)) however, *Culex* sp. and *Berosus* sp. inhabit waterbodies with moderate pollution., while *Brachythemis* sp. has been reported in less polluted to moderately polluted waters (CPCB (2017)). *Diplonychus* sp. recorded during the present study from the eutrophic waters have also been reported from water bodies with heavy metal pollution (Ahmed *et al*., 2017) However, the same species has been reported to be common in less polluted to highly polluted waters (CPCB (2017)).

During the present study ephemeropterans like *Ephemera* sp were more abundant in Upper Lake throughout the year which has been classified as mesotrophic lake, however most of their species are present in both mesotrophic and oligotrophic lakes (Barbour *et al*., 1999 and Bauernfeind and Moog (2000)). CPCB (2017) also reports *Cybister* sp. in moderate polluted waters whosepresenceduring summer is also reported (Choudhary and Ahi (2015)) from Lakhabanjara lake Sagar, M.P. Species *Libellula* though recorded in Upper lake (Mesotrophic lake) was generally found inhabiting the areas having higher values of dissolved oxygen. On the contrary (David and Ray (1966)) reported *Libellula* sp. in deoxygenated waters while (CPCB (2017)) reported the same species from both less polluted to moderate polluted waters. Thus it can safely be concluded that *Ephemera* sp. and *Libellula* sp. are of ubiquitous nature inhabiting almost all types of waterbodies.

Conclusion

Study of different Physico- chemical parameters and nutrients of surface water samples of Upper Lake revealed that the intensity of pollution is on rise due to continuous flow of domestic sewage and agricultural wastes into the water body. The rising pollution has been found to change the trophic status of upper lake towards eutrophic condition. This is further confirmed by the presence of ubiquitous species like *Ephemera* and *Libellula.* Since the present waterbody is one of the prime source of the potable water as such awareness needs to be generated towards maintaining the healthy metabolic processes into the system. Otherwise there is every chance of loosing the present potable quality of the lake.

References

Adoni A.D. Ghosh G. Chouraisia K. Kvaisha S. Yadav A.K. and Verma H.G. (1985): Work Book on Limnology. (Sagar: Pratibha Publishers).

Ahmed S.B. Moneir S.A. Asmaa A.H. and Mohammed A.M. (2017):Valuation of water pollution using enzymatic biomarkers in aquatic insects as bio-indicators from El- Mansouriya stream, Dakahlia, Egypt. Int *J. Adv. Res. Biol. Sci.* **4**(3), 1-15.

Alikunhi K.F. (1957): Fish culture in India. Farm Bulletin of Indian council. *Agr. Res*. **20**, 1-150.

APHA (2005): Standard Methods for the Examination of Water and Wastewater. 21st Edition, American ublic

Health Association/American Water Works Association/Water Environment Federation, Washington DC.

Bal A. Basu R.C. (1994**):** Insecta: Hemiptera: Mesovelidae, Hydrometridae: Veliidae and Gerridae; Belostomatidae; Nepidae: Notonectidae and Pleidae. *Records of the Zoological Survey of India*, Fauna of West Bengal, State Fauna Series**. 3**(5), 535-558.

Barbour M.T. Gerritsen J. Snyder B.D. and Stribling J.B. (1999): Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers, Office of Water, U.S. Environmental Protection Agency, Washington. Periphyton, Benthic Macroinvertebrates and Fish, 2nd Ed : EPA 841-B-99- 002.

Bath S.K. and Kaur H. (1999): Physicochemical characteristics of water of Buddha-Nallah (Ludhiana, Punjab).*Ind J Env Sci.* **3**(1): 27-30

Bauernfeind E. and Moog O. (2000): Mayflies (Insecta : Ephemeroptera) and the assessment of ecological integrity: a methodological approach. *Hydrobiol*. **423**, 71- 83.

Bhat N.A. Wanganeo A. Raina R. Dar J.A. and Nayak A.A. (2012): Phytoplankton diversity in relation to physicochemical characteristics of Upper basin (Bhoj Wetland), Bhopal, India. *Journal of Geology, earth and Environmental Sciences.* **2**(3), 147-153.

Choudhary A. and Ahi J.(2015): Diversity and distribution of aquatic insect population in Lakhabanjara Lake, Sagar, (M.P), India. *J. Int. Acad. Res. for Multidis.***3** (5), 367-374.

CPCB (2017): Biological indicators of water quality in river Ganga. Ministry of environment, forest and climate change. pp 30.

David A. and Ray P. (1966): Studies on the pollution of the river Daha (N.Bihar) by sugar and distillery wastes. *Environ. Heal.* **8**, 6-35.

Devlin M. Bricker S. and Painting S. (2011): Comparison of five methods for assessing impacts of nutrient enrichment using estuarine case studies. *Biogeochemistry* 8-9.

Edmondson W.T. (1996): Changes in the oxygen defict of Lake Washington. *Verhandlungen der International Vereinigung fiirTheoretische und Angewandte Limnologie.* **16**, 153-158.

Hynes H.B.N. (1960): The biology of polluted waters (Liverpool :University Press).

Langdon P.G. Ruiz Z. Brodersen K.P. and Foster I.D.L. (2006): Assessing lake eutrophication using chironomids: understanding the nature of community response in different lake types. *Freshwater Biol*. **51**, 562–577.

Lee G.F. Jones R.A. and Rast W. (1981): Alternative approach to trophic state classification for water quality management. Occasional paper No. 66. Dept. Civil and Environ, Eng, Program. Colorado, State University, Fort Collins, Colorado.

Mccafferty W.P. (1981): Aquatic entomology, the fishermen's and ecologists. illustrated guide to insects and their relatives (Sudbury, Massechusetts : Jones and Bartlett publishers.)

Munawar M. (1970): Limnological studies of fresh water ponds of Hyderabad, India. *Hydrobiol.* **35**, 127-162.

Ohle W. (1934): Chemische and physicaische uterschungen norddeutscher seen. Arch. *Hydrobiol.* **26**, 386-464.

Padisak J. Crossetti L.O. Naselli- Flores L. (2009):Use and misuse in the application of the phytoplankton functional classification: a critical with updates. *Hydrobiol* **621**, 1-19.

Paine G.H. and Gaufin A.R. (1956): Aquatic diptera as indicators of pollution in a mid-western stream. *Ohiu Journal of Science.* **56** (5), 291-304.

Pennak W.R. (1978): Freshwater invertebrates of United States (Willy Interscience Publishing: New York).

Saether O. (1975): Chironomid communities as water quality indicators. *Hol. Eco.* **2**, 65-74.

Sawyer C.H. (1960): Chemistry for sanitary Engineers (New York: McGraw Hill book Co.).

Servia M.J. Cobo F. and Gonzalez M.A. (1998): Deformities in larval *Prodiamesaolivacea* (Meigen, 1818), (Diptera, Chironomidae) and their use as bioindicators of toxic sediment stress. *Hydrobiol.* **385**, 153 – 162.

Spence D.H.N. (1964): The macrophytic vegetation of freshwater lochs, swamps and associated fens. In: The Vegetation of Scotland. (Eds) Oliver & Boyd (Edinburgh): pp: 306-425.

Srivastava N. Harit G. and Srivastava R. (2009): A study of physico-chemical characteristics of lakes around Jaipur, India. *Journal of Environmental Biology.* **30**(5), 889-894.

Subramanian K.A. (2005): Damselflies and dragonflies of peninsular India-A field Guide. E- Book of the Project Lifescape. Indian Academy of Sciences and Centre for Ecological Sciences, Indian Institute of Science, Bangalore, India.

Venkateshwarlu V. (1983): Taxonomy and ecology of algae in the river Moosi, Hyderabad, India. II. Bacillariophyceae. *Bibilotheca Phycologica*. **66**. 1-41.

Wanganeo A. and Wanganeo R. (2011): Bhoj wetland-A review. In: Advances in fish and wildlife ecology and biology. (Ed.) B.L. Koul (New Delhi: Daya

publishing House).

Wanganeo A. Kumar P. Wanganeo R. and Sonaullah F. (2011): Variation in Benthic population in two basins of Bhoj Wetland, Bhopal. *International Journal of Environmental Sciences.* **1**(7), 2004-2017.

Welch P.S (1952): Limonology, 2nd Edition (New York: W.B. McGraw Hill Book Co.,).

Wetzel R.G. (1975): Limnology. (Philadelphia: W.B. Saunders Co.)

Winnell M.H. and White D.S. (1985): Trophic status of Southeastern Michigan based on the Chironomidae (Diptera). *J. Great Lakes Res.* **11**, 540-548.

Xu F. Tao R.W. and Dawson B.L. (2001): A GIS- based method of Lake eutrophication assessment. *Ecol Model*. 231-244.