ISSN 0976 – 3333

Available Online at www.ijpba.info

International Journal of Pharmaceutical & Biological Archives 2012; 3(3):434-439

REVIEW ARTICLE

Biotic Components in Relation with Planktonic Diversity and Heavy Metal Pollution

C. Prabhahar[*1], K .Saleshrani[2], K. Tharmaraj[1] and M.Vellaiyan[1]

[1]*Department of zoology, Annamalai University, Annamalai Nagar - 608 002, Chidambaram, Tamil Nadu, India*
[2]*Department of Zoology, Manonmaniam Sundaranar University, Thirunelveli, Tamil Nadu, India*

Received 28 Feb 2012; Revised 01 Jun 2012; Accepted 07 Jun 2012

ABSTRACT

Rivers are one of the most productive ecosystems, comparable to tropical evergreen forests in the biosphere and play a significant role in the ecological sustainability of a region. They are an essential part of human civilization meeting many crucial needs for life on earth such as drinking water, protein production, water purification, energy, fodder biodiversity, flood storage, transport, recreation, research-education, sinks and climate stabilizers. The values of rivers though overlapping, like the cultural, economic and ecological factors, are inseparable; the geomorphological, climatic, hydrological and biotic diversity across continents has contributed to aquatic diversity. Across the globe, they are getting extinct due to manifold reasons, including anthropogenic and natural processes.

Key words: Rivers, Plankton, Biotic components, Heavy metals and Pollution.

1. INTRODUCTION

Water is a “Cradle of life” on which all organisms play. Water is one of the most peculiar of our natural resources for life; next to air it is likely to become a critical scarce resource in the coming decades. Most of the water on this planet is stored in oceans and ice caps, which is difficult to be recovered for our diverse needs. Most of our demands for water are fulfilled by rainwater that gets deposited in surface and groundwater sources. The quantity of this utilizable water is very much limited on the earth. Though water is continuously purified by evaporation and precipitation, pollution of water has emerged as one of the most significant environmental problem [1].

Rivers and Lakes are economically important ecosystems in the aquatic region phytoplankton are the initiators for the synthesis of organic matter and the energy of which is transferred to higher organisms through the food chain. The Knowledge of micro and macronutrient, and their effect in relation to productivity is highly essential in aquatic ecosystems. In case of allogenic surface strom water drainage is responsible for carrying the nutrient where as in case of autogenic, the nutrients are produced as a result of decaying process [2].

Aquatic ecosystem are transitional zones between land and water are efficient in filtering sediments. They can intercept run-off from land before it reaches the water and help in filtering nutrients, wastes and sediments from floodwaters. In certain lakes, plants are so efficient in removing wastes that artificial wastewater treatment systems use aquatic plants for the removal of pollutants from water. Lakes remove nutrients (especially nitrogen and phosphorus), particulates and total biological oxygen demand from flooding waters for plant growth and help prevent eutrophication or over-enrichment of other forms of natural waters [3].

Rivers and reservoirs are under increasing stress due to the rapidly growing population, technological development, urbanization and economic growth. Additional pressures on reservoirs from natural causes like subsidence, drought, hurricanes, erosion etc., and human threats coming from over exploitation, encroachment, reclamation of vast reservoir areas for agriculture, commercial and residential development and silviculture have altered the rate and nature of the aquatic ecosystem functions particularly, in the last few decades. The primary pollutants causing degradation are sediments, nutrients, pesticides, salinity, heavy metals, metals, low dissolved oxygen, Ph and selenium.

Rivers near urban centers are under increasing developmental pressure for residential, industrial

***Corresponding Author:** C. Prabhakar**, Email:** prabhaharc@yahoo.com

and commercial facilities, increasing population and economic growth create high demand for real estate in sub-urban localities is suitable becomes exhausted, pressure intensifies to develop lakes for residential housing, manufacturing plants, business office complexes and similar uses. They are often the final refuge for wildlife in an increasing urban environment and support many upland animals displaced by development [4]. With accelerating development of adjacent uplands, the role of urban lakes in flood protection and water quality maintenance becomes critical. Urban and industrial development increases the amount of surface water run-off from the land after rainfall. This raises flood heights and increases the flow rate of rivers, increasing the risk of flood damage. Increased run-off brings with it various substances that degrade water quality, such as fertilizer chemicals, grease and oil, road salt, sediment, etc.

Effluents from some sewage treatment plants built to handle the needs of growing communities also reduce water quality. But, passing through rivers, cleansing action takes place as many pollutants are removed, retained or utilized by the lakes. Urban lakes in certain instances functions as recharge areas. This is especially true in communities where ground water withdrawals are heavy. Thus, urban lakes are essential for preserving public water supplies.

2. TOXIC METALS IN WATER AND SEDIMENT

The hydrosphere accounts for a great areas of earth surface than the lithosphere and is divided into lakes, rivers, estuaries and oceans. Metals exists in the hydrosphere as dissolved materials and suspended particles and in areas of deposited sediments. Sediment in river and lakes accounts for the main sinks of heavy metal in the Hydrosphere. Atmospheric deposition, soil leaching, runoff, erosion and breakdown of mineral deposits all contribute to the concentration of metals in natural water supplies.

A number of toxic trace elements are introduced into the environment as a consequence of industrial activity. Many industrial establishments burn huge amount of fossil fuels for energy and extensively use a number of compounds of toxic trace elements. For example, mercury finds widespread application in the manufacture of plastics, chloro-alkali units and electronic industries etc. Effluents from these industries contribute substantially to the mercury content of the environment. The episode of cadmium poisoning in Japan, Itai-itai, has been contributed to the industrial discharge of cadmium. Similarly much of the chromium present in the environment arises from leather tanning, ceramics pigments and paints producing units. Effluents from textile mills and electroplating establishments may contain as much as 25-40 ppm of chromium [5].

The levels of trace metals are usually high in rivers than in oceans because metals from point and non-point sources are discharged into the rivers. Changes in concentration of metals in rivers are easily detected because of their rapid rate of transport. The tannery effluents contain chiefly chromium salts, copper, magnesium, iron, cadmium and arsenic salts when it discharged into the rivers it greatly affects the aquatic ecosystem [6]. The distribution of plankter in the tannery effluents are reduced due to the presence of copper, chromium and some other heavy metals.

A trace amount of chromium is necessary for all the organism as it is needed for the proper utilization of iron and its conversion into haemoglobin excessive discharge of chromium into the aquatic environment can have an adverse effect both on animals and man who eat these animals as food. In animals, it reduces fertility [7].

Copper is an essential trace element, which is widely distributed in nature and also widely used metal in industries. Copper sulphate mixed with lime is used as a fungicide. Medicinally copper sulphate is used as an ementic, it is also used as an antiparasitic agent based on its astringent and caustic actions. Copper levels in human body vary with age. Copper levels in brain increase with age and Cu levels are high in new borns than in adults [8].

Cadmium contamination of water may also come from use of metallic and plastic pipes while super phosphate fertilizers, sewage sludge and automobile tyres also contain some amount of this toxic metal. The main problem with Cd in human nutrition is that the body does not completely excrete whatever Cd is absorbed. Cd in water at 10ppm level can kill fishes in one day while at 2ppm level they will be killed in 10 days. Hardness and salinity of water provides some degree of protection [9].

Human exposure to lead occurs primarily through drinking water, airborne lead-containing particles and lead based paints. Several industrial processes create lead dust / fumes. After lead is airborne for a period of 10 days it falls into the ground and becomes distributed in soils and water sources (fresh, surface, well water and drinking water) EPA (1989). Lead may cause fatigue, irritability, information processing difficulties,

memory problems, a reduction in sensory and motor reaction.

Zinc is nutritionally an essential element and is required for the activity of a number of enzymes. Mining, processing and smelting of ores for the extraction of zinc constitutes the chief source of zinc pollution in the environment. Zinc content in aquatic invertebrates in fresh unpolluted water ranges between 25-200mg per litre. Above 40ppm level this metal imparts a faint but definite metallic taste and milky appearance to fresh water [10].

Increased loads of nutrients, heavy metals and other compounds like pesticides, fertilizers have resulted from changes in land use and anthropogenic development of the river basins [11]. Since, rivers constitute the main inland water resources for domestic, industrial and irrigation purposes, it is imperative to prevent and control the river pollution and to have reliable information on the quality of water for effective management.

Life in aquatic environment is largely governed by physico-chemical characteristics and their stability. Most of the forms exist only within narrow range of conditions. The changes in the water quality may be essential for the existence of some organisms while for others such changes may not be desirable. Aquatic environment depicts ecological feature that lead to the establishment of a very dynamic system in which the plankton communities play an important role.

Phytoplankton is a fundamental component of aquatic ecosystems as they are the major source of biologically important and labile organic carbon, located at the base of food chain. The magnitude and dynamics of phytoplankton population becomes an essential tool to asses the general health of an aquatic ecosystem [12]. The primary producers (phytoplankton) are capable of taking up dissolved organic carbon and incorporating into particulate organic carbon that forms the energy sources for organisms at higher trophic levels. Lakes have a more complex and fragile ecosystem as they do not have self-cleaning ability and therefore readily accumulate pollutions. The increasing anthropogenic influences in recent years in and around aquatic systems and their catchments areas have contributed to a large extent to deterioration of water quality and dwindling of water bodies leading to their accelerated eutrophication [13].

Productivity is of great importance in ecosystem analysis as it integrates the cumulative effects of many physiological processes, which occurs simultaneously within the ecosystem [14]. Primary productivity of aquatic ecosystems is essential for a proper assessment of the biological potential of that habitat. The primary role of phytoplankton is to fix solar energy by photosynthesis and make it available to other organisms. The rate of energy fixation by primary producer is higher in the tropics due to long hours of sunshine and high temperature. The quality of water resources is usually described according to its physical, chemical and biological characteristic. For conforming the good quality of water resources large number of physico-chemical and biological parameters are to be studied in detail and must be found in normal range. In any rational formulation and deciding quality of water resource an adequate knowledge of existing nature of physico-chemical parameter magnitude and source of any pollution load must be known, for which monitoring of physico-chemical parameters and pollutants is essential.

The planktonic organisms in aquatic systems are essential links in the food chain, plankton are highly sensitive to the environment where they live. Any change in the environment leads to the variation in the plankton population with reference to their tolerance, dominance and diversity [15]. Hence, both phytoplankton and zooplankton population may be used as reliable tools for bio-monitoring studies to evaluate the pollution status of aquatic ecosystem. The production, consumption and decomposition are the three important eco regulatory and balancing processes in an aquatic habitat, the interplay between which determine and regulate the out put levels. Natural eutrophication is a slow process of enrichment and is part of aging phenomenon. In natural eutrophication is a beneficial process in that it produces enhanced productivity in the water mass. This invariably results in deterioration of water quality, which in many cases causes

The quality of water is described by its physical, chemical and biological characteristic. But, if some correlations were possible among these parameters, then significant ones would be fairly useful to indicate the quality of water [16]. Supply-and-demand relationships in shallow lakes such as those found in Florida are much different from those of deeper lakes. The nutrient supply to lake is generally based on areal nutrient loading rates normalized for water depth and residence time, but nutrient dynamics of the demand for plant growth and potential water quality problems are based on the nutrient concentration in the water mass.

[17] noted a remarkable variation of turbidity in river Yamuna at Agra. Chemical and Bacteriological water quality of the Songkidong river were studied by [18]. [19] have reported on the nitrate and fluoride levels in drinking water in the twin cities of Hyderabad and Secunderabad. Chemical and Bacteriological water quality of the Songkidong River were studied by [20]. [21] have reported the physico-chemical environment and the plankton managed ponds in Hariyana, India. In Narmada River at Hoshongabad the temperature range of 18 to 32^{0}C was reported by the [22].

In Narmada River at Hoshangabad the temperature range of 18 to 32^{0}C was reported by [23]. Singh and Srivastava (1988) have studied the variation of water quality in Ganga river between Bauxen and Ball. [24] have studied the variation of water quality in Ganga river between Bauxen and Ball. [25] have worked on the pollution ecology of same ponds in urban vicinity of Jodhpur. [26] have reported the water quality parameters of river Panchanganga near Kolhapur and Ichalkaranji, Maharastra, India. Assessment of water quality and aspects of pollution in a stretch of river Gostri have studied by [27]. A study on physico-chemical and biological characteristics of river water has been done by many researchers from time to time [28]. [29] have reported on the physicochemical aspects of pollution in river Betwa, India. Plankton and physio-chemical parameters of river Sutlej was studied by [30]. [31] have made studies on preliminary results about contaminants in the biota of lake Baikal in the muscle of several fish specimens and reported that muscle, liver and fat of the Baikal seal show low levels of heavy metals. [32] have made studies on distribution of heavy metals in sediments of mwanza gulf of lake Victoria, Tanzania and reported that concentration of Cd, Cu & Pb were higher. [33] have studied about the heavy metals in lake Balaton water column, suspended matter, sediments and biota and reported that metal concentrations were higher in almost all compartments. [34] have studied about the plankton distribution of microfungi in polluted and non - polluted waters bodies from an industrial areas of Palar.

Secondary nutrient limitation that developed from increased P loading, including N and Si limitation, is a consequence of historic, eutrophication in aquatic ecosystems, N limitation can be induced by historic P loading may not have been recognized in nutrient enrichment bioassay experiments [35]. N limitation in both Lake Apopka and Okeechobee and Si limitation in the Great Lakes represent historic induced by high historic P loading and was substantiated by paleolimnological evidence. Paleolimnological data [36] as well as data from chemical measurements and nutrient enrichment experiments may be useful in assessing nutrient limitation and trophic state.

The areal integration of tropic state variables related to phytoplankton is also important in such assessments [37,38] and its importance should not be overlooked. Water depth and light attenuation also must be considered in assessing nutrient limitation. Waters in the lower St. Johns River are highly stained by dissolved organic substances [39] in systems such as phytoplankton biomass may be limited by light availability rather than nutrients.

In addition, wind-induced turbulent mixing in shallow lakes frequently suspends the benthic or meroplanktonic algal community from the bottom sediments into the water column producing a large short-term variation in standing crop [40] and by reduction in water transparency due to suspended inorganic materials and dissolved organic compounds [41] by resuspension of meroplanktonic or benthic algae. When turbulence weakens, algal cells settle to the sediments, reducing the algal standing crop and chlorophyll in upper part of the water column. [42] classified tannery, chromate industrial effluent, pesticide contamination of reservoirs and their physico-chemical and ecotoxicological studies.[43] reported metal pollution in Hussainsagar and Banjara lakes of Hyderabad, their evolution of possible metal detoxification and tolerance mechanisms by aquatic algae. – An overview. [44] analysed production ecology of macrophytes of Chilka lake, Orissa.[45] studied Hydrobiology of Hirakud Dam Reservoir.

3. CONCLUSION

This study focuses on the ecological events of the Vellar River to collect information on the state of the art by regarding the seasonal patterns in hydrobiology, primary productivity and diversity abundance, and composition of phytoplankton and zooplankton. Moreover, various types of pollutants that leads to deterioration in water quality in recent times in Vellar River.

REFERENCES

1. Agarwal, S.K: 2005 Water Pollution A.P.H. Publication, New Delhi.
2. Pulle, J.S. and A. M. Khan: 2003. Studies of dissolved nutrients of Isapur Dam India. *J. Envirl. Pollut.,* 22(2) : 249-255
3. Nixon & Lee (1986). Net Source. Status of wetland in Banglaore.

4. Agarwal, S.K: 2005 Water Pollution A.P.H. Publication, New Delhi.
5. Asthana and Meera Asthana. 2005. Environment problems and solutions in pollution of Earths' surface : Land and water 3. Non-Degradable pollutants fifth edition, S.Chand and Company, New Delhi, pp 166-181.
6. Eye, J.D. and Lawrence. L., 1971. Treatment of wastes from a sole lether tannery J. wat. Pollut. cont. Fed. 43; 2291 – 2303.
7. Geetha, R. Kumaraguru, A.K. and Matheyus, A.J., 1996. Toxic effects of heavy metal copper on the fish, *Lepidocephalichthys thermatis* short term exposure. Poll. Res. 15(2) : 151 – 153. Geneva.
8. Arthur Furst, Shirley, B, Radding and Kathryn A. Wurzel., 1998. Chromium. Encyclopedia of Toxicology vol.1.pp: 340-342.
9. Dara, S.S., 2004. Environmental Chemistry and Pollution control in Trace elements – Pollution and Control 7th edition. S.Chand and Company, New Delhi, pp 177-216.
10. Asthana and Meera Asthana. 2005. Environment problems and solutions in pollution of Earths' surface : Land and water 3. Non-Degradable pollutants fifth edition, S.Chand and Company, New Delhi, pp 166-181.
11. Karageorgis, A.P., Nikolaidis, N.P., Karamanos, H., Skoulikidis, N., 2003. Water and sediment quality assessment of the Axios river and its coastal environment. Continental shelf research. 23 : 1929-1944.
12. Bhatt, S.D; Pathak, J.K., 1992. Assesment of water quality and aspects o f pollution in a strech of river Gosti. J. Environ Bio, 13(2) : 113 – 120.
13. Arvind Kumar, 1995. Periodical observation and abundance of plankton in relation to physico-chemical characteristics of a tropical wetland of South Bihar, India. Eco.Env.Cons,. 1(114) : 47-51.
14. Jordan, C.F: 1985. Nutrient cycling in Tropical forest Ecosystem. John Willey and sons, London.
15. Singhal, R.N., Swamjeet and Deavies R.W., 1986. The physico-chemical environment and plankton of managed ponds in Haryana, India. proc. Indian Acad. Sc. Anim, Sci. 9(3): 353-363.
16. Dhembare, A.J Pondhe, G.M. 1997. Correlation of ground water parameters of Pmvara, Maharashtra State, India. 12 (1&1): 32-33.
17. Sangu., R.S.P., and Sharma, K.D., 1985. Studies of variation in turbidity in river Yamuna at Agra Indian. J. Environ. Hlth. 27(3) d: 257-261.
18. Kim and Gwan., 1986. Chemical and Bacteriological water quality of songkdong river (Korea). Bull. Korean Fish Sec., 19:347-385.
19. Lakshmanan, A.R., Krishna Rao, T. and Viswanathan, S., 1986. Nitrate and fluoride levels in drinking waters in the twin cities of Hyderabad and Secunderabad. Indian. J. Env. Health. 28(1): 39-47.
20. Kim and Gwan., 1986. Chemical and Bacteriological water quality of songkdong river (Korea). Bull. Korean Fish Sec., 19:347-385.
21. Singhal, R.N., Swamjeet and Deavies R.W., 1986. The physico-chemical environment and plankton of managed ponds in Haryana, India. proc. Indian Acad. Sc. Anim, Sci. 9(3): 353-363.
22. Palhariya, J.P. and Maliviya, S., 1988. Pollution of Narmada river at Househangabad in Madhya Pradesh and suggested measures for control. Ecology ad pollution of Indian rivers (Ed: R.K. Trivedi). Asian Publishing House, New Delhi. pp: 54-85.
23. Palhariya, J.P. and Maliviya, S., 1988. Pollution of Narmada River at Househangabad in Madhya Pradesh and suggested measures for control. Ecology ad pollution of Indian rivers (Ed: R.K. Trivedi). Asian Publishing House, New Delhi. pp: 54-85.
24. Singh, S.R., and Srivastava, V.K., 1988. Variation of water quality of Ganga River between Bauxer and Ball. Poll. Res. 7(3-4): 85-92.
25. Gupta and Suchitra., 1989. Pollution ecology of some ponds in urban vicinity of Jodhpur. Ph.D. Thesis, University of Jodhpur, Jodhpur (India).
26. Khatavkar, S.D. and Trivedi, R.K., 1992. Water quality parameters of river Padachaganaga near Kolhapur and

Ichlkaranji, Maharashtra, India. J. Ecotoxic. Environ. Monit. 2(2): 113-118
27. Bhatt, S.D; Pathak, J.K., 1992. Assesment of water quality and aspects o f pollution in a strech of river Gosti. J. Environ Bio, 13(2) : 113 – 120.
28. Khatavkar, S.D. and Trivedi, R.K., 1992. Water quality parameters of river Padachaganaga near Kolhapur and Ichlkaranji, Maharashtra, India. J. Ecotoxic. Environ. Monit. 2(2): 113-118
29. Datar, M.O. and Vasistha, R.P., 1992. Physico-chemical aspects of pollution in river Betwa. Indian J. Environ. Prot. 12(8): 557-580.
30. Gill, 1993. Pytoplankton and physico-chemical parameters; examination of river Sutlej. Ind. J. Environ. Pro. 13(3): 171-175.
31. Beim, A., Grocheva, E., Renzoni, A., 2000. Preliminary results about contaminants in the biota of lake Baikal. Aquatic Ecosystem Health and Management. p 245-248.
32. Kishe, M.A. and Machiwa, J.F., 2003. Distribution of heavy metals in sediments of Mwanza Gulf of Lake Victoria, Tanzania. Environmental International. p 619 – 625.
33. Nguyen, H.L., Leermakers, M., Osan, J., Torok, S., Baeyen's W., 2005. Heavy metals in Lake Balaton : Water column, suspended matter, sediment and biota. Science of the total environment. p 213-230.
34. Indra, V. and Meiyalagan, V., 2005. Diversity and distribution of Microfungi in polluted and non polluted water bodies from industrial areas of river Palar, Vellore, India. Asian Jr. of Microbiol.Biotech.Env.Sc.Vol. 7, No. 4 : 723-725.
35. Elser, J. J., E. R. Marzolf and C. R. Goldman (1990). Phosphorus and nitrogen limitation of phytoplankton growth in the freshwaters of North America: a review and critique of experimental enrichments. *Can. J. Fish. Aquat. Sci.* 47:1468-1477.
36. Brenner, M., T.J. Whitmore, M.S. Flannery and M.W. Binford. (1993). Paleolimnological methods for defining target conditions in lake restoration: Florida case studies. *Lake and Reserv. Manage.* 7:209-217.
37. Phlips, E. J., F.J. Aldridge and C. Hanlon, 1995c. Potential limiting factors for phytoplankton standing crop in a shallow subtroiical lake (Lake Okeechobee, Florida). *Arch. Hydrobiol. Beih.* Ergebn. 45:137-155.
38. Carrick, H. J., F. J. Aldridge and C.L. Schelske. 1993. Wind influences phytoplankton biomass and composition in a shallow, productive lake. *Limnol* and *Oceanogr*. 38:1179-1192.
39. Aldridge, F.J., A.D. Chapman, C.L. Schelske, and R.W.Brody. 1997. Interaction of light, nutrients and phytoplankton in a blackwater river, St. Johns Riveer, Florida, USA. *Verh. Internat. Verein. Limnol*. In Press.
40. Schelske, C.L., H.J. Carrick and F.J. Aldridge. (1995). Can wind-induced resuspension of meroplankton affect phytoplankton dynamics. *J.N. Am. Benthol. Soc.* 14:616-630.
41. Phlips, E.J., F.J. Aldridge, C.L. Schelske and T.L. Crisman. (1995a). Relationships between light availability, chlorophyll a and tripton in a large, shallow subtropical lake. *Limnol. Oceanogr*. 40:416-421.
42. Nanda kumar, N.V., K.Bhagyalakshmi and M.Dhananjaya Naidu, (1993). Tannery and chromate industrial effluent and pesticide contamination of reservoirs and other water bodies: Physico-chemical and Ecotoxicological studies. Eco & Poll of India Lakes & Reservoirs. P.C.Mishra, R.K.Trivedy, Ashis Pub. pp 269-292.
43. Prasad, M.N.V. 1993. Metal pollution in Hussainsagar and Banjara Lakes of Hyderabad, Evolution of possible metal Detoxification and Tolerance mechanisms by Aquatic Algae. Eco & Poll of India Lakes & Reservoirs. P.C.Mishra, R.K.Trivedy, *Ashis Pub.* pp 293-300.
44. Rout D.K. and P.K.Durai, (1993). Production Ecology of macrophytes of Chilka Lake, Orissa. Eco & Poll of India Lakes & Reservoirs. P.C.Mishra, R.K.Trivedy, Ashis Pub. pp 301-316.
45. Dash, M.C. P.C. Mishora, G.K.Kar and R.C.Das. (1993). Hydrobiology of Hirakud Dam Reservoir. Ecology & Pollution of Indian Lakes & Reservoirs. P.C.Mishra, R.K.Trivedy, *Ashis Pub.* pp 317-338.