INDIAN STREAMS RESEARCH JOURNAL
ISSN NO : 2230-7850
IMPACT FACTOR : 5.1651 (UIF)
VOLUME - 11 | ISSUE - 11 | DECEMBER - 2021

BIOMONITORING OF WATER QUALITY: RIVERS & OCEANS

Sandeep Shukla
Associate Professor, Department of Zoology,
D.B.S.(P.G.)College Kanpur.

ABSTRACT:

Water quality affects the abundance species composition, stability, productivity and physiological conditions of indigenous population of aquatic organisms .Higher level of population cause a drop in number and species richness of plankton as well as pelagic and benthic communities of the marine water bodies.The fates and behaviour of the heavy metals in the marine environment are of extreme importance due to their impact on the entire ecosystem. Heavy metals accumulation in the marine organisms is directly influenced by the changes in the hydrographical features It is essential to monitor the quality of water for various health effecting parameters in the ground water before it is used by the people.

It is found that some trace elements like copper, manganese ,molybdenum, lead, zinc, nickel and iron are present in ground water which is necessary to be removed from the water which is used for drinking and other household purposes.The fresh water bodies like lakes, ponds, rivers, streams etc are getting polluted day by day, which cause great harm to public health by the presence of water born pathogens.

Many diseases like typhoid, dysentery, cholera etc. are caused which are injurious to human health. The disposal removal and treatment of various pollutants are much time taking and expensive. Some pollutants like oil, hydrocarbon and other non biodegradable substances as pollutants are difficult to be handled.

KEYWORDS: *planktons, benthic , pelagic, microphytobenthos, microbes, fungi , algae, diatoms, macroinvertebrates, heavy metals, lakes, rivers, ponds, oceans, biomonitoring, neurotoxicity, bioindicators.*

INTRODUCTION :

Dudgeon et al., (1994, 2000) stresses the importance of bio monitoring and identifying areas of riverine biodiversity for long term conservation. Biological assessment of the freshwater habitats aims at characterizing and monitoring the conditions of the aquatic resources. The assessments are commonly associated with human impact .The use of living organism for monitoring water quality originated in Europe early in this century and it is widely used A spectrum of 6 biological communities including plankton, periphyton, microphytobenthos, macrozoobenthos, aquatic macrophytes and fish has been used in the assessment of the water quality

Anisocentropus and *Chironomus* are indicators of unpolluted and polluted waters respectively.

It has been found that the microbes help in degradation of complex pollutants and prevent pollution. They may be naturally occurring microbes and also the artificially developed microbes. Microbes such as bacteria, fungi algae ete, have capability to uptake heavy metals found in the water.

Aquatic organisms, such as diatoms , benthic macroinvertebrates and fish , can serve as bioindicators and are the organisms more frequently used.

Analyses of sediment and water indicate the presence of heavy metal pollutants like lead, zinc, copper, mercury and cadmium of the river Damodar of India. These metals are responsible for causing morphological deformities of antennae and other parts of chironomid larvae. Percentage of deformity correlated positively with the concentrations of Pb in water and sediment ($r > 0.6$) at the confluence points.

Pathogens	Diseases
Bacteria	
Campylobacter jejuni	Gastroenteritis
Enteropathogenic *E. coli*	Gastroenteritis
Legionella pneumophila	Acute respiratory illness
Salmonella	Typhoid, paratyphoid, salmonellosis
Shigella	Bacillary dysentery
Vibrio cholerae	Cholera
Yersinia enterocolitica	Gastroenteritis

Protozoa	
Cryptosporidium	Diarrhea
Entamoeba histolytica	Amoebic dysentery
Giardia lamblia	Diarrhea
Naegleria fowleri	Meningoencephalitis
Enteroviruses	
Adenoviruses	Respiratory illness, eye infection, gastroenteritis
Astroviruses	Gastroenteritis
Caliciviruses	Gastroenteritis
Coxsackievirus A	Meningitis, respiratory illness
Coxsackievirus B	Myocarditis, meningitis, respiratory illness

Aquatic organisms, such as diatoms (John 2003), benthic macroinvertebrates (Flores and Zafaralla 2012; Cerniawska-Kusza 2005; Ferreira et al. 2011), and fish (Tejeda-Vera et al. 2007; Trujillo Jime ´nez et al. 2011), can serve as bioindicators and are the organisms more frequently used. The aim of this review is to highlight the role of two groups of important aquatic organisms, fish and macroinvertebrates, as ecological indicators in freshwater ecosystems Aquatic organisms, such as diatoms (John 2003), benthic macroinvertebrates (Flores and Zafaralla 2012; Cerniawska-Kusza 2005; Ferreira et al. 2011), and fish (Tejeda-Vera et al. 2007; Trujillo Jime ´nez et al. 2011), can serve as bioindicators and are the organisms more frequently used. The aim of this review is to highlight the role of two groups of important aquatic organisms, fish and macroinvertebrates, as ecological indicators in freshwater ecosystems

Aquatic organisms, such as diatoms (John 2003), benthic macroinvertebrates (Flores and Zafaralla 2012; Cerniawska-Kusza 2005; Ferreira et al. 2011), and fish (Tejeda-Vera et al. 2007; Trujillo Jime ´nez et al. 2011), can serve as bioindicators and are the organisms more frequently used.

The aim of this review is to highlight the role of two groups of important aquatic organisms, fish and macroinvertebrates, as ecological indicators in freshwater Inhibition of cholinesterases has been widely used as a biomarker for organophos-phate and carbamate pesticides (Garcı ´a et al. 2000), among which, inhibition of acetylcholinesterase (AchE) is one of the most commonly used biomarkers of neurotoxicity. Jebali et al. (2006) assessed the inhibition of AchE in fish Seriola dumerilli exposed to different concentrations of malathion, observing that AchE was significantly inhibited after 2 and 7 days of exposure in a dose-response manner, but no inhibition was observed after 13 days of exposure.

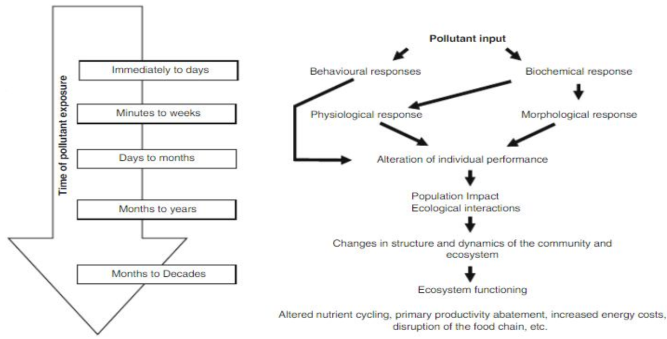


Fig. 37.1 Sequential order of development of biological responses to contaminants through different organization levels (modified of Adams and Greeley 2000)

FREASHWATER FISH AS BIOMONITOR

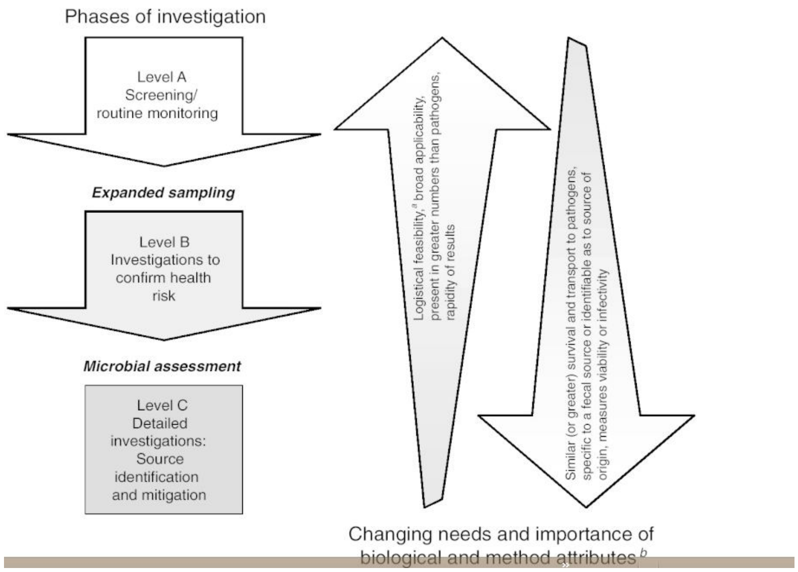
The taxonomic group of fishes, with an estimated number of 28,000–40,000 species(Nelson 2006), probably accounts for nearly 50 % of all vertebrate diversity. Fishes have colonized virtually every aquatic habitat. This condition allows this group to be elected as an indicator of the environmental conditions ofthe aquatic ecosystems. Researchers have focused on fish as biomonitors of waterpollution due to their special biological characters and advantages as indicators ofthe health of freshwater ecosystems. Among these features can be mentioned the following: fish live in the water all their life, unlike many invertebrates , and therefore, they continually inhabit the receiving water and integrate the chemical, physical and biological histories of the aquatic ecosystems; they are sensitive to several kinds of disturbance, such as hydrologic alteration, aswell as to the impact of pollutants; fish living in aquatic environments impacted by several disturbances are excellent models in which to analyze responses to severalstressors; most fish species have a long lifespan (about 2–10 years) and can reflect both long-term and current water quality Inhibition of cholinesterases has been widely used as a biomarker for organophos phate and carbamate pesticides , among which, inhibition of acetylcholinesterase (AchE) is one of the most commonly used biomarkers of neurotoxicity. Jebali et al. (2006) assessed the inhibition of AchE in fish *Seriola dumerilli* exposed to different concentrations of malathion, observing that AchE was significantly inhibited after 2 and 7 days of exposure in a dose-response manner, but no inhibition was observed after 13 days of exposure.

Among other biomarkers can be mentioned the metallothionein levels, which have been used as biomarkers of exposure to heavy metals.

River water, sediments and locally abundant mollusc (*Viviparus* (*V.*) *bengalensis*) were sampled from six different sites and analyzed for seven metals: Cadmium (Cd), Chromium (Cr), Copper (Cu), Manganese (Mn), Nickel (Ni), Lead (Pb) and Zinc (Zn). Pb, Zn, Cd and Ni in sediments may have anthropogenic sources. The findings thus suggest heavy metal contamination of river water and sediments have reached alarming levels, which is well corroborated by elevated level of metal accumulation in *V. bengalensis(a mollusc) found in the river Ganges.*

Indicator applications also vary according to the media in which they are used. For example, warning systems for groundwater typically focus on the presence or absence of bacterial indicators of fecal contamination because high-quality groundwater does not normally contain fecal bacteria and is often used without disinfection. In contrast, quantitative tests for indicator bacteria are used in monitoring surface drinking water intakes because these waters often show some evidence of fecal contamination and are usually treated with filtration and disinfection.

A single microbial water quality indicator or small set of indicators cannot meet this diversity of needs and applications. The committee recommends use of a phased, three-level monitoring framework, for selecting indicators.



The role of algae in oxidation - stabilization ponds is primarily that of an oxygen source for aerobic and facultative bacteria.Stabilization of organic material entering an aerobic pond is accomplished mainly through the aerobic bacterial activity and by blue-green algae. Palmer (1969) reported the algae which were tolerant to pollution found in the polluted areas. Patrik (1973) also discussed the usefulness of algae in assessing water quality under both field and laboratory conditions. Sehlichting (1980) describe and discussed the use of an insitu biological monitoring system which in part utilizes algae as the indicator organisms.

Mainly Cyanophyceae, Euglenophyceae, Centric diatoms and members of Chlorococcales are characteristic of polluted waters while pennate diatoms and desmids are usually found in oligotrophic waters as they can not tolerate high nutrient levels. Cyanophyceae are found to be more useful in assessment of water quality. The presence of Nostoc microscopicum, Hapalosiphon welwitschii and Hapalosiphon confervaceous indicate the pollution of dithane "deltan aldrex B.H.C. Roger phorates etc: Heavy metal pollution of water can be indicated by some green algae like cladophora and stigevelonium

CONCLUSION:

Shashikant (1983) reported a large number of algal species as indicator of pollution of fifteen pond water bodies of Yamuna. He observed that these species are tolerant and act as pollution indicator. Common algae such as Oscillatoria. Scenedesmus, Nitzchia, Phormidium, Merismopodia, Spirulina. Chlorella, Oocystis, Pediastrum Navicula and Euglena were more tolerant forms and can be used in assessing water quality. Many algal forms were recorded from polluted areas rich in organic matter of the River Ganga by Bilgrami et. al. (1985).

Phosphates are the major ingredients of most detergents. They favour luxuriant growth of algae which form water blooms. This excessive algal growth also consumes most of the available oxygen from water. This decreases in oxygen level and decreases the growth of other organisms which produces a foul smell after decay Saccharomyces cerevisiae accumulates uranium from dilute solution The yeast, Some fungi belonging to the genera Trichoderma, Aspergillus Rhodotorula etc. are found to have bisorption ability of heavy metals and this seem to play an important role in detoxification of industrial effluents Radio active metals as uranium and thorium are removed by Rhizopus, Arrhizus and Penicillium chrysogenum can accumulate radium Bacteria like Pseudomonas, Arthrobacter Citrobacter etc remove several toxic metals.

Lot of work has still to be done in relation to water pollution in different water bodies. In coming times, microbes will prove an asset not only as monitor of pollutants and toxic substances, but also as scavengers

REFERENCES

Allen, T. F. H(1977).Phycologia.

Boyle, T.P.(1980) Environmental pollution

Patrice,R (1972) Aquatic communities in indices of pollution. "Indicators of Environmental quality."

(2005 G. Bhattacharyya, A. K. Sadhu, A. Mazumdar & P. K. Chaudhuri)

(Sivaramakrishnan, et al., 1996a) (De Pauw et al., 1992). Tejeda-Vera et al. 2007; Trujillo Jime´nezet al. 2011 Resh, et al., 1995). (Cairns and Pratt, 1993; Metcalfe-Smith, 1994). (Jebali et al. 2006; Linde-Arias et al. 2008

Sahagun, L. (2014). Toxins released by oil spills send fish hearts into cardiac arrest. Los Angeles Times.

Schneyer, J. (2010). U.S. oil spill waters contain carcinogens: report. Reuters.

Singh, R., Singh, P., & Sharma, R. (2014). Microorganism as a tool of bioremediation technology for cleaning environment: A review. Proceedings of the International Academy of Ecology and Environ- mental Sciences, 4(1), 1–6.

Skraber, S., Schijven, J., Gantzer, C., & de Roda Husman, A. M. (2005). Pathogenic viruses in drinking-water biofilms: A public health risk? Biofilms, 2(02), 105–117. doi:10.1017/S1479050505001833

Trogl, J., Chauhan, A., Ripp, S., Layton, A. C., Kuncová, G., & Sayler, G. S. (2012). Pseudomonas fluorescens HK44: Lessons Learned from a Model Whole-Cell Bioreporter with a Broad Application History. Sensors (Basel), 12(2), 1544–1571. doi:10.3390/s120201544 PMID:22438725

Valentine, D. L. (2011). Dynamic autoinoculation and the microbial ecology of a deep water hydrocarbon irruption. Proceedings of the National Academy of Sciences of the United States of America, 109(50).

Wachsmuth, K. (1986). Molecular epidemiology of bacterial infections: Example of methodology and investigations of outbreaks. Infectious Diseases, 8(5), 682–692. doi:10.1093/clinids/8.5.682 PMID:3024288

Ward, O. P. (2004). The industrial sustainability of bioremediation processes. Journal of IndustrialNicholson, C. A., & Fathepure, B. Z. (2004). Biodegradation of benzene by halophilic and halotoler- ant bacteria under aerobic conditions. Applied and Environmental Microbiology, 70(2), 1222–1225. doi:10.1128/AEM.70.2.1222-1225.2004 PMID:14766609

Olivera, N. L., Commendatore, M. G., Delgado, O., & Esteves, J. L. (2003). Microbial characteriza- tion and hydrocarbon biodegradation potential of natural bilge waste microflora. Journal of Industrial Microbiology & Biotechnology, 30(9), 542–548. doi:10.1007/s10295-003-0078-5 PMID:12898391

Olsen, J. E., Brown, D. J., Baggesen, D. L., & Bisgaard, M. (1992). Biochemical and molecular char- acterization of Salmonella enterica serovar berta, and comparison of methods for typing. Epidemiology and Infection, 108(02), 243–260. doi:10.1017/S0950268800049724 PMID:1582467

Paul, D., Pandey, G., & Jain, R. K. (2005). Suicidal genetically engineered microorganisms for bioreme- diation: Need and perspectives. BioEssays, 27(5), 563–573. doi:10.1002/bies.20220 PMID:15832375

Pina, S., Puig, M., & Lucina, F., Jofre, and Girones, R. (1998). Viral pollution in the environment and in shellfish: Human adenovirus detection by PCR as an index of human viruses. Applied and Environmental Microbiology, 64, 3376–3382. PMID:9726885

Pons, W. (2015). An examination of opportunities for small non-community drinking water systems to improve drinking water safety [Ph.D thesis]. Guelph, Ontario, Canada.

Prüss, A. (1998). Review of epidemiological studies on health effects from exposure to recreational water. International Journal of Epidemiology, 27(1), 1–9. doi:10.1093/ije/27.1.1 PMID:9563686

Puig, A., Queralt, N., Jofre, J., & Araujo, R. (1999). Diversity of Bacteroides fragilis strains in their capacity to recover phages from human and animal wastes and from fecally polluted wastewater. Journal of Applied Microbiology, 65, 1772–1776. PMID:10103280

Resnick, I. G., & Levin, M. A. (1981). Assessment of bifidobacteria as indicators of human fecal pollution. Applied and Environmental Microbiology, 42, 433–438. PMID:7294781

Sahagun, L. (2014). Toxins released by oil spills send fish hearts into cardiac arrest. Los Angeles Times.

Schneyer, J. (2010). U.S. oil spill waters contain carcinogens: report. Reuters.

Singh, R., Singh, P., & Sharma, R. (2014). Microorganism as a tool of bioremediation technology for cleaning environment: A review. Proceedings of the International Academy of Ecology and Environ- mental Sciences, 4(1), 1–6.

Skraber, S., Schijven, J., Gantzer, C., & de Roda Husman, A. M. (2005). Pathogenic viruses in drinking-water biofilms: A public health risk? Biofilms, 2(02), 105–117. doi:10.1017/S1479050505001833

Trogl, J., Chauhan, A., Ripp, S., Layton, A. C., Kuncová, G., & Sayler, G. S. (2012). Pseudomonas fluorescens HK44: Lessons Learned from a Model Whole-Cell Bioreporter with a Broad Application History. Sensors (Basel), 12(2), 1544–1571. doi:10.3390/s120201544 PMID:22438725

Valentine, D. L. (2011). Dynamic autoinoculation and the microbial ecology of a deep water hydrocarbon irruption. Proceedings of the National Academy of Sciences of the United States of America, 109(50).

Wachsmuth, K. (1986). Molecular epidemiology of bacterial infections: Example of methodology and investigations of outbreaks. Infectious Diseases, 8(5), 682–692. doi:10.1093/clinids/8.5.682 PMID:3024288

Ward, O. P. (2004). The industrial sustainability of bioremediation processes. Journal of Industrial Kujan, P., Prell, A., Safár, H., Sobotka, M., Rezanka, T., & Holler, P. (2006). Use of the industrial yeast Candida utilis for cadmium sorption. Folia Microbiologica, 51(4), 257–260. doi:10.1007/BF02931807 PMID:17007420

Latham, R. H., & Stamm, F. (1984). Role of fimbriated Escherichia coli in urinary tract infections in adult women: Correlation with localization studies. The Journal of Infectious Diseases, 149(6), 835–840. doi:10.1093/infdis/149.6.835 PMID:6145744

LeChevallier, M. W., Gullick, R. W., Karim, M. R., Friedman, M., & Funk, J. E. (2003). The potential for health risks from intrusion of contaminants into the distribution system from pressure transients. Journal of Water and Health, 1(1), 3–14. PMID:15384268

MacConkey, A. T. (1905). Lactose-fermenting bacteria in faeces. The Journal of Hygiene, 5(03), 333–379. doi:10.1017/S002217240000259X PMID:20474229

MacConkey, A. T. (1909). Further observations on the differentiation of lactose-fermenting bacilli with special reference to those of intestinal origin. The Journal of Hygiene, 9(01), 86–103. doi:10.1017/ S0022172400016156 PMID:20474388

MacDonald, I. A., Bokkenheuser, V. D., Winter, J., McLernon, A. M., & Mosbach, X, A. M. (1983). Degradation of fecal sterols in the human gut. Journal of Lipid Research, 24, 675–694. PMID:6350517

Maneerat, S. (2005). Biosurfactants from marine microorganisms. J. Sci. Technol., 27, 1263–1272.

Mara, D. D., & Oragui, J. I. (1983). Sorbitol-fermenting bifidobacteria as specific indicators of human faecal pollution. The Journal of Applied Bacteriology, 55(2), 349–357. doi:10.1111/j.1365-2672.1983. tb01331.x PMID:6654767

Nicholson, C. A., & Fathepure, B. Z. (2004). Biodegradation of benzene by halophilic and halotoler- ant bacteria under aerobic conditions. Applied and Environmental Microbiology, 70(2), 1222–1225. doi:10.1128/AEM.70.2.1222-1225.2004 PMID:14766609

Olivera, N. L., Commendatore, M. G., Delgado, O., & Esteves, J. L. (2003). Microbial characteriza- tion and hydrocarbon biodegradation potential of natural bilge waste microflora. Journal of Industrial Microbiology & Biotechnology, 30(9), 542–548. doi:10.1007/s10295-003-0078-5 PMID:12898391

Olsen, J. E., Brown, D. J., Baggesen, D. L., & Bisgaard, M. (1992). Biochemical and molecular characterization of Salmonella enterica serovar berta, and comparison of methods for typing. Epidemiology and Infection, 108(02), 243–260. doi:10.1017/S0950268800049724 PMID:1582467

Paul,Pandey, G., & Jain, R. K. (2005). Suicidal genetically engineered microorganisms for bioremediation: Need and perspectives. BioEssays, 27(5), 563–573. doi:10.1002/bies.20220 PMID:15832375

Pina, S., Puig, M., & Lucina, F., Jofre, and Girones, R. (1998). Viral pollution in the environment and in shellfish: Human adenovirus detection by PCR as an index of human viruses. Applied and Environmental Microbiology, 64, 3376–3382. PMID:9726885

Pons, W. (2015). An examination of opportunities for small non-community drinking water systems to improve drinking water safety [Ph.D thesis]. Guelph, Ontario, Canada.59 View publication stats Microbes as Indicators of Water Quality and Bioremediation of Polluted Waters

Prüss, A. (1998). Review of epidemiological studies on health effects from exposure to recreational water. International Journal of Epidemiology, 27(1), 1–9. doi:10.1093/ije/27.1.1 PMID:9563686

Puig, A., Queralt, N., Jofre, J., & Araujo, R. (1999). Diversity of Bacteroides fragilis strains in their capacity to recover phages from human and animal wastes and from fecally polluted wastewater. Journal of Applied Microbiology, 65, 1772–1776. PMID:10103280

Resnick, I. G., & Levin, M. A. (1981). Assessment of bifidobacteria as indicators of human fecal pollution. Applied and Environmental Microbiology, 42, 433–438. PMID:7294781

Sahagun, L. (2014). Toxins released by oil spills send fish hearts into cardiac arrest. Los Angeles Times.

Schneyer, J. (2010). U.S. oil spill waters contain carcinogens: report. Reuters.

Singh, R., Singh, P., & Sharma, R. (2014). Microorganism as a tool of bioremediation technology for cleaning environment: A review. Proceedings of the International Academy of Ecology and Environ- mental Sciences, 4(1), 1–6.

Skraber, S., Schijven, J., Gantzer, C., & de Roda Husman, A. M. (2005). Pathogenic viruses in drinking-water biofilms: A public health risk? Biofilms, 2(02), 105–117. doi:10.1017/S1479050505001833

Trogl, J., Chauhan, A., Ripp, S., Layton, A. C., Kuncová, G., & Sayler, G. S. (2012). Pseudomonas fluorescens HK44: Lessons Learned from a Model Whole-Cell Bioreporter with a Broad Application History. Sensors (Basel), 12(2), 1544–1571. doi:10.3390/s120201544 PMID:22438725

Valentine, D. L. (2011). Dynamic autoinoculation and the microbial ecology of a deep water hydrocarbon irruption. Proceedings of the National Academy of Sciences of the United States of America, 109(50).

Wachsmuth, K. (1986). Molecular epidemiology of bacterial infections: Example of methodology and investigations of outbreaks. Infectious Diseases, 8(5), 682–692. doi:10.1093/clinids/8.5.682 PMID:3024288

Ward, O. P. (2004). The industrial sustainability of bioremediation processes. Journal of Industrial