Effect of heavy metal toxicity on zooplankton community in fresh water ecosystem of southern Rajasthan, India

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ABSTRACT

Zooplanktons are very sensitive fauna of aquatic or fresh water ecosystems; there richness and high diversity indicate healthy and unpolluted aquatic ecosystems, whereas lower abundance & richness indicate polluted water and contaminated with various types of pollutant including heavy metals toxicity. During study total nine species of zooplanktons were selected for assessing heavy metal toxicity (Zn, Cd, Pb) in different lack and rivers of southern Rajasthan. These following species namely (Brachionus, Monostyla, and Filinia belonging to Rotifers, Diaptomus, and Cyclops belonging to Copepoda, Daphnia, Ceriodaphnia and Moina belonging to Cladocera and Cypris belonging to Ostracoda were selected for assessing heavy metals toxicity in various lake. Present study observed Cadmium was the most toxic to Diaptomus, Cyclops, Cypris, Daphnia, Moina, Brachionus, Monostyla and Filinia. Zinc was found more toxic to Ceriodaphnia as compared to cadmium and lead. In general, following trend of metal toxicity was observed in relation to freshwater zooplankters: - Cadmium > Lead > Zinc.

INTRODUCTION

Zooplanktons are important large group of tiny animals. They are useful indicator of water quality and choice food of commercially important fishes. By definition zooplankton is a group of very minute animals which passively float and drift with water currents. zooplankton generally measure several microns to few centimeters in size. In this context, plankton being a sensitive community may be effectively used to assess the impact of waste discharged in aquatic ecosystem. Moreover, zooplankton community forms a major link in aquatic food chain and their composition varies depending upon bizarre environmental factors. zooplanktons respond quickly to environmental change and hence their standing crop and species composition indicate the status of water quality. In fact ichthyofauna is also affected if any change in zooplankton community is caused due to water pollution. zooplanktons of Indian freshwater have been studied by Arora (1966), Ganapati and Pathak (1978), Nasar (1977), Malhotra et al., (1978), Saksena and Sharma (1981), Pandit (1999) and Kumar and Bohra (2001), Alkesander- Waterczak and Helios-Rybića (2009). Although large number of metals are causing surface as well as ground water pollution in Southern Rajasthan but main emphasis has been given to Zn, Cd, Pb, Cu and Fe during present studies. Heavy metal toxicity has attracted wide attention of workers at National as well as International levels. Comparatively less attention is being paid to ecotoxicological studies of zinc on freshwater organisms inhabiting the affected freshwater ecosystem in relation to biomagnifications of this metal during energy transfer in different food chains. Fowler (1931), Huthinson (1933), Naumann (1934), Pawlik-Skowrońska (2002b) Smolyakov et al., (2010a) indicated that zinc is relatively toxic to Daphnia. Ahsanullah (1976); Arnott and Ahsanullah (1978) compared zinc and cadmium toxicity to freshwater invertebrates. Marshall (1983) studied bioaccumulation of zinc in lake Michigan planktonic community. Lolande and Alloul (1985) studied acute toxicity of zinc and other metals to Tropocyclops. The suspended particles carried by various effluents sewage are ultimately deposited as the sediments containing measurable concentration of zinc and other metals (Duddridge and Wainwright 1981; Forstner and Wittman, 1981), Polprasert (1982) has reported elevated levels of Zn and other metals in the fish Heteropeustus fossilis and floating plant Eichhornia crassipes from the Ganga river. Starm et al., (1994) have studied the persistence of metals in soils and selected vertebrates in the vicinity of zinc smelter. Ajmal and Raziueddin (1988), Pandu et al., (1991), Singh et al. (1993) analyzed zinc in different freshwater bodies of India. Zinc content in sediments of Indian canals and reservoirs has been detected by Fender et al. (1993). Sharma and Selvaraj (1994) studied toxicity of zinc, lead, and cadmium to selected freshwater zooplankters. In last two decades several books, monograph and reviews on toxicity dose response and health effects of cadmium have appeared in literature (Williams and Harrison, 1984) described biochemical, physiological and health effects of cadmium exposure along with its interaction with essential elements like Cu, Zn, Ca, and Se. He also reviewed information on role of metallothionin as a regulator of metallo-enzyme biosynthesis, immune response and neurotoxicity. A limnological study in relation to industrial
polution of freshwater bodies has been carried out by many scientists (Jameson and Rana, 1996; Pandey and Sharma, 1998; Musaddiq, 2000; Narain and Chouhan 2000; Ranu, 2001; Ashraj W. 2005; Farombi et al., 2007.) Numerous studies have been made on the acute and chronic toxicity of heavy metals to freshwater organisms. Westfall (1945) suggested that the heavy metals can be lethal by their action on respiratory and excretory organs. Mount (1966) observed effects of metal on gill lamella of freshwater fish. Several investigators have studied toxicity of zinc, cadmium and copper to freshwater organisms. Trophic status and planktonic communities of Rajasthan water have been studied by (Singh 1955; Vyas and Kumar, 1968; Nayer, 1968 and 71; Biswas,1971; Bohra 1977; Wilde et al., 2006; Cunnigham et al., 2010). Besides physico-chemical methods for monitoring water pollution, biological assessment with the use of bioassays methods is becoming popular. Bioassays have been recognized as essential complementary methods to assess the effects of pollutants in a more precise manner (Lamboliz et al., 1994). Cladocerans, crustaceans are useful organisms to study and control water quality and were widely used for biological assay (Navarro et al., 1997).

OBJECTIVE OF STUDY

Present investigation is aimed at studying trophic status and planktonic composition of the Berach river system, various lakes and water bodies of Southern Rajasthan). This study is further extended to observe biodiversity of zooplankton in selected water bodies of Rajasthan to asses’ impact of heavy metal pollution on zooplankton species compositions. Present study is further extend to know zinc, cadmium, lead, copper and iron content in soil, water and animals in different water bodies to compare metal content of polluted and unpolluted zone.

MATERIAL AND METHODS

Toxic effects of different heavy metals i.e. (Zn, Cd, and Pb) were assessed by conducting short term bioassay tests. Bioassay is a test in which the quantity or strength of material is determined by reaction of living organism to it (Sprague 1973). Bioassay methods were evaluated and improved by several workers and agencies (Sprague 1973; American society for testing materials 1974; American Public Health Association 1989) Methods and guidelines of above mentioned workers and agencies were followed during the present work. Bioassay tests are of two types (i) Acute toxicity and (ii) Chronic toxicity. Acute tests are term exposures of organisms that would result in fifty percent mortality. These tests demonstrate the stimulus bringing about a speedy response leading to the death of organisms. This observation on 50% mortality is used as a measure to assess the effects on organisms. The concentration responsible for 50% mortality (LC-50) was calculated on the basis of probit curve on logarithmic graph. For short-term bioassay experiments on zooplankters, glass beakers of 1000 ml capacity were used. Prior to experimentation, the test containers were cleaned thoroughly with detergent and diluted HCl, and finally rinsed with distilled water. Nine types of healthy moving zooplankters belonging to each group of Copepoda, Cladocera, Rotifera and Ostracoda were selected from the acclimatized zooplankton stock for toxicity studies.

RESULTS AND DISCUSSION

Bioassay studies conducted during present work is different from usual toxicity tests, since a group of planktonic animals belonging to different species has been exposed to the Standard indices for assessment of toxicity are as follows:-

1. Median lethal concentration (LC-50):-This is a toxicant concentration obtained by graphical interpolation based on observed percentage of mortality plotted on a logarithmic scale. A straight line was drawn between two points representing mortality for successive concentration of test series. The point at which line intersects the fifty percent mortality a perpendicular line was drawn to indicate LC-50 values.

2. Threshold concentration:-It is a concentration of a toxicant or pollutant in a suitable diluents that first the survival of the test organisms. This concentration is obtained from the results of static bioassay.

3. Maximum Acceptable Toxicant Concentration (MATC):-The MATC or no effect level is the highest toxicant concentration that has no adverse effect on survival, growth and reproduction of animals on the basis of static bioassay. This was determined for the various test animals.

4. Safe Concentration:-It was calculated dividing the MATC by LC-50 value. It is used to determine the safe concentration of toxicant.

Atomic Absorption Spectrophotometer: -

Heavy metal concentration in test water, effluent and exposed animals as well as in water and sediments were detected by Atomic Absorption Spectrophotometer (Speher, 1976). Atomic Absorption Spectrophotometer is based on the principle that atom in the ground state absorbs some radiant energy at its characteristic wave length. This energy is directly proportional to atom present in that solution. The instrument consists of Emission, absorption, selection and photometric system. The resonance line produced by hollow cathode lamp on receiving proper power supply is main characteristics of emission system. The radiant energy from the hollow cathode lamp is focused on the air-acetylene flame. Some of the radiant energy at the resonant wavelength is absorbed which is proportional to the analyze atoms. The radiation leaving the flame is directed on to the monochromatic entrance slit where the parallel beam is dispersed by the grating into constituent
wave length. The light energy from the monochromater exit slit is directed on to the photomultiplier where it is converted into electric current which is finally converted into digital reading. Perkin Elmer 2380 Atomic Absorption Spectrophotometer is used during present study and Zn, Cd and Pb were measured at 213.9 nm, 226.50 nm and 202.35 nm wave length. Different species of zooplankters belonging to cladocera, copepoda and ostracoda were selected for the bioassay tests. Systematic identification of zooplankters was done after Needham and Needham (1962), and Edmondson (1992 ). Planktonic community collected from lake Fatehsagar was analyzed and nine types of zooplankters selected for the study were retained and kept in jars for 24 hrs. After this acclimatization, bioassay experiments were conducted for the period of 48 hrs. in 1 liter beakers. The nine forms of zooplankter’s selected were Brachionus, Monostyla, and Filinia belonging to Rotifera, Diaptomus, and Cyclops belonging to Copepoda, Daphnia, Ceriodaphnia and Moina belonging to Cladocera and Cypris belonging to Ostracoda. Twenty individuals of each zooplankters were kept in beakers for bioassay. During the study out of three metals undertaken for study cadmium was the most toxic to Diaptomus, Cyclops, Cypris, Daphnia, Moina, Brachionus, Monostyla and Filinia. Zinc was found more toxic to Ceriodaphnia as compared to cadmium and lead. In general, following trend of metal toxicity was observed in relation to freshwater zooplankters: - Cadmium > Lead > Zinc

Median lethal concentration of cadmium in relation to different freshwater zooplankters were in the range of 0.05 to 2.15 mg/l. high range (0.05 – 8.00 mg/l) of LC-50 values have been noted in relation to freshwater zooplankters i.e. 0.15 to 5.25 mg/l but this was due to Cyclops and Cypris which were more sensitive to zinc as compared to lead. Sensitivity pattern shown by different experimental zooplankters in relation to zinc, lead and cadmium was as follows:

**REFERENCES**


REFERENCES


