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Multivariate Analysis for distribution of Phytoplankton Community in two Lakes of Mysore

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ABSTRACT

Biomonitoring is of paramount importance in the field of water quality assessment. Phytoplanktons are an important group of aquatic ecosystems which are considered as potential and robust indicators of water quality. In the present study, Biomonitoring of phytoplanktons was performed to assess the water quality of two lakes of Mysore city. A total of 56 species were recorded in Karanji Lake and 25 species were recorded in Kukkarahalli Lake. The principal species and principal physico-chemical parameters were determined by performing the Principal Component Analysis. Percentage similarities between the samples in terms of phytoplankton distribution as well as concentration of physico-chemical parameters were determined using the Bray-Curtis similarity index. The study suggests that phytoplanktons serve as powerful indicators of water quality and the Multivariate analysis is an effective tool in understanding the distribution and biodiversity of organisms.

KEYWORDS : Biomonitoring, Bray-Curtis similarity index, Multivariate analysis, Principal Component Analysis.

Introduction

Water is one of the vital resources for all the living creatures. Freshwater sources such as lakes and rivers face many stress related factors which enhance degrading process in the form of pollution from point and non-point sources (Basavarajappa, 2010). There is an urgent need to develop a more sustainable practice for the management and efficient use of water resources as well as the need to protect the ecosystems where these resources are located. Therefore, it is important to monitor the quality of our limited water supplies.

Presently, there are several methods to monitor water quality. One of the methods that are successfully used for monitoring aquatic environments around the world is biological assessment of water quality. It is considered an essential part in the assessment of the ecological quality of waters apart from the data obtained from other sources such as hydrology, eco morphology, physico-chemical water analysis and eco-toxicological analysis (Suphan *et al*., 2012). Plankton, particularly phytoplankton, has long been used as indicators of water quality because of their short life span and quick responses to environmental changes (Patil *et al*., 2013).

In this study, water quality of two lakes of Mysore was assessed using both phytoplanktons and physico-chemical parameters. In addition, Multivariate analysis was performed to identify the dominant patterns in the data.

Materials and Methods

Study Area

Karanji and Kukkarahalli lakes are located in the city of Mysore in the state of Karnataka, India. The lakes were selected for the study on the basis of factors such as nature of aquatic life, usage and level of animal and human disturbances.

Karanji Lake

This lake is situated between 12^{0}18'10" and 12.30278^0 north latitude and 76^{0}40'25" and 76.67361^{0}E longitude and is owned by the Mysore Zoo Authority. The lake water quality is getting deteriorated due to the discharge of sewage from the nearby residential areas and effluent from the Diary industry.

Kukkarahalli Lake

Kukkarahalli Lake is situated between 12^{0}18' north and 76^{0}38' east and is located in the heart of the Mysore city and provides lung-space to the city. The lake is owned by the University of Mysore. Over the years, sewage and excessive land encroachments (mostly illegal) and blockage of water flow sources almost led to the eutrophication of the lake.

Environmental Variables

Phytoplankton samples and physico-chemical water quality parameters were determined twice in a month during December 2013 – April 2014. Composite samples were collected and standard methods (APHA, 2005) were followed for the analysis of water samples. Collection, preservation, identification and enumeration of phytoplanktons were done by Lackey's drop method (1938) modified by Suxena (1987). Algae were identified using the monographs of Desikachary (1959), Prescott (1982), Scott and Prescott (1961), Sarode and Kamath (1984), Philipose (1960), Gandhi (1998), Taylor *et al*., (2007) and West and West (1909).

Data Analysis

Water quality data and phytoplankton species were analyzed with Principal Component Analysis (PCA), a Multivariate direct gradient analysis method to reveal the main gradients of the variation in data sets using PAST (Hammer *et al*., 2001) software program. Cluster analysis was performed using Bray-Curtis (1957) similarity index to determine the similarity percentage between the monitoring periods using PAST software program.

Results and Discussions

Physico-chemical Properties

A total of 12 physico-chemical parameters were analyzed including pH, temperature, Conductivity, turbidity, total solids, DO, BOD, COD, nitrate, phosphate and total alkalinity. The values of BOD, COD, Fecal Coliform and nutrients were found to be high in summer because of prevalent high temperature and low flow conditions.

Phytoplankton Distribution

In Karanji Lake, a total of 56 species were recorded and classified into 6 classes. Majority of the species were Chlorococcales followed by Cyanophyceae, Bacillariophyceae, Euglenophyceae, Chlorophyceae and Desmidaceae. In Kukkarahalli Lake, 25 species were identified. Majority of the species belonged to Cyanophyceae followed by Bacillariophyceae, Chlorococcales and Euglenophyceae.

PCA

The physico-chemical data and planktonic data of both the lakes were subjected to PCA separately. The PCA for phytoplanktons of Kukkarahalli Lake (Fig 1) revealed that *Microcystis inserta* and *Scenedesmus bijuga* were the principal species with 43.48% and 23.93% variance. *Microcystis aeruginosa* was also found to be significant and inversely proportional to *Achtinastrum hantzschii*. The remaining species were of less significance and the months of February and March were found to be significant.

The PCA for phytoplanktons of Karanji Lake (Fig 2) revealed that *Nostoc sp.* and *Aphanocapsa rivularis* were the principal species with 52.59% and 18.16% variance. The specie *Oscillatoria princeps* was also significant but is not operating as a principal component. *Aphanocapsa rivularis* and *Oscillatoria princeps* were inversely proportional to each other. Most of the species of this lake were closely associated to each other and most of the prominent species appeared in the months of January, February and April indicating that the remaining months were of less significance.

The PCA for physico-chemical parameters of Kukkarahalli Lake **(**Fig 3**)** revealed that phosphate and TDS were the principal parameters with 39.16% and 17.38% variance. TSS and total alkalinity were also prominent and TSS inversely proportional to temperature and BOD. Most of the prominent species appeared in the months of February and March.

In Karanji Lake, BOD and nitrate were found to be the principal components (Fig 4) with 39.16% and 26.78% variance. COD and FC were also found to be prominent. However, they were not operating in the lake as principal components. Nitrate and TS were found to be inversely proportional to each other and consequently, pH and temperature were found to be inversely proportional to each other. The months of March and April were found to be significant for this lake.

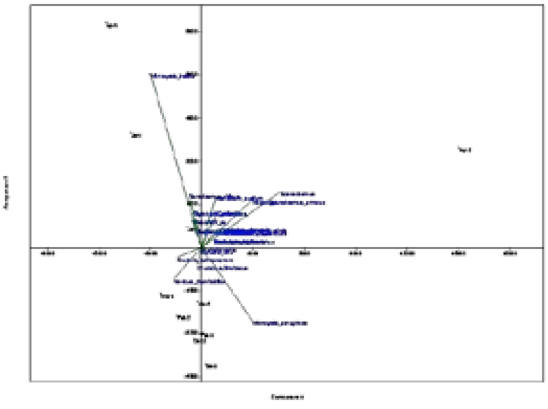

Fig 1 PCA for Phytoplanktons of Kukkarahalli Lake

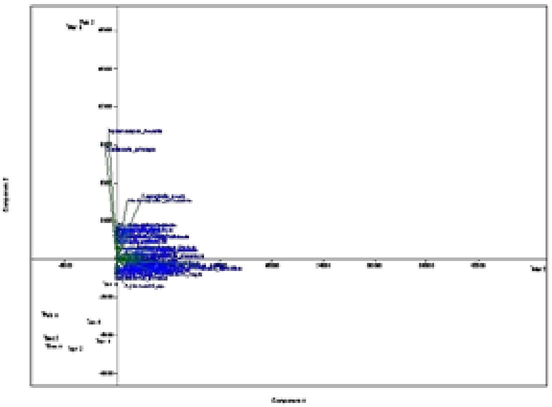

Fig 2 PCA for Phytoplanktons of Karanji Lake

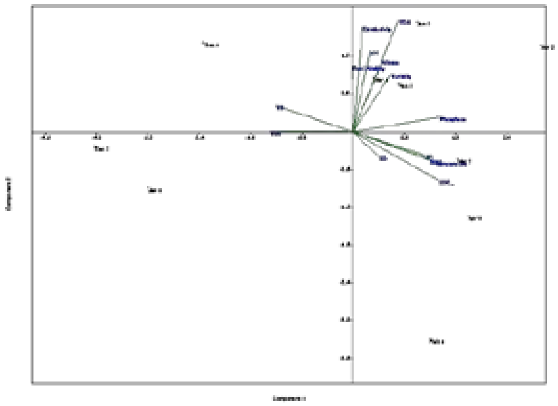

Fig 3 PCA for Physicochemical Parameters of Kukkarahalli Lake

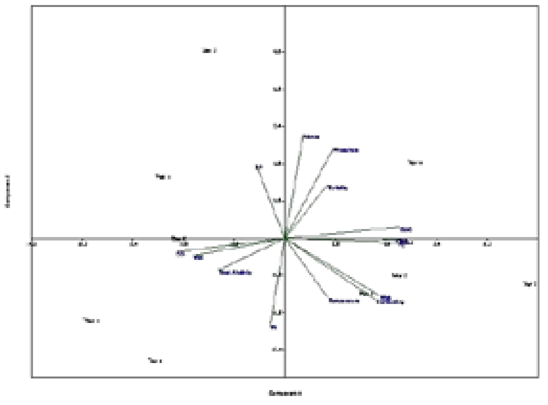

Fig 4 PCA for Physicochemical parameters of Karanji Lake

Bray-Curtis Similarity Index

Bray-Curtis (1957) Similarity Index helps to understand the hierarchical similarities between the associations of phytoplanktons and physicochemical parameters during the study period. Similarities in terms of both physicochemical and phytoplankton distributions have been worked out.

The dendrograms of similarities between the various sampling periods for Kukkarahalli and Karanji lakes according to the phytoplankton association and concentration of physicochemical parameters are presented in Figs 5, 6, 7 and 8 respectively. According to the index, fewer months were similar according to the phytoplankton community. In Kukkarahalli Lake, no significant similarities existed between the months. However, the phytoplankton distribution remained 80% similar throughout February and the months of December and March were 88% similar because the intermittent period between December and March face lot of changes and is a period where phytoplanktons brought by rain starts acclimatizing and gets stabilized by the time of March. With respect to the concentration of physicochemical parameters, the months of March and April are 95% similar to each other and the rest of the months are 76% similar to each other while the months of March and April and the rest of the months are 66% similar.

In Karanji Lake, the distribution of phytoplanktons remained same throughout December and similarity was less among the months. On the other hand, according to the concentration of physicochemical parameters the months of March and April were 98.5% similar whereas the same months were 57% similar to the rest of the months.

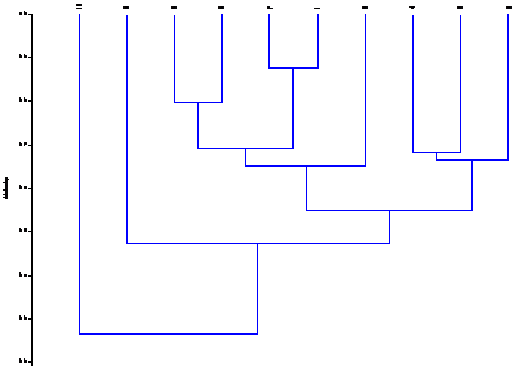

Fig 5: Braycurtis Similarity Index for Phytoplanktons of Kukkarahalli Lake

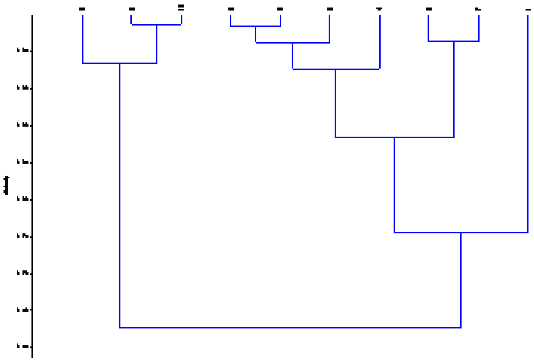

Fig 6: Braycurtis Similarity Index for Physicochemical parameters of Kukkarahalli Lake

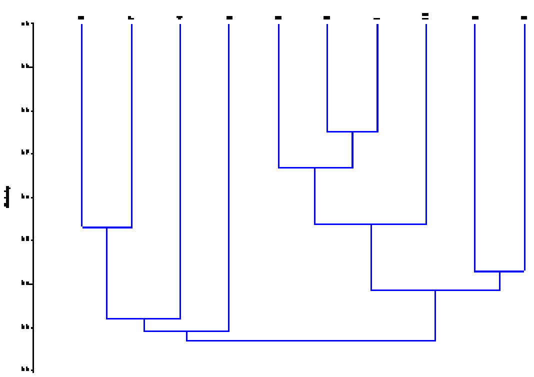

Fig 7: Braycurtis Similarity Index for Phytoplanktons of Karanji Lake

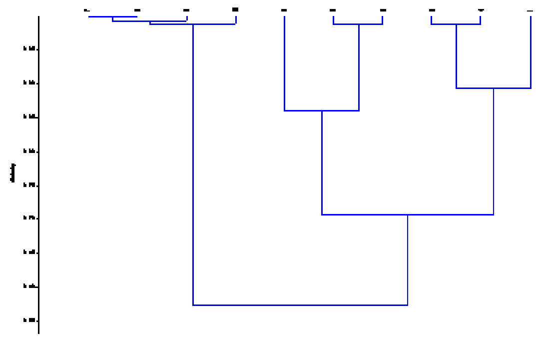

Fig 8: Braycurtis Similarity Index for Physicochemical parameters of Karanji Lake

Conclusions

According to the results, *Microcystis inserta* and *Scenedesmus bijuga* were the principal species and phosphate and TDS were the principal parameters in Kukkarahalli Lake. In Karanji Lake, *Nostoc sp.* and *Aphanocapsa rivularis* were the principal species while BOD and nitrate were the principal parameters. Regulating the principal species and parameters will achieve desired water quality.

Idiosyncracies are high in both the lakes and no significant similarities existed between the months in terms of both physicochemical parameters and phytoplanktons. This indicated unstabilized conditions in the lake ecosystems due to lot of anthropogenic interferences. Hence it is required to stabilize the lake conditions so that all the months remain similar in terms of both physico-chemical and phytoplankton distribution throughout the year which in turn results in a balanced ecosystem.

From the study it was inferred that phytoplanktons serve as powerful indicators of water quality and Multivariate analysis serve as an important asset in understanding the distribution of organisms in fresh water ecosystems.

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