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SEASONAL DISSIMILARITIES IN SPECIES COMPOSITION, DIVERSITY AND POPULATION DYNAMICS OF PHYTOPLANKTON IN DAROJI LENTIC ARTIFICIAL WATER TANK, HOSPET TALUK KARNATAKA (INDIA)

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ABSTRACT

The present work focusses on the general ecological investigation on phytoplankton population dynamics in terms of species composition and density at selected water tank in and around the Hospet city, Bellary district, and Karnataka state. A total of 70 phytoplankton taxa were identified and four classes namely Bacillariophyceae (41), Chlorophyceae (12) and Cyanophyceae (10) and Euglenophyceae (7). The same trends were observed in terms of percentage with decreasing order Bacillariophyceae contributing 56%, followed by Chlorophyceae, (20%); Cyanophyceae (17 %) and Euglenophyceae (7 %). The dominance pattern of species in the population dynamics were Diatoma sp. > *Navicula radiosa* > *Fragilariforma virescens* > *Fragilaria capucina* > *Navicula angusta* >*Amphora ovalis* among Bacillariphyceae, *Cosmarium monomazum* > Spirogyra sp. > *Pediastrum biradiatum* among Chlorophyceae, *Oscillatoria limosa* > *Phormidium mucosum* > *Anabaena torulosa* among Cyanophyceae and *Euglena acus* > *Phacus suecicia* among Euglenophyceae. Maximum species richness was recorded 7.73 Margalef's index (R1) at station D1 during pre-monsoon season and 1.16 Menhinick index (R2) at station D3 during post-monsoon season, minimum Species richness was recorded 7.24 Margalef's index (R1) at station D2 during pre-monsoon season and 1.09 Menhinick index (R2) at station D3 during pre-monsoon season. Maximum species diversity was recorded 0.05 Simpson's index (λ) at station D1 during the entire study, minimum species diversity was recorded 0.03 Simpson's index (λ) at station D3 during the study period. Maximum of 2.86 Shannon - Weiner index (H') at station D2 during post monsoon season and minimum of 2.42 Shannon - Weiner index (H') at station D2 during pre-monsoon season. Maximum species evenness was recorded at stations D1 and D3 during post-monsoon season, minimum species evenness was recorded at station D1 during pre-monsoon season. The study also indicates Daroji tank is subjected to pollution due to addition of vehicular pollution and fertilizers from agricultural lands including domestic waste from the human habitation. This indicates the enrichment of water with nutrients leads to production of species, which in turn leads to the increased productivity and other undesirable biotic changes.

KEYWORDS

Phytoplankton, Seasonal, Species, Population, Diversity and Water tanks.

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INTRODUCTION

In the present says, pollution from organic substances in the water bodies is one of the most important. Due to population explosion and developmental activities in and around the lentic water bodies are putting pressure on almost all the freshwater bodies. Increasing in the nutrient load

into the lentic water tanks may leading into the deterioration of water quality of those lentic water bodies (Smitha, *et al.*, 1999[1] and Dhrubajyoti Bordoloi and Baruah, 2014)[2]. Physico-chemical parameters are the good indicators of any water body and quality, that alone does not reflect the existence condition of the ecological factors of the water body due to lack of proper incorporation with ecological environment (Karr, *et al.*, 2000)[3]. Since a species community is the outcome of the integration and interaction of different physical, chemical and geo-morphological characteristics of any water body, biological assessment is a useful alternative in assessing those systems (Stevenson and Pan, 1999)[4].

Phytoplankton succession is depend upon the ecology of the lentic water body and several studies have described the patterns and underlying phenomenon of the seasonal dissimilarities (Rothhaupt, 2000)[5]. However, the knowledge of the species composition and dynamics of phytoplanktonspicescreates acrucial feature for the analysis of the trophic level in lentic water bodies for the evaluation of the possible and optimal application of different water resources.

Food chain is depends upon the phytoplankton species composition since they the called as primary producers in the lentic water bodies and in open water resources. Phytoplankton are also acts as an indicator of the good quality of water. In the food chain, due to the interdependence existing between phytoplankton and zooplankton species which systems are composed, these dynamics in the phytoplankton populations convert to changes in the trophic level of food chain and the productivity of the lakes.

The biological spectrum of the lentic fresh water bodies is multidimensional where phytoplankton are useful in bio monitoring the ecological disturbance caused by a number of physico-chemical factors, sewage pollutants and other anthropogenic factors Although, voluminous literature is available on the plankton population of freshwater habitats of valley (Pandit, 1998)[6], scanty literature is available on lentic water body. The objective of this study was to assess the seasonal changes in phytoplankton composition, species diversity species richness and species evenness in the Daroji water tank, Hospet city, Bellary district, Karnataka, India.

MATERIALS AND METHOD

Topography of the study area

Hospet is a town head quarter situated 66 Kms away from Ballary district in the Central part of Karnataka state, India. Hospet-Shimoga Highway (SH-25) passes through the study area. Almost all the villages of the area are connected by unmetalled and metalled roads and regular bus facility exits from Hospet to different villages. The study area falls in the survey of India topo map numbers 57 B/6 on 1:50000 scale. The area is bounded by 14.74° to 14.88° N latitude and 75.88° to 76° E longitude. The location map of the study area is represented in Figure No.1. Topography of the study area is generally undulating to rolling topography with frequent mound like structures. Soils of the area are affected by erosion. Isolated hills and hill ranges are also seen. The geology (rock) of the study area consists of metamorphic rocks like gray wacke, argillite and granodiorite and tonalitic gneisss. The study area received a maximum rainfall of 742 mm in the year 2005 and a minimum of 361.9 mm in the year 2003. The normal rainfall of the study area is 656.70 mm.

Daroji tank

It is artificial perennial tank. This tank lies at $15^0.23^1$ N latitude and $76^0.67^1$E longitude. The area of the tank is 92 acres and depth is about 18 feet. Daroji tank is situated 20 kms away from Hospet town to northern region. The tank is rectangular in shape and it receives water from rainfall. The water is used for irrigation and pisci culture purposes. The colour of the tank is pale reddish. Anthropogenic activities are practiced in the vicinity of the tank. The water is used to grow paddy, sugarcane jutes and vegetables. The catchment area received an average rainfall of 656.70 mm (Irrigation Department, 2004-05).

In the present investigation, three sampling locations were selected, viz. Kurkepura (D1), Daroji

village north (D2) and Daroji village west (D3). Surface water samples were collected from these study sites for collection of hydgrographical chemical and chemical features. Temperature and pH were measured with a thermometer and portable pH meter respectively; transparency was estimated by the Secchi disc.

Methods

Both surface and subsurface samples of phytoplankton were collected by using plankton net and preserved in Lugol's solution. Identification was done by consulting standard literature and monographs of Kutzing (1895), Fritsch (1935, 1961), Smith (1950), Desikachary (1959) and Prescott (1975). In this present endeavor only the pollution tolerant genera (Palmer, 1969) with 50 and above individual per ml of water sample were considered for observation following Panigrahi, *et al.,* (2001)[7]. The numbers scored by each pollution tolerant genera as per Palmer (1969) were added and algal pollution index of the pond was thus evaluated. Density of pollution tolerant phytoplankton genera (hereafter used as PTPG) of the pond was determined by Sedgwick-Rafter cell method (Trivedy and Goel, 1986).

In the present investigation, three sampling locations were selected, viz. Kalaparu (S1), Penumakalanka (S2), Venkatapuram (S3), Pulaparru (S4) Chintapadu(S5) Pratikollalanka (S6). Surface water samples were collected from these study sites for collection of hydrographical chemical and chemical features. Temperature and pH were measured with a thermometer and portable pH meter respectively; transparency was estimated by the Secchi disc.

The water samples for phytoplankton analysis were collected at monthly interval for a year from April 2015 to March 2016 randomly at Kampli water tank. The data thus generated were summed up as average data on the basis of seasons viz. summer (April to July), monsoon (August to October) and winter (November to March).

The total number of phytoplankton present in one l water sample was calculated using the formula N= (n x v) / V where N = total number of phytoplankton cells in 1 L water (cells/l); n = average number of phytoplankton cells in 1 ml plankton sample; v = volume of plankton concentrate (ml); and V = volume of total water filtered (L). Taxonomic guides and descriptions proposed by previous studies (Newell and Newel, 1963, Tomas *et al.*, 1996, Horner, 2003, AL-Kandari *et al.*, 2009, Hoppenrath *et al.*, 2009, Al-Yamani, 2009, Al-Yamani and Saburova, 2010) were adopted.

Shannon–Wiener diversity index (Shannon CE, Wiener, 1963), where it is calculated using the formula: $H = -S$*p* diversity measure, whereas *pii* ln/*pi*, Lacdan, *et al.*, 2014). *H* represents the proportion of total species belonging to the *ith* species. Three indices were used to obtain estimation of species diversity, species richness and species evenness (Shannon, 1949[8] and Simpson, 1949)[9]. Species richness (R1 and R2) obtained using equation by Margalef, 1958[10] and Menhinick, 1964[11]. Species evenness was determined by using the following expression. Shannon's equitability (EH) can be calculated by dividing H by HMAX (here HMAX =lnS). Equitability assumes a value between 0 and 1 with 1 being complete evenness.

RESULT AND DISCUSSION

Physico-chemical features of the Kampli water tank was presented in the Table No.1. Surface water temperature of this lentic fresh aquatic ecosystem was varied seasonally with maximum water temperature (26˚C) and minimum (18˚C) were reported.

Temperature indicating highly significant inverse relationship with dissolved oxygen. Such an inverse relationship was observed by many researchers (Sumitra, *et al.*, 2007)[12]. The pH ranges from 7.6 at stations D3 in September to 6.2 at station D3 in November (Table No.1). From the present study indicates that the pH values of all the lantic water tank samples are acceptable as per the drinking, irrigation and aquaculture guidelines. Dissolved oxygen varied from 7.8 mg/l at station D1 in March to 6.3 mg/l at station D3 in May. These values are in well agreement with the findings of some

researchers (Shukla, *et al.,* 1989)[13]. During the study period, the negative correlation of DO with temperature at all sampling locations are in agreement with researchers (Rajashekhar, *et al.,* 2007[14], Reddy Radha Krishna, *et al.,* 2012[15] and Bhanu Prakash, *et al.,* 2014)[16]. Alkalinity ranges from 460 mg/l at stations D2 in June to 240 mg/l in March at station D1. This alkalinity limit is not harmful to human beings and other living organisms (Venkateswarulu, *et al.,* 1990)[17]. It has also been concluded that high alkalinity indicates pollution (Da, *et al.,* 2009)[18]. Alkalinity showed significant negative relationship with dissolved oxygen (r= -0.65). (Table No.2).

Correlation significance

In the present study, temperature showed negative correlation with pH (p=<0.01, r=-0.686) and DO (p=<0.01, r=-0.394). Total alkalinity revealed highly significant positive correlation with transparency (p=<0.01, r=0.521) and negative correlation with DO (p=<0.01, r=-0.656). It was proved and evident from the present work DO and pH was proved statistically.

In the present study, a total of seventy (70) phytoplankton species belonging to 36 genera representing 4 major classes were documented which indicate diverse nature of phytoplankton. Among 70 taxa of phytoplankton, 41 belonged to Chlorophyceae, 12 to Bacileriophyceae, 10 to Cyanophyceae and 7 to Euglenophyceae. Thus, the order of dominance was: Chlophyceae > Bacillariophyceae > Cyanophyceae > Euglenophyceae (Table No.2).

The phytoplankton identified were: *Ankisrodesmus convolutes, Chlamydomonas globosa, Chlorella vulgaris, Chlorococcus varians, Closterium ehernbergi, C. parvulum, C. obsoletum, Cosmarium psedobiramum, C. contractum, Cladophora glomerata, Chara spinosa, Cladophora sps., Chetophora attenuate, C. elegans, Hydrodictyon reticulam, Pandorina morum, Pediastrum ovatum, P.simplex, Pithophora oedogonium, P.varia, Scenedesmus denticulatum, S.abundans, S. dimorphus, S. longus, Spirogyra singularis, S.accidentalis, S.communis, Oedogonium biformae, O.globusum, Ulothrix zonata, U.variabilis, U.cylendricus, Zygnema pectinatum, Z.sterile., Z.gangeticum* (Chlorophyceae); *Navicula bacilliodes, N.cincta, N.mutoca, Melosira sps., Melosira varians, Astsrionella formosa.* (Bacillariophyceae); *Anabaena constrica, Gloeocapsa granosa, Microcystis elegans, Nostoc commune, Oscilllototia chlorine, O.cortica, O.proboscidea, Lyngbya epiphytica, L.nigra, Gleotheca rupestris, Synechococcus cedrorum, phormidium fragile,* (Cyanophyceae); *Euglene viridis, Euglena caudate* (Euglenophyceae). Similar observations were made by other researchers (Tiwari and Chauhan, 2006[19], Balasingh and Shamal, 2007[20], Laskar and Gupta, 2009[21], Adesalu, 2010[22], Bhanu Prakash, *et al.,* 2014)[15].

Species diversity indices can serve as a good indicator of the overall pollution of lentic water tanks. Indices of species diversity can be derived from counting of species and are of three main categories: species richness (Margalef index), species evenness/dominance (Simpson index), and a combination of richness and dominance (Shannon–Wiener index). The diversity indices have been developed by taking into account of the number of species diversity and their relative dynamics, which means the higher the values of these diversity indices, the more the oligotrophic state of lentic water bodies (Sigee, 2004)[23].

Maximum species richness was recorded 7.73 Margalef's index (R1) at station D1 during pre-monsoon season and 1.16 Menhinick index (R2) at station D3 during post-monsoon season, minimum Species richness was recorded 7.24 Margalef's index (R1) at station D2 during pre-monsoon season and 1.09 Menhinick index (R2) at station D3 during pre-monsoon season. Maximum species diversity was recorded 0.05 Simpson's index (λ) at station D1 during the entire study, minimum species diversity was recorded 0.03 Simpson's index (λ) at station D3 during the study period. Maximum of 2.86 Shannon - Weiner index (H') at station D2 during post monsoon season and minimum of 2.42 Shannon - Weiner index (H') at station D2 during pre-monsoon season. Maximum species evenness

was recorded at stations D1 and D3 during post-monsoon season, minimum species evenness was recorded at station D1 during pre-monsoon season (Table No.3).

A comparison of the biodiversity indices in the Daroji water tank water suggested that the diversity indices were higher. Such relationship is well documented in the previous researchers and is related to the exciting preventive environmental conditions associated with the eutrophication process (Sladecek, 1983)[24]. Seasonal variations in abundance and composition of lentic water tank phytoplankton are usually affected by the manmade activity, discharge, hydrology, trophic level and availability of light (Shiddamallayya, N., and Pratima, M, 2008[25] and Kolayli and Sachin, 2009)[26]. From the study reveals that the diversity indices of the lentic water tank is dynamic nature and lentic aquatic ecosystem balanced phytoplankton community are enjoying and representing in the water tank.

Table No.1: Physicochemical parameters of Lake Kolleru during January –December, 2009

S.No	Chemical Parameters	Unit	Daroji Tank					
			Station D1		Station D2		Station D3	
			Max	Min	Max	Min	Max	Min
1	Temperature	^{O}C	29.60	19.20	28.60	18.90	28.90	18.60
2	Transparency	cm	26.0	7.0	25.0	8.0	27.0	7.0
3	Salinity	ppt	0	0	0	0	2.2	0
4	pH	-	7.2	6.6	7.3	6.5	7.6	6.2
5	D.O	mg/L	7.8	6.5	7.5	6.4	7.6	6.3
6	Total Alkalinity	mg/L	440.0	240.0	460.0	280.0	450.0	290.0

Table No.2: Correlation Coefficient (r) among the physico-chemical properties and phytoplankton of Daroji tank during April 2015- March 2016

S.No		Temperature	Transparency	Salinity	pH	DO	Total Alkalinity
1	Temperature	1.000					
2	Transparency	0.200	1.000				
3	Salinity	0.471	0.000	1.000			
4	pH	-0.686	-0.086	0.472	1.000		
5	D.O	-0.394	0.263	0.243	0.316	1.000	
6	Total Alkalinity	0.252	0.521	0.000	-0.172	-0.656	1.000

Table No.1: Phytoplankton Diversity in Daroji Tank at selected locations Hospet city

Locations at Kampli Tank in Hospet City				
S.No		**Station D1**	**Station D2**	**Station D3**
1	Phytoplankton diversity	*Ankistrodesmus* sp. *Chlamydomonas sp. Chlorella sp., Chlorococcus sp. Closterium sp. Scenedesmus* sp. *Pediastrum*sp. *Ulothrix sp.Oscilllototi*a *sp.Amphora* sp. *Cymbella* sp. *Cocconeis* sp. *Navicula* sp. *Nitzschia* sp. *Ociletoria sp.*	*Ankistrodesmus* sp. *Scenedesmus* sp. *Spirogyra* sp. *Chlorella sp., Chlorococcus sp. Closterium sp. Scenedesmus* sp. *Pediastrum*sp. *Ulothrix sp.Amphora* sp. *Cymbella* sp. *Cocconeis* sp. *Nitzschia* sp.	*Ankistrodesmus* sp. *Scenedesmus* sp. *Spirogyra* sp. *Amphora* sp. *Cymbella* sp. *Cocconeis* sp. *Navicula* sp. *Nitzschia* sp. *Ociletoria sp.*
2	Shannon–Wiener diversity index (*H*)	2.188	4.285	2.924

Table No.2: Number of Phytoplankton Taxa during Pre and Post-Monsoon Season

S.No	Group	Pre monsoon	Post Monsoon
1	Chlorophyceae	41	40
2	Bacillariophyceae	12	13
3	Cyanophyceae	10	12
4	Euglenophyceae	7	6

Table No.3: Seasonal variations of phytoplanktons's, biodiversity indices at Daroji tank during April 2015–March 2016

		Pre Monsoon				**Post Monsoon**			
S.No	**Indices**	**Index**	**D1**	**D2**	**D3**	**Index**	**D1**	**D2**	**D3**
1	Species Richness	N_0	67	72	68	N_0	66	71	69
		R_1	7.73	7.24	7.62	R_1	7.62	7.72	7.68
		R_2	1.10	1.11	1.09	R_2	1.12	1.14	1.16
2	Species Diversity	λ	0.05	0.04	0.03	Λ	0.04	0.04	0.03
		H^1	2.28	2.42	2.58	H^1	2.79	2.86	2.82
		E	0.86	0.89	0.87	E	0.92	0.89	0.91

(N_0 = No of all species) λ = Simpson's index
R_1 = Margalef's index H^1 = Shannon – Weiner index
R_2 = Menhinick index E = Evenness index

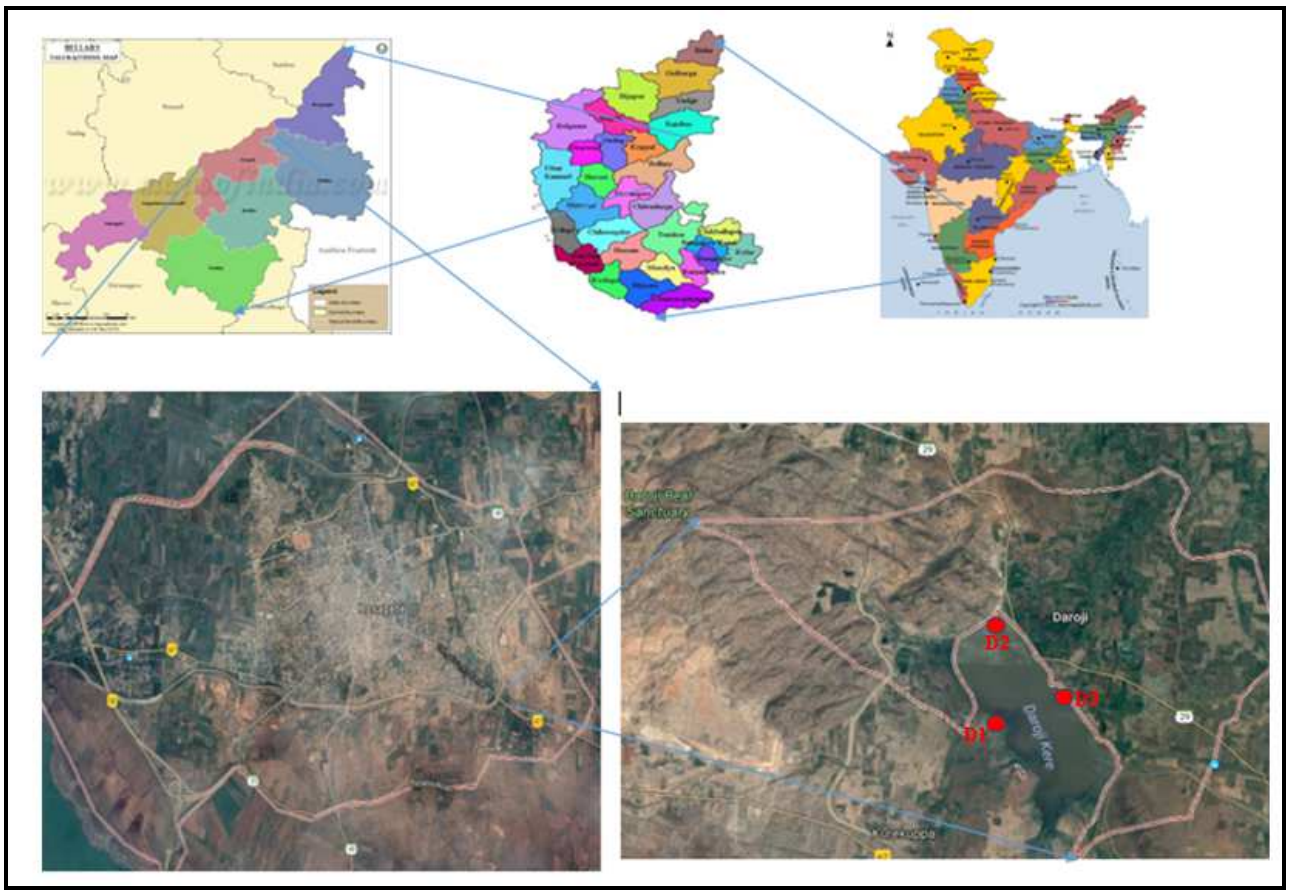

Figure No.1: Location map of the study area

CONCLUSION

The study reveals that counting of phytoplankton species is present the basic information of species diversity, abundance and dynamics of the diversity indices. Hence ecological assessment through indices is the useful tool for further assessment and monitoring of lentic aquatic ecosystem which are suffering from pollution. The study also indicates Daroji tank is subjected to pollution due to addition of vehicular pollution and fertilizers from agricultural lands including domestic waste from the human habitation. This indicates the enrichment of water with nutrients leads to production of species, which in turn leads to the increased productivity and other undesirable biotic changes. The findings of this investigation clearly revealed that in respect to domestic waste and human activity the pollution, phytoplankton perhaps were more tolerant to pollution.

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CONFLICT OF INTEREST

We declare that we have no conflict of interest.

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