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Simple correlation matrix among different physico-chemical parameters and physico-phycological parameters of pond water at Tribeni, Hooghly, West Bengal, India

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ABSTRACT

The statistical analyses of simple correlation coefficient (r) between physico-chemical parameters [temperature, pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), nitrate-nitrogen (NO_3-N), phosphate (PO_4^{3-}), total suspended solids (TSS), total dissolved solids (TDS), sulphate (SO_4^{2-}), salinity, total alkalinity, total hardness, chlorides (Cl^-) and turbidity] and physico-phycological parameters for a two consecutive years, 2009 and 2010 in a pond water at Tribeni in Hooghly district, West Bengal revealed that in this micro environmental niche the correlation values showed variability with respect to their significance and non significance level as well as with respect to positive or inverse correlationship.

Key words: Pond, correlation coefficient, physico-chemical parameters, West Bengal.

1. INTRODUCTION

Ponds have been used as a traditional source of water supply in India. A pond is a man made or natural water body. The water of ponds are polluted mainly due to discharge of wastes from residential area, sewage outlets, solid wastes, detergents and automobiles oil waste (Bhuiyan and Gupta, 2007; Mahobe, 2013; Boualla Nabila, 2015). Pollution of pond water is a great problem in Hooghly district of West Bengal due to rapid urbanization, industrialization and human anthropogenic activities.

Physico-chemical parameters of any aquatic ecosystem are necessary because their hydrochemistry affects its biota to a great extent. Water quality influences the existence and growth of aquatic organisms (Jyotsna et al., 2014). The algal diversity and occurrence in a water body varies considerably based on the changes in physico-chemical characteristics. In the present study, the selected pond is located in the northern side of Tribeni (22°.99'N and 88°.40'E) railway station in Hooghly district, West Bengal and mainly used for fishing, bathing and washing purposes.

The correlation coefficient determination helps in rapid monitoring of water quality parameters that influence the growth and multiplication of algal flora in water bodies. Hence the present study was undertaken. In this work, significant correlationships were noted among different physico-chemical parameters as well as between different physico-chemical parameters and various algal groups (phycological parameters).

2. MATERIALS AND METHODS

Collection of water samples and analyses of physico-chemical parameters

Water sample were collected in sterilized glass container (2 liter capacity) between 9.00 am to 11.00 am at regular intervals of one month from January to December of two consecutive years 2009-2010 for physico-chemical analyses. The water temperature and pH were determined on the spot. The pH and temperature of the water body were determined at the site immediately after collection with the help of portable pH meter (Model No.PP9046 Philips, India) and Zeal's (UK) mercury thermometers. To determine dissolved oxygen, water samples were fixed at the spot immediately after collection. The other limnological parameters such as dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), nitrate-nitrogen (NO_3-N), phosphate (PO_4^{3-}), total suspended solids (TSS), total dissolved solids (TDS), sulphate (SO_4^{2-}), salinity, total alkalinity, total hardness, chlorides (Cl^-) and turbidity of water were determined following the standard method (APHA, 2005). All the reagents used for the analyses were analytical reagent grades.

Quantitative analyses of algal flora

Algal samples were collected monthly by hand or plankton net (mesh 30µm). One liter of surface water was strained through plankton net. Collected algal samples were preserved in 4% formalin. For quantitative estimation of algae 1ml. of sediment stock sample through pipette was taken in Sedgwick-Rafter counting chamber (S-R Cell) and a cover slip was put over it. Then 10 different microscopic fields were observed under microscope for counting the number of algae at each time for accuracy. The seasonal variations of algae had been described upto species level. The algal flora consisted of four taxonomic groups: (a) cyanophyceae (b) chlorophyceae (c) bacillariophyceae and (d) euglenophyceae.

Statistical analysis

The correlation studies were calculated using a statistical software package (SPSS version 13).

3. RESULTS & DISCUSSION

In the pond at Tribeni of Hooghly district, West Bengal the correlation coefficient (r) of 15 limnological parameters was estimated for the two years 2009 and 2010. Here, temperature showed positive correlation with only NO_3-N for both the year. pH did not reveal any significant positive and negative correlation in 2009 and 2010. DO exhibited significant positive correlation with only PO_4^{3-} and significant negative correlation with BOD, COD, TSS, TDS and total hardness in both the year of survey in addition to salinity in 2010. BOD exhibited significant positive correlation with TSS and TDS while negative correlation with only PO_4^{3-} during 2009 and 2010. COD showed significant positive correlation with NO_3-N, TSS, TDS, salinity and total hardness and significant negative correlation with PO_4^{3-}, total alkalinity. NO_3-N exhibited significant positive correlation with only TSS but significant negative correlation with only PO_4^{3-} in 2009 and 2010. PO_4^{3-} was significantly positively correlated with only total alkalinity in 2010 whereas significantly negatively correlated with TSS, TDS, salinity, total hardness and Cl^- in 2009 and 2010. TSS showed positive correlation with TDS, salinity and total hardness while significant negative correlation with only total alkalinity. Similarly, TDS exhibited significant positive correlation with salinity, total hardness and Cl^- and, significant negative correlation with only total alkalinity. SO_4^{2-} and total alkalinity showed no significant positive and negative correlation with any physico-chemical parameters. Salinity revealed significant positive correlation with total hardness and Cl^- for both the year of study. Total hardness was significantly positively correlated with only Cl^-. Cl^- and turbidity did not exhibit any significant positive and negative correlations during the study periods (Table 1 and 2).

While dealing with physico-phycological parameters, the population of cyanophyceae showed significant positive correlation with COD, NO_3-N, TSS, TDS, salinity and total hardness and Cl^- in 2009 and 2010. On the other hand, cyanophyceae population exhibited significant negative correlation with DO and PO_4^{3-} in 2009 and 2010. Similarly, the population of chlorophyceae revealed significant positive correlation with COD, TSS, TDS, salinity, total hardness and Cl^- for both the year of survey. It was significantly negatively correlated with DO, PO_4^{3-} and total alkalinity in 2009 and 2010. The population of bacillariophyceae exhibited significant positive correlation with COD, NO_3-N, TSS,TDS, salinity, total hardness and Cl^- for both the year of survey while it was significantly negatively correlated with DO and PO_4^{3-}. The population of euglenophyceae showed significant positive correlation with salinity and Cl^- for both the year of investigation. The population of euglenophyceae exhibited no significant negative correlation with other physico-chemical parameters studied (Table 3 and 4).

In the present work, temperature showed significant positive correlation with nitrate-nitrogen. Similar finding was observed by Bhandarkar and Gaupale (2008) while studying correlation coefficient of physico-chemical properties of Sagar lake Bhandara in Maharashtra. DO and BOD showed a significant negative correlationship in this pond. Such inverse correlationship was also found in many water bodies by several authors (Abbasi et al., 1996; Jindal, 2008). Shivasharanappa and Bettad Prakash (2013) while studying physico-chemical characteristics of Shri Sharanabasaveshwara lake water of Gulbarga city in Karnataka observed highest positive correlation between total dissolved solids and alkalinity but here negative correlation was noticed. Arya and Gupta (2013) observed that DO was negatively correlated with COD and BOD. In the present study same findings were observed. Gupta et al., (2013) and Shivasharanappa and Bettad Prakash (2013) observed higher positive correlation between chloride and total hardness. The result of the present study also supported this argue. In the present study, chloride and total dissolved solids (Cl^- & TDS) showed significant positive correlation similar to that of Shivasharanappa and Bettad Prakash (2013) report. Chloride also showed significant positive correlation with salinity and total hardness. Nitrate-nitrogen showed significant positive correlation with COD. A significant positive correlation between total hardness and COD, TSS, TDS and salinity was noted in the present study. Shivasharanappa and Bettad Prakash (2013) also established a positive correlationship between total hardness and total dissolved solids.

In the pond water, nitrate-nitrogen showed significant positive correlationship with all the algal groups. Similar results were reported by Rahman et al., (2008) and Mondal et al., (2011).

Table 1

Simple correlation matrix (r) among different physico-chemical parameters of a pond at Tribeni, Hooghly during 2009

	Temp (°C)	pH	DO (mg/1)	BOD(mg/1)	COD(mg/1)	NO_3-N (mg/1)	PO_4^{3-} (mg/1)	TSS (mg/1)	TDS(mg/1)	SO_4^{2} (mg/1)	Salinity (mg/1)	Alkalinity (mg/1)	Hardness (mg/1)	Cl^- (mg/1)	Turbidity (NTU)
Temp (°C)	1														
pH	0.464	1													
DO(mg/1)	-0.319	-0.348	1												
BOD(mg/1)	0.226	0.360	-0.942*	1											
COD(mg/1)	0.404	0.536	-0.815*	0.682	1										
NO_3-N(mg/1)	0.858*	0.592	-0.696	0.573	0.750*	1									
PO_4^{3-} (mg/1)	-0.396	-0.479	0.813*	-0.717*	-0.927*	-0.716*	1								
TSS(mg/1)	0.324	0.498	-0.853*	0.743*	0.971*	0.705*	-0.963*	1							
TDS(mg/1)	0.274	0.420	-0.823*	0.738*	0.935*	0.621	-0.952*	0.977*	1						
SO_4^{2-} (mg/1)	-0.335	-0.336	0.528	-0.510	-0.345	-0.578	0.19 6	-0.281	-0.131	1					
Salinity(mg/1)	0.464	0.282	-0.635	0.506	0.747*	0.602	-0.880*	0.781*	0.829*	0.107	1				
Alkalinity(mg/1)	-0.066	-0.681	0.498	-0.422	-0.771*	-0.356	0.667	-0.736*	-0.710*	0.101	-0.518	1			
Hardness (mg/1)	0.116	0.276	-0.742*	0.680	0.845*	0.450	-0.911*	0.910*	0.965*	0.009	0.843*	-0.673	1		
Cl^- (mg/1)	0.189	-0.060	-0.632	0.562	0.626	0.410	-0.792*	0.721	0.797*	0.075	0.844*	-0.264	0.872*	1	
Turbidity(NTU)	0.578	-0.146	0.303	-0.254	-0.389	0.171	0.222	-0.384	-0.337	0.193	0.040	0.658	-0.362	-0.015	1

Values are significant at p=0.05 (*)

Table 2
Simple correlation matrix (r) among different physico-chemical parameters of a pond at Tribeni, Hooghly during 2010

	Temp (°C)	pH	DO (mg/1)	BOD (mg/1)	COD (mg/1)	NO_3-N (mg/1)	PO_4^{3-} (mg/1)	TSS (mg/1)	TDS (mg/1)	SO_4^{2-} (mg/1)	Salinity (mg/1)	Alkalinity (mg/1)	Hardness (mg/1)	Cl^- (mg/1)	Turbidity (NTU)
Temp (°C)	1														
pH	0.322	1													
DO(mg/1)	-0.295	-0.314	1												
BOD(mg/1)	0.168	0.314	-0.943*	1											
COD(mg/1)	0.344	0.547	-0.810*	0.682	1										
NO_3-N(mg/1)	0.807*	0.499	-0.706*	0.543	0.763*	1									
PO_4^{3-} (mg/1)	-0.379	-0.491	0.837*	-0.714*	-0.940*	-0.754*	1								
TSS(mg/1)	0.340	0.560	-0.831*	0.719*	0.983*	0.753*	-0.956*	1							
TDS(mg/1)	0.272	0.438	-0.841*	0.736*	0.948*	0.685	-0.959*	0.976*	1						
SO_4^{2-} (mg/1)	-0.348	-0.217	0.463	-0.450	-0.285	-0.526	0.172	-0.236	-0.094	1					
Salinity(mg/1)	0.485	0.309	-0.742*	0.558	0.757*	0.691	-0.842*	0.773*	0.787*	-0.112	1				
Alkalinity(mg/1)	-0.002	-0.731*	0.504	-0.429	-0.784*	-0.376	0.718*	-0.772*	-0.727*	0.015	-0.523	1			
Hardness (mg/1)	0.096	0.282	-0.775*	0.698	0.849*	0.490	-0.905*	0.897*	0.958*	0.059	0.749*	-0.684	1		
Cl^- (mg/1)	0.215	-0.089	-0.662	0.561	0.612	0.439	-0.771*	0.678	0.779*	0.112	0.740*	-0.288	0.869*	1	
Turbidity(NTU)	0.597	-0.261	0.294	-0.278	-0.437	0.110	0.288	-0.389	-0.357	0.126	-0.073	0.688	-0.388	-0.020	1

Values are significant at p=0.05 (*)

Table 3
Simple correlation coefficient (r) between physico-chemical parameters and phycological parameters in the pond at Tribeni, Hooghly during 2009

	Temp (°C)	pH	DO (mg/1)	BOD(mg/1)	COD (mg/1)	NO_3-N (mg/1)	PO_4^{3-} (mg/1)	TSS (mg/1)	TDS (mg/1)	SO_4^{2-} (mg/1)	Salinity (mg/1)	Alkalinity (mg/1)	Hardness (mg/1)	Cl^- (mg/1)	Turbidity (NTU)
Cyanophyceae	0.545	0.450	-0.799*	0.694	0.934*	0.804*	-0.929*	0.942*	0.941*	-0.259	0.827*	-0.605	0.866*	0.763*	-0.125
Chlorophyceae	0.236	0.337	-0.736*	0.585	0.873*	0.525	-0.880*	0.887*	0.916*	-0.022	0.889*	-0.763*	0.919*	0.749*	-0.380
Bacillariophyceae	0.477	0.441	-0.773*	0.650	0.916*	0.724*	-0.943*	0.939*	0.959*	-0.105	0.911*	-0.669	0.911*	0.801*	-0.157
Euglenophyceae	0.340	0.124	-0.544	0.470	0.482	0.389	-0.682	0.548	0.633	0.235	0.913*	-0.342	0.693	0.753*	0.149

Values are significant at p=0.05 (*)

Table 4
Simple correlation coefficient (r) between physico-chemical parameters and phycological parameters in the pond at Tribeni, Hooghly during 2010

	Temp (°C)	pH	DO (mg/1)	BOD(mg/1)	COD (mg/1)	NO_3-N (mg/1)	PO_4^{3-} (mg/1)	TSS (mg/1)	TDS (mg/1)	SO_4^{2-} (mg/1)	Salinity (mg/1)	Alkalinity (mg/1)	Hardness (mg/1)	Cl^- (mg/1)	Turbidity (NTU)
Cyanophyceae	0.497	0.415	-0.819*	0.686	0.941*	0.825*	-0.940*	0.955*	0.959*	-0.208	0.783*	-0.627	0.877*	0.756*	-0.181
Chlorophyceae	0.164	0.354	-0.727*	0.576	0.863*	0.522	-0.885*	0.869*	0.906*	0.054	0.883*	-0.771*	0.913*	0.746*	-0.431
Bacillariophyceae	0.436	0.418	-0.790*	0.640	0.915*	0.741*	-0.954*	0.942*	0.966*	-0.042	0.865*	-0.689	0.916*	0.800*	-0.201
Euglenophyceae	0.290	0.090	-0.572	0.478	0.456	0.362	-0.677	0.509	0.604	0.220	0.854*	-0.338	0.677	0.783*	0.092

Values are significant at p=0.05 (*)

4. CONCLUSION

Therefore, the calculation of correlation coefficient analyses among different physico-chemical parameters could be used as an important method for the interpretation of pollution level of water body. The present data showed the significant positive and negative correlations between physico-chemical parameters and physico-phycological (at p=0.05 significance) and, maximum correlations of physico-chemical parameters with algal population were found to be positive which indicated that majority of these physico-chemical characteristics were responsible for congenial algal growth, periodicity and fluctuation of the algal populations.

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