International Journal of Basic and Applied Science
Insan Akademika Publications
E-ISSN: 2301-4458; P-ISSN: 2301-8038

Study on Distribution and Diversity of Phytoplankton in Relation to Physico-chemical Parameters in Bhavanapadu Creek, Andhra Pradesh, India

Amarnath Dogiparti*; Ravi Kumar Kurapati; Uday Ranjan T Joseph; Myla S Chakravarty

Andhra University, Visakhapatnam, India
*Corresponding author: amarnathdogiparti@gmail.com

Abstract – *The Phytoplankton distribution and diversity was studied with compare to the Physico-chemical parameters in Bhavanapadu Creek. A monthly sampling was carried out from December 2010 to November 2011 at 5 different stations. The four classes of phytoplankton comprises of 39 species and Bacillariophyceae were contributed (0-90%), more percentage of composition fallowed by Chlorophyceae (1-62%), Cyanophyceae (2-46%) and Pyrrophyceae (0-10%). The Phytoplankton population density and diversity depends upon the Physico-chemical parameters and showed significant correlation with the parameters like temperature, pH, ammonia, magnesium, phosphates and dissolved oxygen (D.O.). The Shannon-weavers index (H) was 0.000 to 0.595.*

Key Words – *Phytoplankton; Diversity and Abundance; Physico-chemical parameters; Shannon-weavers index; Bhavanapadu Creek*

1 Introduction

The Bhavanapadu Creek is valuable resource for the aquaculture, salt pans and fishery for the local people. The present study was the distribution, abundance and diversity of the phytoplankton at Bhavanapadu Creek for a period of one year. The Physico-chemical parameters have been observed to influence strongly on phytoplankton distribution and composition. The phytoplankton, as the basis of the tropic chain, constitutes the most important biological community in any aquatic system. The phytoplankton composition was influenced by so many factors and they change according to ecological changes. Phytoplankton forms the vital source of energy in the marine environment. They initiate the marine food chain, by serving as food to primary consumers [1]. The plankton in mangrove habitats contribute from 20 to 50% total fish productivity [2]. The productivity of any water body is determined by the amount of plankton it contains as they are the major primary and secondary producers. Plankton communities serve as a base for the food chain that supports the commercial fisheries [3]. The distributions, abundance, species diversity, species composition of the phytoplankton are used to assess the biological integrity of the water body [4]. The rate of production of phytoplankton biomass depends directly on the rate of photosynthesis, and this in turn is controlled by the light intensity [5].Variations in some of the physical and chemical parameters have been reported to influence phytoplankton abundance [6]. The major limiting nutrients for phytoplankton are nitrogen in form of ammonium ($NH4^+$), nitrite ($NO2^-$) and phosphate ($PO4^-$). Nitrogen tends to be the limiting

nutrients in marine systems, while phosphate in the limiting nutrient in the freshwater systems [7]. These two nutrients are needed for construction of cell membranes and for proteins such as enzymes.

2 Material and Methods

Five surface water samples were collected for water analysis at different stations i.e., Station I–Creek mouth (18°33'48.7"N & 84°21'19.6"E), Station II–Seethanagaram (18°33'01.1"N & 84°20'16.3"E), Station III–Kothalingudu (18°32'05.3"N & 84°18'09.3"E), Station IV–Akasalakkavaram (18°30'50" N & 84°16'10" E), Station V–Maruvada (18°30'30" N & 84°15'30" E) (Fig 1) in Bhavanapadu Creek from December 2010 to November 2011 to study the spatial and temporal variations of different hydrographical parameters and phytoplankton diversity and distribution. The sampling points were recorded where the fresh water canals was joined and also sensitive areas of the creek.

Fig.1: Research location

The hydrographical methods were Depth measured by Masson's weight. The temperature was recorded by using Celsius thermometer of 0.1ºC readability. Salinity measured by Refractometer (Hand Refractometer- ERMA). The pH of the samples was estimated digital pH meter (Elico). The samples for dissolved oxygen collected in separate 125 ml bottles and fixed by Wrinklers reagents in situ. The further analysis of D.O. was carried in lab by following Winkler's method [8]. The water samples were carried to lab for the measurement of remaining parameters. The Salinity [9] was carried out again for accuracy. The magnesium was calculated indirectly by hardness and calcium. Nutrients (Ammonia, Nitrates, Phosphates, Silicates) measured by standard methodology [10]. The nitrates were estimated by "Cd" redactor method. The phosphates were estimated by Ascorbic acid method, the silicates were estimated by Molybdosilicate method and the ammonia was estimated by Phenate method.

The phytoplankton samples were collected through plankton nets (60µ) and preserved in 4% formaldehyde for further analysis. The phytoplankton samples were analysed by using Sedgwick rafter cell (1ml Capacity) [11]. After shaking the bottle the 1ml sample was drawn by pipette and poured in the rafter cell. All the 1000 squares on the chamber were screened and phytoplankton identified up to

generic level by trinocular microscope (LabomediVu 3000) and the phytoplankton was identified by standard keys [12], each sample was counted three times and taken as average value. The diversity of phytoplankton was calculated by Shannon's diversity index [13].

$$H = \sum_{i=1}^{s} -(P_i * \ln P_i) \quad \ldots(1)$$

Where: H = the Shannon diversity index
P_i = fraction of the entire population made up of species i
S = numbers of species encountered
$\sum$ = sum from species 1 to species S

3 Results and Discussion

During the study period *Asterionella japonica, Rhizosolenia sp., Coscinodiscus sp., Ditylum sol, Bacteriastrum sp. Biddulphia sinensis, B .mobiliensis, B. heteroceros, Chaetoceros sp., Triceratium sp., Thallasiothrix longissima, Thalassiothrix frauenfeldi, Thalassionema nitzschioides, Skeletonema costatum, Pleurosigma sp., Ceratium furca, Spyrogyra sp., Oscillatoria sp.,* etc were dominant. The different species were recorded at different stations. From the Bacillariophyceae 24 species, 7 species from the Pyrrophyceae, 5species from the Chlorophyceae and 3 species from the Cyanophyceae. The diatoms were recorded as more dominant than other classes, it was observed at station I, II and III due to saline waters from the sea. The Physico-chemical parameters of the water were compared to the phytoplankton population by correlation (Tables 1 to 5).

Table 1: The Physico-chemical parameters in Station I

Station I	Depth	Temperature	Salinity	pH	D.O.	Magnesium	Ammonia	Nitrates	Phosphates	Silicates	Plankton/ m^3
Depth (m)	1.	*	*	*	*	*	*	*	*	*	*
Temperature (ºC)	0.1702	1.	*	*	*	*	*	*	*	*	*
Salinity (ppt)	0.1397	0.2495	1.	*	*	*	*	*	*	*	*
pH	0.2312	-0.0206	-0.4054	1.	*	*	*	*	*	*	*
D.O (mg/l)	0.433	-0.001	0.2426	-0.2923	1.	*	*	*	*	*	*
Magnesium (mg/l)	-0.5281	-0.1838	-0.0335	-0.3309	-0.214	1.	*	*	*	*	*
Ammonia (mg/l)	0.3331	0.0723	0.0245	0.7979	-0.35	-0.4415	1.	*	*	*	*
Nitrates (mg/l)	-0.271	-0.3045	0.2727	0.167	-0.0876	0.6161	0.2258	1.	*	*	*
Phosphates (mg/l)	0.475	-0.0184	0.2246	0.2817	-0.0859	-0.2941	0.2994	0.0129	1.	*	*
Silicates (mg/l)	0.6119	0.6154	0.3183	0.3739	0.0401	-0.596	0.6393	-0.1565	0.4271	1.	*
Plankton/m3	-0.3441	0.3883	0.2962	-0.4171	0.3883	0.4251	**-0.5353***	0.1743	**-0.5538***	-0.2563	1.

Table 2: The Physico-chemical parameters in Station II

Station II	Depth	Temperature	Salinity	pH	D.O.	Magnesium	Ammonia	Nitrates	Phosphates	Silicates	Plankton/ m^3
Depth (m)	1.	*	*	*	*	*	*	*	*	*	*
Temperature (ºC)	0.2795	1.	*	*	*	*	*	*	*	*	*
Salinity (ppt)	0.0852	-0.0162	1.	*	*	*	*	*	*	*	*
pH	0.3001	0.5394	-0.5397	1.	*	*	*	*	*	*	*
D.O (mg/l)	0.0329	0.5391	-0.1605	0.6367	1.	*	*	*	*	*	*
Magnesium (mg/l)	-0.4078	-0.0883	0.4953	-0.5135	-0.4308	1.	*	*	*	*	*
Ammonia (mg/l)	0.3244	0.4345	-0.1304	0.6151	0.4586	-0.3128	1.	*	*	*	*
Nitrates (mg/l)	-0.1151	0.443	0.2319	0.3585	0.132	0.4897	0.1317	1.	*	*	*
Phosphates (mg/l)	-0.0858	-0.5608	-0.1724	-0.1457	-0.3161	-0.4126	0.135	-0.5657	1.	*	*
Silicates (mg/l)	0.5965	0.4761	0.497	0.0826	0.2633	-0.2751	0.517	-0.0962	0.0118	1.	*
Plankton/m3	-0.1099	0.0071	0.4614	-0.4642	0.1604	0.2197	-0.3252	-0.0299	-0.5005	0.1103	1.

Table 3: The Physico-chemical parameters in Station III

Station III	Depth	Temperature	Salinity	pH	D.O.	Magnesium	Ammonia	Nitrates	Phosphates	Silicates	Plankton/ m^3
Depth (m)	1.	*	*	*	*	*	*	*	*	*	*
Temperature (ºC)	0.2084	1.	*	*	*	*	*	*	*	*	*
Salinity (ppt)	-0.1088	-0.1748	1.	*	*	*	*	*	*	*	*
pH	0.4024	0.0672	0.0212	1.	*	*	*	*	*	*	*
D.O (mg/l)	-0.2131	-0.0187	-0.8258	-0.049	1.	*	*	*	*	*	*
Magnesium (mg/l)	-0.1298	-0.2181	0.6618	-0.1666	-0.7625	1.	*	*	*	*	*
Ammonia (mg/l)	0.7344	0.1567	-0.0481	0.3749	-0.0015	-0.3611	1.	*	*	*	*
Nitrates (mg/l)	-0.1764	0.4383	0.2206	0.0942	-0.1499	0.3784	0.0494	1.	*	*	*
Phosphates (mg/l)	-0.1011	-0.72	0.2857	0.0647	-0.0557	0.2616	0.268	0.1245	1.	*	*
Silicates (mg/l)	0.4848	-0.0944	0.549	0.0827	-0.6819	0.1622	0.5186	-0.3002	0.1694	1.	*
Plankton/m3	-0.3766	0.0273	0.5178	**-0.5235***	**-0.6281***	**0.7575***	**-0.6931***	0.1126	-0.2271	0.0675	1.

Table 4: The Physico-chemical parameters in Station IV

Station IV	Depth	Temperature	Salinity	pH	D.O.	Magnesium	Ammonia	Nitrates	Phosphates	Silicates	Plankton/ m^3
Depth (m)	1.	*	*	*	*	*	*	*	*	*	*
Temperature (ºC)	0.2594	1.	*	*	*	*	*	*	*	*	*
Salinity (ppt)	0.0599	-0.6665	1.	*	*	*	*	*	*	*	*
pH	0.2285	0.7049	-0.5667	1.	*	*	*	*	*	*	*
D.O (mg/l)	-0.7856	0.2377	-0.4742	0.2119	1.	*	*	*	*	*	*
Magnesium (mg/l)	-0.1649	-0.4014	0.7799	-0.421	-0.1998	1.	*	*	*	*	*
Ammonia (mg/l)	0.158	0.1351	0.4117	-0.0887	0.0233	0.2934	1.	*	*	*	*
Nitrates (mg/l)	0.8379	0.2891	0.159	0.2049	-0.6521	0.1995	0.2073	1.	*	*	*
Phosphates (mg/l)	-0.207	-0.4409	-0.0837	0.0145	0.275	-0.3656	-0.2791	-0.3636	1.	*	*
Silicates (mg/l)	0.5557	-0.3083	0.6103	-0.4623	-0.6432	0.5307	0.4439	0.6652	-0.2262	1.	*
Plankton/m3	0.1055	**0.8055***	-0.4476	**0.7988***	0.4106	-0.1893	0.3494	0.2448	-0.2183	-0.2717	1.

Table 5: The Physico-chemical parameters in Station V

Station V	Depth	Temperature	Salinity	pH	D.O.	Magnesium	Ammonia	Nitrates	Phosphates	Silicates	Plankton/ m^3
Depth (m)	1.	*	*	*	*	*	*	*	*	*	*
Temperature (ºC)	-0.0294	1.	*	*	*	*	*	*	*	*	*
Salinity (ppt)	-0.3057	-0.5919	1.	*	*	*	*	*	*	*	*
pH	0.3274	0.5855	-0.6709	1.	*	*	*	*	*	*	*
D.O (mg/l)	-0.2792	0.6849	-0.2664	0.2607	1.	*	*	*	*	*	*
Magnesium(mg/l)	-0.1849	-0.5166	0.9679	-0.6329	-0.1836	1.	*	*	*	*	*
Ammonia (mg/l)	0.3846	0.4323	-0.1534	0.2501	0.6137	0.0737	1.	*	*	*	*
Nitrates (mg/l)	-0.0679	0.3612	-0.4217	0.3617	-0.2028	-0.4039	-0.1122	1.	*	*	*
Phosphates (mg/l)	0.1257	-0.4277	-0.0986	0.1406	-0.2873	-0.199	-0.4021	-0.4222	1.	*	*
Silicates (mg/l)	0.3078	-0.005	0.3886	-0.4565	0.0436	0.4835	0.3318	-0.355	-0.5026	1.	*
Plankton/m3	0.1548	**0.7205***	-0.4047	**0.7011***	**0.65***	-0.268	**0.6159***	0.1572	-0.2699	0.0153	1.

($P \leq 0.05$, * showing significant)

The plankton was showed significant correlation to the temperature, pH, dissolved oxygen, ammonia, magnesium and phosphates at respective stations. The temperature was shown as positive correlation and it indicates the growth and population is favorable with increasing the temperature [14]. The pH was shown as positive correlation and which indicates high pH, high phyto-plankton production. The changes in pH levels in marine systems appear to correlate with changes in temperature, dissolved oxygen, and phytoplankton production [15].The dissolved oxygen was showed positive correlation which indicates the amount of productivity is high. The dissolved oxygen concentration depends on the photosynthetic rate and subsequently on nutrient concentrations. The dissolved oxygen concentration increases with increasing of photosynthetic rate [16]. The dissolved oxygen also showed negative correlation due to high temperature at station III. Generally high temperature and salinity cause the oxygen to be relatively low [17]. The ammonia was shown as negative correlation which indicates the decreasing the growth and population of phytoplankton with increasing the ammonia levels. The ammonia is a leading factor for the reduction of number and species richness for the phytoplankton [18]. The magnesium and ammonia shown positive correlation due to high productivity of phyto plankton [19]. Phytoplankton had a negative correlation with phosphates due to the high rate of phytoplankton phosphorus uptake at low concentrations throughout the study period at station I. The other nutrients are not shown significant due to lower concentrations or rapid recycling [20].

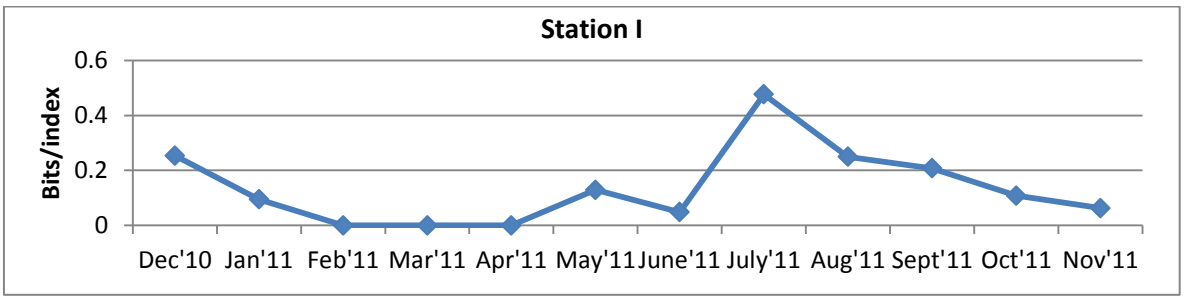

Fig. 1: Shannon-weaver diversity at Station I

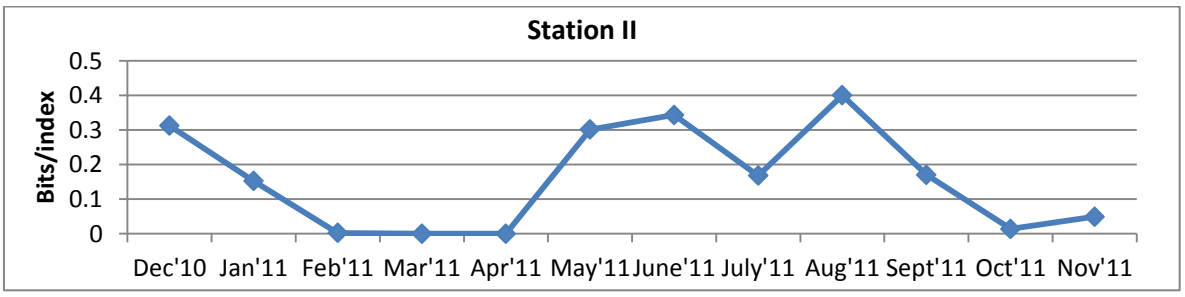

Fig. 2: Shannon-weaver diversity at Station II

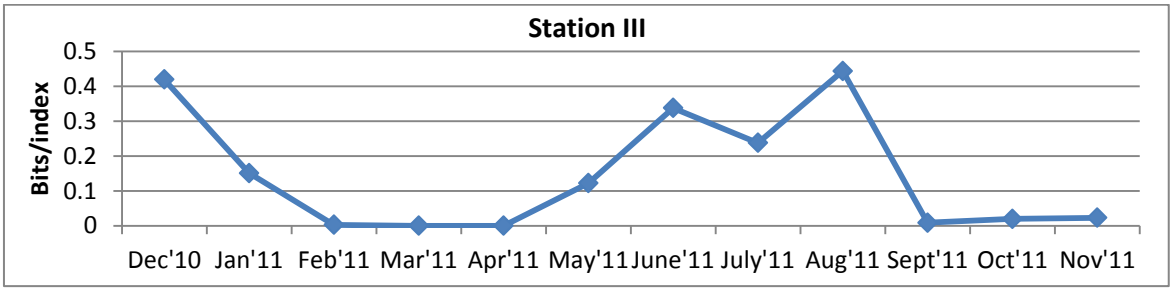

Fig. 3: Shannon-weaver diversity at Station III

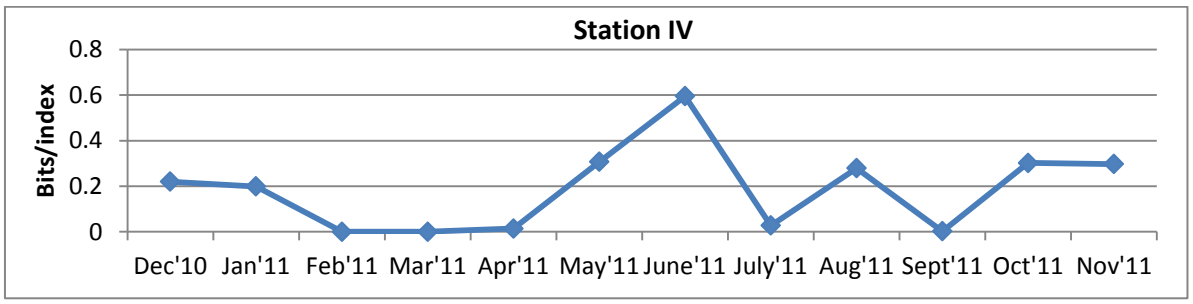

Fig. 4: Shannon-weaver diversity at Station IV

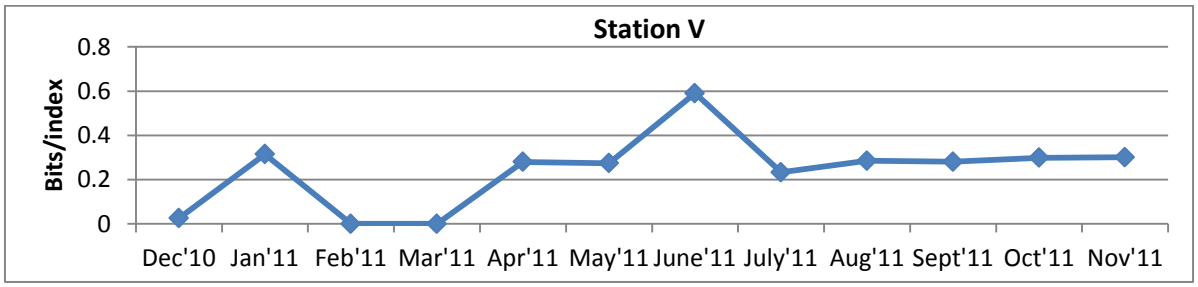

Fig. 5: Shannon-weaver diversity at Station V

The plankton density was 3.48×10^{2}/m3 reached as maximum. Among the phytoplankton *Asterionella japonica* was recorded more dominant. The pi diagrams (Fig. 6) indicate the Bacillariophyceae were more dominant in all the stations and followed by Chlorophyceae, Cyanophyceae and than Pyrrophyceae members. Cyanophyceae and Chlorophyceae were recorded at the station IV and V due to the fresh water influxes. The Shannon weaver's diversity index was represented as a graph below (Figs. 1-5) and it was shown 0 to 0.595, during the study period in some months showing low diversity due to the number of different of species were low but not the density and the abundance. The Shannon-weaver index is low due to the distribution factor [21] and also a week internal structure of population [22]. The plankton was shown seasonal variation in the creek and the planktonic communities served as indicator for change in the ecosystem [23]. The abiotic factors were responses to the phytoplankton diversity [24], and they were change both from the spatial and temporally according to the seasons [25].

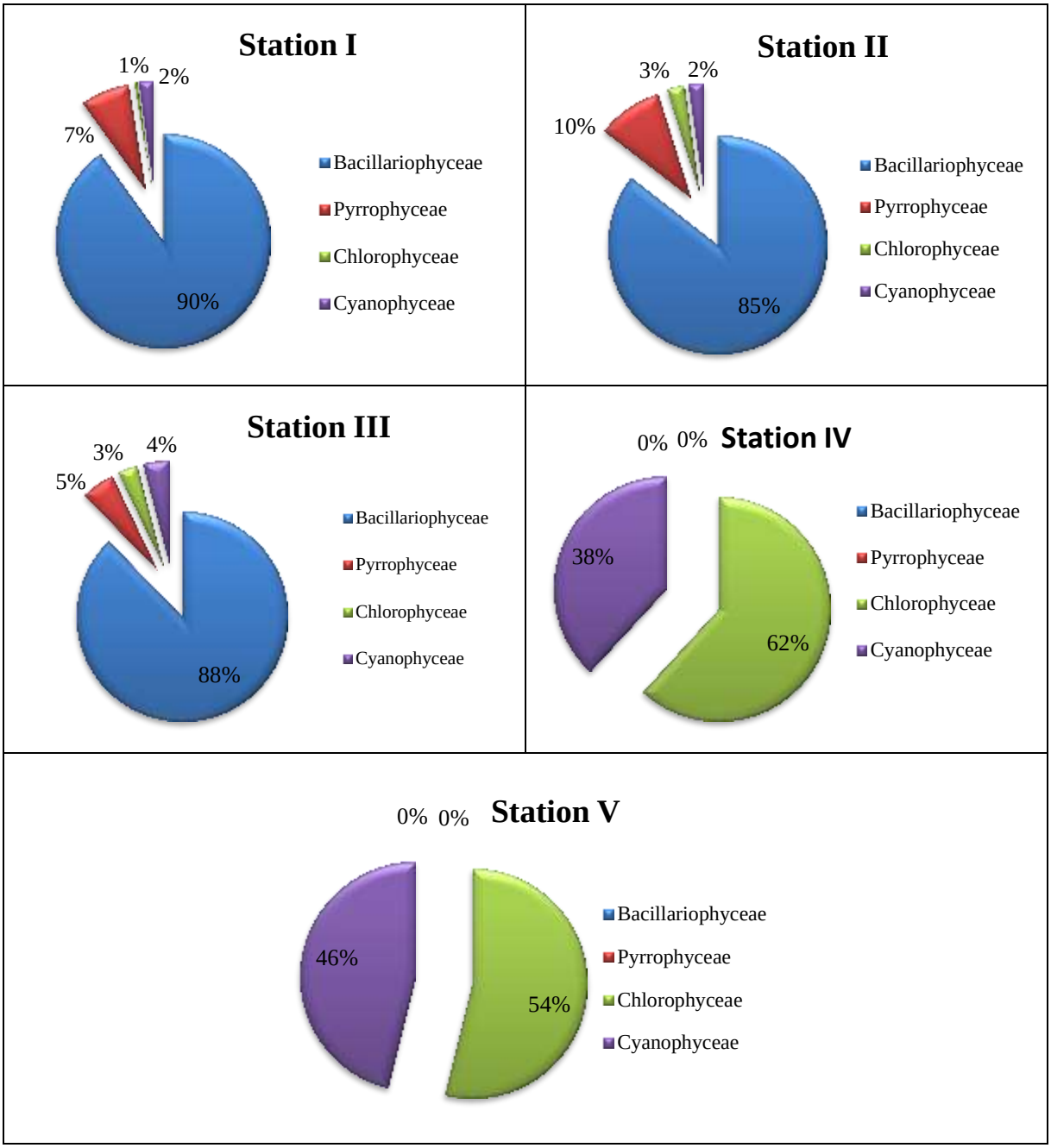

Fig. 6: Distribution and Abundance of Phytoplankton at Different Stations

4 Conclusion

The salinity was measured because of its influence on the distribution and the diversity of marine species at stations I to III. The Chlorophyceae and Cyanophyceae were recorded at stations IV and V due to influences of the fresh waters. The overall observations of the present study, the some of the Physico-chemical parameters were strongly influences the species composition, abundance and

diversity of the phytoplankton at Bhavanapadu Creek. There is no harsh effect on the biotic community because of there is no record of the any toxic species. The study provides clear information regarding the low diversity in some months due less species proliferation in this Creek.

References

[1] Ananthan, G., P. Sampathkumar, P. Soundarapandian, & L. Kannan: Observations onenvironmental characteristics of Ariyankuppam estuary and Verampattinam coast ofPondicherry. *J. Aqua. Biol*., 19, 67-72 (2004).

[2] Robeston, A. I. & S. J. M. Bladder. Plankton, epibenthos and fish communities. In: Tropical mangrove ecosystem (Eds: A. I. Roberston, & D. M. Alongi). *CoastalEstuar.Stud*., 41, 173-224 (1992)

[3] Conde, D., S. Bonilla, L. Aubriot, R. de León, & W. Pintos. Relative contribution of planktonic and benthic microalgae production in an eutrophic coastal lagoon of South America. 2007

[4] Townsend, C.R., J. L. Harper, & M. Begon. Essentials of Ecology. 3rd Edn., Blackwell Science Publishers, London, 2000, ISBN: 1405103280, pp: 530

[5] Ghosal, S., Rogers, M., & Wray, A. The turbulent life of phytoplankton. Standford University Press, Standford. 2000, p 13-45.

[6] Adesalu, T. A., & Nwankwo, D. I.A checklist of Lekki lagoon diatoms. International Journal of Botany, 5(2), 2009, 126-134.

[7] Suthers, I. M., & Rissik, D.A Guide to their Ecology and Monitoring for Water Quality. 2nd edition. CSIRO Publishing, Collingwood Victoria. 2009, 272p.

[8] Strickland, J. D. H. & T. R. Parsons. A Practice Handbook of Sea water Analysis. 2nd Edn. *Bull.Fish.Res.Board.Can*., 167,1972, 311.

[9] Harvey, H W. The chemistry and Fertility of Sea-water, Cambridge University Press, Cambridge (2ndEdition), 1960, 204.

[10] APHA, Standard methods for the Examination of water and waste water, 20th Edition.1998, Washington, D.C.

[11] Bernard J. McAlice. Phytoplankton Sampling With The Sedgwick-Rafter Cell January, 1971, 16 (1)

[12] R. Santhanam, N. Ramanathan, K. Venkataramanujam, & G. Jehatheesan. Phytoplankton of the Indian Seas Daya Publishing House, 1987.

[13] Shannon, C. E., & Weaver, W. The Mathematical Theory of Communication, The University of Illinois Press, Urbana, 117, 1949.

[14] Adesalu, T., & Kunrunmi, O. Effect of Physico-Chemical Parameters on Phytoplankton of a Tidal Creek, Logos, Nigeria Journal of Environment and Ecology, 3(1), 2012.

[15] Celia Y. Hen, Edward G. Durbin. Effect of pH on the growth and carbon uptake of marine phytoplankton. Marine Ecology Progress Series, 1994, Vol.190, 83-94

[16] Wheeler P. A., Huyer A., Fleischbein J., Cold halocline, increased nutrientsand higher chlorophyll off Oregon in 2002, Geophys. Res. Lett., 30 (15), 8021, doi:10.1029/2003GL017395.

[17] Badran M. I., Dissolved oxygen, chlorophyll a and nutrients: seasonal cyclesin waters of the Gulf Aqaba, Red Sea, Aquat. Ecosys. Health Manage., 2001, 4 (2), 139-150.

[18] Rober, J. Livingston, Akshithala K. Prasad, XufengNiu, Sean E. McGlynn. Effect of ammonia in pulp mill effluents on estuarine phytoplankton assemblages: field descriptive results and experimental results. Aquatic Botany 74(2002), 343-367

[19] Thajuddin, N. Marine cyanobacteria of the southern east coast of India. Survey and ecological studies. Ph.D. Thesis. Bharathidasan University, Tiruchirapalli. 1991.

[20] Steinhart, G S, Likens and G E, Soto, D. Physiological Indicators of nutrient deficiency in Phytoplankton in Southern Chilean Lakes, Hydrobiologia, 489(1-3), 2002, 21-27.

[21] Adesalu, T.A. & Nwankwo, D. I. Effect of water quality indices on phytoplankton of a sluggish Tidel Creek in Lagos, Nigeria. Pakistan J. Biol. Sci., 2008, 11, 836-844.

[22] Le Bris H. & Glémarec M. Stands macro zoo benthiques a coastal ecosystem under-saturated with oxygen: the Bay of Vilaine (South Brittany). Oceanologica Acta, 18, 1995, 573-581.

[23] A. Saravankumar, M. Rajkumar, G. A. Thivakaran, & J. Sesh Serebiah. Abundance and Seasonal Variations of Phytoplankton in the Creek Waters of Western Mangrove of Kachchh-Gujarat Journal of Environmental Biology, 29(2), 2008, 271-274.

[24] Swati S. Panda, Dhal N.K and Panda C.R. Phytoplankton Diversity in Response to Abiotic Factors Along Orissa Coast, Bay of Bengal International Journal of Environmental Sciences, 2 (3), 2012.

[25] Puspalata Moharana, A. K. Patra, & S. C. Pradhan. Spatial Distribution and Seasonal Abundance of Phytoplankton of Bay of Bengal at Digha Sea-shore. West Bengal International Journal of Sustainable Development and Green Economics, 1(1), 2012.