A Study on Seasonal Changes of Phytoplankton in relation to the Physico-Chemical Parameters of Satyavaram Pond, Srikakulam

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Abstract: In the present study, some hydrographical and chemical studies were made on the Satyavaram pond near Narasannapeta of Srikakulam District, Andhra Pradesh. In this investigation, Seasonal changes in the growth and distribution of phytoplankton along with physico-chemical parameters were studied for a period of two years from November 2006 to October 2008. Water samples were analyzed for Physical and Chemical parameters. The average values of p^H, turbidity, conductivity, dissolved oxygen, B.O.D, carbonate, bicarbonate, dissolved solids, chloride, fluoride, ammonia, nitrate, phosphate, silicate for two years were 7.21, 18.40NTU, 673µMhos, 6.16mg/lit, 3.43mg/lit, 3.08mg/lit, 180mg/lit, 347.4mg/lit, 106.6mg/lit, 0.15mg/lit, 2.57µg/lit, 7.69µg/lit, 2.08µg/lit and 29.2µg/lit respectively. Observations of the Satyavaram Pond revealed that the dominant members belonged to Chlorophyceae (44 genera) followed by Cyanophyceae (20 genera), Bacillariophyceae (15 genera) and Euglenophyceae (3 genera).The abundance of various algal groups in this pond were in the percentage of Chlorophyceae 60.95%, Cyanophyceae 20%, Bacillariophyceae 15.55% and Euglenophyceae with 3.5% in two year study. The Interrelationship between environmental, physico-chemical parameters and phytoplankton (Pearson's correlation Matrix) was also studied.

Keywords*:* Phytoplankton, Hydrographical features, Physico-chemical parameters

INTRODUCTION

A pond is typical example for lentic type of fresh water ecosystem. Seasonal variations appear due to change in temperature, pH, rainfall and annual growth of some organisms. Several studies were undertaken on physico-chemical parameters of water in various geographical regions by Kadiri (2002), Imoobe and Oboh (2003), Atoma (2004). In India, many researchers have done significant investigations on physico-chemical characteristics of fresh water bodies (Rajasekhar *et al.* 2007, Chaudhari 2009, Suma *et al.* 2010). Further study in relation with seasonality of phytoplankton was carried out by Tiwari and Shukla (2007), Smita Achary *et al.* (2010), Marykensa (2011).

India has wide variation in climatic factors in different months in different regions. Climate of a region determines its agriculture, aquaculture as well as its ecology. But very few information is available in the freshwater ponds in the Southern coastal region of this country. Therefore investigations were carried out on physico chemical and biological parameters of Satyavaram pond of Narasannapet mandal, Srikakulam district, for a 2 years period (2006-08). This Study aim at determining water quality with the help of physico-chemical and biological parameters. In the present study an attempt has been made to correlate certain physical and chemical factors with the fluctuations in plankton populations.

MATERIALS AND METHODS

Seasonal studies on microalgae present in the two ponds were carried out for period of two years. Satyavaram pond is located at latitudes of 18°24'18" and with longitudes of 84° 01' 30". Surface area of the water in the Pond during rainy season is around 4.68 hectares and 3 hectares in the summer months. Water depth of this Pond during the rainy season is 12 feet and 5feet in summer months. Water samples were collected from 10 stations for chemical studies and phytoplankton analysis for 2 years study period and the average

values were taken. The mateorological data is collected from the Head office of Meteorological department, Begampet, Hyderabad. The data include atmospheric temperature, rainfall and relative humidity were collected during the study period (2006-08) and average values were taken (Table 1).

Turbidity, temperature, pH and Conductivity were measured with the help of Nephelometer, thermometer, pH meter and conductivity meter. D.O and B.O.D. were determined by the modified Winkler's method. Water samples were also analyzed for Total alkalinity, dissolved solids, carbonate, bicarbonate, chloride, flouride, silicate, ammonia, nitrate, phosphate and few heavy metals like cadmium, copper, iron, nickel and lead (APHA, 1989). The abundance of phytoplankton was measured with Sedgwick rafter counting cell method.

RESULTS AND DISCUSSION

Information collected on the physico-chemical features, distribution and seasonal changes in the phytoplankton growth at Satyavaram pond.

ENVIRONMENTAL DATA

In the present study, higher values of temperature was recorded in the month of May and lower values in the month of January as reported by the earlier studies of Salve and Hiware (2006), Aher *et al.*(2006), Sharma (2007) and Kadam (2007), Chaudhari (2009) and Suma *et al.*(2010), Javaid Ahmad and Ashok (2012).Maximum rainfall was reported in June (259.1cm) and July onwards rainfall was decreasing with a minimum rainfall in January (3.2cm). There was no significant change in the relative humidity of the study sites. Maximum relative humidity observed in September (86%) and minimum in the month of December (74%) (Table1, Fig 1). In Satyavaram pond, maximum water temperature was reported in the month of May (29.1^0C) and Temperature decreases slowly with a minimum water temperature in the month of January (21.2^0C).

Hydrological features

The hydrological features were studied for two years and average values were expressed in Table.2, Fig 2. Water transparency was more during summer and maximum in rainy season. Maximum turbidity values were recorded in the month of September (32.56NTU) and minimum turbidity values were recorded in the month of March (7.32 NTU). The P^H value gradually increases from mid winter to late summer and then decreases in monsoon (Bade *et al.* 2009, Jayabhaye *et* investigation. In this pond, maximum P^H value (7.71) was recorded in the months of April and May and minimum value (6.87) in July and August months. These findings agree with the findings of George (1961, 1962 and 1966) and Biswas (1980). Regarding the conductivity, higher values were reported in May (983µMhos) and minimum values reported in February i.e., 315µMhos. In Satyavaram pond maximum D.O values (8.46mg/l) were observed in July. The results were correlated with the findings of Sampath Kumar (1977) and Welch (1980). In the present investigation, high B.O.D. values were recorded in July (5.23mg/L) which correlated with the findings of Kiran (2010).

Chemical Factors

The chemical parameters were studied for two years and average values were expressed in Table.2, Fig 2&4. Maximum carbonate values were observed in June (5.24mg/l) minimum values in December (1.15mg/l). Maximum values of Bicarbonates reported in the month of May (214mg/l), minimum values observed in the month of November (120 mg/l) .The Maximum Dissolved Solids found in Satyavaram pond were 498mg/l in May, and minimum 256mg/l was in February. The highest chloride value of Satyavaram pond was 128mg/L in September. It was supported with Conductivity 814 µMhos, dissolved solids of 412 mg/L, atmospheric temperature 28.4^o C, RH of 86% and rainfall of 191.1 cm. The higher temperature leads to evaporation which further increases chloride concentration. The high chloride concentration of the pond water was due to high rate of evaporation (Manjare *et al.* 2010).

The maximum Fluoride values recorded for Satyavaram pond was 0.26 mg/l in the month of May and the minimum value recorded was 0.08mg/l in the months of November. The Maximum values of Ammonia content found in Satyavaram pond was 9.21µg/l in July and minimum was 1.08µg/l in November. The Maximum nitrate value found in Satyavaram pond was 12.24µg/L in September and minimum Nitrate value was 4.61µg/L in February. Other influential

factors recorded during September were conductivity-814 µMhos, dissolved solids-412 mg/L. chloride-128mg/L, RH 86% and rainfall of 191.2 cm.

The maximum Phosphate and Silicate values found in Satyavaram pond were 3.56 µg/l in the month of October and 48.35µg/l in September. The minimum values of Phosphate and Silicate were recorded as 1.14 µg/l, 4.28 µg/l in the months of February and April (Fig 3).

Heavy Metals: Analysis of Heavy metals such as Cadmium, Copper, Iron, Nickel and Lead Was conducted only twice in a year i.e. in September and March for Satyavaram pond. Their values were 0.58µg/l, 4.35µg/l, 22.34µg/l, 1.26µg/l, 2.28µg/l respectively in September month for Satyavaram pond and 0.25µg/l, 3.46µg/l, 15.62µg/l, 0.28µg/l and 0.35µg/l values in March (Table 2).

PHYCOLOGICAL STUDIES

The Observations on phytoplankton revealed the dominance of Chlorophycean members in the Pond. The members of Cyanophyceae were second in Satyavaram pond and members of Bacillariophyceae ranked third and Euglenophyceae ranked 4th position. The ponds investigated shows the various groups of algae in the following order.

Chlorophyceae > Cyanophyceae > Bacillariophyceae> Euglenophyceae

High rainfall, high nitrate content, high temperature, maximum relative humidity; bicarbonates are promoted the maximum growth of Chlorophyceae members. It was supported by higher turbidity, Alkaline P^{H}, high D.O content, higher value of conductivity, higher value of TDS, high nitrate value. Zero rainfall in December decreases the growth of Chlorophyceae members. Observations of this Pond revealed that the dominant members belonged to Chlorophyceae (44 genera) followed by Cyanophyceae (20 genera), Bacillariophyceae (15 genera) and Euglenophyceae (3 genera). The various algal groups in this pond were in the percentage of Chlorophyceae 61%, Cyanophyceae 21%, Bacillariophyceae 15% and Euglenophyceae with 3% in two year study (Fig 4).

Shankar Hosmani and Vasanth kumar (2000) observed the maximum peak of the bluegreen algae is observed during the summer months. The abundant presence of blue green algae has an antagonistic effect on the occurrence of desmids. The water bodies have Myxophycean population and low desmid population. Secondly, the diversity of Chlorococcales seems to be high but the total number is low and both these algal groups have a role in reducing the number of desmids in the lakes which correlated with the present wok. Turbidity reported high in monsoon due to influx of rain water from catchments area, washes, silt, sand and organic matter. This decreases the total phytoplankton (Kulkarni *et al.* 1995, Narayana *et al.* 2008, Reddy Vasumathi *et al.* 2009, Shinde *et al.*2011).

Interrelationship between environmental, physico-chemical parameters and phytoplankton (Pearson's Correlation matrix): Satyavaram pond

The Interrelationship between environmental, physico-chemical parameters and Phytoplankton was shown in Table 3 and Fig.5. Correlation between Chlorophyceae members and different physico-chemical factors such as temperature, chloride, TDS, phosphate and dissolved oxygen in the present study was correlated with the findings of Venkateswarlu 1969a,b; Tripathy and Pandey 1989, Murugesan and Sivasubramanian 2008, Jawale *et al.* 2009. Atmospheric temperature, rainfall and RH showed positive correlation with nitrate, phosphate and silicate in both ponds. This correlated with the findings of Salve and Hiware 2006, Kadam *et al.* 2007 and Chaudhari 2009. RH showed positive correlation with nitrate (r=0.77), phosphate (r=0.5644) and silicate (r=0.5980). Turbidity showed positive correlation with carbonate (r=0.6971), and silicate (r=0.6913). But turbidity showed significant negative correlation with total phytoplankton (r=-0.678). In the present study, P^{H} showed significant positive relationship with water temperature. Alkaline nature high in summer (r=0.98) and minimum in winter. Similar trend was reported by Wetzel, 1983, Anita, 2002, Kadam *et al.* 2007, Narayana *et al.* 2008, Reddy Vasumathi *et al.* 2009, Shinde *et al.* 2011. P^{H} showed positive correlation with chlorophyceae (r=0.5166) members. Conductivity showed significant positive correlation with TDS (r=0.947) and turbidity. This correlated with the work of Salve and Hiware 2006, Narayana *et al.* 2008, Jawale and Patil 2009 and Shinde *et al.* 2011.

Conductivity showed positive correlation with TDS (r=0.947), flouride (r=0.612). D.O showed positive correlation with ammonia (r=0.6177) and significant negative correlation with total cyanophyceae members (r=-0.604). B.O.D showed positive correlation with flouride (r=0.7821) and significant negative correlation with phosphate (r=-0.671), and oedogoniales (r=-0.797). Carbonate showed significant positive correlation with Euglenophyceae (r=0.6764) and negative correlation with bacillariophyceae members (r=-0.524). Bicarbonates showed positive correlation with conjugales (r=0.5387). TDS showed significant positive correlation with chloride (r=0.6343), flouride (r=0.6598), nitrate (r=0.571) Ammonia showed negative correlation with phytoplankton (r=-0.568) Nitrate showed positive correlation with silicate (r=0.7493) bacillariophyceae members (r=-0.511). Phosphate showed positive correlation with silicate (r=0.5718). Silicate showed negative correlation with total phytoplankton (r=-0.644) which include chlorophyceae members (r=-0.708). Chlorine showed significant positive correlation with water temperature in summer (Nirmal Kumar 2005, Chouhan 2007, Narayana *et al.* 2008, Reddy Vasumathi 2009, Shinde *et al.* 2011). Similar trend was observed during the study period. Cyanophyceae have show very close positive relation with temperature and phosphate (Wilk-Wozniak 1998, Harsha and Mallammanavar 2004). Similar findings were found in present investigation. Bacillariophyceae members have shown significant positive relation with temperature, chlorine and phosphate (Sadguru prakash 2001, Chitra and Meera 2004). The domination of bluegreen algae, observed frequently when there are low numbers of diatoms and green algae, is an indicator of eutrophication which correlated with the present work (Munawar 1972, Lampert and Sommer 1996, Elzbieta Zebek 2005).

CONCLUSION

The present study Predicts the nature of the water bodies. This shows the Satyavaram pond was non-polluted with dominant chlorophyceae members followed by cyanophyceae, bacillariophyceae and Euglenophyceae members. This helps in remodification of the fresh water bodies and conservation of rare microalgae which are useful in industry and pharmaceutical fields. To minimize the pollution some measures should be taken i.e. preventing washing clothes, bathing of cattle, dumping of agricultural waste, avoiding the use of chemical fertilizers and other human activities. This helps for maintenance of ecological balance in the fresh water bodies by which the purity of the pond can be maintained.

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Table1. Meteorological Data for Satyavaram Pond

Meterological Data (Average Calculations for 2 years i.e Nov 2006-Oct 2008)																						
		Temperature Maximum				Temperature Minimum					Rainfall				Relative Humidity rh_1				Rlative humidity rh_2				
S.No.	Month	2006	2007	2008	Average	2006	2007	2008	Average	Average Temperature(°C)	2006	2007	2008	Average Rainfall(Cm)	2006	2007	2008	Average	2006	2007	2008	Average	Average Relative Humidity(%)
1	Nov	29.2	29.49	0	29.3	21.02	19.9	0	20.5	24.9	10.8	1.2	0	6	79.97	76.43	0	78.2	75.06	68.5	0	71.8	75
2	Dec	28.78	27.79	0	28.3	17.94	18.2	0	18.1	23.2	0	0	0	0	81.4	75.97	0	78.7	70.6	68.77	0	69.7	74
3	Jan		28.24	27.82	28		17.5	16.66	17.1	22.6		0	6.3	3.2		85.25	81	83.1		71.32	69.35	70.3	77
4	Feb		29.86	27.84	28.9		19.1	20.42	19.8	24.4		0.2	43.3	21.8		79.53	87.89	83.7		70.32	81.31	75.8	80
5	Mar		31.12	31.39	31.3		23.35	21.76	22.6	27		1.1	41.4	21.3		79.29	75.61	77.5		76.29	75.83	76.1	77
6	Apr		32.39	32.7	32.5		25.58	24.7	25.1	28.8		0	15.6	7.8		73.67	77.47	75.6		81.03	79.46	80.2	78
7	May		34.03	34.42	34.2		26.94	26.55	26.7	30.5		45.6	126.6	86.1		75.42	77.45	76.4		79.45	79.55	79.5	78
8	Jun		32.09	31.59	31.8		26.65	25.89	26.3	29.1		429	89.1	259.1		85.23	83.9	84.6		84.83	83.86	84.3	84
9	Jul		31.71	31.47	31.6		26.32	25.46	25.9	28.8		89.5	222.8	156.2		82.5	85.39	83.9		82.7	83.48	83.1	84
10	Aug		31.58	31.24	31.4		25.82	25.81	25.8	28.6		123.4	123.4	123.4		83.16	87.23	85.2		83.58	85.13	84.4	85
11	Sep		30.67	31.91	31.3		25.47	25.26	25.4	28.4		277.2	105	191.1		88.13	84.66	86.4		86.56	84.03	85.3	86
12	Oct		30.91	32.12	31.5		23.58	23.74	23.7	27.6		137.7	82.6	110.2		74.45	81.06	77.8		74.45	74.87	74.7	76

Table 2. Hydrological, Physico-chemical Data of Satyavaram Pond

Months	Average Water Temperature(°C)	Turbidity(NTU)	pH	Coductivity(uMhos.)	Dissolved Oxygen(mg./L)	B.O.D(mg./L)	Carbonate(mg./L)	Bicarbonate(mg/L)	Dissolved solids(mg/L)	Chloride(mg/L)	Flouride(mg/L)	Ammonia(µg/L)	Nitrate(µg/L)	Phosphate(µg/L)	Silicate(µg/L)	Cadmium(µg/L)	Copper(µg/L)	Iron(µg/L)	Nickel(µg/L)	Lead(µg/L)
Jan	23	16.77	7.52	638	6.82	3.77	2.36	158	318	110	0.21	3.12	5.25	2.46	32.85					
Feb	21.5	14.26	7.07	315	4.73	3.15	2.58	205	256	96	0.11	1.56	4.61	1.14	10.23					
Mar	21.2	7.32	7.32	810	6.54	3.56	2.36	210	402	93	0.13	2.18	6.59	2.11	15.64	0.25	3.46	15.62	0.28	0.35
Apr	23.2	12.36	7.71	540	6.58	3.54	4.38	175	276	104	0.05	1.15	5.68	1.26	4.28					
May	23.9	15.46	7.71	983	7.35	3.98	2.31	214	498	782	0.26	2.25	7.65	1.25	22.31					
Jun	27.2	26.72	7.05	683	4.26	3.21	5.24	170	372	574	0.16	2.28	8.65	1.85	32.65					
Jul	29.1	31.11	6.87	615	8.46	5.23	4.12	156	306	115	0.21	9.21	6.28	1.125	38.38					
Aug	28	23.51	6.87	812	5.82	3.42	4.23	201	402	101	0.25	1.85	11.32	2.15	42.35					
Sep	27.2	32.56	7.28	814	6.35	3.26	3.85	165	412	128	0.15	2.18	12.24	2.56	48.35	0.58	4.35	22.34	1.26	2.28
Oct	26.8	19.16	7.02	721	5.18	2.27	3.21	210	354	103	0.12	1.78	10.45	3.56	42.38					
Nov	26.5	11.46	7.02	568	6.56	3.28	1.26	120	284	114	0.08	1.08	7.68	2.85	35.62					
Dec	25.9	10.12	7.13	582	5.35	2.58	1.15	187	289	104	0.09	2.16	5.98	2.68	25.62					

Fig 1

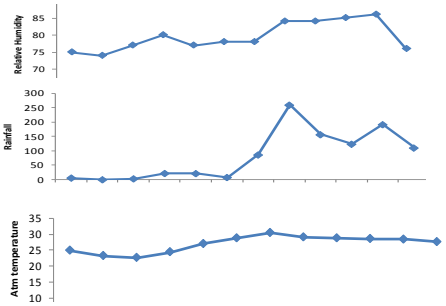


Fig 2

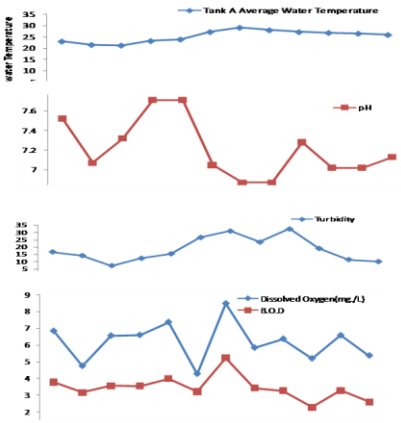


Fig 3

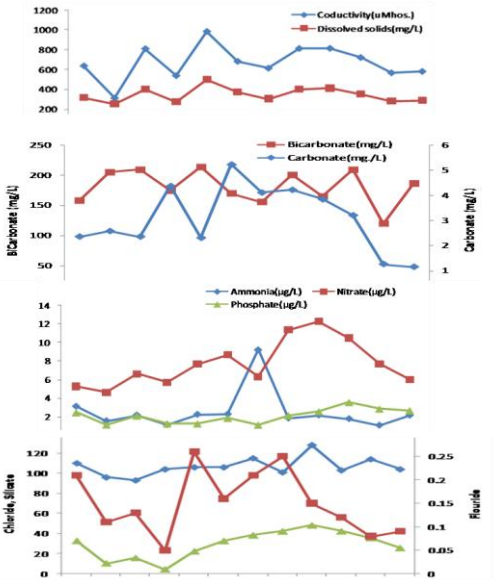
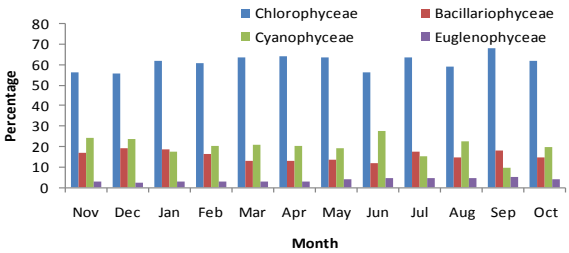


Fig 4

SEASONAL DISTRIBUTION OF PHYTOPLANKTON IN SATYAVARAM POND



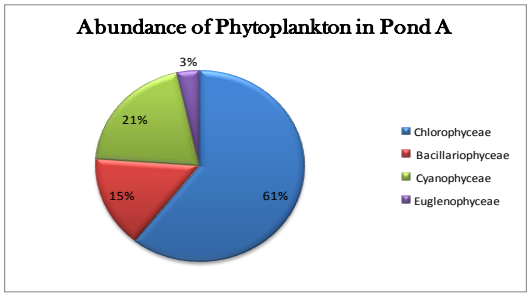
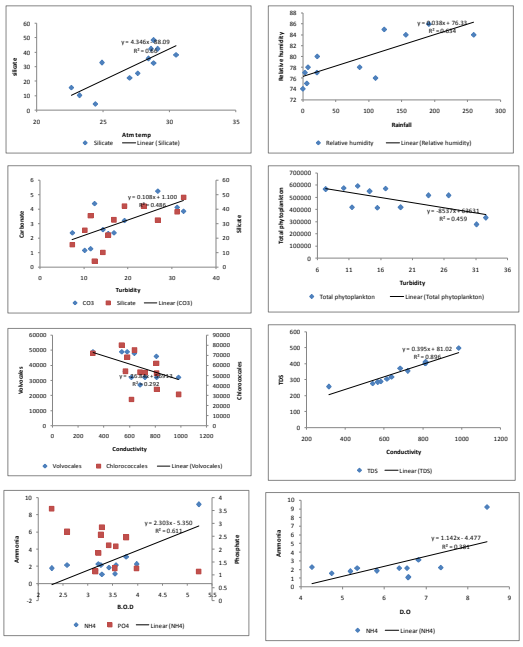


Table 3. PEARSON'S CORRELATION MATRIX OF PHYSICO-CHEMICAL PARAMETERS OF SATYAVARAM POND

	Atm temp	Rainfall	Relative humidity	Water temp	Turbidity	pH	Conductivity	D.O	B.O.D	CO3	HCO3	TDS	Cl	F	NH4	NO3	PO4	Silicate	Chlorophyceae	Bacillariophyceae	Cyanophyceae	Euglenophyceae	Total phytoplankton
Atm temp	1																						
Rainfall	**0.64938**	1																					
RH	**0.551444**	**0.79683**	1																				
Water temp	**0.980981**	**0.6878**	**0.578738**	1																			
Turb	**0.702963**	0.29068	0.274659	**0.724797**	1																		
pH	**-0.56838**	**-0.58045**	-0.35302	**-0.64467**	-0.42838	1																	
Conduct	0.28954	0.19756	0.274047	0.212558	0.220964	0.227553	1																
D.O	0.122176	0.02163	-0.00093	0.08604	0.113565	0.278046	0.30049	1															
B.O.D	0.119838	-0.18858	-0.27173	0.112657	0.337081	0.099473	0.120359	**0.811697**	1														
CO3	0.301966	-0.01779	0.165722	0.384729	**0.697146**	-0.14406	0.121436	-0.09969	0.243625	1													
HCO3	-0.34953	-0.23217	-0.28153	-0.37263	-0.22128	0.168287	0.300185	-0.28651	-0.27124	0.035867	1												
TDS	0.182275	0.06934	0.143758	0.0907	0.244489	0.232199	**0.946972**	0.160461	0.099292	0.166961	0.43987	1											
Cl	0.157057	-0.33629	-0.21215	0.016029	0.118169	0.359094	**0.504303**	-0.01608	0.152171	0.155388	0.213391	**0.63431**	1										
F	0.327369	0.09682	-0.12459	0.256825	0.463993	-0.02313	**0.612026**	0.358106	**0.509195**	0.222784	0.220961	**0.659844**	0.459469	1									
NH4	0.407939	-0.06679	-0.23051	0.422098	**0.520265**	-0.29676	-0.00212	**0.617717**	**0.782138**	0.239361	-0.2279	-0.07321	-0.05223	0.410956	1								
NO3	**0.608513**	**0.68105**	**0.771088**	**0.613964**	**0.573255**	-0.35832	**0.598405**	-0.16495	-0.28173	0.381885	0.0712	**0.570954**	0.083185	0.271074	-0.17628	1							
PO4	0.263191	**0.49403**	**0.564427**	0.265311	-0.08027	-0.28432	0.165417	-0.30267	**-0.67141**	-0.32977	-0.13442	0.00735	-0.33683	-0.23339	-0.3491	0.478049	1						
Silicate	**0.812398**	**0.67977**	**0.598022**	**0.803375**	**0.691319**	**-0.57415**	0.394494	0.067653	-0.02312	0.170545	-0.31059	0.291308	-0.06339	0.412975	0.270113	**0.749323**	**0.571799**	1					
Chlorophy	**-0.82127**	-0.46204	-0.45466	**-0.76635**	**-0.66038**	**0.516597**	-0.2372	-0.35858	-0.32591	-0.11246	0.357441	-0.19801	-0.14762	-0.30033	-0.55004	-0.45877	-0.11325	**-0.70812**	1				
Bacillario	**-0.52366**	-0.15405	-0.45297	**-0.49292**	**-0.57487**	0.204967	-0.45795	-0.29436	-0.36913	**-0.5236**	0.018487	-0.48067	-0.39201	-0.28218	-0.35632	**-0.51107**	0.1689	-0.35573	**0.699081**	1			
Cyanophy	-0.41096	-0.23142	-0.29298	-0.36613	**-0.60274**	0.097335	-0.28011	**-0.60438**	-0.43799	-0.1001	0.181867	-0.25518	0.059225	-0.31954	**-0.52355**	-0.35396	0.005204	**-0.51016**	**0.739641**	**0.547291**	1		
Eugleno	0.041861	-0.03852	0.002976	0.087553	0.279198	-0.05454	0.253901	**-0.5773**	-0.23161	**0.676369**	0.383967	0.374911	0.367866	0.273413	-0.30999	0.390764	-0.12296	0.029317	0.31276	-0.10845	0.451625	1	
Total	**-0.70869**	-0.37539	-0.44391	-0.65476	**-0.6776**	0.369906	-0.30438	-0.47993	-0.40836	-0.17007	0.28534	-0.27323	-0.12582	-0.32157	**-0.56796**	-0.46318	-0.03831	**-0.64443**	**0.964345**	**0.765506**	**0.873349**	0.34499	1

Figure 5: SIMPLE LINEAR REGRESSION BETWEEN ENVIRONMENTAL, PHYSICO-CHEMICAL AND PHYTOPLANKTON IN SATYAVARAM POND



Photographs of some microalgae prevailing in Satyavaram Pond