

# Seasonal Distribution of Phytoplankton In Laddia Dam In Sikar Disrict of Rajasthan

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This paper reports on study carried out from January 2008 to December 2009 in Madhav Sagar pond. The study emphasizes the local and regional climatic influence on phytoplankton species composition, diversity and density variation in the pond ecosystem. In addition Nitrate, Inorganic phosphorous, Temperature, pH, Conductivity, Dissolve oxygen, Chloride, Total hardness, Calcium and Sodium were analyzed. The result obtained indicates that a significant difference in abundance of phytoplankton groups was found between year 2008 and 2009. Though the highest phytoplankton abundance was observed in July 2008 and February showed the highest number of taxa (highest diversity). Chlorophytes were the major dominant group in both periods.

**Keywords:** Algae, phytoplankton, Sikar, Rajasthan, ecology

**Received:** December 2, 2011 **Revised:** May 14, 2012 **Accepted:** September 29, 2012

## INTRODUCTION

Phytoplanktons are the primary producers and constitute the first level trophic status in aquatic food chain for all aquatic animals (Baruah and Das 2001). They play an important role in maintaining the equilibrium between living organisms and abiotic factors. The importance of algal dynamics particularly their response to environmental changes and nutrient fluctuation has been studied by several workers (Mishra and Sakasena 1998, Duncan *et al.* 2000, Dwivedi and Pandey 2003, Hosetti *et al.* 2009). The density and diversity of phytoplankton and their association as biological indicator in the assessment of water quality has been worked out (Clessari *et al.* 1998).

The main source of water for the inhabitants of Sikar city is ground water and rainwater harvesting. In months of July and August rainwater is stored in pucca tanks (ponds) and used throughout the year for drinking purposes. Bawadis and Johads are traditionally constructed for storing water received from rainfall. Madhav Sagar is also a traditional pond which was constructed for drinking purpose and this is the first investigation of the algal flora in this pond.

Study of urban pond ecology has mostly concentrated

on physicochemical characteristics. An increasing number of surface water bodies have come under serious threat of degradation. In view of importance of aquatic plants, a baseline data on monthly variation in occurrence, phenotype, coverage and nutrients contents of various species of aquatic flora found in Madhav Sagar was collected over a period of two years in order to gain an insight into their conservation and management option or strategies.

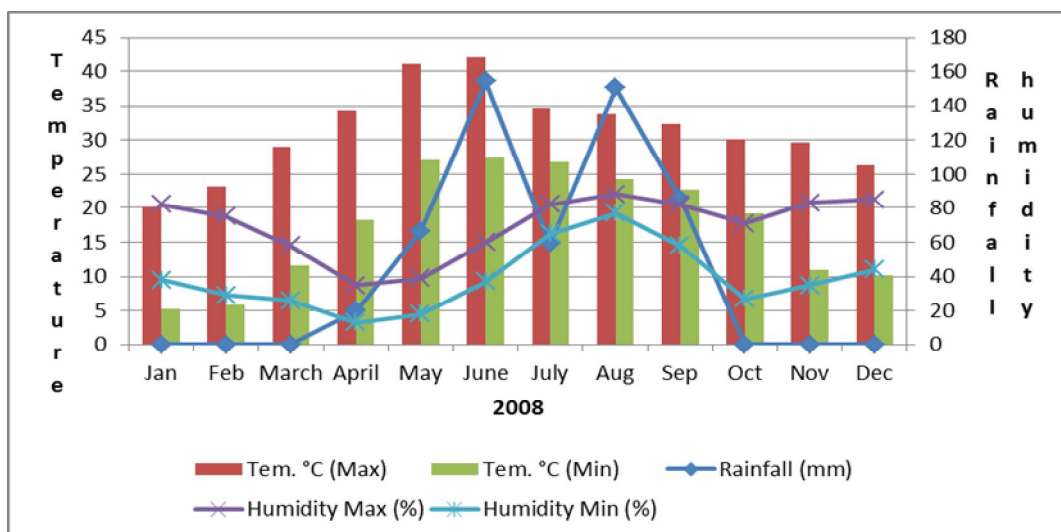
## MATERIALS AND METHOD

### Investigated area

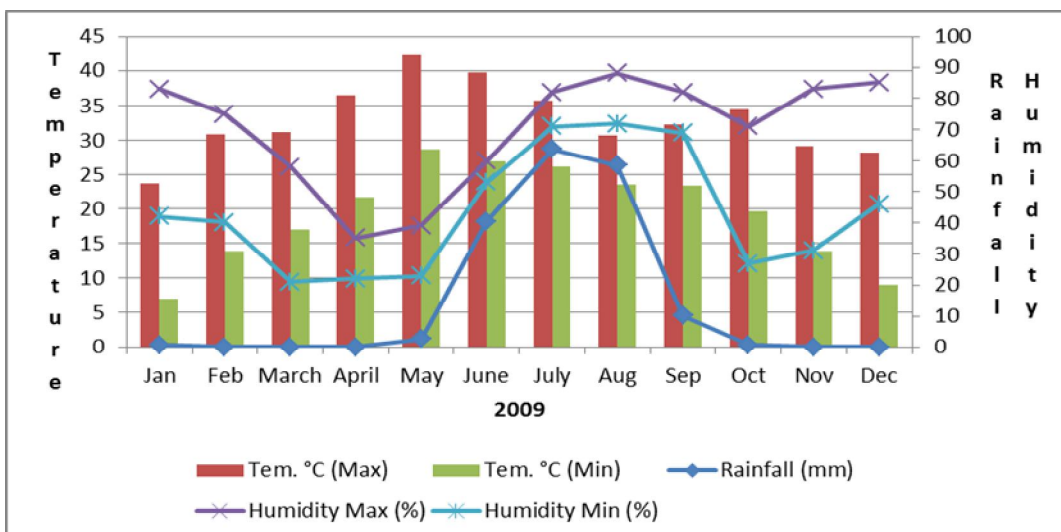
Sikar is situated between the east longitude 75° 16' and north latitude 27° 30'. The natural climatic condition in this region is very typical and extreme. The temperature range is from 0°C in winter to more than 48° C in summer. This site has a hot summer, scanty rainfall, a chilly winter season and general dryness of the air except in brief monsoon season. The normal rainfall received from south west monsoon. Semi arid to arid climate prevails in the district.

Madav Sagar pond situated at the west side of Sikar district, which is a symbol of architect as well as traditional heritage.

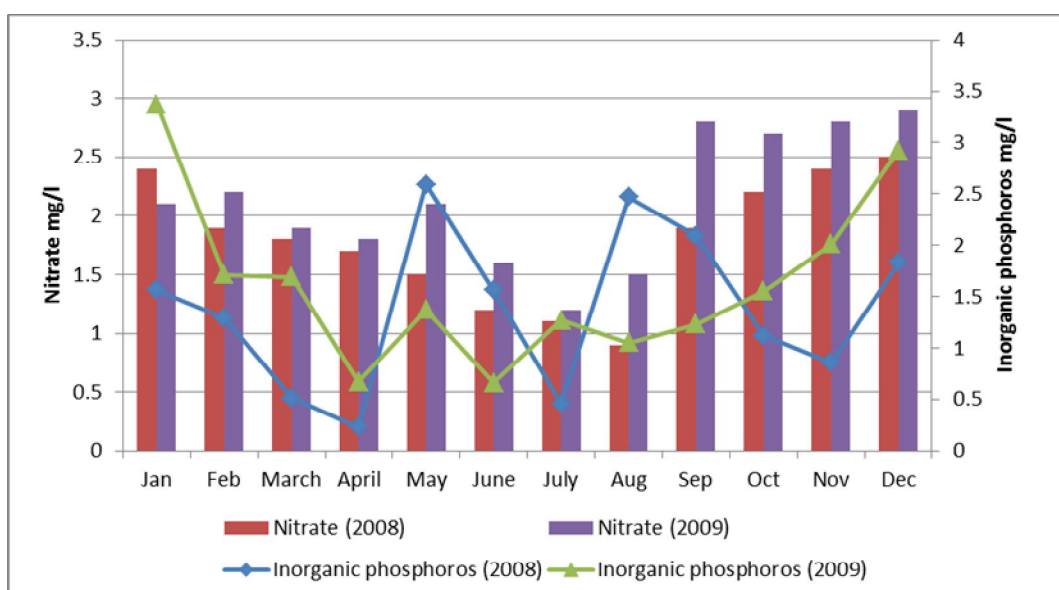
**Fig 1a. Profile of meteorological variables in 2008**



**Fig 1b. Profile of meteorological variables in 2009**



**Fig 2. Variation of nutrient concentration.**



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**Table 1. Correlation studies of various parameters in the years 2008 and 2009.**

2009											
	Rain-fall	Tempera-ture	pH	Conductiv-ity	DO	Calcium	Sodium	Hard-ness	Chloride	I.P.	Nitrate
Rainfall	1.000										
Temperature	0.799	1.000									
pH	0.912	0.865	1.000								
Conductivity	0.367	0.251	0.338	1.000							
DO	-0.099	-0.107	-0.297	-0.643	1.000						
Calcium	0.644	0.588	0.735	0.635	-0.618	1.000					
Sodium	-0.128	-0.039	-0.027	-0.487	0.326	-0.372	1.000				
Hardness	-0.315	0.108	-0.031	-0.329	0.004	-0.038	0.496	1.000			
Chloride	0.288	0.684	0.520	0.010	-0.293	0.528	-0.034	0.329	1.000		
I.P.	-0.447	-0.747	-0.600	-0.092	0.032	-0.281	-0.484	-0.411	-0.585	1.000	
Nitrate	-0.764	-0.514	-0.698	-0.451	0.234	-0.594	-0.251	0.014	-0.128	0.472	1.000

2008											
	Rainfall	Tempera-ture	pH	Conductivi-ty	DO	Calcium	Sodium	Hard-ness	Chloride	I.P.	Nitrate
Rainfall	1.000										
Temperature	0.778	1.000									
pH	0.534	0.807	1.000								
Conductivity	0.362	0.449	0.078	1.000							
DO	-0.062	-0.105	-0.097	0.008	1.000						
Calcium	-0.126	-0.202	-0.461	0.156	-0.400	1.000					
Sodium	0.462	0.410	0.308	0.210	-0.639	0.494	1.000				
Hardness	0.252	0.225	0.000	0.197	-0.801	0.355	0.565	1.000			
Chloride	0.569	0.580	0.547	0.232	-0.297	-0.117	0.222	0.507	1.000		
I.P.	0.505	0.155	0.128	-0.369	0.001	0.008	0.256	0.132	0.343	1.000	
Nitrate	-0.803	-0.811	-0.478	-0.561	-0.037	-0.145	-0.506	-0.142	-0.334	-0.136	1.000

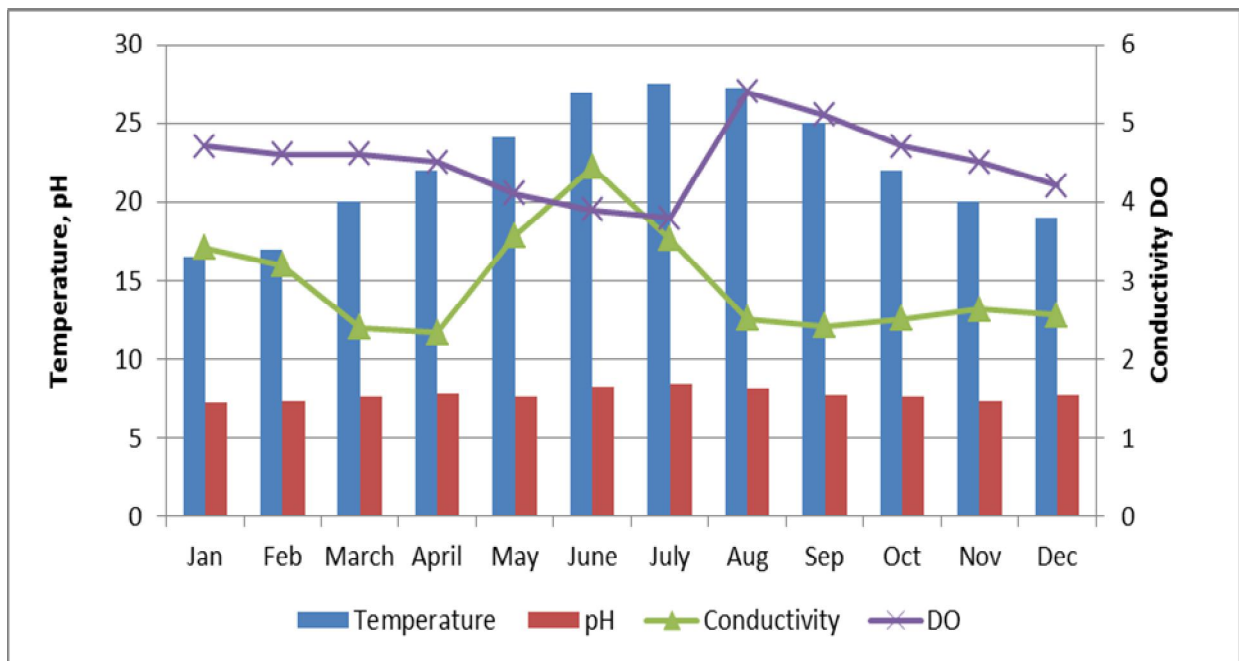
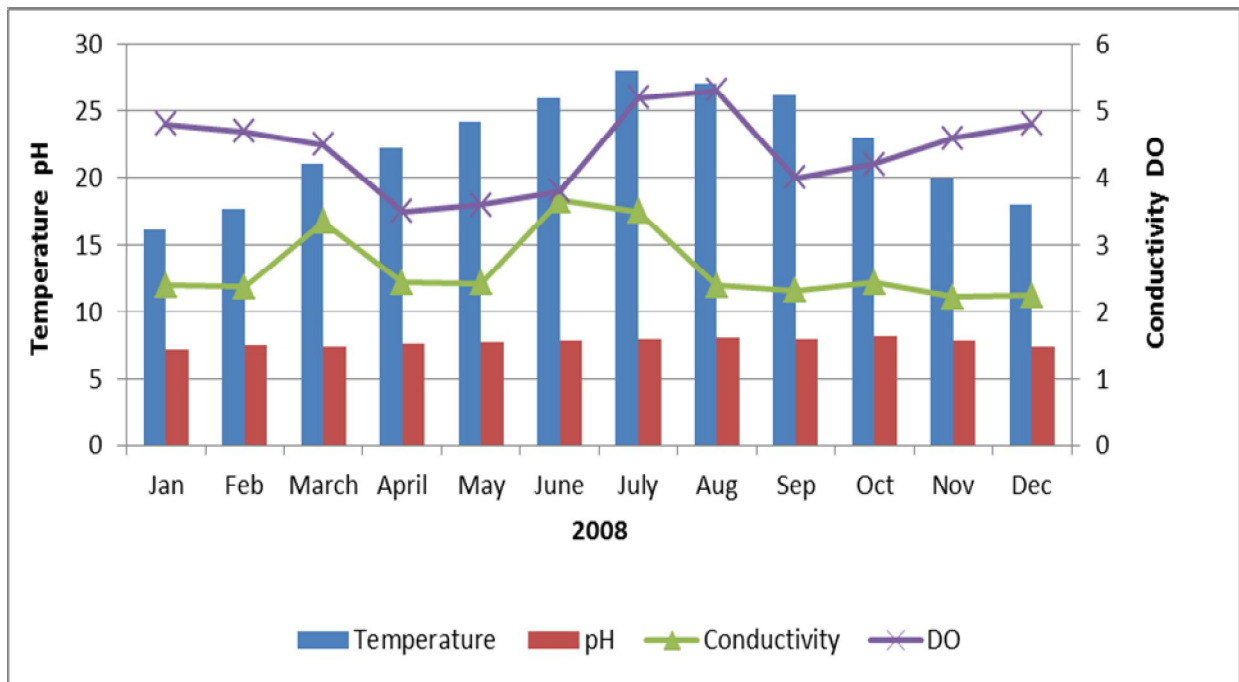
It is also known as Madho Sagar or Bada Talab. This pond was constructed by Rao Madhav Singh during 1899 for drinking purpose. The pond is octagonal with the depth of 32 feet and constructed with 11 pillars.

**Chemical and Biological Analysis**

The water sample was collected in morning between 7.00 am to 9.00 am during January 2008 to December

2009. Temperature and pH was recorded on the field, temperature was recorded by thermometer and pH was measured with a field pH meter. For further analysis water samples were collected in cleaned acid washed plastic bottles and stored at 4 °C. Conductivity of water sample was measured directly after standardization of electronic digital instrument (Century Soil and Water Testing kit). Dissolved oxygen was estimated

Fig 3. Variation of Temperature, pH, Conductivity and Dissolved oxygen.



by Wrinkler's method. Nitrate and Inorganic phosphorous were measured colorimetrically using standard methods (Trivedy and Goel, 1986). Sodium and Calcium in water sample were estimated by a Flame photometer (Model – Century digital flame photometer) following the instruction provided by the manufacturer for use. Total hardness measured by EDTA method (Trivedy and Goel, 1986).

Collected algal samples were preserved in 4% formalin and lugol's iodine solution. Counting of phytoplankton population was done by Haemocytometer originally devised for counting blood cells. Algal identification was done by using standard monographs (Desikachary 1959, Randahwa 1959, Phillipose 1967, Iyenger and Desikachary 1981 and Anand 1998, Prescott 1962).

## RESULTS

### Meteorological Data

Experiment was conducted for a period of two years from January 2008 to December 2009. Physical factor viz. rainfall, humidity (minimum and maximum), air temperature (minimum and maximum) are presented in figure -1a and 1b . Second year was much drier than the first due to distribution of rainfall. In first year the total rainfall was 535.8 mm but in second year it was only 176.9 mm it means, in the second year rainfall was 67% less compare to first year.

Air temperature ranged between 42.3 to 5.2° C. At this temperature physical, chemical and biological process in the water are usually affected. The humidity of environment ranged between 88 to 13 during the study period. Meteorological data were collected from the Indian Meteorological Department, Delhi and Rajasthan state Irrigation Department, Jaipur.

### Comparative Assessment of Madhav Sagar (2008 & 2009) Nutrient profile

Nutrient concentration is in terms of nitrate and inorganic phosphorus. Nitrate can be of natural origin and their level in water can give a general indication of nutrient status and level of organic pollution. Nitrate value was slightly higher in the year 2009 throughout the study period, ranging between 0.9 – 2.5 mg/l in 2008 and 1.2 – 2.9 mg/l in 2009 (Figure 2). Nitrate concentration change during the study period exhibited major peak (2.5 mg/l) in December and minor peak (0.9 mg/l) in August. In year 2009 nitrate concentration remained essentially constant between September to December.

Inorganic Phosphorous (I.P.) is considered to be one of the most important factors in the maintenance of an aquatic ecosystem. IP values were higher in 2009. Its maximum value (3.37 mg/l) was recorded during winter of year 2009 and minimum in the early summer (April = 0.23 mg/l) in the year 2008.

### Temperature, pH, Conductivity and DO profile

During the study period, similar patterns of temperature fluctuations in surface water were observed in the both years, with highest peak during July, after that these was gradual decrease up to January. The Temperature range in surface water varied between 16.2 -28 in 2008 and 16.5 to 27.5 in 2009 respectively (Figure - 3)

Oxygen is an important parameter of the pond/wetland/reservoir which is essential to the metabolism of all aquatic organisms that possess aerobic respiration. Concentration of dissolved oxygen indicates water quality and its relation to the distribution and abundance of various algal species. In the present study, the DO of water sample ranged from 3.5 to 5.4 mg/l. The minimum DO value was observed in

April (3.5 mg/L) and highest peak was observed in August 2009 (5.4 mg/L).

One of the most important factor that serve as an index for pollution is pH. The water in the pond was slightly alkaline and pH was highest in second year respectively first year. In the year 2008 the maximum pH value was observed in October (8.2) and minimum in January (7.2) and in year 2009 highest peak in July (8.5) and lowest peak in January (7.3). Conductivity of water depends upon the concentration of ions and its nutrient status and variation in dissolved solid content. The highest Electrical Conductivity was recorded in year 2009. Both the year lowest EC value was in the rainy season due to rainfall.

### Sodium, Total Hardness, Calcium and Chloride

Since there are no major industries around the study site, the major source of organic pollution is the domestic and to some extent nearby park runoff. Monovalent and divalent cation play very important role in the productivity of pond water. Calcium and Sodium are reported to be of importance of phytoplankton production (Hussein, 1989).

The value of sodium in between was 115 to 295 mg/l in year 2008 and 125 to 290 mg/l in year 2009 (maximum value in May 2008 and minimum in December 2008 (Figure - 4). Highest peak value of total hardness was in April 2009 (360 mg/l) and minimum in July 2009 (170 mg/l).hardness in water is predominantly contributed by Ca and Mg along with Zn, Mn, Al and Fe ions.

Chloride in water is generally due to salts of sodium, potassium and calcium. It is also be contributed by sewage discharge, irrigation drainage to natural waters. Almost the same chloride values were exhibited in both the year with highest peak of 190 mg/l (in June, 2008 and April, 2009) and minimum peak of 100 mg/l (February, 2009).

### Phytoplankton and community structure

Four algal groups were recorded throughout the investigation period, Bacillariophyceae, Chlorophyceae, Cyanophyceae and Euglenophyceae . The total percentage composition of four main phytoplankton group show that Chlorophyceae group dominated throughout the study period in Madhav Sagar pond, Cyanophyceae ranked second and third were the Bacillariophyceae, Euglenophyceae ranked fourth in order of dominance (Fig. 6 )

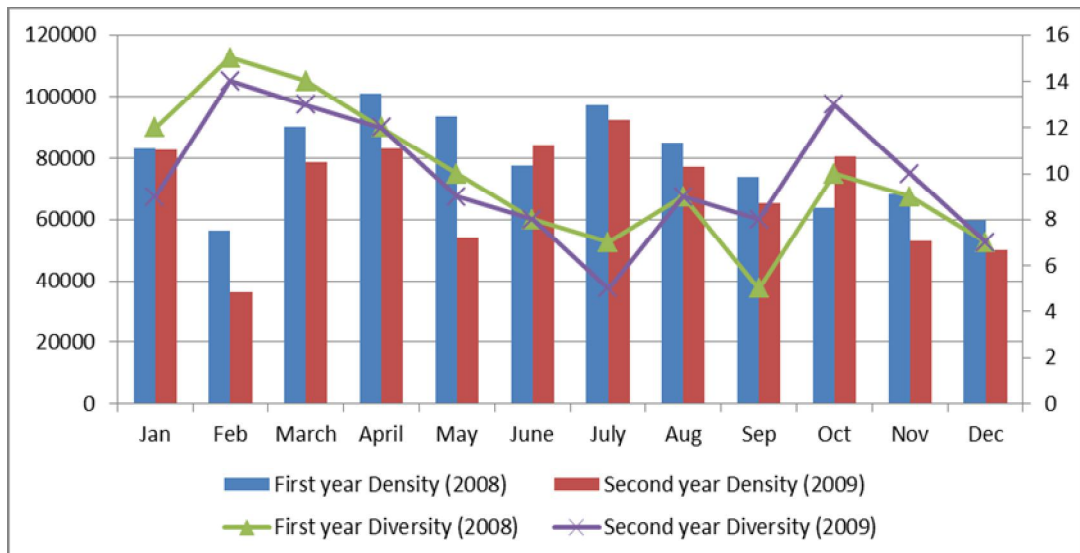
According to the study of phytoplankton diversity, a total 16 taxa and 24 species were distinguished in two year (2008-2009) of these taxa, 6 genera and 9 species (*Ankistrodesmus fusiformis*, *Chorella vulgaris*, *Chlorococcum humicola*, *Coleastrum microporum*, *Pediastrum duplex*, *P. boryanum*, *Scenedesmus dimorphus*, *S. obliques*, and *S. quardicauda* ) of Chlorophyceae, 5 genera and 7 species (*Chroococcus giganticus*, *Merismopedia minima*, *Microcystis litoralis*, *M. flo-aqae*, *Oscillatoria anruina*, *O. tenuis*, *Spiruli-*



Fig 4. Variation of Sodium, Hardness, Calcium, Chloride in the pond system.



Fig 5. Population dynamics of phytoplankton in Madhav Sagar in 2008 & 2009.



*na maxima* ) of Cyanophyceae, 4 genera and 5 species (*Cymbella ventricosa*, *Navicula* sp., *Pinnularia microstauron*, *Nitzschia palea*, *Nitzschia amphibia*) of Bacillariophyceae and 2 genera and 3 species (*Euglena acus*, *Euglena viridis*, *Phacus* sp.) of Euglenophyceae were reported first time from Madhav Sagar pond.

Green algae were more abundant than the other group (both qualitatively and quantitatively) for entire study period except November to January, when Diatoms in the term of cell count were dominant. Further decline in diatom were followed by increase in green algae and Blue green algae and Eugleno group found continuously during the research period.

Monthly change in the total cell count and diversity of phytoplankton in year 2008-2009 were show in figure-. In year 2008 maximum density was observed in April and minimum in October but in year 2009 maximum in July and minimum in February. In both years maximum algal species diversity was present in February .In year 2008 minimum diversity was present in September month and minimum was found in July (Fig. 5).

#### Statistical analysis

According to the correlation studies in year 2008 (Table 1), Nitrate was highly affected by the meteorological factors. Although, a highly significant negative correlation existed between nitrate and rainfall ( $r = -0.803$ ) but correlation between nitrate and other physicochemical parameter were not statistically significant. A negative correlation ( $r = -0.811$ ) was found between nitrate and surface water temperature.

In year 2009 (Table 1), pH was highly positive correlation with rainfall ( $r = 0.799$ ) and temperature ( $r = 0.865$ ) whereas no other correlation existed between pH and other chemical parameter. Surface water temperature highly positive correlation with pH ( $r = 0.807$ ) and negatively correlation with Nitrate ( $r = -0.811$ ) Total hardness was negatively correlated with DO ( $r = -0.801$ ), whereas no other correlation existed between DO and chemical parameter.

#### DISCUSSION

The climate of Sikar is semi arid to arid type. Summer are hot with temperature reaching nearby 50°C. Winter temperature can drop as low as -1 °C and fog is common during the winter months. The rainfall over Sikar is scanty and is concentrated over four months i.e. June to September. The rains are erratic but agriculture and the animal wealth are totally depended on rain fall to large extent. Algal density was higher in year 2008, in this year the total rainfall was 538.8 mm but in the year 2009 it was just 176.9 mm, it is the main reason for the major difference between phytoplankton diversity and density.

The total phytoplankton population in the Madhav Sagar pond was found to be maximum during summer season, moderate during winter and minimum during monsoon due to rainfall. Similar observations have been reported by Saify et al (1986), Karikal (1995), Sunkad (2002), Hujare (2005), Hulyal and Kaliwal (2009). Temperature is a determine factor in phytoplankton productivity. Beside the temperature, higher pH during summer may be another factor for summer maxima of total phytoplankton density (Hujare, 2005).

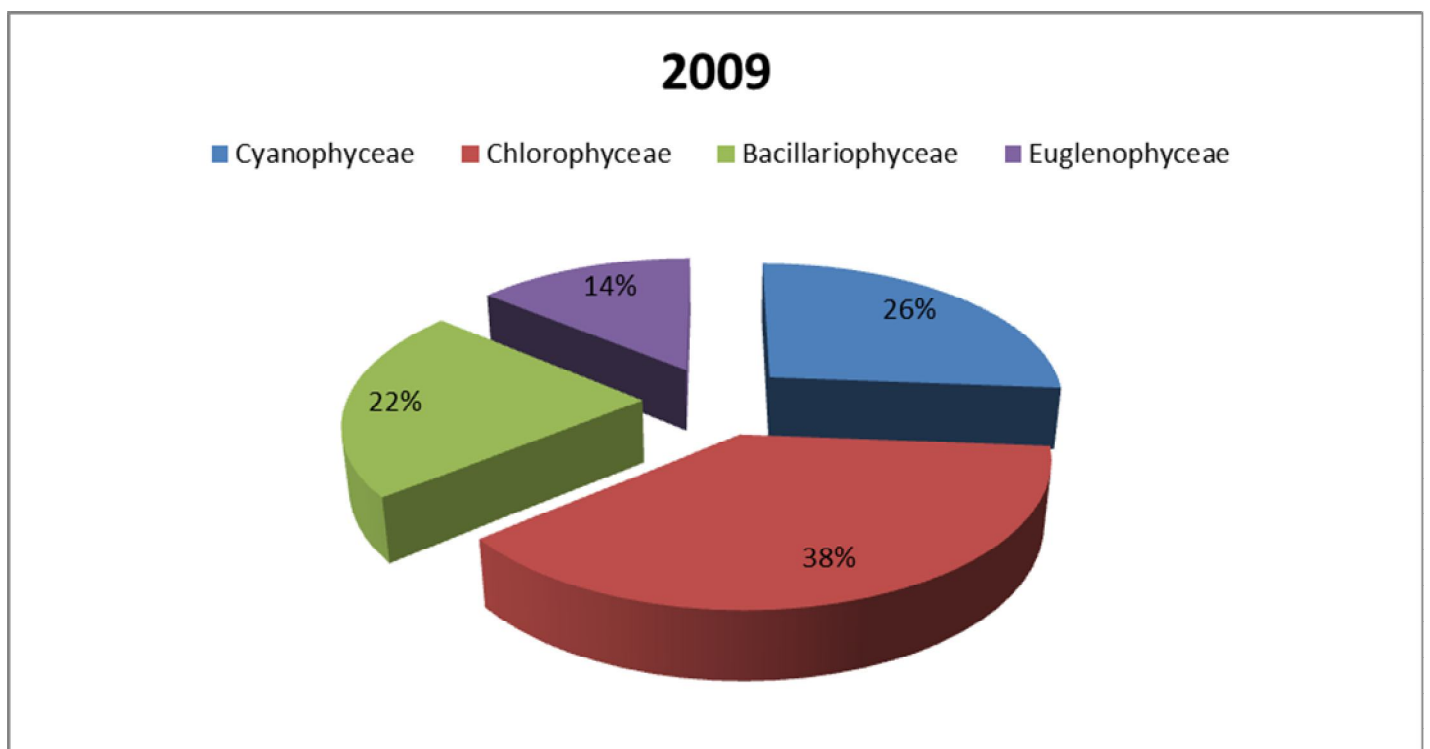
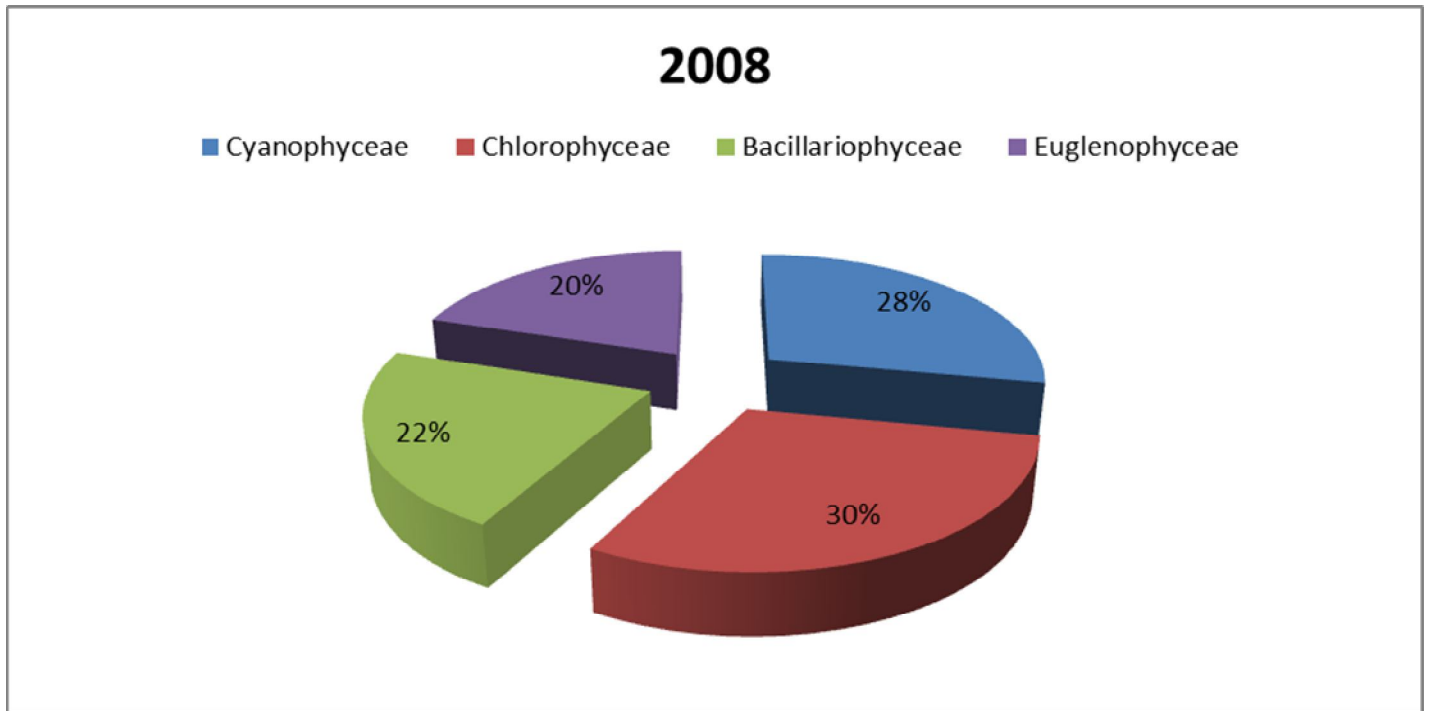
The Madav Sagar pond harbored genera of algae with *Chlorella*, *Microcystis*, *Scenedesmus*, *Navicula*, *Phacus*, *Euglena* whereas *Pinnularia*, *Phacus*, *Euglenoids* were represented as subdominant form. Maximum algal cell number was recorded in February in both years. *Chlorella* was the most dominant organism because of its tolerance to anaerobiosis and extreme temperature according to Hosetti and Patil (1987).

Euglenoids exhibit a great deal of adaptability of varying level of physical environment and nutrients. The important species *Euglena* and *Phacus* were continuously observed during the study period due to oxidisable organic matter in water (Nayak and Khare, 1993). Certain genera like *S. quardicauda*, *E. acus*, *Phacus* and *Merismopedia* prefer water with tendency of self purifier were also found during the study period.

Physical and chemical parameter shows the effect of temperature. High air temperature (42°C - 20°C) changes the climate, directly affecting water and water surface temperature. High temperature of water surface helps in dissolving the organic and inorganic matter. A desirable range of pH between 7.2 – 8.5 shows that water is alkaline and pH increase was due to high temperature, concentration of dissolved organic and inorganic matters and algal flora. The relatively high concentration of Dissolved oxygen recorded in rainy and winter season due to monsoon and low temperature and in summer it was declined due to high temperature, low dissolution of oxygen and high oxidisable organic matter, other workers also find the similar finding (Quasin 1980, Patra and Azadi 1987).

The high concentration of chloride recorded in the summer season could be mainly attributed to high summer temperature which accelerates evaporation. Sodium was present in higher amount in summer season and minimum in winter became of presence of bicarbonate, hydroxide and borate in pond water. Total hardness concentration show the sufficient quantity of blue green algae was available in water increase in calcium increase the production of green algae. Algal blooms were noted at two occasions in 2008, first in the beginning of summer (April) and the second in the post-rainy season (September- October) whereas only in the spring

Fig 6. Composition of phytoplankton population.





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(April) season in 2009. The member of Chlorophyceae especially Chlorella contributed maximum to bloom formed in April 2008 whereas blooms formed in the post-rainy-season were primarily due to Cynophycean members, mainly by Spirulina in 2008 and Merismopedia in 2009.

### Conclusion

This paper investigated the impacts of physical and chemical factors on the water quality of small man made pond in Sikar district. Water quality throughout the study area was acceptable levels, and there was some significantly difference due rainfall between two years.

This study suggests that local and regional processes interact to produce patterns of species density and diversity in fresh water pond ecosystem. pH indicate that water is alkaline. There is considerable need for better understanding of small man made water pond ( Madhav Sagar ) so that they can be managed effectively.

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