Study of greens and nutrients in a pond of the Bikaner (Rajasthan) region of the Thar Desert

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Abstract: The study was conducted at the Thar Desert's Harsholav Pond near Bikaner for fifteen months, over all seasons. This desert region has a shortage of water and hot, semi-arid climatic conditions; thus, this pond was built primarily to supply the drinking needs of humans and animals. Three major nutrients were investigated: nitrates, phosphates, and silicate. The Chlorophyceae (greens) were researched, containing five taxa: Spirogyra, Cladophora, Oedogonium, Coelastrum, and Scenedesmus, with Spirogyra dominating during the study period. Spirogyra population ranged from 100 X 10^3/l (May) to 600 X 10^3/l (September, October). The population peaked during the rainy season and declined throughout the summer. Nitrate, phosphate, and silicate concentrations ranged from 0.006 to 5.8 mg/l.

Keywords: Nitrate, phosphate, silicate, greens, Harsholav Pond, Thar Desert.

I. INTRODUCTION

Freshwater ecosystems have diverse flora, including phytoplankton. Phytoplankton are microscopic floating plants classified into three primary algae groups: Chlorophyceae (greens), Cyanophyceae (blue-greens), and Bacillariophyceae (diatoms). Greens are algae consisting of chlorophyll-bearing phytoplankton taxa. They play an important role in primary production in aquatic ecosystems by converting inorganic carbon into organic compounds. Greens are extremely significant since they are the primary producers and most sensitive aspects of freshwater habitat, sending immediate signs of environmental disturbances or change. The primary productivity of an ecosystem is the rate at which the Sun's radiant energy is stored by the activities (photosynthetic and chemosynthetic) of green plants (primary producers) in the form of organic substances (food). Plant nutrients such as nitrate, phosphate, and silica are required for primary producer growth and development, making them crucial to the entire aquatic environment. Rajasthan is the largest state with the most extreme climatic variances. The Thar Desert, also known as the Great Indian Desert, is characterized by shallow and ephemeral water sources of both natural and man-made origin (village ponds, temple ponds, reservoirs, canal systems, and lakes) that contain saline water and high electrolytes. The study was conducted at Bikaner's Harsholav Pond, which is in Rajasthan's Thar Desert. The Thar Desert region season sees drastic variations in phytoplankton population and nutritional condition.

II. MATERIALS AND METHODS

The research was conducted in Harsholav Pond, which is in the southwest region of Bikaner district. This pond is still as it was created since the Harsh race has faith in it based on religion and ethnicity. The pond's spread area is 400 x 225 feet, and its depth is 16 feet. Many temples can be found along the pond's banks. The hue of the pond water varies according to the season. The pond water appears crystal clear when stable, but the monsoon season makes it murky, and the water afterward turns a turbid green. This hue shift relates to plankton and suspended debris. Throughout the present investigation, the water stayed lush green, which could be attributed to the significant proliferation of phytoplankton, particularly greens (Chlorophycea).

Water samples were drawn straight from Harsholav Pond immediately in 500 mL polythene bottles for phytoplankton analysis. Samples were preserved and stained on the spot using 4% formaldehyde and Lugol's iodine solution before being transported to the laboratory. Samples were examined after one week of sedimentation following[1]&[2]. The quantity of phytoplankton was measured in units of 10^3/l.

Nitrate was tested with the brucine method, phosphate with spectrophotometry, and silicate with the hydrochloric method[3].

III. RESULTS AND DISCUSSION

The plant nutrients nitrates, phosphates, and silicates were calculated. Table 1 and Figure 1 provide monthly values for nitrate, phosphate, and silicate. In Harsholav pond, nitrate levels ranged from 0.09 to 0.30 mg/L. The lowest amount was recorded in the summer month (May), and the most in the monsoon season in September. Phosphates were measured in the range of 0.006mg/l to 0.027mg/l, with an average value of 0.017mg/l, as indicated in Table 1. Low levels were recorded in the winter and summer, while high values were observed during the wet season. Silica concentrations ranged from 1.2 to 5.8mg/l. The value was low in the winter and high during the monsoon season. The high concentration of silica during the monsoon season could be attributed to loose binding in the surrounding ground, which is drained into the pond with rainwater. A water body in a desert location had nitrate levels up to 0.119mg/l, phosphorus from 0.0009 to 0.0103mg/l, and silica from 0.3 to 5.0mg/l[4]. Phosphate levels above 0.5 mg/l indicate water pollution[5]. The present analysis revealed a phosphate value of less than 0.5mg/l, indicating that Harsholav Pond is not a polluted water body. Silica levels ranged from 1.52 to 4.23mg/l, with summer being the highest. The current study found a similar range. In a desert water body, phosphorus levels range from 0.004 to 0.007 mg/l in June, whereas nitrate levels range from 0.066 to 0.1056 mg/l. Greater variations in Silica levels varied from 2.705mg/l to 32.97mg/l, while the lowest values of nitrate levels ranged from 0.002 to 0.013mg/l[7]. Nitrate concentration ranged from 1.425 to 1.570mg/l, phosphorus from 0.0074mg/l to 0.00091mg/l, and silica from 22.823 to 23.47mg/l in Bikaner's canal water[8]. In a desert water pond, low levels of Nitrate (0.118mg/l to 0.739mg/l), Phosphate (0.0003mg/L to 0.0029mg/l), and Silica (1.058 to 4.235mg/l) were detected[9]. Nitrates, phosphates, and silicate concentrations ranged from 0.059 to 1.425 mg/l in three desert water bodies[10]. Consistent nitrogen input and low phosphorus levels promote the growth of algae, particularly green algae[11]. Chemical fertilizers used in farms near water bodies increase nitrate levels in water[12]. The eutrophic water body has a nitrate content between 5mg/l to 50mg/l[13]. Applying this viewpoint to the current study, the Harsholav pond is not an eutrophic water body. Plankton development requires only 0.01mg/l of phosphate[14]. By applying this to the current investigation, the phosphate levels were sufficient for normal plankton growth. The calculated N:P ratio can predict phytoplankton abundance and assemblages, as well as help understand their ecology[15]. Reducing nitrogen and phosphate levels can effectively reduce eutrophication in water bodies[16].

At Harsholav Pond, the Chlorophyceae (greens) population ranged between 500 to 1800 units X 10^3/l. Table 2 and Figure 2 show the population of greens. The population was highest during the monsoon season and lowest during the summer season. Spirogyra was the dominant taxon in the Chlorophyceae population during the study period, followed by Cladophera, Oedogorium, Coelastrum, and Scenedesmus. The population was lowest in the month of May and greatest in September. High temperatures and evaporation throughout the summer restrict phytoplankton growth, which may explain why the Chlorophyceae group has the lowest population in the summer. The highest population was observed during the monsoon season, which might be attributed to low temperatures, low evaporation rates, high water levels, low salinity, and so on. Chlorophyceae is the dominating group at Bikaner's Darbari village pond7. In three water bodies in the Bikaner region, nine phytoplankton taxa were identified, with Chlorophyceae being the dominating group in terms of total population and number of taxa[17]. Six green taxa were found in a desert water body, with concentrations ranging from 1250 units X 10^3/l to 2900 units X 10^3/l.[18]. Seven green taxa were found in desert water bodies, with the highest population during the monsoon season[10]. The lowest number of phytoplankton was seen during the summer season. The Chlorophyceae group dominated in oligotrophic lakes[20]. Harsholav Pond is classified as an oligotrophic water body based on Prescott's observations in this study. High nitrogen levels in water promote the growth of Chlorophyceae, Euglenophyceae, and Cyanophyceae[21]. Greens were dominant at various temperatures[22]. This was also observed in the Harsholav pond during the current study. Phytoplankton population and diversity are influenced by various physical, chemical, and biological factors[23]. In the current study, it was discovered that there was a significant change in the Chlorophyceae population in Harsholav Pond as the seasons changed.

Table 1. Nutrient values of Harsholav Pond, Bikaner (all values are in mg/l)

Months	Monsoon		Winter				Summer				Monsoon				Winter	Avg
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	
Nutrients																
Nitrate	0.28	0.29	0.24	0.16	0.23	0.20	0.28	0.11	0.09	0.29	0.22	0.25	0.30	0.24	0.23	0.22
Phosphate	0.022	0.027	0.020	0.020	0.019	0.024	0.011	0.009	0.007	0.006	0.017	0.022	0.024	0.018	0.016	0.017
Silicate	5.11	4.58	2.82	1.01	1.24	1.02	2.05	2.54	2.11	4.25	4.25	5.22	4.86	4.41	3.66	3.61

Table 2. Chlorophyceae population (units x 10^3/l) at Harsholav Pond of Bikaner

Seasons	Monsoon		Winter				Summer				Monsoon				Winter	Avg
Months	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	
Phytoplankton																
Chlorophyceae																
Spirogyra	600	500	500	400	200	300	300	200	100	-	100	300	500	600	400	333.33
Cladophora	400	300	200	-	100	200	-	100	-	100	200	200	300	-	200	153.33
Oedogonium	300	-	600	500	500	400	200	100	100	200	200	400	500	400	500	326.67
Coelastrum	200	300	-	100	-	200	300	200	200	100	150	300	-	200	300	170
Scenedesmus	300	200	300	200	150	300	100	-	100	150	300	300	400	300	200	220
Total greens	1800	1300	1600	1200	950	1400	900	600	500	550	950	1500	1700	1500	1600	1203.33

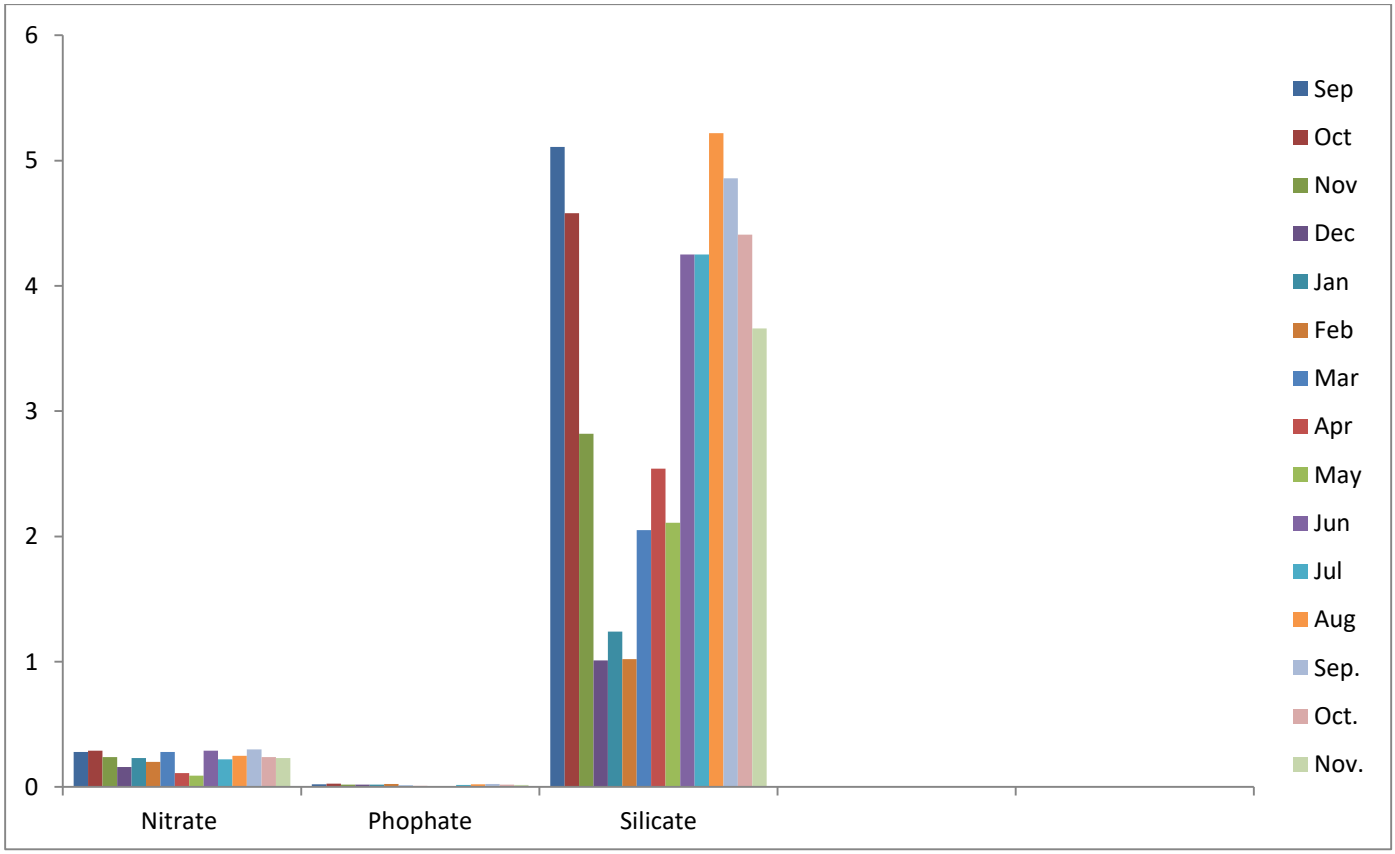

Fig 1. Nutrient status of the water of Harsholav Pond, Bikaner (all values are in mg/l)

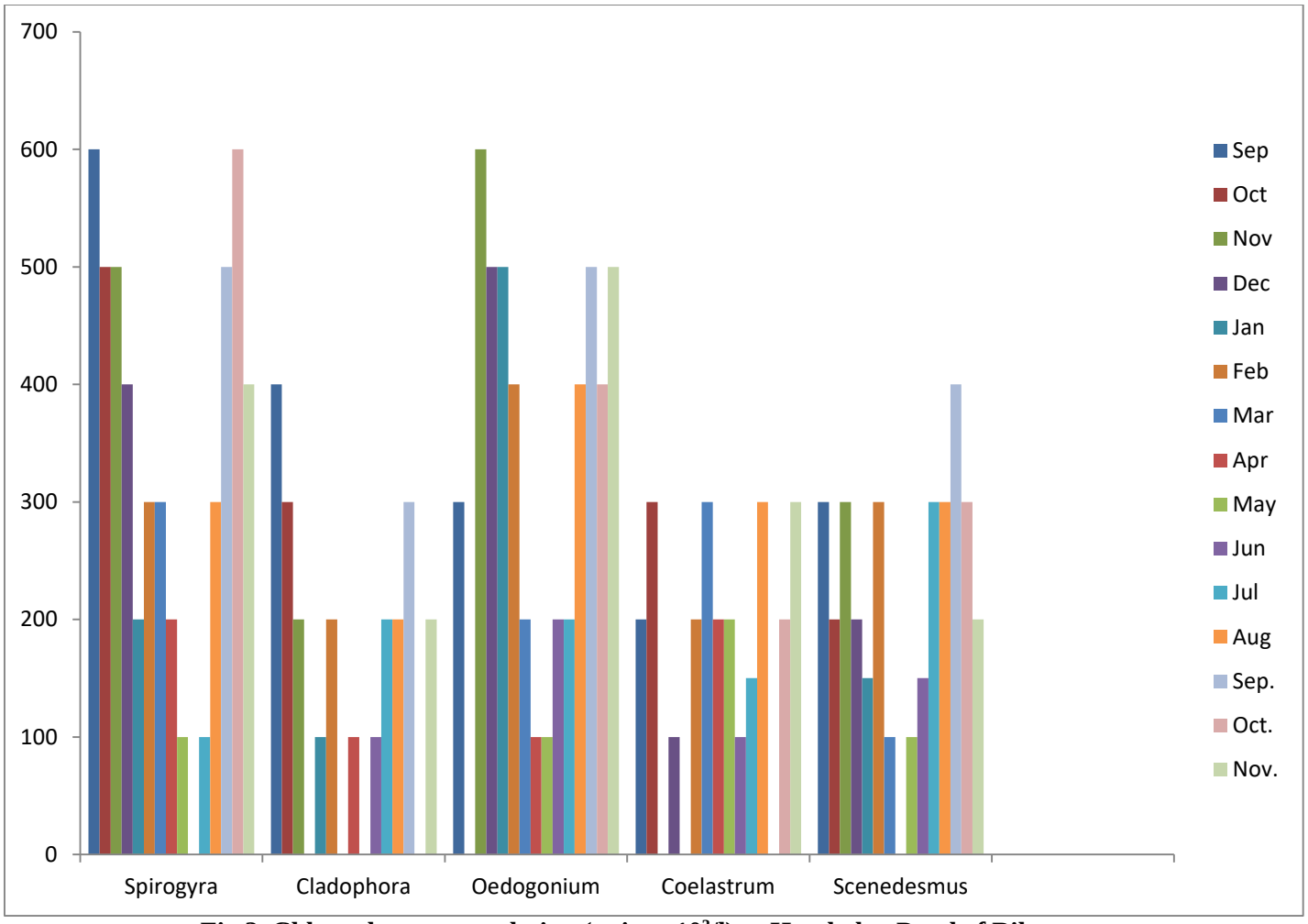

Fig 2. Chlorophyceae population (units x 10^3/l) at Harsholav Pond of Bikaner

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