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PHYSICOCHEMICAL AND PHYTOPLANKTON STATUS OF JANGALI POND IN RANTHAMBHORE FORT, RAJASTHAN, INDIA

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ABSTRACT

Regular monitoring of every water body has become an important environmental concern due to their contamination by human activities and modernization. These days, most of the freshwater bodies all over the world are getting polluted, thereby decreasing the suitability of the freshwater. The present paper deals with the assessment of certain physicochemical parameters and phytoplankton community in surface water samples of Jangali Pond man-made ancient freshwater reservoir located in Ranthambhore Fort in Sawai Madhopur District of Rajasthan State. The water samples were collected from the sampling site for two years study period between November 2014 to October 2016 on a monthly basis and the seasonal data were evaluated. The results show fluctuations in the values of different physicochemical parameters in each season of both the sampling years. However, the values of most parameters were recorded higher in summer season except for the pH and dissolved oxygen which found slight higher in winter season, while fluoride and alkalinity were

noted highest in the rainy season. A total of 17 genera and 26 species belonging to four classes of algae have been accounted with Chlorophyceae 10 species, Cyanophyceae 10 species, Euglenophyceae 4 species and Bacillariophyceae 2 species. Seasonal variation with regard to the presence of various phytoplankton species has been observed. The majority of phytoplankton species were found to be abundant during the summer season where values of most physicochemical factors were also higher. The pollution tolerant species observed throughout the study period were *Oscillatoria sp,Closterium sp,Microcystis sp,Nostoc sp, Pediastrum sp and Euglena sp.*These species are good indicators of water pollution.

Key Words: Phytoplankton, Rani Sagar Pond, Ranthambhore Fort, Water quality assessment

INTRODUCTION

Water is a life-supporting factor of ecosystem, every cell (microcosm), individual organism and cosmos required water for their life.During the recent past, many studies on microscopic forms of algae (phytoplankton) have been highlighted their important role in monitoring the human-modified aquatic ecosystems. Phytoplankton, also regarded as biological indicator organisms, is essential component of any aquatic habitat and their presence are good source for the assessment of water quality[1]. The water quality assessment invades the analysis of both physicochemical and biological characters of water and it reflect the biotic and abiotic status of an ecosystem. Aquatic organisms need a healthy environment to live and they require adequate nutrients for their growth and development, the productivity depends on the unique physicochemical properties of the water. The changes in hydrological condition of water considered as ecological indicators are being used to estimate the status of water pollution[2]

Stagnant water bodies like Ponds, Dams and Lakes etc. have an ecology that is more complicated and delicate than running water bodies, since they lack the capacity to self-clean and hence collect more populations easily. Increased anthropogenic activities have affected the fragile aquatic system and, consequently, physicochemical characteristics of water in and around these water bodies.. Increased anthropogenic activities have affected the fragile aquatic system and, consequently, physicochemical characteristics of water in and around these water bodies.Day-by-day, the water pollution is becoming a serious problem. Water pollution is enhancing due to increase in human population, urbanization, industrialization, development of new technologies, excess use of fertilizers etc. This problem is resulting turbidity (cloudiness) in water and rich growth of diversified phytoplankton which render the water unfit for use[3]. Furthermore, the loss of fauna, flora and ecosystem of freshwater could have significant impacts on our identity, wellbeing, cultural values and economy[4].

A study in phytoplankton are very valuable tools for the quality and productivity assessment of water in any water body and play a important role in maintaining an aquatic ecosytem and form the base of food chain.[5]

During the recent past, many studies on microscopic forms of algae (phytoplankton) have been highlighted their important role in monitoring the human-modified aquatic ecosystems. Phytoplankton's, also regarded as biological indicator organisms, are essential component of any aquatic habitat and their presence are good source for the assessment of water quality. The productivity of an aquatic system is directly dependent on phytoplanktons, which are tiny free-floating algae colonies found in water bodies. Phytoplankton also affect water properties (such as colour,odor,and chemical composition) which may cause potential hazard for human and animal health.[6] The drinking water is sometimes rendered unfit for use owing to the presence of Myxophyceae, Diatoms, etc. Temperature, pH, turbidity, nutrients, hardness, alkalinity, BOD, DO etc. are some of the important hydrological factors that determine the growth of living organism in several freshwater bodies[7]. In the last three decades, a number of authors have studied the occurrence and range of algal flora in relation

to physicochemical properties of polluted as well as non-polluted freshwater bodies across the world[8-17]. Several of these reports also emphasized the seasonal distribution of phytoplankton community[14-17].The Ranthambhore fort is a well-known fort in the Southeastern Rajasthan. It has marvelous architectural monuments, ponds and lakes enlighten avid lovers. Every part of the fort reflects the ancient character of Indian culture and philosophy. Many people around the world visit the fort throughout the year. In the fort,Padmala Pond, Rani Sagar Pond and Jangali Pond is the major freshwater bodies and a regular source of water for drinking, washing, bathing and other activities of the local inhabitants and pilgrims. The local people of fort ,Shopkeepers,take water either directly from the pond or nearby water-wells. Since last two decades, daily human activities resulting into pollution of water with visible growth of water blooms and hydrophytes in the pond. This situation may cause a serious problem for future use of water.Since last two decades, daily human activities resulting into pollution of water with visible growth of water blooms and hydrophytes in the pond. This situation may cause a serious problem for future use of water. Thus, these freshwater pond has been selected for the present study with regard to the assessment of water quality and phytoplankton community and further to know the current status of water pollution.

Material and Methods Investigation area

Sawai Madhopur is the gateway to the world renowned Ranthambhore (also Ranthambore) National Park (http://www.ranthambhorenationalpark.com) in district Sawai Madhopur (Rajasthan).The Ranthambhore fort, a famous place of historical importance, is situated 14 km away from Sawai Madhopur, located 76˚28' East longitude and 26˚2' North

latitude, which is surrounded by the Vindhyas and Aravalli hills of the desert ecology of Rajasthan state. Ranthambhore National Park (RNP) is derived its name from the fort situated within its precincts. This park is one of the best parks in the country for observing and photographing the activities of tigers by the visitors of all around the world. Ranthambhore fort is part of World Heritage site under the category hill forts of Rajasthan, which is situated near Sawai Madhopur town in Rajasthan.(Fig-1(a). Ranthambhore Fort lies within the RNP. Ranthambhore Fort is located 5 km inside the park on a hill top.The area of fort amidst vast and arid ecosystem having summer temperature (maximum 37°C, minimum 23°C), winter temperature (maximum 29°C, minimum 9°C), relative humidity 67.17%, average rain fall 680 mm annually and monsoon period from July to September. *Anogeissus pendula*, *Butea monosperma, Ziziphus mauritiana* are some of the dominant tree species of this area. From various places of historical interest inside the fort, the 'Trinetra Ganesh temple' is a major attraction of the fort where millions of people come from every corner of the country to seek blessing for happiness and prosperity.

There are five ancient artificial (man-made) water-bodies situated in and around the Ranthambhore fort. These are Padmala Pond, Rani Sagar Pond, Jangali Pond, Sukh Sagar Pond and Bada Sagar Pond. All these ponds are located within the area of about 4 sq. km in and around the fort area. Some of these ponds are the major source of water for inhabitants living in the fort.

Few distance from the Ganesh Temple, on the way of Gupt ganga, Jangali Pond (also called Jangali Talab) was developed as an extremely effective water harvesting region which was made to flow through a channel of hard, impermeable rock, ultimateley flowing into Jangali Pond (Fig-1(b).

This freshwater pond has been selected for the present study with regard to the assessment of water quality and phytoplankton community and further to know the current.

Sample collection

A systematic survey for sample collection, identification of phytoplankton and the physicochecal properties of water was done for a period of two years between November, 2014 to October, 2016. The surface water samples were collected in the clean sampling bottles (plastic, one liter capacity) manually on a monthly basis. Every water sample was taken during the morning time (between 9-10 am) in every first week of each month and photography was done to see the actual view of the pond. Every month, samples were taken from the sampling site approximately 6-8 feet away from bank of the pond with the help of a bamboo stick. Physical factors like water temperature and pH was recorded at the site. The water samples were brought to laboratory for estimation of certain physicochemical parameters according to the standard methods[18]. The samples for algal forms were collected through the phytoplankton-net and stored in separate bottles. Algal samples were also brought to the laboratory for microscopic examinations as reported earlier[16]. Most of the algal samples were analyzed fresh as far as possible while some amount of the samples were preserved in 4% formalin for further study. Various forms of algae were seen with the help of Japan make mirror type microscope and Camera Lucida and were drawn by HB pencil. The taxonomic identification of phytoplankton species was done with the reference of standard monographs and books[19-23].

Statistical analysis Data for physicochemical parameters and algal community were recorded as the mean and standard deviation (Mean ± S.D.). Statistical analysis of data was carried out using Excel analysis ToolPak (MS Office). The quantitative measurements of algae were performed as reported earlier[16]

Figure.,1(a)- A view of Ranthambhore Fort

Fig.,1(b)- A view of Jangali Pond (Sampling Site)

RESULTS AND DISCUSSION

The present study was carried out for two subsequent years i.e. from October 2014 to November 2016. The monthly data on certain physicochemical parameters and possible phytoplankton population were observed in the surface water samples of Padmala Pond, Rani Sagar Pond and Jangali pond is located in the Ranthambhore fort in Sawai Madhopur (Rajasthan). The data of both the study years were

evaluated seasonally (summer, rainy and winter). The recorded data on physiochemical parameters were given in Table 1, the data on seasonal diversity of Phytoplankton were represented in Table 2, and the Camera Lucida diagram of various forms of phytoplankton observed in the current study were given in Figure Plates 1 and 2.

Physicochemical characteristics

A total of thirteen physicochemical parameters of water were analyzed, these were temperature, pH, Chemical oxygen demand (COD), Biological oxygen demand (BOD), Dissolved oxygen (DO), Chloride, Calcium, Fluoride, Total alkalinity, Total hardness, Total dissolved solids (TDS), Nitrate and Phosphate **(Table-1)**. The results show fluctuations in the values of physicochemical parameters in different seasons in both the sampling years which could be due to variation in climatic condition[24]. The mean value of most of the parameters was observed greater in summer season The higher values of DO in winter may be due to higher solubility of oxygen at relatively lower temperature and also by the circulation and mixing of water due to surface runoff in monsoon[25]. Fluoride and total alkalinity contents were noted higher in the rainy season (July to October) with highest alkalinity in both the years. TDS, nitrate and phosphate values were recorded maximum in summer season (Table 1). The ranges of water temperature were varied, noted minimum (17^0C) in winter season and maximum (36^0C) in summer which may be due to the seasonal variation of sunshine and rain[24]. The high temperature resulted in the decrease of water level, promoted high rate of organic decomposition and huge growth of hydrophytes as described[26]. In India, the temperature is quite high during dry pre-monsoon season but with the advent of the southwest monsoon water temperature reaches its lowest value in Auguest[27]. Among the physicochemical parameters of water, temperature was found to play a crucial role in determining the diversity, productivity and periodicity of the algal flora. The concentration of different ranges of nitrate gives a useful indication of pollution in water and thus has the ability to support phytoplankton growth. The pH values indicate the slight alkaline nature of water. pH

is one of the most important and single factor which influences the production of aquatic organisms[28]. Limits of the majority of analyzed parameters were observed almost within the range of required and permissible limits as prescribed by Indian standards[29, 30] except for the phosphate and DO values. The higher contents of phosphate (1.5 mg/l) and low levels of DO (1.5 mg/l) were recorded in summer season. Low DO assign of organic pollution, it's also due to inorganic reductions and other waste materials[11, 13]. The values of hardness show moderate-hard to hard nature of pond water in all seasons. In general, the hardness of water may be temporary or permanent while the presence of phosphate is in lower amount.The results of both the study years regarding monthly, seasonal and annual variation of physicochemical parameters of the ponds have been shown in the graphical diagrams **(Plates -9)**.

Phytoplankton diversity

Seasonal variation with regard to the presence of various phytoplankton species has been observed (**Table-2**).The visible water blooms and the majority of phytoplankton community were found to be abundant during the summer season (March to June) where values of most of the physicochemical factors were also higher, such findings were also observed by several workers[11-17]. Higher quantity of Ca (38 - 32 mg/l) (Table 1) in summer have been shown to promote the growth of all genera of green algae and most of the members of blue-green algae observed similarly as investigated[13].In the present study period in Jangali Pond, a total of 17 genera and 26 species were found which belonging to Cyanophyceae (10 species), Chlorophyceae (10 species), Euglenophyceae (2 species) and Bacillariophyceae (4 species) were observed. The major presence of the members of Chlorophyceae and Cyanophyceae was dominant in summer thereafter decreased in rainy and winter seasons. While all species of Euglenophyceae and Bacillariophyceae attain maximum development during winter months

than in rainy and lowest in summer season as also observed previously[16]. In summer months, the water level declines while in the rainy month's water level increases and become turbid. Several previous studies also showed that the winter months are more favorable for maximum development of diatoms[16, 17]. The species of diatoms grow richly during high value of pH, high DO, low quantity of phosphate and low temperature. The occurrence and massive growth of phytoplankton in water bodies depends not only on physical factors (light, temperature and pH) but also on the chemical load which affects species composition[10].Cyanophyceae was representing with 6 genera (*Oscillatoria, Lyngbya*, *Phormidium*, *Spirullina*, *Microcystis* and *Nostoc*) and 10 species and Chorophyceae represented 6 genera with 10 species (Chlorococcales, Zygnematales Oedogonales) and Euglenophyceae represents only one order Euglenales while Bacillariophyceae class represents two orders Centrales and Pennales during the study period.

Table 1. Physicochemical parameters of water samples of Jangali Pond, Ranthambhore fort in district Sawai Madhopur, Rajasthan .(Nov 2014-Oct 2016)

Parameter	Winter Season					Summer Season					Rainy Season					Annual Mean±SD
	Nov	Dec	Jan	Feb	Mean±SD	Mar	Apr	May	June	Mean±SD	July	Aug	Sept	Oct	Mean±SD	
Temp (°C)	20	18	**17**	18	18.25±1.26	22	28	32	**36**	29.50±5.97	30	26	24	22	25.50±3.42	24.42±2.36
pH	7.6	7.8	**8.1**	7.8	7.83±0.21	7.5	7.3	7.2	7.9	7.50±0.31	**7.1**	7.4	7.7	7.5	7.43±0.25	7.54±0.08
COD	42	**25**	30	50	36.75±11.35	187	180	186	**190**	185.80±4.19	170	160	85	65	120±52.76	114.17±26.22
BOD	5	2.1	2.5	**1**	2.65±1.69	4	4.5	**10**	8	6.63±2.87	4	4.2	1.2	2	2.85±1.48	4.04±0.75
DO	**6.5**	5.5	5.7	4.5	5.55±0.82	2.5	**1.5**	1.6	2	1.80±0.57	2.5	3	5.2	6	4.18±1.69	3.84±0.59
Chloride	34	**32**	36	40	35.50±3.42	55	45	50	**60**	52.50±6.45	58	55	52	52	54.25±2.87	47.42±1.93
Calcium	28	30	26	20	26±4.32	18	26	**38**	31	26.80±6.40	**16**	17	22.5	25	20.13±4.33	24.29±1.20

Fluoride	0.2	0.1	0.1	**0.01**	0.10±0.08	0.7	**0.8**	**0.8**	0.7	0.80±0.06	0.5	0.1	0.4	0.3	0.33±0.17	0.39±0.06
Alkalinity	160	123	105	**102**	122.50±26.66	130	140	145	160	143.80±12.50	170	172	**185**	168	173.75±7.68	146.67±9.87
TH	88	98	105	115	101.50±11.39	110	**125**	102	90	106.80±14.68	84	78	**66**	78	76.50±7.55	94.92±3.57
TDS	240	255	280	290	266.25±22.87	280	300	310	**325**	303.80±18.87	225	205	190	**188**	202.±17.11	257.33±2.95
Nitrate	6.2	7	8.2	9	7.60±1.24	**13**	10	8	6	9.30±2.99	6.5	8	6.5	**3.2**	6.05±2.03	7.63±0.87
Phosphate	0.2	0.4	0.25	0.3	0.29±0.09	0.2	**0.1**	**1.5**	1	0.70±0.67	0.8	0.6	0.2	**0.1**	0.43±0.33	0.47±0.29

All values are in mg/l except the values of temperature and p

Table 2: Monthly and seasonal variation of phytoplankton species in Jangali Pond situated in Ranthambhore Fort, Sawai Madhopur (Rajasthan): November, 2014 to October, 2016

S. No.	Algal Forms	Winter Season				Summer Season				Rainy Season			
		Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct
	Cyanophyceae												
1	*Phormidium retzii*	-	-	+	+	+	-	+	+	-	-	-	-
2	*Microcystis flos-aquae*	+	-	-	-	+	+	+	+	-	-	-	-
3	*Spirullina* sp.	-	-	-	-	+	+	-	+	-	+	-	-
4	*Nostoc muscorum*	-	-	-	+	+	-	+	+	+	-	-	+
5	*N. passerinianum*	-	-	-	-	+	+	-	+	+	-	-	-
6	*N. punctiforme*	-	-	+	+	+	-	+	+	+	-	-	+
7	*Oscillatoria proteus*	-	-	-	-	+	+	+	+	+	-	+	-
8	*O. limosa*	-	+	+	+	+	+	+	+	-	-	-	-
9	*Lyngbya aestuarii*	-	-	-	-	+	+	+	+	-	-	-	-
10	*L. hieronymusii*	-	-	-	-	+	+	+	+	-	-	-	-
	Chlorophyceae												
1	*Chlorella vulgaris*	+	+	-	+	+	+	+	+	+	-	-	+
2	*Closterium dinae*	-	-	-	-	-	+	+	+	+	-	-	+

S. No.	Algal Forms	Winter Season				Summer Season				Rainy Season			
		Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct
3	*Oedogonium curtum*	-	-	-	-	+	+	+	+	+	-	+	-

Summer (March-June), Rainy (July-October), Winter (November-February); Present (+), Absent (-), Rare (±)

S. No.	Algal Forms	Winter Season				Summer Season				Rainy Season			
		Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct
4	*Spirogyra jungalis*	-	-	-	-	+	+	+	+	+	-	+	+
5	*S. punctulata*	-	-	-	-	+	-	+	+	+	-	-	-
6	*Pediastrum tetras*	-	+	+	+	+	-	+	+	+	-	-	-
7	*P. simplex*	+	-	+	+	+	-	+	+	-	-	-	-
8	*P. duplex*	+	+	+	+	-	-	-	-	-	-	-	-
9	*Scenedesmus dimorphus*	-	-	+	-	+	+	+	+	-	-	-	-
10	*S. quadricauda*	+	-	-	+	+	+	+	+	+	-	+	+
	Euglenophyceae												
1	*Euglena acus*	-	-	-	+	+	+	+	+	+	-	-	-
2	*E. spirogyra*	-	-	+	+	-	+	+	+	-	-	-	-
	Bacillariophyceae												
1	*Synedra ulna*	+	+	+	+	-	-	+	-	-	-	-	+
2	*Nitzschia palea*	+	+	+	+	-	-	-	-	-	-	-	-
3	*Pinnularia major*	+	+	+	+	-	-	-	-	-	-	-	-
4	*Cyclotella* sp.	+	+	+	+	-	-	-	-	-	-	-	+

Summer (March-June), Rainy (July-October), Winter (November-February); Present (+), Absent (-), Rare (±)

PLATE - 9

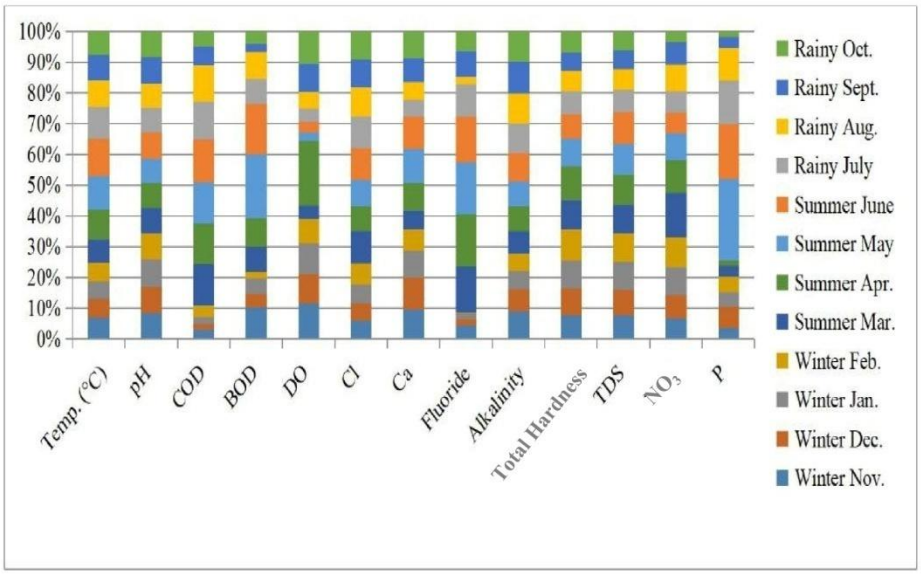

Figure 1. Monthly, seasonal and annual variation of physicochemical parameters in Jangali Pond (November, 2014 to October, 2015).

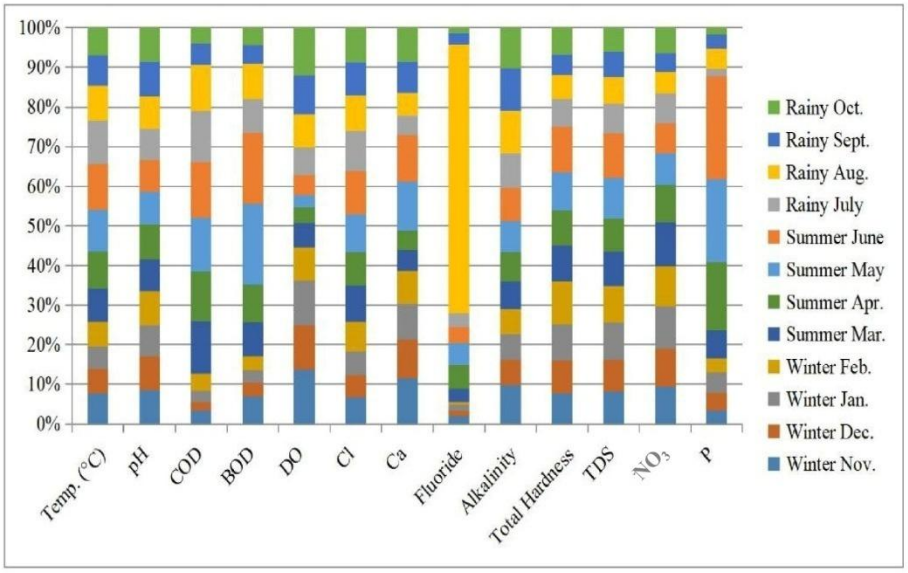

Figure 2. Monthly, seasonal and annual variation of physicochemical parameters in Jangali Pond (November, 2015 to October, 2016).

CONCLUSIONS

The recorded values of thirteen physicochemical parameters of water show fluctuations in different seasons, but the values of most of the parameters were found higher in summer season except for the pH and DO values which found slight higher in winter season. The results also show variation in both the sampling years. Fluoride and total alkalinity contents were noted higher in the rainy season. Limits of the analyzed parameters were observed almost within the range of required and permissible limits of Indian standards except phosphate (higher) and DO levels (low) in summer. The values of hardness show moderate-hard to hard nature of water. Seasonal variation regarding the presence of various phytoplankton species has been observed in both the study years. The majority of phytoplankton taxa were found to be profuse during the summer season where values of most physicochemical factors were also higher. The summer and rainy months were more favorable for the proliferation of water blooms with dominant presence of Chlorophyceae and Cyanophyceae members. On the other hand, the members of Euglenophyceae and Bacillariophyceae were abundant in winter season.*Oscillatoria sp,Closterium sp,Microcystis sp,Nostoc sp, Pediastrum sp and Euglena sp. Etc* species are good indicators of water pollution.

These species are highly sensitive to pollution and thus recognized as good indicator of water pollution. This situation depicted a moderate level of pollution in the Rani Sagar pond. We conclude that adequate knowledge of phytoplankton is necessary for proper utilization of any water resource.

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