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ANALYSIS OF WATER QUALITY OF PANIYALA STATE FISH POND WITH SPECIAL REFERENCE TO PHYSICO-CHEMICAL CHARACTERISTICS

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ABSTRACT

Ponds are one of the major source water in the rural India. They can contain water throughout the year or they can be seasonal, holding water for only part of the year. Many plants and animals live in the water or at the water's edge or use ponds at a stage of their life cycle also provide a source of water for live stock. Paniyala State Fish Pond is one of the major pond of fisheries department of Roorkee city in Haridwar Distt. with such importance it is necessary to regularly monitor the different limnological aspects. In the present study, various physico-chemical parameters were studied and on the basis of findings it is found that the water quality of pond is suitable for the fish culture.

INTRODUCTION

Freshwater is one of the scare natural resources and its conservation is assuming greater and greater significance due to ever increasing demand of water for drinking, irrigation and aquaculture. Freshwater bodies are very essential for the existence of ecosystem contributing immensely in shaping and evolving the biotic and abiotic systems. The fresh water bodies can be classified into two categories viz. running water (Lotic) and standing water (Lentic). Reservoirs, Ponds, Lakes and Swamps come under second category; these are very useful for different activities besides drinking water sources. Ponds and reservoirs containing fresh water are used for fish culture, aquaculture, navigation and transport, recreation, irrigation hydropower generation and a host of such other purposes.

Over exploitation of these water bodies due to civilization have been causing deterioration of water quality. It is quite essential that the natural environment of the water body should be conducive to the extent that water should be used for drinking purpose; therefore besides considering limnological status, it is essential to monitor the quality of water. As water resource become more limited and waste discharge becomes increasingly problematic, the concept of water reuse is becoming important (Buckley *et al.*, 2000). The global consumption of water is doubling every 20 yrs, more than twice the rate of human population growth. According to the United Nations, more than one billion people already lack access to fresh drinking water. If the current trend persists by 2025 the demand for fresh water is expected to rise by 56% above the amount of water that is currently available.

Ponds are small (1.00 m^2 to about 5.00 ha), man-made or natural shallow water bodies which permanently or temporarily hold water. They are numerous, typically outnumbering larger lakes by a ratio of about 100.00 to 1.00 (Oertli *et al.*, 2005), and occur in virtually all terrestrial environments, from polar deserts to tropical rainforests. Ponds are vital for a wide range of rare and endangered species. In countries where data are available, high concentrations of Red Data Book species are always found in ponds. Rare species are not only associated with the wet areas of ponds, but with the semi-aquatic margins.

Pond ecology is best described as the interaction of the life in pond with the environment that exists there. A shallow, nutrient-rich pond exposed to sunlight with little water flowing through it will be teeming with algae and aquatic plants. It may have very little animal life present because of low oxygen levels. In contrast, a newly created, deep, spring-fed pond may have little life of any kind in it because of low temperatures and lack of food supply. Essential for the conservation of pond biodiversity is a good knowledge of its threats. Land use practices in the surroundings of ponds may, to an important extent, affect pond characteristics through a diversity of processes that play at the scale of the pond catchment (e.g. nutrient loading, increased erosion, pesticide contamination).

Aquatic life is influenced directly or indirectly by the physical, chemical and biological factors. Fluctuation in any one of the factors may create an adverse environment to the organisms, affecting their growth and life phenomena. All the hydrobiologists have given their attention towards it. The physico-chemical characteristics of any aquatic ecosystem and the nature and distribution of its biota are directly related to and influenced by each other and controlled by a multiplicity of natural regulatory mechanisms. However, because of men's exploitation of the water resources, the normal dynamic balance in the aquatic ecosystem is continuously disturbed, and often results in each dramatic response as depletion of fauna and flora, fish kill, change in physico-chemical characteristics etc. Artificial changes which lead to such ecological responses are referred to as pollution and pollutional stage may reach a stage when these valuable aquatic resources are no longer safe for human use.

Evaluation of water requirement is essential for all human activities, ranging from drinking to agricultural production and industrial development to all forms of large- scale energy generation. Accordingly, as the total global population increases, so do the aggregated human activities, which would increase water requirements (Biswas, 1998). This contributes to two contradictory trends, which further complicate the water-management process. On one hand a country's water requirements steadily increase with higher levels of human activities: on the other hand per capita water available declines steadily since the total amount of freshwater available is limited.

The study of physico-chemical conditions and their relationships with the flora and fauna in lakes, reservoirs and ponds is of great importance for the productivity of pertinacious food such as the fish etc. The morphological features of a lake basin that decisively affect the physico-chemical characteristics and productivity of the water bodies, still remains a neglected area of limnology in the Indian context. Physico-chemical characteristics are the most influencing parameters, which affect the life in water. Fluctuations in these constituents create an adverse environment to organisms and reduce their ability to compete with other population within the environment. The erosion and siltation has reduced the water holding capacity of pond and lakes and if they are not checked in time, the pond may be converted into a shallow lake. Turbidity caused by suspended silt (deposited silt), reduces photosynthesis which affects the food chain. Existing physico-chemical characteristics of the water are conductive to life of organisms. Depth, temperature, turbidity and light constitute the most important physical parameter on which the productivity of ponds depends. Turbidity caused by suspended silt significantly reduces photosynthesis, which affect the food chain. The eroded soil and other materials, which contain leachable nitrogen, phosphorus, sulphur and trace elements become the source of nutrients, which leads to eutrophication of the water body.

MATERIALS AND METHODS

The analysis of the samples was done with the standard methods of APHA (2005) and Khanna and Bhutiani (2008). The collection of samples was done during morning between 7.30 A.M. to 9. 30. A.M. Some of the parameters like pH and temperature are analyzed at the sampling site itself, remaining Turbidity, Total Solid, Conductivity, DO, BOD, COD, Total Alkalinity, Free CO_2, Calcium Hardness, Magnesium Hardness and Chlorides are in the laboratory.

RESULTS AND DISCUSSION

The observation recorded in the present study for the different parameters are giver in Table 1 and Table 2 and are graphically presented in Fig. 1 to Fig. 12.

Water temperature is one of the most important ecological factors which control physiological behaviour and distribution. In the present study of Paniyala State Fish Pond the maximum temperature was observed in the year 2008-2009 with 29.70 °C ± 2.75 in the May month and the minimum value of the temperature was observed in the December month of first year of study (2007-2008) with 17.63 °C ± 3.66. Hutchinson (1957) reported that shallow water in influenced considerably by meteorological factors, such as air temperature and wind. During the present investigation, water temperature followed more or less similar trend as that of atmospheric temperature. These results are well in agreement with those of Kaur *et al.* (1995). The annual mean value of year 2007-2008 was 25.73 °C ± 4.33 and of year 2008-2009 was 25.66 °C ± 4.09.

Conductivity determines the total amount of ionisable salts in water. It is due to ionization of dissolved inorganic solids. Seasonal fluctuations in this factor were caused mainly by variations in the ionic precipitations and diluting effect of rains (Welch, 1948). Conductivity is an important factor for detecting fish community structure and plays a vital role in the productivity of aquatic ecosystem, also opinioned by Kaul (1983). During the study of Paniyala State Fish Pond the conductivity fluctuation was found maximum in November month of 2007-2008 with 93.50 µmhos/cm^2 ±

5.51 and minimum with 37.50 µmhos/cm^2 ± 2.97 in May month of 2008-2009. Bhatt *et al.* (1999) observed the conductivity between 27 to 411 ìmhos/cm for Taudha lake. The annual average of conductivity for the year 2007-2008 was 58.08 µmhos/cm^2 ± 9.87 and for the year 2008-2009 was 56.19 µmhos/cm^2 ± 7.17.

Water of pond is found turbid throughout the year but goes highest in monsoon and recorded 140.80 JTU ± 5.64 in August and lowest in November with 18.75 JTU ± 3.78 in the same year (2007-2008). The turbidity of the water is actually the expression of optical property in which the light is scattered by the particles present in water. It is caused by the substances which are not present in the form of solution. Turbid water can adversely affect fish population by preventing successful development of fish eggs and larvae and by reducing the abundance of food available to fish. The annual mean value of turbidity for the first year of study was 61.94 JTU ± 6.66 and in second year it was 68.18 JTU ± 8.59. In a study in similar lines Sakthivel and Shingdia (2001) observed rise in turbidity and total solids, post Durga pooja and idol immersion along silver beach in Mumbai. In summer and winter season, turbidity was found to be comparatively low. Bilgrami and Duttamunshi (1985) observed minimum values of turbidity in winter and summer seasons, while maximum in monsoon period. The turbidity and total solids were observed to be closely and directly related to each other, as also reported by Verma *et al.* (1984) and Khanna (1993). The water is generally clean in other season with lowest turbidity in winters. The quantity of total solid was also found highest in monsoon season i.e. in July with 811.67 mg/l ± 5.35 and lowest in winters (January) with 73.35 mg/l ± 3.70 in the same year 2008-2009

Low pH also interferes with oxygen uptake, and pH outside range of 4.00 to 10.00 can kill fish (Mathew, 1998). The water of pond was found to be slightly alkaline during the course of study. The maximum value of pH was recorded in April month of 2008-2009 with 8.37 ± 1.08 and lowest was also recorded in the same year with 7.73 ± 0.25 in August month. Similar trend have been reported by Badola (1979). However, in contrast to this, Khanna and Chugh (2004) observed higher pH value in winter season at Bhimgoda. Khanna (1993) also reported higher pH values in winter and less in rainy season. The annual average of the year 2007-2008 was 8.17 ± 0.16 and of the year 2008-2009 was 8.18 ± 0.20.

Lower oxygen content during summer season may be due to high temperature and decay of macrovegetation. Decomposition of organic matter goes on faster in warm than in cold season (Welch, 1948) which may result in depletion of oxygen in summer. Singh (1965) also reported the high value of oxygen in winter due to the greater solubility of oxygen in water at lower temperature. The dissolved oxygen level in the pond was found highest in the January month of 2007-2008 with 8.13 mg/l ± 3.30 and was lowest was 5.13 mg/l ± 2.39 in the may month of same year. Kaushik and Saxena (1999) have reported high values of DO in monsoon season in the water bodies of central India and attributed it to circulating and ingressing rainwater into these water bodies. The annual mean value in 2007-2008 was 6.59 mg/l ± 1.33 and for the second year 2008-2009 was 6.64 mg/l ± 0.37.

The oxygen consumed by organisms is proportional to the magnitude of organic matter present in water. BOD is lower in unpolluted water while it is high in case of polluted water (Hynes, 1960). The BOD is direct measure of biodegradable organic matter. It is an indicator parameter to know the presence of biodegradable matter in the wastes and express degree of contamination. The BOD concentration in the pond was recorded highest in the June month of 2008-2009 with 4.73 mg/l ± 1.91 and was minimum in the December month of 2007-2008 with 2.83 mg/l ± 0.80. BOD showed a significant positive correlation with temperature. Rise in temperature increases the values of BOD as also have been reported by Gambhir (1999) in Maithon reservoir. A negative correlation has been observed between BOD and DO contents. A similar pattern has been reported by Khanna (1993), Chugh (2000). The annual average of 2007-2008 year was 3.71 mg/l ± 0.64 and of 2008-2009 was 3.77 mg/l ± 0.59.

In chemically polluted water due to the presence of toxicants/ chemicals in which microbacterial degradation is not possible, BOD cannot be determined accurately. In such water degree of organic pollution can be assessed by chemical oxygen demand (COD). COD determines the amount of oxygen required for chemical oxidation of organic matter using a strong chemical oxidant. The COD level was found maximum in the June month of 2008-2009 with 11.73 mg/l ± 2.20 and minimum was recorded with 8.73 mg/l ± 1.75 in the November month of same month. Higher values in monsoon may be due to inflow of dead organic matter. Minimum COD in winter is due to settlement effect. Kudesia *et al.* (1986) also observed similar trend. Higher values of COD indicate the higher microbial activities and presence of oxidizable organic matter. Khulbe and Durgapal (1993) have also reported similar findings. The annual mean value of first year of study was 10.42 mg/l ± 0.72 and of second year was 10.41 mg/l ± 1.00.

Carbon dioxide is of vital importance in the life of plant and microorganisms. It is produced as a result of respiration of aquatic organisms. As free CO_2 is highly soluble in water, it is found to be larger amount in polluted water as compared to fresh water bodies. Free CO_2 was recorded in all the months of study period with its maximum concentration in summer and minimum in winter season. High level of free CO_2 in summer and monsoon season could be coincided with the decline in the water level and increased load of organic matter. The concentration of free CO_2 usually does not exceed more than 20 ml/l (Doudoroff, 1957). However, it may reach as high as 50 mg/l in an organically polluted water body (Hynes, 1970). In the present study of Paniyala State pond highest free CO_2 concentration was in April month with 3.63 mg/l ± 1.24 in 2008-2009 and was found lowest with 1.178 mg/l ± 0.49 in December month of 2007-2008. CO_2 has a great effect on photosynthesis which affect fish growth. Surface area constantly absorbs or gives up carbon dioxide to maintain equilibrium with the atmosphere. The mean annual value of free CO_2 was 2.144 mg/l ± 0.65 for (2007-2008) and for 2008-2009 was 2.399 mg/l ± 0.98.

The alkalinity is considered as an indicator of pond productivity (Davis, 1955). Alkalinity determines the availability of free CO_2

Table 1: Monthly variation in Physical Parameters of Paniyala State Fish Pond, 2007-2009

Months	Water temp. (°C)	Conductivity (μmhos/cm²)	Turbidity (JTU)	Total solids (mg/l)
		2007-2008		
March	25.85 ± 1.01	39.75 ±2.31	48.00 ±2.52	222.64 ±2.55
April	27.85 ± 0.45	38.00 ±2.67	78.25 ±1.57	237.39 ±3.13
May	29.60 ±0.32	40.50 ±4.22	82.00 ±4.58	251.29 ±2.40
June	29.60 ±2.43	40.00 ±3.82	101.00 ±4.79	436.78 ±1.12
July	29.15 ±3.53	41.00 ±3.79	135.80 ±5.37	799.32 ±2.36
August	27.50 ±3.72	51.75 ±2.96	140.80 ±5.64	735.52 ±3.59
September	28.83 ±2.87	56.00 ±3.02	36.00 ±6.14	723.49 ±5.04
October	29.33 ±2.59	82.25 ±3.68	19.75 ±5.96	262.07 ±3.97
November	21.48 ±3.12	93.50 ±5.51	18.75 ±3.78	118.50 ±2.52
December	17.63 ± 3.66	81.75 ±4.28	22.25 ±3.95	88.30 ±1.98
January	19.45 ±2.49	73.25 ±5.24	29.25 ±4.31	95.31 ±1.55
February	22.45 ±2.25	59.25 ±4.24	31.50 ±2.17	94.28 ±1.49
Average ±Sd	25.73 ±4.33	58.08±9.87	61.94 ±6.66	338.74 ±8.79
		2008-2009		
March	26.35 ±2.23	42.50 ±3.65	80.00 ±2.54	216.13 ±3.35
April	28.13 ±2.58	38.50 ±2.82	86.50 ±4.33	210.28 ±3.06
May	29.70 ±2.75	37.50 ±2.97	91.25 ±2.70	300.59 ±2.79
June	29.05 ±2.21	39.25 ±1.15	108.80 ±1.84	494.31 ±3.34
July	28.98 ±3.10	41.50 ±1.81	137.80 ±3.47	811.67 ±5.35
August	27.13 ±3.52	58.00 ±1.80	107.50 ±1.98	793.06 ±6.10
September	29.13 ±1.70	52.00 ±2.97	34.25 ±2.89	598.19 ±5.06
October	27.48 ±0.32	75.25 ±4.54	23.00 ±3.77	216.85 ±5.98
November	20.78 ±0.92	82.25 ±3.89	25.50 ±1.09	100.83 ±3.83
December	17.93 ±4.11	79.33 ±3.42	33.67 ±1.52	93.477 ±3.35
January	20.05 ±2.19	73.25 ±4.94	39.50 ±3.15	73.35 ±3.70
February	23.23 ±1.28	55.00 ±4.23	50.50 ±3.53	102.11 ±4.33
Average ±Sd	25.66 ±4.09	56.19±7.17	68.18 ±8.59	334.24±7.76

Sd±:Standard Deviation

Table: 2 Monthly variation in Chemical Parameters of Paniyala State Fish Pond, 2007-2009

Months	pH	DO (mg/l)	BOD (mg/l)	COD (mg/l)	Free CO_2 (mg/l)	Total Alkalinity (mg/l)	Total Hardness (mg/l) Ca	Total Hardness (mg/l) Mg
				2007-2008				
March	8.24 ±0.32	6.70 ±0.57	3.75 ±0.55	10.65 ±0.47	2.253 ±0.19	339.00 ±7.57	31.40 ±2.4	16.79 ±1.08
April	8.27 ±0.36	5.58 ±0.45	3.93 ±0.19	10.98 ±0.40	2.765 ±0.47	330.00 ±4.78	33.70 ±3.62	17.60 ±1.41
May	8.31 ±1.90	5.13 ±2.39	4.28 ±1.82	11.23 ±1.06	3.245 ±1.30	306.00 ±6.24	36.03 ±1.88	23.90 ±6.35
June	8.28 ±1.11	5.38 ±2.70	4.70 ±1.88	11.68 ±1.25	2.603 ±1.02	262.00 ±4.73	37.33 ±1.15	26.03 ±5.07
July	7.88 ±1.16	5.50 ±1.01	4.48 ±1.20	11.10 ±2.07	2.463 ±0.99	253.00 ±6.68	29.45 ±1.69	11.23 ±5.85
August	7.80 ±2.02	5.53 ±1.47	4.20 ±1.38	10.38 ±1.98	2.59 ±0.79	341.00 ±8.89	27.58 ±1.37	11.30 ±5.09
September	8.17 ±2.18	6.13 ±2.30	3.90 ±1.64	9.82 ±2.68	2.055 ±0.71	352.00 ±8.20	27.83 ±1.62	11.60 ±3.88
October	8.26 ±2.60	6.15 ±2.11	3.08 ±1.41	9.75 ±3.56	2.258 ±0.82	425.00 ±5.40	29.08 ±1.88	12.18 ±2.73
November	8.23 ±2.68	8.35 ±1.96	2.98 ±1.16	9.42 ±2.93	1.280 ±0.55	347.00 ±3.10	28.00 ±2.09	13.05 ±5.35
December	8.23 ±2.43	8.93 ±2.16	2.83 ±0.80	9.65 ±3.06	1.178 ±0.49	341.00 ±4.14	27.83 ±1.56	14.20 ±5.24
January	8.21 ±2.81	8.13 ±3.30	3.08 ±0.90	9.97 ±3.19	1.398 ±0.17	322.00 ±6.42	27.63 ±2.41	14.70 ±4.06
February	8.22 ±2.76	7.60 ±3.50	3.33 ±0.98	10.43 ±3.27	1.643 ±0.28	338.00 ±8.64	28.50 ±2.65	15.76 ±4.50
Average±Sd	8.17±0.16	6.59±1.33	3.71±0.64	10.42±0.72	2.144 ±0.65	329.00 ±9.20	30.36 ±3.47	15.69 ±4.84
				2008-2009				
March	8.32 ±1.14	6.63 ±1.08	3.73 ±1.16	10.90 ±2.47	2.813 ±1.43	338.00 ± 5.44	29.55 ±3.20	16.79 ±1.09
April	8.37 ±1.08	5.55 ±3.85	4.05 ±1.34	1.18 ±2.82	3.630 ±1.24	335.00 ±7.20	32.98 ±2.46	18.05 ±4.81
May	8.34 ±1.42	4.98 ±3.16	4.28 ±1.75	1.40 ±1.16	3.225 ±1.75	309.00 ±6.28	36.10 ±2.67	24.98 ±6.62
June	8.28 ±1.85	5.13 ±2.80	4.73 ±1.91	11.73 ±2.20	2.588 ±1.46	273.00 ±5.03	37.25 ±2.27	26.05 ±7.35
July	7.84 ±1.49	5.50 ±2.53	4.50 ±2.07	11.48 ±2.02	1.915 ±1.20	264.00 ±4.59	29.35 ±1.88	12.30 ±6.75
August	7.73 ±0.25	5.70 ±1.15	4.18 ±0.30	10.65 ±1.50	2.738 ±0.77	291.00 ±8.19	27.43 ±1.50	11.93 ±3.05
September	8.12 ±0.39	6.43 ±1.26	3.85 ±0.67	10.18 ±1.57	1.375 ±0.66	328.00 ±3.72	27.88 ±1.66	12.03 ±1.74
October	8.27 ±0.77	6.48 ±1.81	3.28 ±0.85	9.47 ±1.85	1.218 ±0.23	385.00 ±9.74	28.78 ±1.10	12.73 ±2.58
November	8.24 ±0.57	8.43 ±0.94	3.13 ±0.80	8.72 ±1.75	1.365 ±0.09	364.00 ±3.56	28.33 ±2.20	11.08 ±2.73
December	8.23 ±0.52	8.90 ±0.47	2.93 ±0.21	8.97 ±1.55	2.215 ±0.23	351.00 ±6.65	27.50 ±1.41	14.25 ±1.59
January	8.20 ±0.75	8.25 ±1.10	3.18 ±0.21	9.82 ±0.76	2.915 ±0.68	324.00 ±5.79	27.43 ±0.87	14.53 ±1.40
February	8.22 ±0.82	7.70 ±0.29	3.45 ±0.14	10.43 ±0.30	2.788 ±0.61	338.00 ±4.04	26.90 ±1.72	16.28 ±1.53
Average±Sd	8.18±0.20	6.64±0.37	3.77 ±0.59	10.41 ±1.00	2.399 ±0.98	325.00 ±8.73	29.95 ±3.53	15.91 ±4.98

Sd ± :Standard Deviation

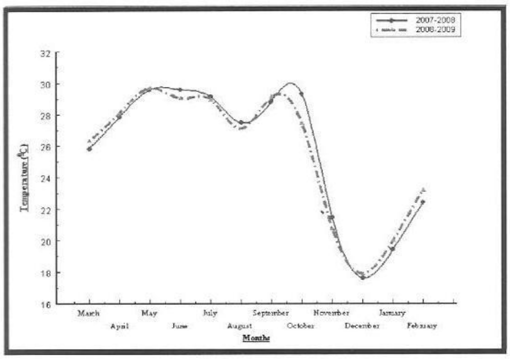


Fig. 1: Water temperature

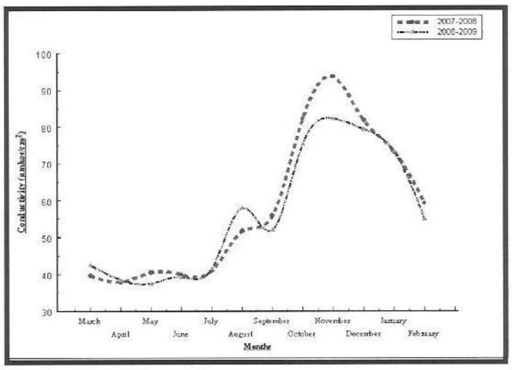


Fig. 2: Conductivity

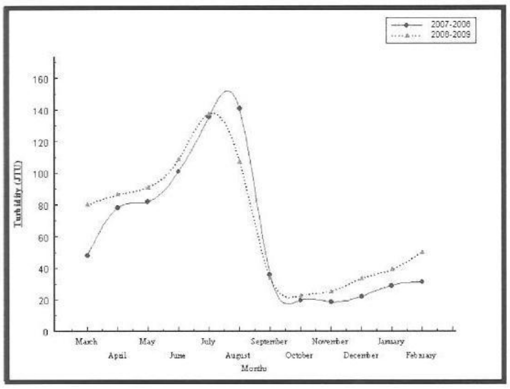


Fig. 3: Turbidity

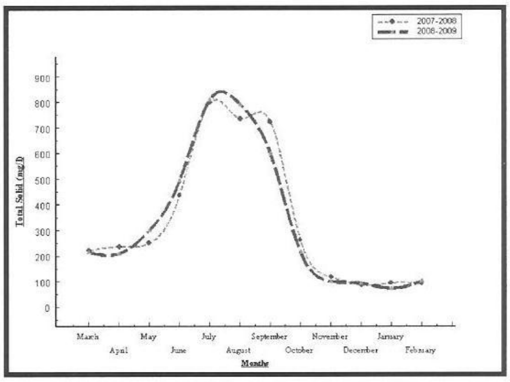


Fig. 4: Total solid

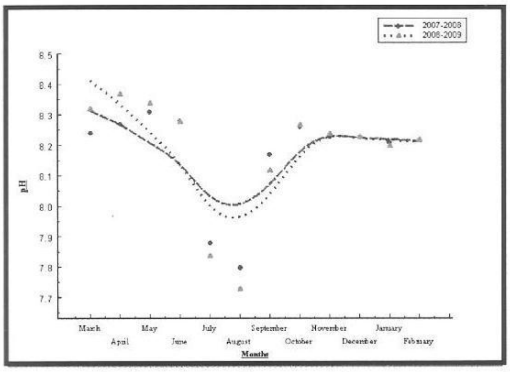


Fig. 5: pH

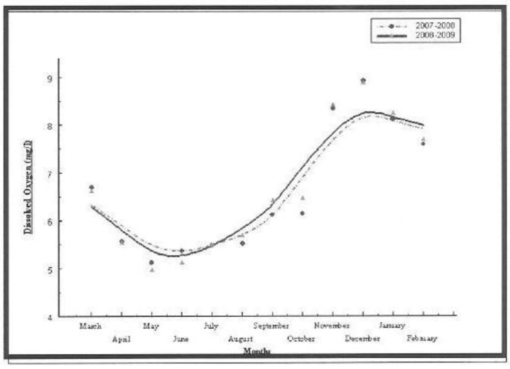
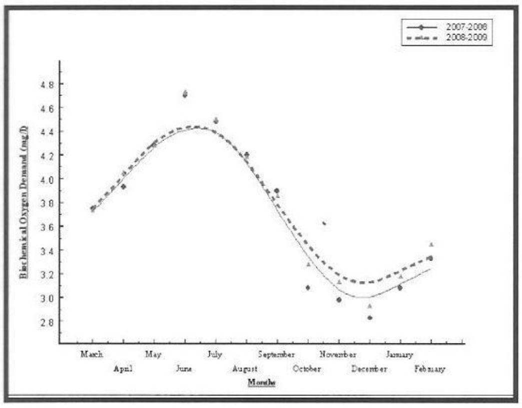


Fig.6: DO



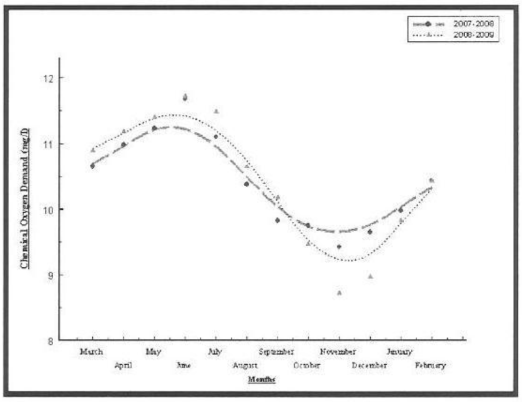
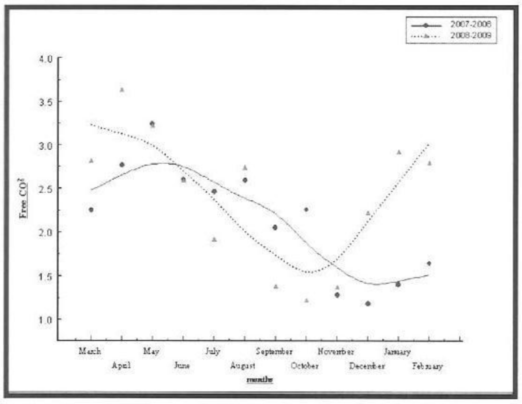


Fig. 7: BOD

Fig. 8: COD



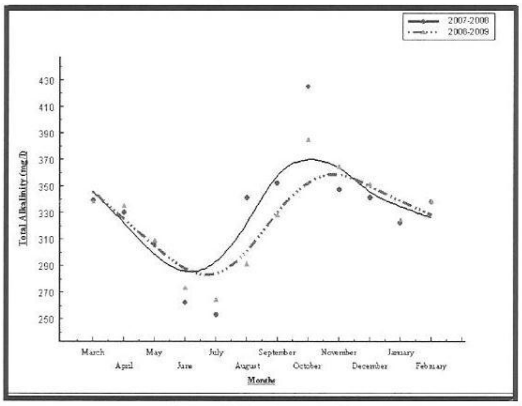
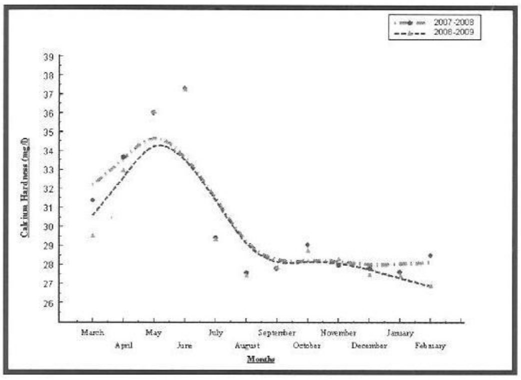


Fig. 7: BOD

Fig. 9: Free CO_2



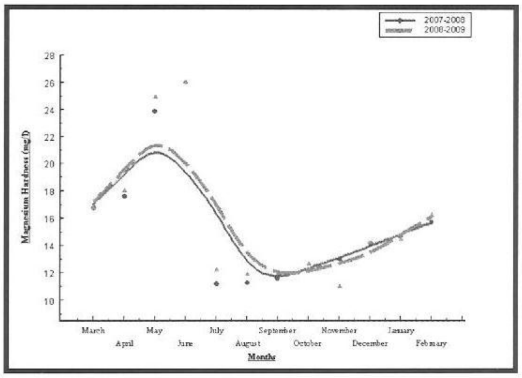


Fig. 11: Ca hardness

Fig. 12: Mg hardness

which is essential for photosynthesis and thus it is directly related to productivity. Thus, alkaline water is more productive and support the diversity of aquatic life. In present investigation, the total alkalinity was observed maximum with 425.00 mg/l ± 5.40 in October month and minimum was 253.00 mg/l ± 6.66 in July month of same year 2007-2008. According to Jhingran (1982), the range of total alkalinity in Indian water may be found from 40 mg/l to over 1000 mg/l. A well marked seasonal fluctuation in total alkalinity has been reported by majority of authors who have encountered minimum values in monsoon season and maximum values in summer season (Munawar, 1970; Ayyappan and Gupta, 1981). The annual average recorded for the total alkalinity was 329.00 mg/l ± 9.20 for 2007-2008 and was 325.00 mg/l ± 8.73 for 2008-2009.

Hardness of water is the sum of concentration of alkaline earth metal cations present in it. Calcium and magnesium are the principal cations imparting hardness. Calcium is an important micronutrient in an aquatic environment. In the current study of Paniyala State fish Pond the maximum Ca and Mg Hardness was found 37.33 mg/l ± 1.15 and 26.05 mg/l ± 7.35 in June month of both the years, while the lowest value was 26.90 mg/l ± 1.72 (February) and 11.08 mg/l ±2.73 (November) of 2008-2009. Calcium is found in abundance in all natural waters and its source lies in the rocks from which it is leached. Calcium being an important contributor to hardness in water and reduces the utility of water for domestic use. The annual average of Ca and Mg Hardness in 2007-2008 was 30.36 mg/l ± 3.47 and 15.69 mg/l ± 4.84 and in year 2008-2009 was 29.95 mg/l ± 3.53 15.91 mg/l ± 4.98. Basin geology has direct impact on calcium hardness. In urban environment, two other anthropological impacts are worth mentioning, one is construction activities and second idol immersion (Kodarkar and Chandrashekkar, 1995). Lund (1964) suggested calcium has main effect on phytoplankters by buffering pH of water.

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