# Physico-chemical assessment of three freshwater ponds of Jammu (J\&K) 

K.K. SHARMA, SHVETAMBRI*, PREETI VERMA and SURINDER P. SHARMA

Department of Zoology, University of Jammu - 180006 (India).
(Received: July 12, 2009; Accepted: August 07, 2009)


#### Abstract

In order to comprehend the complex biological interactions occurring within an aquatic ecosystem an assessment of its physicochemical conditions holds a momentous position. Any changes encountered in these conditions have a direct bearing on the biota inhabiting therein. In the present study an investigation was made on the physicochemical conditions of three freshwater ponds of Jammu viz. Dilli Village Pond, Jammu; Botanical Garden Pond, University of Jammu and Fish Pond, University of Jammu, for a period of one year from May 2005 to April 2006 in which some physicochemical parameters (temperature, transparency, and $\mathrm{pH}, \mathrm{DO}, \mathrm{FCO}_{2}, \mathrm{CO}_{3}^{-}, \mathrm{HCO}_{3}^{-}, \mathrm{Cl}, \mathrm{Ca}^{++}$and $\mathrm{Mg}^{++}$) were analysed. All the parameters showed well-marked seasonal fluctuations.


Keywords: Physico-chemical, ponds and aquatic ecosystem.

## INTRODUCTION

The physico-chemical parameters, a reflection of the health of an aquatic ecosystem, are of immense significance in determining the trophic status of aquatic habitats. With its implications on the biological processes, abiotic parameters determine the planktonic and neustonic community structure thereby influencing the food chains and food web in natural waters. So, a detailed analysis of the same is always wanting, and consequently, hydrobiologists throughout the globe have always paid attention to this important aspect and subsequently voluminous literature has so far emerged on the said matter of interest. Considerable amount of work on the physico-chemical characters of lentic systems has been carried out by various workers viz. Welch ${ }^{1}$ (1952), Hutchinson ${ }^{2}$ (1967), Wetzel ${ }^{3}$ (1975), Goldman and Horne4 (1983). All these workers have discussed the importance and influence of various physico-chemical parameters on the water bodies. The physicochemical status of various ponds of Jammu and Kashmir has though been discussed by a number of workers viz. Kour ${ }^{5}$ (2002), Akhtar ${ }^{6}$ (2003), Nelofar ${ }^{7}$ (2003) and Jan ${ }^{8}$
(2005), yet it remains abstract. Keeping this in view a detailed investigation has been carried out on the physico-chemical status of three subtropical ponds of Jammu.

## MATERIAL AND METHODS

## Study Area

Dilli Village Pond is a countryside natural pond and located at a distance of about 8 kms from University of Jammu. It is a perennial, shallow and eutrophic water body with an area of 300 square meters and depth ranging from 2.5 feet to 5 feet during the rainy season. The surface of the pond remains covered with a thick blanket of Lemna species during most months of the year except during rainy season. Run-off containing fertilizers, agricultural waste, sewage and detergents, silt and decomposed organic matter enrich the pond with nutrients that supports the growth of aquatic macrophytes.

Botanical Garden Pond is an artificial pond in the Botanical Garden of University of Jammu. It is a perennial, somewhat sub-oval, shallow water
body covering an area of 20 square meters and has an average depth ranging between 2.3 feet to 4 feet. The pond receives regular water supply through galvanized pipes. Pond shows luxuriant growth of emergents like Typha, Nymphea sps, aquatic grass and wild ferns. Trees, especially, Bottle-brush (Salix), Cetrum, Magnolia, Eucalyptus, and Acacia fairly curtail the penetration of light into the pond water.

Fish Pond is concrete pond located in the University of Jammu, receiving freshwater from the galvanized pipes. The pond receives sunlight throughout the day due to the absence of trees in its surroundings. The pond is rectangular in shape with an area of 157.5 square meters and a depth of 7 feet.

The parameters like temperature (air and water), transparency, $\mathrm{pH}, \mathrm{DO}, \mathrm{FCO}_{2}, \mathrm{CO}_{3}^{--}, \mathrm{HCO}_{3}^{-}$, $\mathrm{Cl}^{-}, \mathrm{Ca}^{++}$and $\mathrm{Mg}^{++}$were recorded. For the analysis of the physicochemical parameters standard methods of APHA ${ }^{9}$ (1985) were followed.

## RESULTS AND DISCUSSION

The seasonal variations in the physicochemical parameters of the three ponds have been presented in Tables 1, 2 and 3.

The variations in the air and water temperature are influenced by various season variables such as location, topography, duration of the sun rays, turbidity of the water and wind velocity (Wetzel ${ }^{3}$ 1975; Kour ${ }^{5}$, 2002; Akhtar ${ }^{6}$ 2003; Islam10 2007). In the present study the air and water temperatures were found to be closely related with each other in Dilli Village Pond) ( $r=0.922$ ), Botanical Garden Pond ( $r=0.930$ ) and Fish Pond ( $r=0.894$ ) (Table 4). Similar results have been recorded by Zafar ${ }^{11}$ (1955), Begum et al. ${ }^{12}$ (1989) and Islam ${ }^{10}$ (2007).
pH values in the study ponds exhibited least variations throughout the year. This could be linked with the less variation in the level of water and high bicarbonate values over the year (Sharma et al., ${ }^{13}$ 2007). pH values in the ponds registered alkaline nature. Such results are in conformity with Islam10 (2007), Asalou14 (1999) and Chowdhary
and Mamun ${ }^{15}$ (2006). pH showed a positive relationship with DO in the Dilli Village Pond ( $r=$ 0.345), Botanical Garden Pond ( $r=0.558$ ) and Fish Pond ( $r=0.693$ ) which is in contradiction with Nargis and Pramnik ${ }^{16}$ (2008) who recorded an inverse relation of pH with DO .

Many natural waters exhibit seasonal and irregular variations in transparency (Welch ${ }^{1}$, 1952). The variations observed in the transparency of a particular water body may be attributed to the production of plankton which hamper light penetration considerably and the presence of suspended organic matter which result in turbidity ( $\mathrm{Baba}^{\text {17 }}, 2002$ ). In the present study it was found that the water of the Dilli Village Pond was least transparent followed by Fish Pond and Botanical Garden Pond. High turbidity of water in the Dilli Village Pond was attributed to the presence of the Lemna sps. cover on the water surface during most of the year. Maximum transparency in the ponds was observed from July to August. This increase in transparency may be attributed to increased dilution of dissolved solids, organic and inorganic materials due to an increase in the water level from the tubewell in the Dilli Pond and from the galvanized pipes in the Botanical Garden Pond and Fish Pond. Similar results have been put on record by Chowdhary and Mamun ${ }^{15}$ (2006). Transparency shared a positive relationship with air and water temperature in all the ponds.

Dissolved Oxygen is one of the important parameters that play a vital role in the rate of chemical reaction and the nature of various biological activities, since it governs the assimilative capacity of the aquatic system (EPA ${ }^{18}$, 1976). Dissolved oxygen content showed negative relationship with air temperature ( $r=-0.475$ ) and water temperature $(r=-0.253)$ in Dilli Village Pond and Fish Pond ( $r=-0.637$ with water temperature). These results are in accordance with Islam ${ }^{10}$ (2007). On the other hand, DO showed a positive relationship with air temperature $(r=0.894)$ in Fish Pond and Botanical Garden Pond ( $r=0.170$ ) with air temperature and ( $r=0.147$ ) with water temperature. Highest DO values in the ponds were recorded to be $4.2 \mathrm{mg} / \mathrm{lt}$ in September (Dilli Village Pond); $6.4 \mathrm{mg} / \mathrm{lt}$ in October (Botanical Garden Pond) and 14.0 mg/tt in February (Fish Pond). These may
Table 1: Seasonal variations in the physicochemical parameters of dilli village pond from May, 2005 to April, 2006

| Parameters | May'05 | Jun | July | Aug | Sept | Oct | Nov | Dec | Jan'06 | Feb | Mar | Apr'06 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Air temperature ( ${ }^{\circ} \mathrm{C}$ ) | 31 | 31 | 28 | 30 | 25 | 20 | 14 | 11 | 15 | 22 | 26 | 30 |
| Water temp. ( ${ }^{\circ} \mathrm{C}$ ) | 26.5 | 28 | 28 | 29 | 26 | 21 | 13 | 10 | 17 | 18 | 20 | 24 |
| Transparency(cms) | 28.0 | 25 | 28 | 35 | 25 | 20 | 18.5 | 22 | 22 | 18 | 22.5 | 24.5 |
| pH | 7.3 | 7.6 | 8.2 | 7.0 | 7.1 | 7.4 | 7.3 | 7.1 | 7.0 | 7.0 | 6.9 | 7.2 |
| DO (mg/ts) | 1.2 | 2.8 | 3.2 | 1.2 | 4.2 | 3.8 | 3.6 | 3.2 | 2.6 | 1.8 | 1.6 | 2.2 |
| $\mathrm{FCO}_{2}$ (mg/ts) | 6.6 | 5.2 | 4.0 | 9.2 | 8.6 | 6.0 | 5.8 | 6.4 | 7.8 | 7.9 | 6.6 | 7.6 |
| $\mathrm{CO}_{3}^{-{ }^{-}}$(mg/ts) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| $\mathrm{HCO}_{3}{ }^{\text {( }}$ (mg/ts) | 375.20 | 408.85 | 420.90 | 475.80 | 480.60 | 520.80 | 565.20 | 590.80 | 475.60 | 420.80 | 402.20 | 375.20 |
| Cl ( $\mathrm{mg} / \mathrm{ts}$ ) | 112.76 | 105.48 | 99.8 | 139.72 | 158.7 | 125.84 | 110.54 | 101.79 | 89.40 | 98.82 | 85.8 | 89.40 |
| $\mathrm{Ca}^{++}$(mg/ts) | 35.28 | 34.48 | 32.08 | 33.88 | 38.49 | 36.09 | 40.10 | 36.80 | 32.08 | 21.65 | 22.45 | 28.63 |
| $\mathrm{Mg}^{++}$(mg/ts) | 24.54 | 22.60 | 17.98 | 24.30 | 30.13 | 29.16 | 34.02 | 35.56 | 24.81 | 28.82 | 26.20 | 32.1 |
| Table 2: Seasonal variations in the physicochemical parameters of botanical garden pond from May, 2005 to April, 2006 |  |  |  |  |  |  |  |  |  |  |  |  |
| Parameters | May'05 | Jun | July | Aug | Sept | Oct | Nov | Dec | Jan'06 | Feb | Mar | Apr'06 |
| Air temperature $\left({ }^{\circ} \mathrm{C}\right)$ | 33 | 35 | 30 | 29 | 29 | 25 | 19 | 14 | 16 | 25 | 21 | 34 |
| Water temp. ( ${ }^{\circ} \mathrm{C}$ ) | 26 | 29 | 28 | 28 | 25 | 20 | 15 | 12 | 14 | 19 | 19 | 24 |
| Transparency(cms) | 48 | 48 | 50 | 50 | 45 | 45 | 46 | 47 | 47 | 45.5 | 45 | 48 |
| pH | 7.5 | 7.8 | 7.4 | 7.2 | 7.0 | 7.8 | 7.7 | 7.6 | 7.5 | 7.3 | 7.6 | 7.7 |
| DO (mg/ts) | 4.2 | 4.2 | 3.6 | 4.6 | 2.4 | 6.4 | 5.2 | 3.2 | 2.8 | 1.6 | 2.8 | 4.0 |
| $\mathrm{FCO}_{2}$ (mg/ts) | 2.8 | 2.6 | 2.8 | 2.4 | 4.0 | 2.0 | 2.8 | 4.0 | 4.2 | 5.0 | 3.6 | 3.2 |
| $\mathrm{CO}_{3}^{--}$(mg/ts) | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| $\mathrm{HCO}_{3}{ }^{\text {( }} \mathrm{mg} / \mathrm{ts}$ ) | 318.20 | 352.95 | 366.40 | 390.45 | 451.40 | 420.40 | 404.80 | 410.35 | 427.00 | 440.50 | 353.80 | 280.60 |
| Cl ( $\mathrm{mg} / \mathrm{ts}$ ) | 91.81 | 99.73 | 109.8 | 119.76 | 111.77 | 68.97 | 77.96 | 95.92 | 100.94 | 117.94 | 129.94 | 101.94 |
| $\mathrm{Ca}^{++}$(mg/ts) | 32.08 | 36.89 | 39.29 | 40.10 | 38.49 | 35.28 | 30.42 | 38.24 | 32.40 | 29.67 | 26.51 | 20.10 |
| $\mathrm{Mg}^{++}$(mg/ts) | 15.47 | 18.99 | 21.64 | 25.6 | 22.8 | 20.74 | 16.04 | 24.33 | 15.33 | 12.56 | 12.62 | 10.04 |

Table: 3. Seasonal variations in the physicochemical parameters of fish pond from May, 2005 to April, 2006
be due to the wind action causing agitation of water (Sharma et al., ${ }^{13}$ 2007). Lowest concentrations of DO in the study ponds were observed as $1.2 \mathrm{mg} / \mathrm{t}$ in May and August (Dilli Village Pond); $1.6 \mathrm{mg} / \mathrm{lt}$ in February (Botanical Garden Pond) and $2.0 \mathrm{mg} / \mathrm{lt}$ in September (Fish Pond). Low values of DO during these months may be due to the rains causing mixing of the water and resulting in the turbid conditions (Pennak, ${ }^{19}$ 1968; Sharma et al., ${ }^{13}$ 2007).

Increase in Free $\mathrm{CO}_{2}$ in Dilli Village Pond and Fish Pond during the months of August and September was attributed to inflow of rainwater along with the inflow of decomposing organic matter. Increase in $\mathrm{FCO}_{2}$ in the month of February in Botanical Garden Pond was due to increased metabolic rate and decreased oxygen retention capacity of water due to high temperature and rains in that month. $\mathrm{FCO}_{2}$ recorded a negative relationship with DO in all the ponds with $(r=-0.324)$ in Dilli Village Pond, ( $r=-0.910$ ) in Botanical Garden Pond and ( $r=-0.764$ ) in Fish Pond.

Carbonates $\left(\mathrm{CO}_{3}^{-}\right)$were completely absent throughout the year in the Dilli Village Pond and Botanical Garden Pond. There absence may be credited to the continuous presence of $\mathrm{FCO}_{2}$ (Sehgal, ${ }^{20}$ 1980). In the Fish Pond, $\mathrm{CO}_{3}{ }^{-}$were present only from July to October and recorded their absence during rest of the year. $\mathrm{CO}_{3}^{-}$showed a negative relationship with $\operatorname{FCO} 2(r=-0.849)$ and a positive relationship with $\mathrm{DO}(r=0.597)$ in the Fish Pond.

Bicarbonate alkalinity showed an increment during the months of December and January in all the ponds and this may be mainly due to reduction in the photosynthetic absorption of $\mathrm{HCO}_{3}$ due to retarded algal and macrophytic growth. $\mathrm{HCO}_{3}$ - content was lowest from April to May in both Botanical Garden Pond and Dilli Village Pond and lowest in August in the Fish Pond. Low bicarbonate alkalinity may be due to high free $\mathrm{CO}_{2}$ and high rainfall, which cause a dilution effect. $\mathrm{HCO}_{3}^{3}$ recorded a positive relationship with DO in Dilli Village Pond ( $r=0.592$ ) and Fish Pond ( $r=0.747$ ) and a negative relationship ( $r=-0.234$ ) in the Botanical Garden Pond.

Table 4: Correlation co-efficient ( $r$ ) between physicochemical parameters in the three study ponds.

| Physicochemical parameters | Dilli Village Pond | Botanical Garden Pond | Fish Pond |
| :---: | :---: | :---: | :---: |
| Air temperature and $\mathrm{H}_{2} \mathrm{O}$ temp. | 0.922 | 0.930 | 0.894 |
| pH and DO | 0.345 | 0.558 | 0.693 |
| pH and $\mathrm{CO}_{3}{ }^{2-}$ | -- | -- | 0.435 |
| pH and $\mathrm{HCO}_{3}^{-}$ | 0.146 | 0.433 | 0.214 |
| Transparency and air Temp. | 0.658 | 0.423 | 0.702 |
| Transparency and $\mathrm{H}_{2} \mathrm{O}$ Temp | 0.748 | 0.549 | 0.499 |
| DO and Air Temperature | -0.475 | 0.170 | 0.894 |
| DO and $\mathrm{H}_{2} \mathrm{O}$ Temperature | -0.253 | 0.147 | -0.637 |
| DO and $\mathrm{FCO}_{2}$ | -0.324 | -0.910 | -0.764 |
| DO and $\mathrm{CO}_{3}^{--}$ | -- | -- | 0.597 |
| DO and $\mathrm{HCO}_{3}^{-}$ | 0.592 | -0.234 | 0.747 |
| $\mathrm{CO}_{3}{ }^{-}$and $\mathrm{FCO}_{2}$ | -- | -- | -0.849 |
| $\mathrm{CO}_{3}{ }^{-}$and DO | -- | -- | -0.849 |
| $\mathrm{Cl}^{-}$and pH | -0.055 | -0.581 | -0.399 |
| Cl and $\mathrm{HCO}_{3}{ }^{-}$ | 0.294 | -0.047 | -0.403 |
| $\mathrm{Ca}^{++}$and pH | 0.260 | -0.383 | 0.141 |
| $\mathrm{Ca}^{++}$and $\mathrm{HCO}_{3}^{-}$ | 0.597 | 0.507 | 0.669 |
| $\mathrm{Mg}^{++}$and pH | -0.529 | -0.344 | -0.015 |
| $\mathrm{Mg}^{++}$and $\mathrm{HCO}_{3}{ }^{-}$ | 0.579 | 0.429 | 0.711 |

The major ion contents vary in different freshwaters due to five factors, which are climate, geography, topography, biotic activity and time. These are not completely independent and they interact (Munshi and Munshi, ${ }^{21}$ 1995). Chloride concentration was found to be highest during September ( $158.7 \mathrm{mg} / \mathrm{lt}$ ) in the Dilli Village Pond and during August ( $109.84 \mathrm{mg} / \mathrm{lt}$ ) in the Fish Pond which may be linked with high temperature, organic decomposition, and high sewage influx (Sharma, ${ }^{22}$ 1999; Baba, ${ }^{17}$ 2002) along with rains, especially in Dilli Village Pond which receives laundry and cattle wastes. In Botanical Garden Pond high chloride content was found to be in the month of March. This increase may be due to evapo-transpiration of water body (Kahabade and Mule, ${ }^{23}$ 2005) and autochthonous decomposition. Minimum chloride values were obtained during November ( $77.96 \mathrm{mg} /$ It) in Botanical Garden Pond, during December ( $53.95 \mathrm{mg} / \mathrm{lt}$ ) in Fish Pond and March ( $85.8 \mathrm{mg} / \mathrm{lt}$ ) in the Dilli Village Pond. Similar results have been put forth by Sharma ${ }^{24}$ (2006).

Calcium and Magnesium are the major cations, which have a significant impact on the
aquatic ecosystems. Calcium is found more in natural waters, as its main source is weathering of rocks from which it leeches out. Thus, basin geology has a direct impact on calcium hardness (Chandrashekhar, ${ }^{25}$ 2005). In the present study, a $\mathrm{Ca}^{++}$maxima was observed in November (40.10 $\mathrm{mg} / \mathrm{tt}$ ) in Dilli Village Pond and in January ( $40.1 \mathrm{mg} /$ It) in Fish Pond which may be due to low water temperature that results in increased Ca++solubility. A minima in Ca++ concentration was recorded during February ( $21.65 \mathrm{mg} / \mathrm{It}$ ) in Dilli Village Pond and during June ( $20.85 \mathrm{mg} / \mathrm{lt}$ ) in Fish Pond. Such low values may be credited to increased temperature and dilution effect caused by rains. Similar results have been documented by Kumar et al. ${ }^{26}$ (2006). Decrease in $\mathrm{Ca}^{++}$ions during February in Dilli Village Pond may be linked with rains during that time. However, contrary to this, in the Botanical Garden Pond, high values of calcium were obtained during August ( $40.10 \mathrm{mg} / \mathrm{tt}$ ) and this may be attributed to reduction in algal and macrophytic growth due to manual cleaning of the pond. Low content of calcium in this pond during the month of April ( $20.10 \mathrm{mg} / \mathrm{tt}$ ) may be because of alkaline nature of pH and reduction in calcium
solubility due to increase in temperature. $\mathrm{Ca}^{++}$ recorded a negative relationship with $\mathrm{pH}(r=-0.383)$ in the Botanical Garden Pond and a positive relation with pH in the other two ponds. Calcium recorded a positive relationship with $\mathrm{HCO}_{3}{ }^{-}$in all the ponds under study.

It was seen that magnesium closely followed the calcium concentrations in the three ponds. $\mathrm{Ca}^{++}$recorded a positive relation with $\mathrm{Mg}^{++}$ in all the ponds. High $\mathrm{Mg}^{++}$values were found during December ( $35.56 \mathrm{mg} / \mathrm{lt}$ ) in Dilli Village Pond; January (19.96 mg/t) in Fish Pond and during August (25.6
$\mathrm{mg} / \mathrm{t})$ in Botanical Garden Pond. Low magnesium content was recorded in July(17.98 mg/lt) in Dilli Village Pond; June (10.04 mg/lt) in Fish Pond and in April ( $10.04 \mathrm{mg} / \mathrm{t})$ in Botanical Garden Pond. $\mathrm{Mg}^{++}$ recorded a negative relationship with pH in all the ponds and a positive relation with bicarbonates in the three ponds under study.

## ACKNOWLEDGEMENTS

Authors are thankful to the head, department of Zoology, University of Jammu (J\&K) for providing necessary facilities.

## REFERENCES

1. Welch, P. S. Limnology. McGraw Hill Book Company.1952. New York, Toronto, London : 538 (1952).
2. Hutchinson, G.E. A treatise on Limnology. Vol I. Geography, Physics and Chemistry. John Wiley \& Sons. Inc. N.Y: 1015. (1967).
3. Wetzel, R.G. Limnology. W.B. Saunders College Publishers. Philadelphia 74 (1975).
4. Goldman, C.R. and Horne, A.J. Limnology. Mc Graw-Hill. International Book Company: 464. (1983).
5. Kour, S. Studies on the diversity of rotifers in Lake Mansar, Jammu. M. Phil Dissertation submitted to the Department of Zoology, University of Jammu. (2002).
6. Akhtar, R. Assessment of water quality of two high altitude (Sarkoot and Shalimar) ponds with special reference to fish performance. M.Phil Dissertation, University of Jammu, Jammu. (2003).
7. Nelofar, N. Limnology of a high altitude Sarkoot pond. M.Phil Dissertation, University of Jammu, Jammu. (2003).
8. Jan, N. Ecology of Janipur Pond (Jammu) with special reference to zooplankton dynamics. M. Phil. dissertation submitted to University of Jammu, Jammu. (2005).
9. APHA. Standard methods of the examination of waste and wastewater. 16th edu. American Public Health Association, Washington, D. C. (1985).
10. Islam, S.N. Physicochemical condition and occurrence of some zooplankton in a pond of Rajshahi University. Research Journal of Fisheries and Hydrobiology. 2(2): 21-25. (2007).
11. Zafar, A.R. On the periodicity and distribution of algae in certain fish ponds in the vicinity of Hydrabad, India.. Doctoral dissertation at Osmanis University, India. (1955).
12. Begum, A., G. Mustafa, S. Ali and Ahmed.K. Studies on Limnology in a mini pond and growth of Tilapia (= Oreochromis) nilotica. Bangladesh Journal of Zoology. 17(1):35-45. (1989).
13. Sharma, K.K., Sawhney, N and Kour, S. Some limnological investigations in Ban Ganga Stream, Katra, Jammu\& Kashmir State. Journal of Aquatic Biology 22(1):1-6. (2007).
14. Asalou, S.S. Variation in the physico-chemical parameters of the coastal water of Ondo State. African Journal of Science: 81-86 (1999).
15. Chowdhary, A.H and Al Mamun, A. Physicochemical conditions and plankton population of two fishponds in Khulna. University Journal of Zoology, Rajshahi University. 25: 41-44. (2006).
16. Nargis, A and Pramnik, S.H. Physicochemical parameters in relation to Meteorological and climatic conditions in a

Fish Pond. Bangladesh Journal of Science and Industrial Research. 43(3): 405-410. (2008).
17. Baba, D.I. Ecosystemic studies with special reference to faunal diversity in river Chenab. Ph.D thesis, University of Jammu, Jammu. (2002).
18. Environmental Protection Agency (E.P.A). Quality criteria for water use. EPA, 440, 1a-76-023, Environmental Agency. Washington. (1976).
19. Pennak, R. W. Field and experimental limnology of Colorado Mountain Lakes. Ecology. 19(3):505-20. (1968).
20. Sehgal, H.S. Limnology of lake Sruinsar, Jammu with reference to zooplankton and fisheries prospectus. Ph.D Thesis, University of Jammu, Jammu. (1980).
21. Munshi, J.D. and Munshi, J.S.D. Fundamentals of freshwater Biology.Narendra Publishing House. Delhi110006, India. (1995).
22. Sharma, A. Limnological studies of BanGanga and distributional pattern of stream
fauna. Ph.D. thesis, University of Jammu, Jammu. (1999).
23. Khabade, S.A. and Mule, M.B. Studies on physico-chemical parameters of Pundi reservoir from Tasgaon tehsil (Maharashtra). In: Fundamentals of Limnology. APH Publishing Corporation. N.Delhi. (2005).
24. Sharma, D.K. Seasonal variations in certain physico-chemical characteristics of Rampur reservoir of Guna district (M.P.). In: Ecology of lakes and reservoirs. Vishwas Balasheb Sakhare (Eds.). Daya Publishing House:125131. (2006).
25. Chandrashekhar, S.V.A. Limnological studies on Kondakarla lake Visakha District,Andhra Pradesh. In: Ecology of lakes and reservoirs. Vishwas Balasheb Sakhare (Eds.). Daya Publishing House: 63-104. (2005).
26. Kumar A, Qureshi, T.A., Parashar, A and Patiyal, R.S. Seasonal variation in physicochemical characteristics of Ranjit Sagar reservoir, Jammu \& Kashmir. Journal of Ecophysiology and Occupational Health. (2006).

