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Research Article

Studies of Some Physico-Chemical Parameters (Part-II) of Some Selected Fresh Water Lakes in Telangana State, India.

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Abstract: Investigations were conducted on physico – chemical characteristics of ten lakes of Telangana State (India) from June 2013 to November 2013. The parameters whish were included were variable temperature, pH, salinity and total dissolved solids were investigated. Temperature is the most important ecological factor influencing the activities of aquatic life organism and other environmental factors and there by the zooplanktons where reduced in these lakes. pH also influences the distribution of fauna in these lakes in different months. It is closely related to the carbon dioxide complex in water. The pH range of ten lakes are 6.5 to 8.4 from June -2013 to November – 2013. The variations may cause stress to the fauna and there by the reduction of faunal species as observed. The salinity varies from vertical to horizontal tidal waves and from top to bottom in a stratified lake. Salinity is an important factor for survival for metabolism and distribution of many species. High salinity was observed from June to September. In the total dissolved solids (TDS) all kinds of solids which are suspended volatile in water sample. The TDS are highly fluctuating in these lakes. Since the tropic status in these lakes is very rich, it will be an economical venture to use Fresh water fish culture or aquaculture. Environment has strong impact on the aquatic fauna, and also this study gives the critical aspects of the fresh water fauna for their survival, as observed.
Keywords: Lakes, temperature, pH, salinity, total dissolved solids (TDS).

INTRODUCTION

Technological advancement has made life more pleasant but it has increased the pollution potential level. Extensive domestic and agricultural uses of chemicals constitute one of the main sources of environmental pollution. Heavy metal contamination of aquatic fresh water ecosystem has been recognised as a serious pollution problem [4]. Heavy metal ions especially mercury, lead and cadmium have become prominent even in trace amount in the aquatic system [40]. Heavy metals show strong affinity for ligand such as phosphate crystal and histidyl side chains of pyrines and porpyrines and are capable of forming complexes which ligands containing sulphur, nitrogen and oxygen as an electron donor [26]. Due to metal complex formation of the normal function of the cell is disturbed and in turn, may change in the fundamental and physiological mechanism of animals [31]. Many pollutants even produce genetic effect [18, 20]. Bioaccumulation of metal toxicants depends on the availability and the persistence of the contaminants in water and food [43].

The effect of heavy metals on different aquatic organisms is often complex and difficult to interpret the sole of pH, Salinity, temperature and total dissolved solids. In general salinity of the marine environment is relatively constant and has little influence on the heavy metal concentration compared to the role of estuaries. In estuaries salinity however, plays a dominant role in influencing metal concentrations [50].

The major factors involved in determining the seasonal fluctuation of trace metal level in aquatic biota, are due to the entry of pollutants into the aquatic environment. Salinity temperature and other water qualities very seasonally and affect the physiology of the organisms. Several physiological changes occur in the organisms with the change of seasons and may cause fluctuation in the trace metal levels either in the whole organisms or in the tissues [28].

Temperature is one of the most important parameters for aquatic environment almost all physical, chemical and biochemical properties are maintained by it. The density viscosity, surface tension and vapour pressure of water is more or less depends on the

temperature profiles of the system. The rate of mortality resistance of fishes and the concentration of toxic substance are closely related to temperature of water [35].Total dissolved solids contents of water are defined as a residue left upon evaporation at 103 ^{0}c to 105^{o}c and it is aggregated amount of entire floating. Suspended, settled and dissolved solids present in water samples [46]. Several authors have studies the effects of physic o-chemical parameters in different rivers and estuarine ecosystems such as [1, 2, 8, 9, 17, 27, 30, 32, 33, 37, 39, 49]. The literature shows that the effect of the aquatic fauna.

In the present investigation, the authors attempted to the effect of some physical ecosystem which influence the biotic fauna of the fresh water ecosystem to lead their life and which helps in the study of commercial venture of aquatic organisms.

MATERIALS AND METHODS

It includes the following procedures:

1. Sampling Method:

Two litres of water samples were collected by using acid washed poly-propylene containers from a depth of 5 to 10 cms. Ten samples were taken randomly and were preserved by following standard methods adapted from APHA,1989, for various studies as shown in table for the estimation of dissolved solids in brown bottle (Wrinklers type) and fixed in the field itself, the samples were collected during morning time between 7 am and 10am.

2. Collection of water Samples:

The study was carried out for a period of 6 months from June to November 2013. Ten samples of water were carried out on monthly Viz., throughout the study period.

3. Physical parameters:

3.1: Temperature: Water temperature was measured by using a constant reading and the temperature was recorded in Celsius scale during morning hours from 7 am to 10 am.

3.2: pH: pH was determined by using electrical digital pH meter

3.3: Salinity: Salinity was estimated with the help of a salinometer model E2.Values were expressed in ppt in percentages.

3.4: Total dissolved solids (TDS): Total dissolved solids were estimated by gravimetric method. [45]. 50ml of well mixed sample was poured through a glass fibre filter and allow to drain completely and suction for 3 minutes after the filtration was completed. The filtrate was then transferred to a pre weighed evaporating dish and evaporated to dry on steam water bath after at least an hour in the oven at 125^{0}c, the filtrate was cooled in a desiccators and weighed.

Calculation:

(A-B) X 1000

Mg of TDS /litre=volume of the sample

A=Weight of the filter with dried residue + dish (mg)

B=Weight of dish (mg)

Note: All these physical parameters were given in table.1 for their method of container either plastic/glass, preservation method and their storage time

RESULTS

The observed values with regard to temperature, pH, salinity and total dissolved solids (TDS) are described below.

1. Temperature:

The observed temperature values from June to November, 2013 at different lakes. The temperature was highest in Manakondur and Saidapoor (30^{O}C) in the June month but in July month temperature was high (30^{O}C) in Ellanthakunta lake and low in Saidappor lake (14^{O}C) in August month. In September, the highest temperature was 28oc and lowest temperature was 24^o C in respective lakes. In October, the temperature was high at 28 ^{0} c in Ramagundam Lake and low in Ellanthakunta and Saidapoor lakes. The temperature was high at 27oc in Vemulavada, Ramagundam and Metpally lakes respectively. All these observed values were given in table.1.

2. pH:

The observed pH values from June-November, 2013 from ten different lakes .The pH was observed 8.4 in Jagityal Lake and lowest pH was observed in Saidapoor lakes in June month but in July the pH was high in Jagityal (8.4) and low in Saidapoor Lake. The Ph was more 8.3 in Manakondur and low in Ramagundam and Saidapoor lakes (6.8) in August month but in October month the pH was higher in Manakondur Lake and low in Bejjanki Lake. During November, the pH was similar to October. The pH was high in Manakondur and low in Bejjanki and Saidapoor. All these observed values were given in Table.2.

3. Salinity:

The observed salinity values from June-November, 2013 from ten different lakes. The amount of salinity observed in Ramagundam Lake and less amount of salinity observed in Metpally Lake in the month of June but in July period, the highest salinity was 3.7 ppt in Vemulavada and lowest salinity was 1.8 ppt in Metpallay, Chandurthy and Saidapoor lakes. The salinity level was high 3.2 ppt in Vemulavada lake and low in Metpally lake (i.e.) 1.6 ppt in August month .During September, the salinity level was higher at 3.5ppt in Ramagundam lake and 1.8 ppt at Metpally and Chandurthy lake and maximum salinity observed in October at 1.4 ppt. In November, the salinity was observed very high at 2.2 ppt in Ramagundam lake and low at 1.5 ppt at five different lakes. All these data were presented in Table.3.

4. Total Dissolved Solids (TDS):

The observed TDS values from June-November, 2013 from different lakes of Telangana State, India. The TDS level was higher at 2680 mg/l in Vemulavada Lake and lower at 1523 mg/l in Metpally Lake in June month. In July period, the level of TDS was higher at 2630 mg/l n Jagiyal Lake and lower at 1540 mg/l in Saidapoor Lake. During August, the higher TDS at 2550 mg/l observed in Jagityal Lake and lowest TDS level at 1540 mg/l observed in Bejjanki lakes. The TDS levels were high at 2518 mg/l in Vemulawada Lake and low at 1543 mg/l in Metpally Lake in September. During October, The level of TDS was observed higher level at 2432 mg/l in Vemulawada Lake and lower at 1549 mg/l at Metpally lakes. At November month, the level of TDS was high at 2521 mg/l in Vemulawada Lake and low at 1603 mg/l in Chandurthy Lake all these values were presented in table 4.

DISCUSSION

Environmental Pollution causes the normal physiological activities, According to the reference [20]. Increased industrialization in recent years has created the ecological problems, creating threat to the aquatic ecosystem environment. Pollution effect can drastically alter the characteristics of the habitat, [51]. Increasing biotic pressure and environmental pollution is expected to alter the productivity of species composition by bringing about significant changes in temporal distribution of key climatic features, [12]. Under these conditions, it is essential pre – requisite to know the influence of some environmental factors effecting on aquatic organisms. The authors attempted some parameters such as temperature, pH, Salinity and total dissolved solids in particular selected lakes of Telangana State.

1. Temperature:

Temperature is most pervasive of all the environmental variables, influencing the life not only because of its different structural and functional effect. [13] and also modulates the effect of almost all the other environmental parameters. Temperature affects the Physical property of water quality including the density, viscosity, vapour pressure, surface tension, and gas diffusion. Temperature addicts the longevity of aquatic animals as well as their reproduction, [3]. In the present investigation, the variation in temperature has been observed among different lakes at different periods. The temperature was slightly higher in June and July at different lakes when compared with other months. This may be due to the influence of summer season and the roles of solar radiation similar variation in temperature were reported as cited in [1, 37, and 36]. The low temperature was due to the inclement weather with the overcast sky, [19]. The fluctuations of temperature and temperature–dependent organisms are directly affected, as the number of Zooplanktons is reduced in the lakes as found.

2. pH:

The concentration of hydrogen ion i.e. pH of the media relative to acidity or alkalinity has been found to have limited effect on the distribution of animals. The pH also affects the concentration and potentially influences the toxicity and limitation in the environment [5]. Generally pH is closely related to carbon dioxide complex in water .when total alkalinity is constant; ph change is directly proportional to the change in carbon dioxide. The occurrence of carbon dioxide decreases pH value and its utilization (by way of photosynthesis) increases ph in soft and mountain stream waters.

In the present investigation, the pH level ranges from 6.5 to 8.4 in June, 6.8 to 8.0 in July, 6.8 to 8.3 in August, 6.5 to 7.8 in September, 7.2 to 7.8 in October and 7.0 to 7.6 in November. The ranges approach maximum permissible level as cited in [40] and [14].The permissible limit of pH was 6.5 to 8.5. As per the cited reference [14].These variations may cause stress to the organism in different lakes, leading to the effect of population. Biochemical reactions are sensitive to variation in pH .The pH value of 7.0 was considered to be best and most ideal for most of the biochemical reactions**.**

In the present observation, the pH range was high (8.2 and 8.4) in Manakondur lake and Jagityal lake in June respectively .This may be due to high buffering capacity of the system. As per the references [21, 11, and 38] have observed the range of pH as 8.0 to 9.0 in Indian River water. The pH plays an important role in the formation of algal bottom, [16].The high ph in June, July and August may be due to high temperature associated with decrease in volume of river water system. [36] reported the higher ph value in summer and lower pH value during rainy season in the river [15] have also recorded higher ph in summer and lower ph in monsoon season and [10] have recorded high ph values (8.41 to 8.61) in Chelam coastal lagoon at Yucatan, Mexico.

3. Salinity:

Salinity is an important factor for survival metabolism and distribution of many species. It may exert Salinity varies from vertically to horizontally, often within one tidal cycle. Salinity may be from top to bottom or it may be completely stratified, with a layer of fresh water on top and a layer of dense salty water in the bottom. Salinity of homogeneous when currents particularly eddy currents are strong enough to mix the water from top to bottom. Horizontally, the least saline waters are at the mouth of the lake. Incoming and outgoing currents deflect this configuration and cited references indicates [23, 24, 29, 41, 42, 47, 51] different ecological and physiological effects depending on the interaction with other factors like temperature, oxygen and ionic compounds, [25]. The salinity fluctuation has shown a dominant nature for the estuarine environment.

Distribution of organisms in the lakes is determined by complex factors including local rainfall, river flow, water levels and minds. Salinity is the most fluctuating parameter with wide range of variations in the estuarine environment.

In the present investigation, it has been observed that the salinity in the different lakes, their changes may be attributed to the land run off and disposal of untreated or partially treated industrial effluents into the aquatic lakes. In the present observation, high salinity was observed in June, July, August and September at 3.6, 3.4, 3.2 and 3.2 ppt in Ramagundam Lake. High salinity in these lakes is due to high evaporation with increased temperature and decreased inflow of fresh water.

In the present observation, low salinity was recorded during October and November. It may be associated with high degree of dilution by continuous inflow of fresh water due to seasonal rainfall, [6], [26].

4. Total Dissolved Solids:

Total dissolved solids at the measure of all kinds of solids which are suspended, volatile, etc, in a water sample, total dissolved solids can be measured as the residue left after evaporation of the samples, [48]. Total dissolved samples indicate the general nature of the water quality. The total dissolved solids in water are considered as the desirable limit for drinking purposes which larges from 500 mg/l as maximum permissible limit suggested by [14]. In the present investigation, it has been observed that the total solids content in the 10 different lakes are highly fluctuated among different months. As per the reference [44] have recorded higher total solid range from 180 to 5130 mg/l in different stations in the Nandira river, Orissa state in India. As per the reference [34] have also observed 800 mg/l and 2560 mg/l of total dissolved solids in the effluents of Bata and McDowell Industries in Bihar state, total solids (584 – 750 mg/l and [22]. In contrary to this to the reference [7] noted lower amount of total solids 35 – 120 mg/l. The higher level of total dissolved solids was also observed by [32] in the tannery belt of Vaniambadi and Ambur area, in Tamilnaidu. The lower dissolved solids have been recorded in the different lakes this may be due to the dilution of effluents by fresh water inflow from adjoin river by heavy rainfall. [1] has suggested that lower content of total solids are due to seasonal dilution during the season in Uyyakondan Channel water of Cauvery in Tamilnadu.

Table-1: Temperature variation (^{O}C) in 10 Lakes of Telangana State from June 2013 to November 2013

S. No	PLACE	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER
1	Elanthakunta	28	30	30	26	24	24
2	Huzurabad	25	27	26	25	25	24
3	Jagitial	32	28	24	26	23	25
4	Vemulavada	26	25	26	24	26	27
5	Manakondur	30.9	26	28	24	26	26
6	Ramagundam	31	28	27	28	28	27
7	Bejenki	23	26	25	26	25	26
8	Metpally	25	25	28	24	26	24
9	Chandurthy	28	26	25	24	25	25
10	Saidapur	30	24	26	28	24	25

TWO WAY ANOVA

Source of	SS	df	MS	F	P-Value	F crit
Between months	48.266667	9	5.362963	1.717268	0.112895	2.095753**
Between places	50.13333	5	10.02667	3.210626	0.014571	2.422084*
Error	140.5333	45	3.122963			
Total	238.9333	59				

Significance at P< 0.05

Table: 2. pH variation in 10 Lakes of Telangana State from June 2013 to November 2013

S. No	PLACE	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER
1	Elanthakunta	7.4	7.2	7.3	7.0	7.5	7.5
2	Huzurabad	8.1	7.7	7.8	7.5	7.8	7.6
3	Jagitial	8.4	8.2	7.9	8.0	7.5	7.7
4	Vemulavada	7.6	7.6	7.3	7.4	7.5	7.2
5	Manakondur	8.2	8.0	8.3	7.8	7.8	7.5
6	Ramagundam	7.2	7.0	.8	6.5	7.0	7.2
7	Bejenki	6.8	7.2	7.0	6.8	7.0	7.0031
8	Metpally	7.2	7.1	6.8	7.0	7.0	7.2
9	Chandurthy	7.2	7.3	7.0	7.1	7.2	7.0
10	Saidapur	6.5	6.5	6.8	7.0	7.2	7.1

TWO WAY ANOVA

Source of	SS	df	MS	F	P-Value	F crit
Between months	9.007333	9	1.000815	21.35789	1.83E-13	2.095753**
Between places	0.388	5	0.0776	1.656023	0.164864	2.422084*
Error	2.10866	45	0.046859			
Total	11.504	59				

Significance at P< 0.05

Table: 3. Salinity (ppt) Variation in 10 Lakes of Telangana State from June 2013 to November 2013

S. No	Place	June	July	August	September	October	November
1	Ellanthkunta	7.4	7.2	7.3	7.0	7.5	7.5
2	Huzurabad	8.1	7.7	7.8	7.5	7.8	7.6
3	Jagitial	8.4	8.2	7.9	8.0	7.5	7.5
4	Manakondur	7.6	7.6	7.3	7.4	7.5	7.2
5	Vemulavada	8.2	8.0	8.3	7.8	7.8	7.5
6	Ramagundam	7.2	7.0	6.8	6.5	7.0	7.2
7	Bejanki	6.8	7.2	7.0	6.8	7.0	7.1
8	Metapally	7.2	7.1	6.8	7.0	7.0	7.2
9	Chandurthy	7.2	7.3	7.0	7.1	7.2	7.0
10	Saidapoor	6.5	6.8	6.8	7.0	7.2	7.1

TWO WAY ANOVA

Source of variation	SS	df	MS	F	P –Value	Fcrit
Between months	9.007333	9	1.0000815	21.35789	1.83E- 13	2.095753**
Between places	0.388	5	0.0776	1.656023	0.164864	2.422084*
Error	2.10866	45	0.046859			
Total	11.504	59				

Significance at P < 0.05

Table: 4. Total Dissolved Solids (TDS) Variation in 10 Lakes of Telangana State from June 2013 to November 2013

S. No	PLACE	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER
1	Elanthakunta	1740	1820	1505	1920	1870	1820
2	Huzurabad	2108	2210	2015	2102	2080	2240
3	Jagitial	2420	2630	2550	2310	2420	2520
4	Vemulavada	2680	2629	2714	2518	2432	2521
5	Manakondur	2014	1957	2003	2114	2058	2147
6	Ramagundam	2157	2450	2212	2051	2246	2133
7	Bejenki	1680	1710	1540	1672	1740	1820
8	Metpally	1523	1610	1580	1543	1549	1610
9	Chandurthy	1622	1580	1610	1627	1593	1603
10	Saidapur	1680	1540	1575	1621	1710	1649

TWO WAY ANOVA

Source of variation	SS	df	MS	F	P –Value	F crit
Between months	7344988	9	816109.7	112.36336	8.14E-28	2.095753**
Between places	7.174833	5	6975.52	0.960042	0.4523	2.422084*
Error	326869.4	45	7263.764			
Total	7706725	59				

Significance at P < 0.05‘

RESEARCH HIGHLIGHTS

The research highlights of this paper are:

- Temperature is the most important ecological factor influencing the activities of aquatic life organism and other environmental factors and there by the zooplanktons where reduced in these lakes as observed.
- pH also influences the distribution of fauna in these lakes in different months. It is closely related to the carbon dioxide complex in water.
- The variations may cause stress to the fauna and there by the reduction of faunal species as observed.
- Salinity is an important factor for survival for metabolism and distribution of many species.
- The TDS are highly fluctuating in these lakes. Since the tropic status in these lakes is very rich, it will be an economical venture to use fresh water fish culture or aquaculture

All these parameters will help in thresholds for the threatened species criterion currently consider a site's share of a threatened species' population; and the environment has strong impact on the aquatic fauna, as observed.

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REFERENCES

1. Abdul Jameel A; Physico chemical studies in Uyyakondan channel water of river Cauvery, Poll.Res, 1998; 17 (2):111-114.
2. Anand VK, Sharma Suman; Physico chemical characteristics of bottom sediments of Lacustrine habitats of Jammu lake. Eco.Env.Conservation, 2000; 6 (4):409-418.
3. Anantha Krishna KR, Kutty MN; Mortality and breathing rate at higher ambient temperatures in the cichlids fish, *Tilapia mossambia*. Ind.J.Exp.Biol, 1974; 12:55-59.
4. Benson WH, Francis PC, Birge WJ, Black JA; A Simple method for acid extraction of cadmium from fish eggs or fish tissues. Atomic Spectroscopy, 1983; 4:212 – 213.
5. Campbell PGC, Stokes PM; Acidification and toxicity of methods to aquatic biota. Can. J. Fish Aquat. Sci, 1983; 42: 2034- 2049.
6. Chandran C; The effect of ethanol in the brain and liver of rat, *Rattus norvegicus*, M.Phil dissertation, University of Madras, India, 1987.
7. Chandra R, Prasad RN; Deterioration of water quality mass bathing in Surya Kaunda, Lohargal (Rajasthan), India. Ind. J. Environ Biol, 2005; 26 (2):205 – 211.
8. Das JS, Das N, Sahoo RK; Semi diurnal variation of some physic-chemical parameters in the Mahanadi estuary, East Coast of India. Ind.J.Mar.Sci, 1997; 26. 323:326.
9. Dasgupta ADAK; Purohit KM; Status of the surface water ‘quality of Mandiakudur. Poll. Res, 2001;20 (1):103-110.
10. David SV, Elizabeth R; Variations and relationships of salinity, Nutrients and suspended solids in Chelam Coastal Lagoon at Yucatan, Mexico. Ind. J. Mar. Sci, 1998; 27:149 – 156.
11. Ganapathi SV; The ecology of Tropical waters. Proc. Sym. Algalogy. ICAR, 1960; 204 – 218.
12. Gupta KA; Assessment of environmental consequences on the eco system health. A model project formulation. Ecol. Env and Cons, 1997; 3 (2):71-72.
13. Hochsachka DW, Somero GN; Strategies of bio-chemical adaption. Philadelphia Sanders publications. Co. USA, 1973.
14. ICMR. Water quality Standards. Indian Council of Medical Research Special Pub, 1975, 44. 21.
15. Jain BN, Meenakshi S, Ramesh T; Seasonal Variations in Physico- chemical parameters of Helali Reservoir of Vidisha District. Ind. J. Ecobiol, 1995; 8 (3):181– 188.
16. King DL; Carbon limitation in sewage lagoon. Nutrients and eutriphication. Amer. Soc. Limno. Oce. Kansas, 1975; 23:98 – 113.
17. Konda KY, Si Ke, Hashitani; The role of monocline on the control of vertical distribution of nutrients and phytoplankton in brackish lake Nakanoumi. Jap.J.Limno, 1994;55(1):47-60.
18. Kumara guru AK; Water pollution and fisheries. Ecol. Env. And cons, 1995;1(1-4):143 – 150.
19. Lyla PS; Heavy metal toxicity in the hermit crab *Clibanarius Longitarsus* (Dehaan). PhD Thesis,

CAS in Marine Biology, Annamalai University, India. 1991.
20. Mawachiro EC, Durve; Trace element in the water of the reservoir Bari in Udaipur (Rajasthan, India) and in the organs of the natural fish *Cirhinus mrigala*. Ecol.Env & Cons, 1997; 3(2):63-69.
21. More WG; Limnological studies of Lovisiara Lakes. Lakes Province. Ecology, 1995; 31:86 – 89.
22. Narayan R, Saxena KK, Chauhan S; Limnological investigations of texi Temple Pond of district Etawah (UP state), India. J. Environ. Biol, 2007; 28 (1): 155 – 157.
23. Nixon SW, Oviatt CA; Ecology of a New England Salt Marsh. Ecological Monographs, 1973; 43:463 – 498.
24. Nybakken JW; Marine biology: An Ecological approach, Chapters on estuaries, Salt Marshes and mangrove Forests. 4th Ed. Menlo Park, CA: Benjamin / Cumming. 1997.
25. Odum EP; Fundamentals of Ecology (third Ed). W.B. Saunders co. Philadelphia, 1971; 324 – 362.
26. Palanichamy S, Baskran P; Selected biochemical and Physiological responses of the fish *Channa striates* as bio monitor to assess heavy metal pollution in fresh water environment. J. Ecotoxicology and Environ, 1995; 5 (2):131 – 138.
27. Patnaik KC, Misra PM; Seasonal Variations in the physic chemical properties of Rushikula estuary and its effect on the occurrence of Channa fry. J. Indian Fish, 1990; 20:69-71.
28. Philips DJH; The common mussel *Mytilus edulis* as an indicator of pollution by zinc cadmium lead and copper. Effect of environmental variables on uptake of metals. Mar. Biol, 1976; 38:59 – 65.
29. Pomeroy LR, Wiegert RG; The ecology of a salt marsh. Verlog. Synthesis of a 20- year study of all aspects of a southern United States Coastal marsh. New York: Springer Verlog, 1981.
30. Prahlad AK, Seenayya G; Physico-chemical interactions and bio concentration of Zinc and lead in the industrially polluted Hussain sagar, Hyderabad. Ind. Environmental pollution, 1989; 58:139-154.
31. Radhakrishnan K, Suresh A, Urmala B, Sivaramakrishnan B; Effect of mercury on lipid metabolic profiles on the organs of *Cyprinus carpio* (Linn). J. Mondal, 1991; 8:125 – 135.
32. Ramaswamy S, Sridharan S; Physico-Chemical Characteristics of Surface and ground waters in the tannery belt of Vaniambadi and Ambur, North Arcot District, Tamil Nadu. Poll. Res, 1988; 17 (2):141-147.
33. Rath P, Bhatta D, Sahoo N, Panda U; Multivriate statistical approach to study of physico-chemical characteristics in Nandira Brahman river, Angul-Talcher belt , Orissa, India. Poll . Res, 2002; 19 (4):701-746.
34. Rao SN, Chanbey R, Srinivasan KV; Ganga water quality in Bihar. Ind.J. Environ. Health, 1990; 32 (4): 391 – 400.
35. Renukadevi C, Sastry CA; Toxicity of phenols to fish. Ind. J. Environ. Prot, 1987; 7(4):271 – 283.
36. Sharma SD, Ponde KS; Pollution Studies on Ram-ganga River at Moradabad, physico- chemical characteristics and toxic metals. Poll. Res, 1998; 15:111 - 113.
37. Singh VV, Raje SG; Recurring fish mortalities at Versora stress exigency for new strategies of conservation. Ind. J. Mar. Sci, 1998; 27: 502-505.
38. Singh M; Phytoplankton productivity in a small lake near Delhi. Physico-chemical variations. Phycus, 1965; 4:61 – 68.
39. Spehar RL, Carison RW, Lemke AE, Mount D, Pickering QH, Snakrshi VM;): Effect of pollution of fresh water fish. J. Hydrobiologia, 1981*;* 45. 127-162.
40. Srinivasa Rao A, Ram Mohan Rao P; Kolleru lake water pollution by pesticides. Ind. J. Environ. Health, 2002; 42 (4):169-175.
41. Sterrit RM, Lester JN; Interaction of heavy metals with bacteria. J. Ecotoxicology and Environ, 1980; 5 (2):131 – 138.
42. Stout JP; The ecology of irregularly flooded salt marshes of north-eastern Gulf of Mexico: A Community Profile. U.S. Fish and Wildlife service. Biol. Rep, 1984; 85(71).
43. Teal J, Teal M; Life and death of the salt marsh. Boston: Little, Brown. A Classic, 1969.
44. Teil MJ, Blanchard M, Carru AM, Cheoteri Koff A, Chevevil M; Portion of metabolic and organo chlorinated pollutants and mono ortho substituted PCB pattern in the trophic web from different areas of the river. Environment J, 1996; 181:111 – 123.
45. Tripathy DK, Adhikary SP; Preliminary studies on the water pollution of River Narmada. Ind .J. Environ. Health, 1990; 32 (4):363 – 368.
46. Trivedy RK, Goel PK; Chemical and biological methods for water pollution studies. Environmental Publication, Karad, India. 1986.
47. Trivedi P, Gurdeepraj; Water Pollution, Akashadeep Publishing House, New Delhi, 1992; 139 – 152.
48. Valiela I, Teal JM; The nitrogen Budget of a salt marsh ecosystem, Nature, 1979; 47:337 – 371.
49. Verma PS, Agarwal VK; Principles of Ecology. S. Chand and Company Ltd, New Delhi, India, 1992.
50. WHO; Management and control of the environment. World Health Organisation, Geneva, Switzerland, 1989.
51. Wittmann GTW; Toxic metals in: Metal pollution in the aquatic environment, chap. B. Forsner U., Wittman, G. T. W. (Eds). Springer Verlag Pub, 1979; 3-70.