Tuijin Jishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 44 No. 06 (2023)

Impact of Anthropogenic Activities on Certain Physico-Chemical Factor of Sediment Soil and Benthic Fauna in a Pond of Godda District Santal Pargana (Jharkhand)

Shashi Kant[1], M. K. Dubey[2], N. K. Mandal[3], P. K. Verma[4]
[1,2,3,4]Life Science Research Laboratory, Dept. of Zoology, Godda College Godda – 814133

***Abstract*:** Sediment soils provide substrate for benthic fauna as well as deliver nutrient, minerals and detoxify chemical pollutant to the aquatic ecosystem. Available nitrogen and Phosphorus in the sediment soil stimulate algal growth and enrich Cyanobacteria. Higher organic carbon promotes water retention capacity, soil structure and its fertility. Surface run off through agriculture and rain fall generally carry soil particle, fertilizer and pesticide etc that enter the pond and settle as sediment. Settling of sediment in the pond further improves the water quality. Nowadays, anthropogenic activities like bathing, washing of clothes, Utensil, immersion of idols, cattle dumping and disposable of domestic wastes are adversely affecting the pond ecosystem. Fish productivity mostly depends upon sediment soil properties. With this background lentic aquatic bodies are always at risk so its proper management and regular quality assessment are encountered in Rajkachari Pond situated in North-East area of Godda district in Santal Pargana of Jharkhand. The Plan of work includes both survey and laboratory analysis of sediment soil samples. Physico-chemical properties of sediment soil include (Conductivity, Specific gravity, pH, Organic Carbon, Total Alkalinity, Phosphorus, Potassium and Nitrate). Sediment soil analysis was carried out periodically on a monthly basis for twenty four months from January 2018 to December 2019. The investigation revealed remarkable variation in physico-chemical properties of sediment soil like (Organic Carbon, pH, Total Alkalinity, Phosphorus, Potassium and Nitrate) in the pond probably due to human induced allochthonous input of organic and inorganic matter mainly due to idol immersion, cattle dumping, washing of clothes, and regular influx of domestic waste, leading towards eutrophication process.

Keywords: *Anthropogenic activities, Physico-chemical factors, Sediment soil, Eutrophication.*

1. Introduction

Water is one of the most vital natural resources for the existence and survival of the organisms, so assessment of water quality and proper management of aquatic bodies of great concern. Ponds are most valuable water resources for fish culture as well as a convenient source for domestic needs. Nowadays, most of the ponds are adversely affected by anthropogenic activities such as washing of clothes, utensil, and disposable of domestic wastes causes undesirable changes in the sediment soil characteristics of the pond. Pond sediment soil play vital role in the balance of water ecosystem and subsequently on the growth and survival of aquatic biota (Ahmed, 2004). Sediment soils provide

substrate for benthic fauna as well as deliver nutrient, minerals and detoxify chemical pollutant to the aquatic ecosystem. Available nitrogen and Phosphorus in the sediment soil stimulate algal growth and enrich Cyanobacteria. Higher organic carbon promotes water retention capacity, soil structure and its fertility. Surface run off through agriculture and rain fall generally carry soil particle, fertilizer and pesticide etc that enter the pond and settle as sediment. Settling of sediment in the pond further improves the water quality. Sediment soil quality is one of the essential factors in the success of water culture especially in semi- intensive and intensive aqua culture ecosystem.

Benthic animals play significant role in the circulation and recirculation of essential nutrients in aquatic environment. They established a connecting link between the unavailable essential nutrients in detritus and useful protein materials in high trophic level such as zooplankton and fish. Many benthic individuals feed on debris that settle on the bottom of water and in turn serve as a major food source for wide range of zooplankton and fishes. Benthic communities are usually used as physico-chemical and biological indicators (e.g. the Water Framework Directive) because they can provide essential information on environment stages either due to the sensitivity of single species (indicator species) or because of some general characteristics that makes them integrate environmental signals over a long period of time. The features are exposure to chemical contaminants often accumulated in the sediment; exposure to low dissolved oxygen levels (hypoxia/anoxia) that often occur near the bottom surface due to organic and inorganic matter degradation.

Benthic fauna have physical, chemical and biological importance because they are consumed mainly by crustacean, fishes, and birds and also serve as an important food source of human being. Some of the benthic insects have parasitological importance due to being hosts to parasitic organisms which are agricultural pests. The study of benthic organisms are important due to the fact that the presence of some species is related to polluted areas, while for others, the presence of clean, unpolluted water is essential for their occurrence. Fresh water benthic organisms have been known to play vital role in the public and veterinary health and thus, needs to be scientifically explored more extensively.

The observation on physico-chemical properties of sediment soil of inland water bodies made by Mahapatra and Patrick (1969), (Manjare et.,al 2010) (Krishnamurhty, 1966), Rao et.,al (1990), Ahmed (2004), Borkar (2015), Trivedy and Goel (1986), Kashyap (2016) have been of special relevance to this investigation. Organisms were identified up to genus or species level as could be possible and number of each type was noted. The quantitative and qualitative analysis of macro invertebrate's samples was made with the help of Edmondson (1959), Pennak (1978) and Tonapi (1980).

Study area

The Pond under investigation is situated in the Northern-Eastern area about 800m away from the main chawk of Godda district under santal Pargana of Jharkhand state, India, Popularly known as Rajkachari pond. It is perennial in nature and rectangular in shape. The area of the pond is about 1.6 hectare having maximum depth of about 4.16m. Rajkachari pond is a good source of fish culture and fulfills fish demand of Godda district. The pond is surrounded by human habitation and affected by various anthropogenic activities mainly by dumping of domestic and municipal sewage, cattle dumping, washing of clothes, utensils, idol immersions etc. The monsoon water runoff also enter pond through inlet.

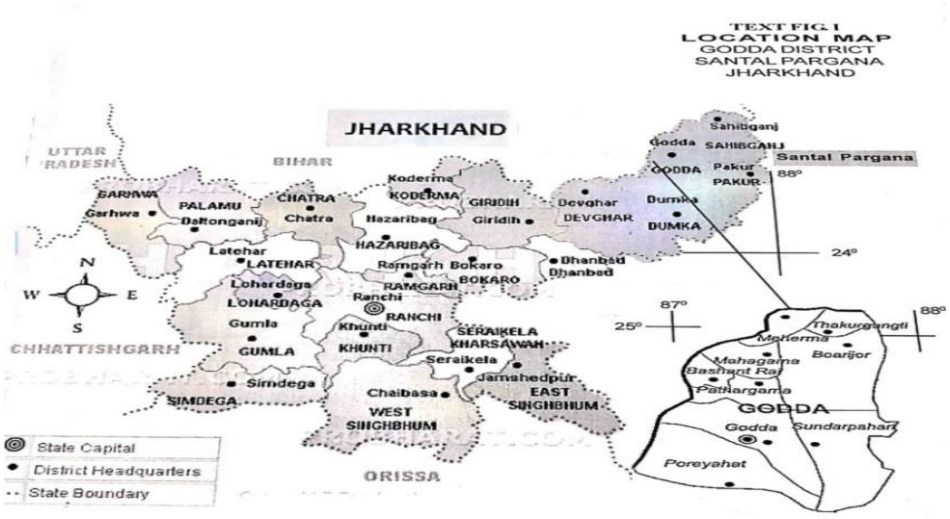

Fig 1: Map of Godda District (Santal Pargana) Jharkhand

Fig 2: Glimpse of Rajkachari Pond showing Chatt Puja Celebration

2. Material and Methods

Collection of Soil samples

Sediment soil samples from two spots were collected with the help of special borer samplers at a depth of 20-40cm. The samples were immediately brought to the laboratory in polythene Bag. The samples were dried at room temperature and powdered with the help of pistle-motor and sieved through a fine nylon sieve (2mm mesh size).

Bottom soil samples were collected from the pond with 10 cm diameter core tube at a depth of 20-40 cm. Colour of the soil was ascertained using Munsel soil colour chart. Texture was determined by using hand lens and mechanical analysis. Soil temperature and pH were immediately determined at the spot using fresh soil samples.

Physico-chemical properties of sediment soil condition in the pond were studied during twenty four month period (January 2018 to December 2019). Sediment soil samples were collected in monthly interval from surface of the pond at 9 am to 11 am. Sediment soil samples were collected from

sampling spot in the pond bottom and analyzed for its texture, Electrical conductivity, Specific gravity, pH, Organic carbon, Total alkalinity, available Phosphours, Potassium, Nitrate in the laboratory by using standard method of Adoni et.,al (1985) and Trivedy and Goel (1986).

Sample collection of Benthic fauna

The sampling strategy comprises a series of process aimed at selecting the favorable sampling site and determining the appropriate sampling density for accurate quality and quantification of benthic assemblage in a pond. Sampling procedure was carried out during pre-monsoon and Post monsoon season. Samples were collected 14th day of every month during the entire study period. The benthic fauna collection was done at day time 9:00 to 11:00 am. Devices used to sample soft bottom macro benthos basically comprise grabs, dredges, box- corners and hand nets. These devices allow good reproducibility and reliable replicates of samples. Ekmandredge was used for sampling. The suction sampler device was also used for collecting soft bottom macro benthos. These devices were pipe like tubes that suck small organisms and bottom sediments into a net, similar to the operation of a vacuum cleaner.

Sample preparation

The sampler was labeled in a bag. Samples are sieved in order to remove fine minute sediments and any other extraneous material. Before sieving the sample was noted on surface characteristics, individual diversity and density, occurrence of organic and inorganic detritus, etc. observed in a sampling form. Distilled water was used to avoid the introduction of unrelated small living organisms. The sample was then sieved; water was sprinkled directly onto the sample with a low pressure nozzle in order to prevent any damage to animals. In order to separate macro fauna, a sieve of 1mm to mesh was used. Aquatic vegetations present in sample were carefully removed from the surface of the sample rinsed apart and the resulting water sieved.

Sample analysis

The sieved material was fixed in a plastic container. The volume of the fixative was about three times the volume of the sample. The most common fixative for benthic organisms was used in a 10% formalin solution (or 4% formaldehyde). Formalin is an acids olution therefore it should be buffered in order to avoid the dissolution of calcareous part of the animals. For identification, the samples were taken into a round petridish (diameter15 cm and depth 2 cm) and placed on a white tissue paper for the easy observation. Organisms were categorized and counted under major taxa and preserved in small vials by using small brush or forceps. Binocular microscope was used to identify the benthic macro invertebrate organisms.

Organisms were identified up to genus or species level as could be possible and number of each type was noted. The quantitative and qualitative analysis of macro invertebrate's samples was made with the help of Edmondson (1959), Pennak (1978) and Tonapi (1980).

Table1.1: Physico-chemical characteristics of sediment soil such as pH, Electrical conductivity, Alkalinity, Organic Carbon, Phosphorus Potassium and Nitrate

(January 2018 to December 2018)

Month (2018)	Conductivity (Dsm/m)	Specific gravity	pH	Organic Carbon (%)	Alkalinity (meq/ 100 gm)	Phosphorus (mg/cm²)	Potassium (mg/cm²)	Nitrate (mg/cm²)
JAN	0.41	1.15	7.4	1.41	1.59	1.91	4.47	5.97
FEB	0.46	1.21	7.6	1.56	1.62	1.93	4.51	6.17
Mar	0.51	1.34	8.1	1.64	1.64	1.96	4.53	6.28
APR	0.64	1.42	8.3	1.72	1.67	2.03	4.58	6.32
MAY	0.69	1.53	7.9	1.78	1.73	2.14	4.63	6.38
JUN	0.62	1.58	7.2	1.82	1.61	2.23	4.69	6.47
JUL	0.58	1.47	6.9	1.84	1.54	2.35	4.76	6.56
AUG	0.52	1.44	6.4	1.73	1.42	2.40	4.85	6.60
SEP	0.49	1.32	6.6	1.68	1.46	2.32	4.70	6.52
OCT	0.45	1.28	6.8	1.62	1.49	2.28	4.62	6.44
NOV	0.43	1.23	7.1	1.59	1.52	2.14	4.56	6.28
DEC	0.39	1.19	7.3	1.53	1.56	2.06	4.42	6.21
Range Value	0.39-0.69	1.15-1.58	6.4-8.3	1.41-1.84	1.42-1.73	1.91-2.40	4.42-4.85	5.97-6.60

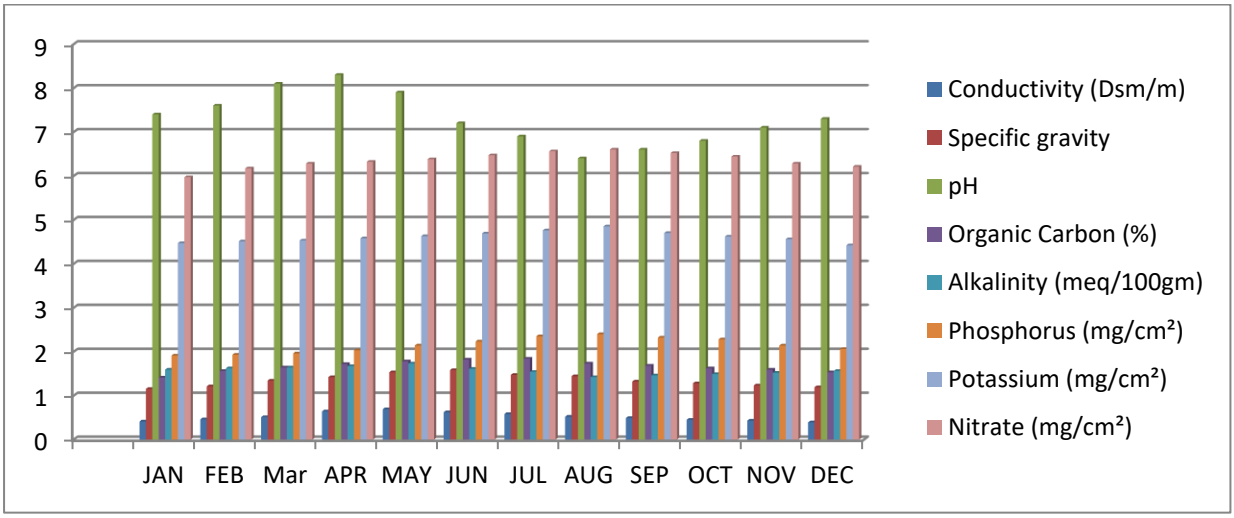

Fig 3: Monthly variation of Conductivity, Specific gravity, pH, Organic carbon, Alkalinity, Phosphorus, Potassium, Nitrate (January 2018 to December 2018)

Table 1.2: Physico-chemical characteristics of sediment soil such as pH, Electrical conductivity, Alkalinity, Organic Carbon, Phosphorus Potassium and Nitrate

(January 2019 to December 2019)

Month (2019)	Conductivity (Dsm/m)	Specific gravity	pH	Organic Carbon (%)	Alkalinity (meq/100gm)	Phosphorus (mg/cm²)	Potassium (mg/cm²)	Nitrate (mg/cm²)
JAN	0.32	1.18	7.3	1.46	1.37	2.04	4.29	6.08
FEB	0.37	1.21	7.5	1.48	1.39	2.09	4.38	6.09
Mar	0.43	1.24	7.9	1.56	1.48	2.13	4.44	6.18
APR	0.57	1.39	8.1	1.62	1.56	2.18	4.52	6.27
MAY	0.71	1.46	8.2	1.74	1.65	2.21	4.59	6.36
JUN	0.53	1.54	7.6	1.89	1.53	2.28	4.64	6.49
JUL	0.49	1.67	6.8	1.73	1.46	2.39	4.76	6.54
AUG	0.46	1.51	6.6	1.67	1.38	2.46	4.89	6.62
SEP	0.41	1.43	6.5	1.63	1.33	2.35	4.72	6.52
OCT	0.39	1.36	6.7	1.58	1.35	2.31	4.64	6.44
NOV	0.36	1.27	6.9	1.51	1.34	2.26	4.58	6.37
DEC	0.34	1.12	7.1	1.46	1.36	2.13	4.41	6.18
Range Value	0.32-0.71	1.12-1.67	6.5-8.2	1.46-1.89	1.33-1.65	2.04-2.46	4.29-4.89	6.08-6.62

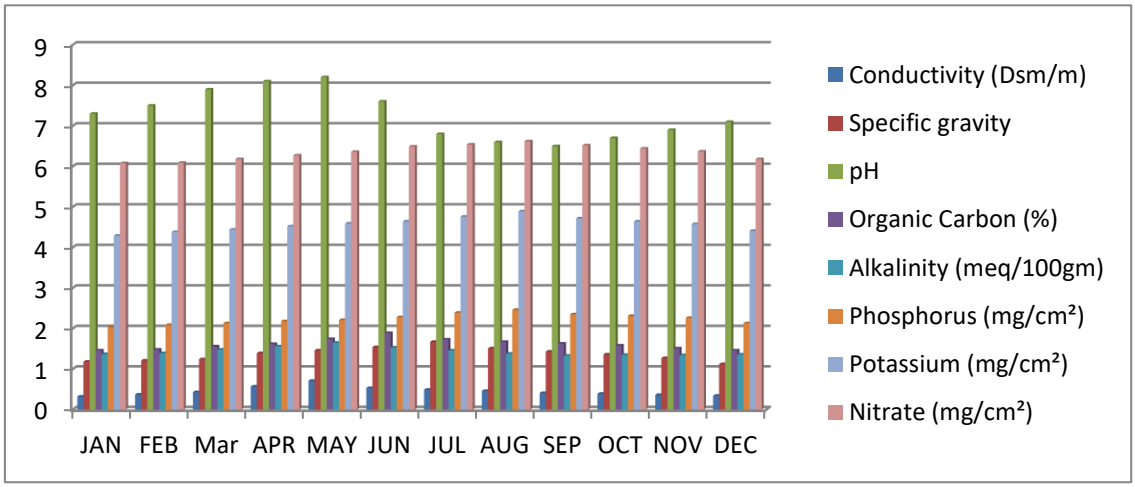

Fig 4: Monthly variation of Conductivity, Specific gravity, pH, Organic carbon, Alkalinity, Phosphorus, Potassium, Nitrate(January 2019 to December2019)

Table 1.3: List of identified Benthic organism found in Rajkachari Pond

Coleoptera	Gasrtropoda	Hemiptera
1.Dineutus indicus (Aube)	1.Bellamaya bengalensis	1.Belostoma flumineum

	(Lamarck)	
2.Dytiscus marginalis (Linneus)	2.Pila globosa (Swainson)	2.Hydrophilus triangularis
3. Haliplus flavicollis	3.Melania scabra (Hutton)	
4.Berosus luridus		

3. Results and Discussion

The results obtained are presented in table (1.1, 1.2 and 1.3) and illustrated in Fig 1-4. In the present study the colour of sediment is olive green in winter and early summer due to low amount of organic matter while it becomes gradually black in late summer and monsoon due to high organic matter. The soil texture of pond sediment contain 50-55% sand, 25-30% silt, 10-15% clay which may considered as sandy loam nature of soil. Electrical conductivity values recorded as minimum during winter months (0.32-0.41 Dsm/m) and maximum in summer months (0.69-0.71 Dsm/m) in April-May, reflects the rate of mineralization in the soil and is used to determine the harmful effects of salts/ions on the plant growth and seed germination (Green, 1963). The maximum value of electrical conductivity during summer month April-may (0.64-0.71Dsm/m) may be due to low water level as an outcome of higher temperature result in an increment in salt concentration. The rapid decomposition of Biomass may be another reason for the higher Electrical conductivity during summer months. Specific gravity values recorded as maximum during winter months December-January (1.12-1.15) and maximum during monsoon season June – July (1.58-1.67). The highest value of specific gravity was found in monsoon season may be due to agriculture run off. pH value recorded as minimum during monsoon August- September (6.4-6.5) and maximum in summer months April-May (8.2-8.3). In the present study alkaline nature of pond was observed. As the optimum pH of soil for fish production is ranged from 6.5 to 7.3 therefore, it had been concluded that highly alkaline condition of pond soil is undesirable for production of fish as reported by Ahmed (2004).

Organic carbon values recorded as minimum during winter months January (1.41-1.46 %) and maximum during monsoon months June-July (1.84-1.89%). The source of organic carbon is organic matter which influences colour, nutrient holding capacity and productive potentiality of the pond. Total alkalinity values recorded as maximum during summer months May (1.65-1.73 meq/100gm) and minimum in monsoon month August-September (1.33-1.42meq/100gm). Generally, higher value of total alkalinity indicated the eutrophic nature of the water body (Khasyap 2016). The sediment of a pond is alkaline in nature due to presence of humus which possesses different amino acid. Break down of these humus results in increased concentration of Carbon dioxide, hydrolysis of acids, salts and production of organic acids which add the total alkalinity of sediment (Krishnamurhty, 1966). Phosphorus values recorded as maximum in monsoon months August (2.40-2.46mg/cm^2) and minimum in winter month January (1.91-2.04mg/cm^2). Phosphorus is a common component of agricultural fertilizer, manure and organic waste in domestic and municipal sewage. It Play major role in productivity of the pond. The highest value of phosphorus during monsoon season may be due to leaching of soil from catchment area through rains, cattle dung, and other allochthonous material which enter the pond water along with surface runoff where the phosphorus quickly settles down at the bottom of the pond resulting in increase in total phosphorus content of sediments. Potassium (K) value recorded as maximum during monsoon season August (4.85-4.89 mg/cm^2) and minimum in winter month January (4.29-4.42 mg/cm^2). High Clay and Organic matter content of fish pond soil associated with alkaline pH value usually tend to maintain moderate to good amount of Potassium (K)

in pond soil (Manjare, et.,al 2010). Nitrate values recorded as minimum during winter month (5.97-6.08 mg/cm^2) and maximum in monsoon month August (6.60-6.62 mg/cm^2). Nitrate is an important component of aquatic ecosystem. Intrusion of domestic and municipal sewage into the natural water increases the level of nitrate.

Benthos are the biocoenoses of the solid liquid interface. They form an important component of the secondary production of aquatic ecosystem mainly utilizing the energy of decaying organic matter settles at the bottom as organic detritus. Benthic fauna have ecological as well as economic importance because they are consumed mainly by fish, mammals, crustaceans, birds and also serve as human food. The composition and abundance of benthic organism are commonly used as a biological indicator to determine the impact of anthropogenic activities on water. The distribution and abundance of benthic organism are correlated with the particulate composition, soil texture, and organic matter content of sediment (Rao et., al 1990). In the present study the overall benthic composition in the pond constitutes 9 species. Among these 4 species belongs to order Coeloptera, and 3 species belongs to Gastropoda, and 2 species belongs to Hemiptera. During the investigation the density of benthic fauna was found maximum during winter season because during winter season the predation pressure is low as well as the capacity of water to holding Oxygen is high which makes suitable condition for benthic organism (Adoni et.,al 1985).

4. Conclusions

The observation substantiated by physico-chemical properties of sediment soil and benthic fauna confirm that the pond receives organic pollution of anthropogenic activities, water quality in the pond is slowly reaching to alarming stage and therefore, proper planning is essential to conserve its fragile ecosystem.

Recommendations

Certain effective remedial measures should be taken into consideration for raising the productive potentiality, fish yield and proper conservation of the pond.

1. Discharge of domestic and municipal should be restricted.
2. Human activities like cattle dumping, idol immersion, washing of clothes etc should be strictly discouraged.
3. Plantation around pond will check soil erosion that usually occur during monsoon.
4. Periodical renovation by removing silt will help to restore its perennial nature and productivity.
5. Fisherman Cooperative society should properly uptake the fish culture management to improve the fish yield on commercial basis.

5. References

[1] Adoni, A.D., Joshi, G., Ghosh,K., Chourasia, S.K., Vaishya ,A.k., Yadav, M. and Verma, H.G. (1985) : work book on limnology, Pratibha publishers, sagar.

[2] Ahmed, H. (2004): Soil quality Analysis and consideration in the selection of sites for sustainable Aquaculture in the south East coast of Chittagong specially Halishahar Area. M.sc. Thesis (unpublished), Institute of Marine science and fisheries, University of Chittagong Bangladesh 80 pp.

[3] Borkar, A.D.,(2015): Studies on some physcico-chemical parameters of soil samples in Katol taluka District Nagpur Maharastra India, Research Journal of Agriculture and Forestry Sciences ,3(1):16-18pp.

[4] Edmondson. W.T. (1959): Freshwater Biology 2nd Edition.Johnwiley And Sons Inc. New York.
[5] Green, J. (1963): Zooplankton of the River Sokoto. The Rhizopods, Testacia Proc. Zool. Soc. London., 141:497-514.
[6] Kashyap, V.R (2016): Physicochemical Analysis of Various water sample Rewa district (M.P), International Journal of Applied Research 2:311-313.
[7] Krishnamurthy, K.P. (1966): Hydroiological studies in Gandhisagar (Jammu tank) seasonal variation in plankton. J. Ecol. 27:227-232.
[8] Mahapatra, J.c. and Patrick, Jr. W.H. (1969): Inorganic phosphate transformation in water logged Soil Sci. 107:281-288.
[9] Manjare, S.A, Vahanlakar S.A, Muley, D.V (2010): Analysis of water Quality using Physico-chemical parameter Tamdalge tank in Kohlapur district Maharastra. International Journal of advanced Biotechnology and research 1:1(2)115-119.
[10] Pennak, R.W. (1978): Fresh water invertebrates of United states, 2nd Ed. John Willey and Sons Inc. New York. 803pp.
[11] Rao, K. S., Karth, K.N., Gupta, D. R., Srivastava, S., Choubey, Usha and Pandaya, S. S. (1990): Studies on morphometric, hydro-biological and sediment characterstics of Gandhi sagar lake in relation to its fisheries. J. Inland Fish. Soc. India, 22 (1&2) : 55-65
[12] Tonapi, G.T. (1980): Fresh water animals of India. Oxford and IBH Publishing Co., New Delhi, 341pp.
[13] Trivedy, R.k and Goel, P.k. (1986): Chemical and Biological Methods for Water pollution Studies. Environmental publication, Karad.