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Studies on the Nutrient Status and Plankton Succession in Four Ponds of Rajshahi Pisciculture Hatchery

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STUDIES ON THE NUTRIENT STATUS AND PLANKTON SUCCESSION IN FOUR PONDS OF RAJSHAHI PISCICULTURE HATCHERY

BY

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UNIVERSITY OF RAJSHAHI

DECLARATION

I do hereby declare that whole of the work submitted as a thesis for the degree of Master of Philosophy in Botany of the University of Rajshahi, as the result of my own investigation.

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Candidate

CERTIFICATE

I do hereby certify that the work embodied in this thesis has not already been submitted in substance for any degree and has not been concurrently submitted in candidature for any degree.

MOHD. Azizul Islam

MOHD. AZIZUL ISLAM
Candidate

CERTIFICATE

Certified that the thesis entitled "Studies On The Nutrient Status and Plankton Succession in Four Ponds of Rajshahi Pisciculture Hatchery" is suitable for submission for the Degree of Master of Philosophy of the Rajshahi University, as to the style and content.

M. Zaman

Dr. M.Zaman
Professor of Botany
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CONTENTS

ABSTRACT

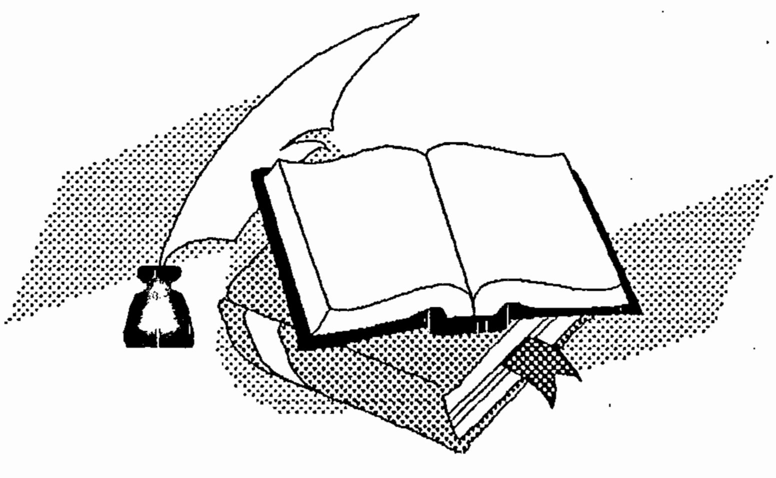
Physico-Chemical and Biologycal investigation of four selceted ponds of Rajshahi Pisciculture Hatchery was carried out for twelve months from May ,1994 to April,1995. Fortnightly Sampling was performed in the study ponds. The Physico-chemical parameter and plankton abudance with their seasonal succession was studied . The range of phyico-chemical and Biological conditions of the study ponds were considered separately.

The range of the water temperature varied from 19.3-31.8^{0}c,in pond-1, 18.4-32.8^{0}c in pond-2,19.0-32.5^{0}c in pond-3 and 19.1-32.5^{0}c in pond-4 Average depth-0.9-1.2 M. in pond-1, 1.4-1.8 M. in pond-2, 1.7-2.3 M.in pond-3 and 1.4-1.9 M. in pond-4; TDS-353-488.3 mg/l in pond-1, 383-499 mg/l in pond-2, 381.6-450.1 mg/l in pond-3 and 351.3-404.6 mg/l in pond-4; E. cond-543-753 µmoh/cm in pond-1, 422-767µ moh/cm in pond-2, 597-690µ moh/cm in pond-3 , and 541-724 µmoh/cm in pond-4 : p^H 7.7-8.7 in pond-1 , 7.8-8.9 in pond-2 , 8.2-8.9 in pond-3 and 8.1-8.9 in pond-4; Free $C0_2$-2.8-34.7 mg/l in pond-1, 4.3-32.5 mg/l in pond-2, 1-4.6 mg/l in pond-3 and 0-5.7 mg/l in pond-4 ; $C0_3$-alk. 0-34.5 mg/l in pond-1 , 0-15.2 mg/l in pond-2 ,1.2-8 mg/l in pond-3 and 1.8-7.7 mg/l in pond-4 ; HCO_3-alk. 21-403 mg/l in pond-1, 18.7-356.7 mg/l in pond-2, 15.1-445.2 mg/l in pond-3 and 15.2-366.6 mg/l in pond-4; Total hardness-200-467 mg/l in pond-1 ,214.2-609.2 mg/l in pond-2 , 238.7-608.8 mg/l in pond-3 and

197.8-469.3 mg/l in pond-4; Chloride 99-143 mg/l in pond-1, 103.6-191.7 mg/l in pond-2, 103.4-201.3 mg/l in pond-3 and 93.4-142 mg/l in pond-4; DO 4-7.6 mg/l in pond-1, 5-8.4 mg/l in pond-2, 5.7-9.6 mg/l in pond-3 and 6.5-10.6 mg/l in pond-4; BOD_5-2.7-12 mg/l in pond-1, 2.5-9.6 mg/l in pond-2, 3.2-13.6 mg/l in pond-3 and 8.6-16.8 mg/l in pond-4; COD-7.2-22 mg/l in pond-1, 6.4-20.7 mg/l in pond-2, 8.7-26.3 mg/l in pond-3 and 17.3-37.2 mg/l in pond-4; Ammonium-nitrogen-0-0.13 mg/l in pond-1, 0-0.2 mg/l in pond-2, 0-0.13 mg/l in pond-3 and 0-0.2 mg/l in pond-4, PO_4.0.1-0.7 mg/l in pond-1, 0.03-0.2 mg/l in pond-2, 0.01-0.3 mg/l in pond-3 and 0.02-0.4 mg/l in pond-4; Eh-0.25-0.35 mv. in pond-1, 0.22-0.35 mv. in pond-2, 0.23-0.31 mv. in pond-3 and 0.23-0.32 mv in pond-4 and rH_2-25.8-27.8 in pond-1, 25.3-27.6 in pond-2, 25-27 in pond-3 and 15.8-27.2 in pond-4.

In all 33 genera of phytoplankton were indentified of which 12 genera belonged to Chlorophyceae, 7 to Cyanophyceae, 10 to Bacillariophyceae, 3 to Euglenophyceae and 1 to Dinophyceae. In all 38 genera of Zooplankton were recorded of which 8 belonged to Copepoda, 7 to Cladocera and 12 to Rotifera. The quantitative and qualitative analysis of physico-chemical factors of waters and abundance of phytoplankton and Zooplankton reveal that all the ponds under study are eutrophic in nature.

INTRODUCTION



INTRODUCTION

Bangladesh lies between 20.30^0 and 6.45^0 north latitude and between 88.00^0 east longitude. It is a humid-tropical, low lying flat country abounding in large number of rivers, haors, beels, flood plain wetlands, khals and artificial ponds .Many of these water bodies are lentic and lotic water systems differing ecosystemologically with respect to their biotic and abiotic components which lead to overall productivity. During the recent few years captive or pond fishery has become popular in the country. In this sector Bangladesh has immense potential for increased food production in her vast inland water bodies especially the ponds. Utilization of this production potential is most essential to meet the protein requirement of the country. The total area of culturable water bodies in the country is estimated to be 150,000 ha. and 50 percent of these are being utilized for aquaculture (Nuruzzaman, 1992). FAO and world Bank indicated that through proper culture-based fishery and efficient management, an increased production of about 300,000 ton/year is possible in Bangladesh.

Ponds and tanks occupy 360,000 acres or 10 percent of total inland water area in Bangladesh. Bangladesh Bureau of Statistics states that the total number of ponds in the country are 12,888,222 covering an area of 362,980 acres. According to SPARSO (1994), the total number is estimated to be 13.76 lacs covering 1.44 lac hector. However, there is dearth of detailed statistics on pond fishery in the country. Number of culturable ponds and other types of water bodies is high in Rajshahi district compared to other regions of the country. Side by side with the Government managed pisciculture hatcheries, a large number of such organizations are in function under private management in the Rajshahi region.

Rajshahi City Corporation covers an area of about 299.43 sq.km. where the total cultivable land is about 1790.20 hector and the total span of water in terms of ponds is about 320 hector (Naz, 1995). A total number of 818 ponds of various sizes are present in the Rajshahi City Corporation area. Of these 818 ponds 676 ponds are under pisciculture and 142 are derelict (Naz, 1995). The annual production of fish in these ponds is estimated at about 439.15 m.t. per year. Of these total number of 818 ponds, a large number of ponds are within the jurisdiction of the Government. Rajshahi Pisciculture hatchery, situated at the heart of the city, is a Governmental organization having a good number of exotic and indigenous origin and for raising fish hatchlings to be sold to the fish farmers. The hatchery ponds are under intensive cultivation and frequently charged heavily with organic and inorganic manures and fish feed indiscriminately. Toxic chemicals including some chlorinated hydrocarbons are used at the time of pond preparation prior to stocking. Such actions are taken to eliminate the non-culturable fishes. This has resulted in the total elimination of a large number of inland fresh water non-culturable fishes from the area. Indiscriminate use of organic and inorganic manure along with frequent use of supplementary feed and toxic chemicals have a deleterious effect on the pond ecosystem as a whole. The hatchery ponds were found to be without any macrophytes and visual algal blooms were absent, which warrant thorough investigation.

The applied aspect of limnological studies involves the evaluation of fresh water resources delimited by the quantity and quality of the flora and fauna which a water body can support. Plankton including phytoplankton and the zooplankton are regarded as the best index of biological productivity and the nature of the habitat (Welch, 1948; Hutchinson, 1967; Philipose, 1959). In the culturable ponds, the production of plankton, especially the right type of plankton, is essential for successful rearing of fish and higher fish production. Among many problems involving the fish cultivation in ponds, scientific ways of management of pond water for fish augmentation and perpetual use of the culturable water bodies as renewable natural resources are considered very important. Limnological knowledge and their proper application for better fish yield and management of the ecosystems are pre-requisites for sustainable fish-sectoral development and maintenance of the eutrophic nature of the pond ecosystem. As a matter of fact, fish farming is a practical application of limnology and aquacultural biology. It is therefore, most important to study the interrelationships between the physico-chemical aspects and plankton and also between phytoplankton and zooplankton and the effect of cultural practices on this biota. Although there are a lot of phycological and limnological works carried out elsewhere in the country, Rajshahi region is not represented as yet, and this region still remain a virgin field for such investigations. Now-a days smaller water bodies are regarded as one of the best ecosystems for conducting researches on biomanipulation with a view to boosting up of the aquatic terminal product in terms of fish for human needs. Although, Rajshahi pisciculture hatchery is a suitable organization for such activities of biomanipulation, yet it is known to suffer from improper management of the pond ecosystem from limnolgical and ecological point of view. Considering this fact, the present investigation was undertaken.

Objectives of the work.

1. To know the physical condition of the habitat including air and water temperature, average depth, limit of visibility or penetration of light in water, TDS and electric conductivity of water of the study waters.

2. To know the major chemical conditions including P^H, free CO_2, CO_3, and HCO_3 alkalinities, total hardness, Chloride, DO, % saturation of O_2, BOD, COD, NH_3 - N, PO_4, Oxidation-reduction (Eh) and Oxidation-reduction index (rH_2).

3. To study the monthly, seasonal and annual abundance and percentage composition of the phyto-and zooplankton and their seasonal succession in the study ponds.

4. To study the interrelationships between the physico-chemical variables and between the physico-chemical variables and the phyto and zooplankton.

5. To study the primary productivity in the study ponds.

6. To evaluate the trophic nature of the study ponds.

Review of Literature

Bangladesh abound with large number of natural bodies of inland water known as rivers, khals, beels, haors, baors, marshes and ponds. Many of these lentic and lotic water systems are permanent and seasonal water bodies.

Bangladesh had been almost a Virgin field for phycological studies till the first half of the present century. A few workers made some contributions in this field during the early thirties. Notable among of them were Benerjee (1936) who worked on the Myxophyceae of water logged conditions of lower Bengal covering the districts Mymensingh, Dhaka, Faridpur and Jessore of Bangladesh and 24-parganas of West Bengal of India. Kundu (1934, 1935 and 1938) worked on the characeae of Rajshahi district of Bangladesh. During the last twenty years, there have been a tremendous progress in the study of the algal taxonomy in Bangladesh. Islam and his students of University of Dhaka have made valuable and original contributions to the field of algal taxonomy and ecology of the inland waters in the country. Among the large number of their works, the notable publications on the algal taxonomy and ecology of the inland waters of Bangladesh are Islam (1960, 1962, 1963, 1965, 1969, 1970, 1972, 1973a, 1973b, 1974a, 1975, 1976, 1980 and 1982), Islam and Ahia (1964), Islam and Sarma (1964a), Islam and Sarma (1964b), Islam and Khatun (1966), Islam and Nahar (1967), Islam and Sarma (1965), Islam and Sarma (1968), Islam and Begum (1970), Islam and Zaman (1974), Islam *et al* (1978), Islam and Sarma (1976), Islam *et al* (1978), Islam *et al* (1978), Islam *et al* (1978), Islam and Hossain (1978), Islam and Uddin (1973), Islam and Uddin (1978a), Islam and Uddin (1978b), Islam and Haroon (1978), Islam and Aziz (1975), Islam and aziz (1979), Islam and Alam (1980), Islam and Zaman (1981), Islam and Haroon (1980). In these papers, the authors have described the algal flora of the fresh water habitats of Dhaka and the adjoining districts.

Although, a noteworthy progress have been made on the taxonomy of algal flora in Bangladesh since the early seventies, studies on the hydrobiological and limnological aspects of the inland water are not sufficient. Our knowledge is poor about the effects of various physico-chemical factors on the qualitative and quantitative aspects of aquatic flora and fauna which are of immense value from the biological and ecological points of view. Recently, however, a few workers have made some preliminary hydrobiological and limnological studies in some selected places of the country. Begum (1958) made some preliminary studies on the plankton in a fresh water pond in Dhaka. Islam and Khtun (1966) and Islam and Nahar (1967) worked on the plankton of polluted water. Islam and Begum (1970) made some contributions to the knowledge of phytoplankton of Dhaka district. Das and Bhuiyan (1974) worked on the limnoplankton of Dhaka. Islam *et al.* (1974) and Islam and Haroon (1975) studied the limnology of the river, Buriganga covering its physico-chemical and biological aspects. Islam and Shaha (1975) studied on the limnology of Ramna lake in Dhaka with some observation on the degree of pollution in this aquatic habitat Mahmood *et al.* (1976) made some hydrobiological observations on the Karnafully estuary. Islam and Mendes (1976) worked on the limnological aspects of a Jheel in Sher-E-Bangla Nagar in Dhaka. Shafi *et al.*(1978) made some valuable contributions to the limnology of river, Meghna. Mollah and Haque (1978) made some valuable additions to the knowledge of physico-chemical and biological aspects of some lotic and lemtic habitats in Mymensingh. Islam *et al.*(1978) studied the limnology of some fresh water ponds in Dhaka. Islam and Paul (1978) made some hydrobiological studies of the Hakaluki Haor in the Sylhet district of Bangladesh. Islam *et al.*(1979) and Islam and Chowdhury (1979) worked on the macrophytes, benthic flora and the phytoplankton of the Dhanmondi lake in Dhaka.

Ali *et al.* (1980) studied the seasonal abundance of plankton in a pond in Dhaka. Islam *et. al* (1980) made some hydrobiological observation at Naogaon in Rajshahi and recorded a few new algal species and discussed the environmental conditions of the habitat. Rahman *et. al* (1982) and Mumtazuddin *et. al* (1982) worked on the limnology of fish ponds in Mymensingh and made some suggestions for the improvement of the overall productivity. Habib *et. al* (1983), Islam *et. al* (1983), Habib and Badruddin (1983) and Habib *et. al* (1984) worked on the physico-chemical characters of water and made some practical suggestions for high productivity in these aquatic bodies of Mymensingh. Ameen *et. al* (1986) also made some observations on the physico-chemical and biological conditions of some selected fish ponds in Dhaka. Ronald and Azadi (1987) studied the ecology of Halda river in Chittagong and made some estimations of the planktonic organisms and their co'relation with the physico-chemical conditions of water. Begum *et. al* (1989) and Nesha *et. al* (1989) worked on the physico-chemical conditions of water and seasonal variation of the plankton in some selected fish ponds in Dhaka with some notes on the productivity of these ponds.

Oppenheimer *et. al* (1978) and Islam *et. al* (1978) studied the lomnology of some fresh water ponds in Dhaka. Chowdhury *et. al* (1989) worked on the seasonal variation of zooplankton in a fish pond of Dhaka in relation to some physico-chemical factors. Mahmood (1986) studied the hydrobiology of Kaptic reservoir. Khondker *et. al* (1988) and Khondker and Rahim (1991) studied the primary productivity and water quality of Dhanmondi lake of Dhaka. Khondker *et. al* (1990) made limnological studied of some ponds in and around Dhaka city. Khondker and Perveen (1992) worked on the limnology of a lake. Naz (1991) studied the eutrophic and hypertrophic nature of fish ponds of Rajshahi University and the adjacent region. Khondker *et. al* (1993) studied the periphytic and planktonic algae as indicators in Dhanmondi lake. Zaman *et. al* (1993) made a comparative limnological studies of three ponds in the Jahangirnagar University campus.

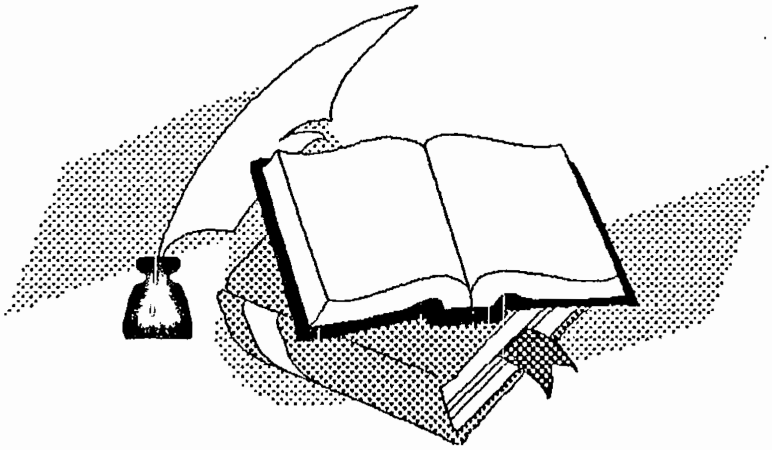
Many other scientists including Bhouyain *et. al* (1981), Mirza *et. al* (1985), Ali *et. al* (1980 and 1982) and Ali *et. al* (1983), Bhouyain and Asmat (1992), Zafar (1964), Zafar (1967), Bhouyain (1983), Khondker (1994 and 1995), Latif *et. al* (1986), Munawar (1970), Banu *et. al* (1987), Ameen *et. al* (1986), Ameen *et. al* (1987), Ameen *et. al* (1988), Khan *et. al* (1990), Zaman *et. al* (1993) have also made valuable addition to the knowledge of physico-chemical and biological aspects of various lentic and lotic water systems including the fish culture ponds in the country during the recent years. Zaman (1991) studied the physico-chemical and biological aspects of Chalan beel and discussed the interrelationships between the physico-chemical parameters and plankton abundance including their periodicity and seasonal variations. Mushfaqua (1995), studied on the physico-chemical conditions and occurrence of the plankton biota in Ramsagar in Dinajpur. Fakruzzaman (1987) studied on the heleo planktion of lower barind region in relation to physico-chemical conditions.

Presently pond fishery is being practiced in the country in large scale for better augmentation of fish product. During the recent years a number of works on pond fishery have been done, but evaluation of modern technique of pisciculture as captive fishery is yet to be made.

Alongside, in India a large numbers of Limnological studies have been made during the last 3 decades. Notable amongst them are Venkateswarlu (1969 and 1986), Philipose (1957, 1959 and 1960), Sreenivasan (1963, 1964 and 1965), Rao (1953 and 1955), Rao (1977) and Rao (1979), Singh (1960), Singh and Ahmed (1990), Das and Srivastava (1956), Akhtar (1970), Kant and Anand (1978), Agrawal *et. al* (1976), Adebisi (1980), Biswas (1993), Chandler and Weeks (1945), Chakrabarty *et. al* (1959), Bhatnagar and Sharma (1973), Chakrabarty (1995), Ganapati (1957), Mirsha and Yadev (1978), Goutom (1990), Mirsha and Trivedy (1993), Palharya *et. al* (1993), Arora (1961), Trivedy (1990), Trivedy and Raj (1992), Paramasivam and Sreenivasan (1981) Ganapati (1940 and 1960), Mishra and Saksena (1992), Patil (1982), Sahai and Sinha (1969), Nasar and Sharma (1980), Pandey (1965), Lakshminarayana (1965), Roy (1955), Sukla (1971) and Rai (1978).

CHAPTER -2

MATERIALS & METHODS



Materials and Methods

Water and Plankton samples were collected at fortnightly intervals from the four study ponds in Rajshahi Pisciculture hatchery thrice in each sampling date (8 AM; 12 AM and 4 PM).

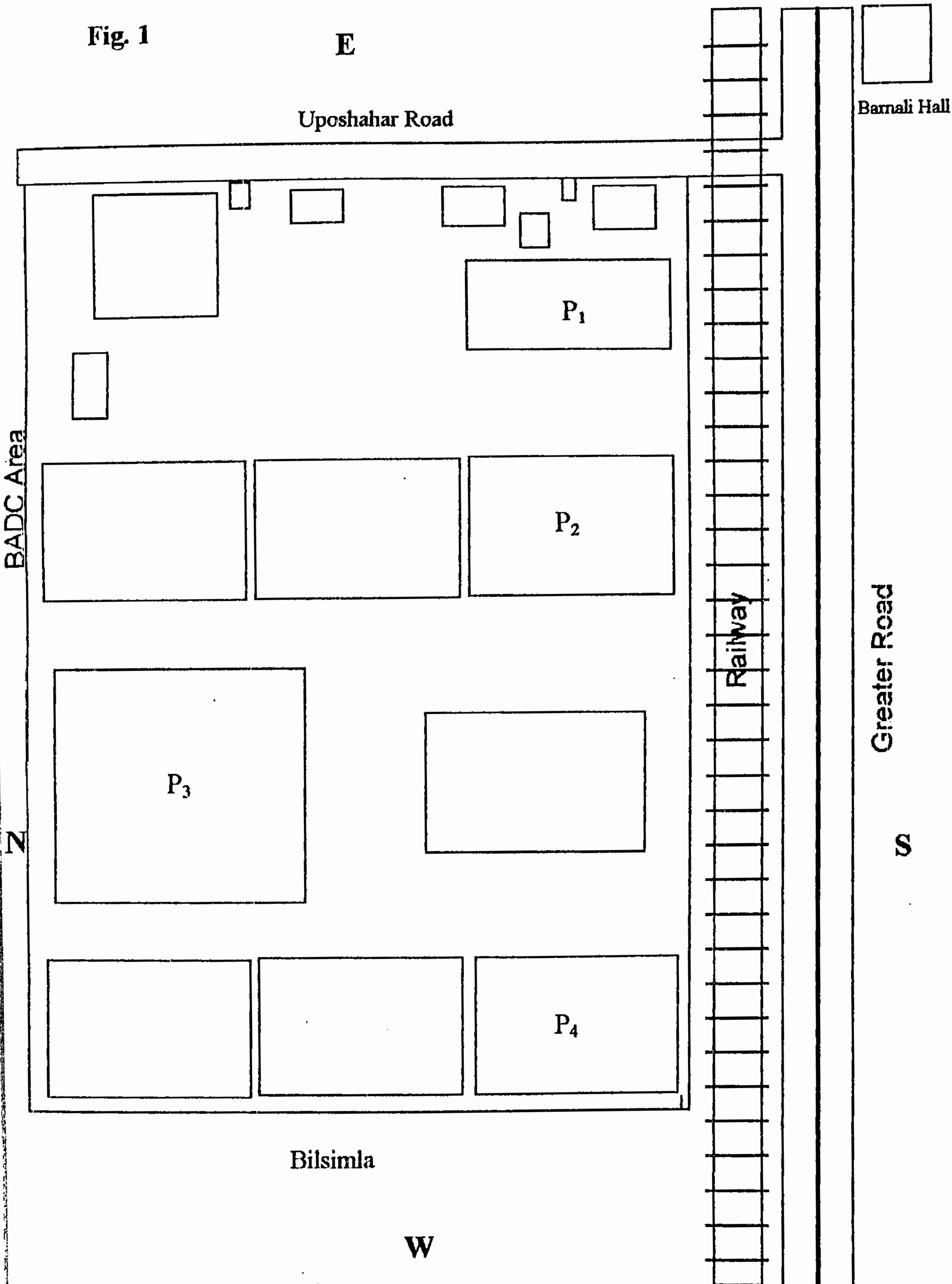
The sampling dates were fixed between the 14th & 15th and the 29th & 30th days of each month. The data obtained from the regular analysis of the physico-chemical conditions were shown in tabular forms. The monthly abundance of phyto-and zooplankton were also presented in separate tables.

Description of the study ponds

The four study ponds are located in the Piscicultural Hatchery in Rajshahi. There are nine ponds in the hatchery under semi-intensive fish cultivation. Of these culture ponds, four were selected for the present investigation. These four ponds are located at a distance of 15 Meters from each-other (Fig.1). All the pond are highly charged. Each year in the month of November all ponds were de-watered and lime, Cow-dung, Poultry-litter, Urea, Triple-super-phosphate, Mustard oil-cake were used as needed. At the end of the year, 1993, 3 kg/decimal and at the end of the year, 1994, 9 kg/decimal lime were used in all the ponds.

Copper-sulphate, Sumithion and Dipterex were used three to five times in each month of the year in all ponds to control the plankton to avoid oxygen deflation. Triple-super-phosphate, Urea, Cow-dung and additional mixed food made by cattle-blood, rice-bran and mustard oil-cake were used in each day in all the ponds at the rate of 2-3% of total weight of stocked fishes.

Fig. 1


E
Uposhahar Road
Barnali Hall
BADC Area
P1
P2
P3
P4
Railway
Greater Road
N
S
Bilsimla
W

Pond-1 (P_1): This ponds is situated near the hatchery. This is rectangular in shape. This pond covers an area of (15X45) 675M^2. No slope is presented in this pond. This pond is highly charged. Hatchery washing materials like Copper-sulphate ($CuSO_4.5H_2O$); sulphuric acid (H_2SO_4); Hydrochloric acid (Hcl); Bleaching powder [Ca[Ocl]cl]; washing soda ($Na_2CO_3.1OH_2O$); Potassium Permanganate ($KMno_4$); Methyline blue ($C_{16}H_{18}ClN_3S.2H_2O$); Formaline (HCHO); are regularly mixed into the water of this pond as Hatchery effluent. The average depth of this pond is o.75M.

Pond II (P_2): This Pond is situated near the pond (P_1). This Pond is rectangular in shape and covers an area (37X45) 1665M^2. Slopes of this pond are broken and irregular. This pond is a charged pond. Average depth of this pond is 1.5M.

Pond III (P_3): This pond is located at the middle of all other hatchery ponds. This pond is square in shape and covers an area (64X64) 4096M^2. The slopes of this are broken and irregular due to feeding activity of Common Carps. This pond is also a charged pond. The average depth of this pond is 1.5M.

Pond IV (P_4): This pond is located near study pond- 3 (P_3). This pond is rectangular in shape and covers an area (87X45) 1665 M^2. Slopes of this pond are broken due to feeding activity of Common Carps. This is a charged pond. The average depth of this study pond is 1.2 M.

Physical Conditions :

Air and Water Temperature :

A centigrade thermometer with the range of 0^0c to 110^0c was used to note the air and water temperature simultaneously during the time of sample collection. The temperature of water below the surface was recorded by dipping the thermometer at a depth of 10 to 12 cm. below the surface. To record the bottom temperature, the thermometer was tied with a silk line and descended till it reached the bottom and was kept for some times. Then it was drown upward quickly but Carefully and withdrawn from water Then, the Temperature was recorded immediately.

Transparency of water:

Measurement of limit of visibility i.e. Penetration of light in water was done by a secchi-disk. The secchi-disk was tied with a line and a meter- scale tape. Then it was slowly lowered into the water and depth at which it became invisible was noted. It was then, allowed to drop a little farther and the disk was pulled upward slowly the depth at which it reappeared was noted. The average of these two readings was taken to be the limit of visibility.

The sinking of the disk was always viewed under a sunshed for considerable accuracy in result. The data, thus, obtained, were expressed as secchi-disk depth in cm. Monthly variations of the secchi-disk depth were presented in tabular forms.

Average depth:

Average depth of water in the study ponds were taken regularly at fortnightly intervals during the study period from May 1994 - April 1995. It was accomplished by lowering a graduated nylon tape holding a metal weight at the end for sinking. Sometimes a graduated bamboo pole was also used for this purpose. The data for all the twelve months (two fish culturable years) from May, 1994 to April, 1995, were presented in tabular forms.

Chemical Conditions:

Dissolved oxygen Content and Percentage of Saturation of oxygen in water:

winkler,s method (unmodified) was followed for the estimation of dissolved oxygen content of water below the surface and also at the bottom. A glass stoppered bottle of 250 ml capacity was dipped into water. 10-15 cm. below the surface. The bottle was held under water and the glass-stopper was taken off and replaced again when the bottle was completely filled with water. The water-filled bottle was then take up for analysis in the field. Sample water from the bottom was collected by diving with sample bottle. The water filled bottles were taken up for analysis in the field. Dissolved oxygen was estimated immediately after collection, or the samples were treated with manganous sulphate soln., alkaline iodine soln. (KOH-KI soln.) and acidified with conc. sulphuric acid for later estimation. The treated samples were transferred to the laboratory and the remaining steps of analysis were done. The quantity of dissolved oxygen, thus estimated, was expressed in milligrams per liter of water (mg/l). The percentage of saturation of oxygen in water below the surface and at bottom, was calculated by dividing the titration value in ml. by the solubility value as determined by temperature, following the methods of Montogomary *et al* (1964), and Murry and Riley (1969). Rowson's nomogram (1944) was also used for a quicker reference to the oxygen saturation values. Percentage of saturation values vary with altitude, atmospheric pressure and temperature. As the study area is situated about 25 meter above the sea level, the saturation correction value was corrected by dividing it by the appropriate correction factors as followed by Mortimer (1956). The data, thus obtained were presented in tables. The monthly variation of dissolved oxygen content were presented in separate tables:

Carbonate alkalinity (CaCO3):

Carbonate alkalinity or phenolphthalein alkalinity was determined by titration of 100 ml. of water sample (from below the surface and at bottom), with N/150 sulphuric acid using phenolphthalein as an indicator (welch, 1948). The resultant data was, expressed in mg/l of $CaCo_3$ per litre. Monthly variations were computed in tables.

Bicarbonate alkalinity ($CaHCO_3$) :

Bicarbonate alkalinity or methyl orange alkalinity was determined by titration of 100 ml. of water sample (from below the surface and at bottom) with N/50 sulphuric acid using methyl orange as an indicator (welch, 1948). The results were expressed in mg/l of $CaHCO_3$. Monthly variations were presented in tables:

Hydrogen Ion Concentration (p^H) :

Water samples were collected by dipping the broad mouthed glass stoppered bottles below the surface and at the bottom to estimate the values of p^H. The p^H values were determined by using a digital p^H meter (Model. Hanna-Instrument). All the data with monthly variations were presented in the tabular forms.

Electric Conductivity:

The value of Electric conductivity of water determined by using a portable conductivity meter (Moole, CM-1k) of range 0-10,000 Mm. moh/cm. All the resultant data were expressed in micro ohms per centimeter (µmoh/cm). Monthly variations were presented in tables. The value of Electric Conductivity was estimated by the formula given FAO (1984).

Oxidation - Reduction or Redox potential (Eh) :

The value of oxidation- Reduction (Redox potential) [Eh] was determined indirectly from the following equation based on the p^H value of water samples.

$$Eh = Eo - o.o58\ p^H + o.o145\ X \log PO_2$$

Where, Eo= standard electrode

Potential was determined directly as per O_2 values following Gautom (1994). The monthly variations of Redox Potentials were presented in the tabular forms.

Oxidation- Reduction Index (rH_2) :

The value of Oxidation-Reduction Index (rH_2) was calculated by following the equation similar to that of Eh. $rH_2 = Eh/0.029 + 2P^H$ (Gautom-1994).

The monthly variations of rH_2 were presented in the tabular forms.

Total Dissolved Solids (TDS) :

The values of total dissolved solids were determined indirectly from the following formula based on the value of Electric Conductivity of water samples.

Total Dissolved solids = Electric Conductivity X Conv. Factor.

Where, the value of Conv. factor = 0.65. TDS = E. Conductivity X 0.65.

The values of TDS were expressed in milligram per liter (mg/l). Monthly variations of TDS were presented in the tabular forms.

Free CO_2 :

Free Carbon-dioxide (CO_2) was estimated by titration of water sample (from below the surface and bottom) with N/44 Sodium hydroxide

(NaoH)solution using phenolphthalein as an indicator (welch, 1948) The results were expressed in mg. of free CO_2 per litre (mg./l) of water. Monthly variations were presented in tabular forms .

Biochemical Oxygen Demand (BOD):

The samples of BOD bottles were filled with water and immediately transported to the laboratory and left for incubation in 20^0c for five days. Dissolved Oxygen (DO) content of BOD bottle sample was determined after five days by following the Winkler's Method (Unmodified). The value of BOD was obtained by subtracting final dissolved Oxygen (FDO) from initial dissolved oxygen (IDO) values. When the DO content was almost negligible or showing the condition nearing anoxia, the BOD was determined by diluted method (APHA, 1989).

Chemical Oxygen Demand (COD) :

It was determined by ferrous ammonium sulphate method (APHA,1989). A 5o ml. of sample was placed in a 500 ml. refluxing flask and 1 gm of $HgSO_4$ Crystals and a 5 ml. H_2SO_4 (conc). were added with several boiling chips. After some times a 25 ml. of o.25 N K_2Cr_2O7 soln. was again mixed. The refluxing flask was attached to a condenser through which (condenser) a 70 ml. Sulphuric acid was added again. After mixing well, all the regents of the flask, heat was applied for half an hour. The sample was cooled in room temperature and was titrated (the sample) against ferrous ammonium sulphate with ferroin indicator. A blank was also run (double distilled H_2O) in the same procedure. The result was expressed in mg/l.

Total Hardness:

A 50 ml. sample pretreated with 1 ml. ammonia buffer solution was titrated against EDTA using Eriocrome Black-T as an indicator (Mishra *et al.* 1992). Samples were collected from below the surface and at bottom. All the resultant data were expressed in mg/l. Monthly variations of total hardness were presented in tabular forms.

Total hardness was calculated by using the formula.

$$\text{Total hardness} = \frac{\text{ml of EDTA used X1000}}{\text{ml of sample}} \text{mg/l}$$

Phosphate (PO4):

A 50 ml. of sample was taken in a flask followed by the addition of acid ammonium molybodate soln. (2 ml.) and 4-5 drops of $Sncl_2$ soln. A blue colour appeared. A blank was run following the same procedure for comparison. Both sample and blank were then kept on white paper, followed by the addition of standard phosphate soln. to the blank drop by drop with the help of graduated pipette (1ml) until the colour of blank matches the sample, at the end point, the ml. of standard phosphate used was noted. Amount of phosphate was calculated by the following formulae;

Phosphate= ml. of solution used x 0.01 x 20.

The result was expressed in mg/l. Monthly variations of phosphate were presented in the table.

Mounting Fluid:

Ten percent glycerin solution in distilled water was used as mounting fluid for the preparation of temporary and semi-permanent slides for microscopic studies. Cotton blue and lactophenol were used as mounting fluid and as stain, which facilitated a clear view of the materials under the microscope.

Plankton analysis :

The planktonic forms were collected by a plankton-net of No. 20 silk-bolting cloth. A 100 litres of water from the study pond was passed through the plankton-net using a 5 litre capacity bucket. Water was poured round the innerside of the net to wash down the adhering plankter from the meshes. After collection the plankton, materials were transferred into the glass bottle and preserved permanently in Transeau's Solution. The final volume of the planktonic materials was adjusted to 30 ml. These were regarded as the original concentrate.

The composition of the preservative : Distilled water 60 ml, or 6 parts. Absolute alcohol 30 ml, or 3 parts. Foromaldehyde 10 ml, or 1 parts.

To each 100 ml, of above solution a 5 ml. of glycerin was added to prevent the materials from becoming brittle (Transeau, 1951).

The quantitative enumeration of the phyto and zooplankton were carried out with the help of a Sedwick Rafter counting cell and Occular Whiple micrometer and by drop method (welch, 1948). The counting cell was filled with water to test for any leakage and it was emptied and dried properly. The vials containing the concentrate were shaken properly and 1 ml. of concentrate was taken into the Sedwick Rafter counting cell. Numerical counts of all members of phyto-and-zooplankton were made using the whiple micrometer.

To achieve a random sampling, each time 10 fields were examined for each sample and an average of the counts were recorded. The organisms thus counted, were expressed as units per litre (units/l) of the sample, irrespective of whether they were solitary cells, colonies or filaments or part there of. The monthly abundance of phyto-and- zooplankton were presented in tables. The abundance of plankton groups were calculated according to the following formulae (welch-, 1948).

$$N = \frac{(a \times 1000)c}{L}$$

where, N = Number of plankton per litre of original water.

a= average No. of plankton in all counts in the counting unit.

c= volume of original concentrate in ml.

L= volume of water passed through the net.

Primary Productivity :

Primary productivity was estimated by the method suggested by Gaader and Grane (1927) with an incubation period of four hours. At first, the value of initial dissolved oxygen content was determined by titration and it was recorded. Then, two glass stoppered bottles of 250 ml. capacity were filled with water from below the surface. One bottle was covered with black aluminium foil and other white bottle was uncovered. These two bottles were kept together under water parallelly for four hours for incubation. After the mentioned time, The values of dissolved oxygen contents of both the bottles were determined. the value of primary productivity was estimated by the following formulae:

$$\text{Gross primary productivity} = \frac{LB - DB \times F}{\text{Time}}$$

$$\text{Net primary productivity} = \frac{L\,B - I\,B \times F}{\text{Time}}$$

Where, LB = DO in the light bottle, DB= DO in the dark bottle,

IB = Initial DO, GPP = gross primary productivity,

NPP = Net primary productivity,

F= conversion factor. Ratio of molecular weights of carbon and oxygen (o.375). All oxygen values were converted into carbon values.

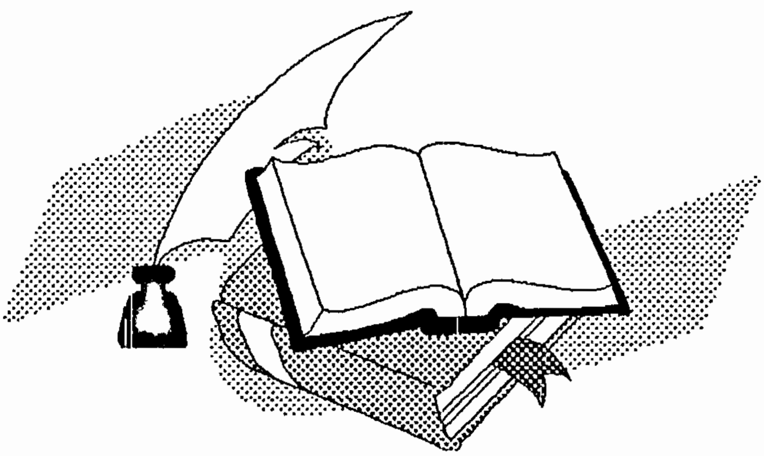
The values of GPP and NPP were expressed in milligrame carbon per litre per hour (mgC/l /h). The monthly variations of average of GPP and NPP were presented in tables.

Ammonium-nitrogen (NH_3-N) :

Ammonia-nitrogen was determined by the Fish Farmer's Water Quality Test-kit, Model, FF-1A, range- 0.1 to 3.0 mg/l. To determine ammonia-nitrogen, 5 ml. of water sample was taken to a vial treated with Nessler reagent (APHA-1989) and was kept for a 15 minutes. After changing of colour of the sample, was matched with the disk of kit to determine the volume NH_3-N. Ammonia-nitrogen was expressed in mg/l. Monthly variations of ammonia-nitrogen were presented in tables.

CHAPTER -3

OBSERVATIONS AND RESULTS



OBSERVATIONS AND RESULTS

A. Physical Factors: Air-Temperature

Air temperature varied considerably over the year and ranged from 17.5 ± 3.3^{0}C to 0 38.3 ± 1.7^{0}C. Records of air temperature indicated a gradual fall from October (1994) and it reached the minimum in January (1995). It began to rise from the mid February to April. From May to July the air temperature was found to be more or less uniform with slight variation in June and August. The highest temperature was recorded in April (1995).

Average Depth of Water. The average depth of water in the study ponds was found to vary from 0.9 ± 0 m to 2.3 ± 0.1 m. The average depth of water in study pond-1, varied from 0.9 ± 0 m to 1.2 ± 0 m throughout the study period. The maximum depth of water was observed in the months of August and November (1.2 ± 0 m) which fell to 0.9 ± 0 m in September and October which rose again from December to March. The average depth maintained an uniformity in the months of May to July (1994). In the month of April (1995) the average depth started to rise again (Tab-1). In study pond -2, the average depth of water varied from 1.4 ± 0 m to 1.8 ± 0 m throughout the study period. The highest depth was recorded in August and April while the lowest value was observed in October to December (1994) and February to March (1994). The study pond is comparatively deep and the average depth was found to show an uniform value during the study months (Tab -2). Study pond -3, is also a deep pond and the highest depth was observed in August (2.3 ± 0.1 m) while the lowest value was obtained in the months of November to December (1.7 ± 0.1

m). The average depth of this study pond was found to be fairly uniform in other months of the year (Tab -3). The average depth of water in study pond-4, was found to vary from 1.4 ± 0 m to 2.0 ± 0 m throughout the study period. The highest depth was observed in August (1994) while the lowest depth was recorded in September to October (1994) and January to February (1995). This pond maintained an uniform depth in rest of the study months (Tab -4). All the study ponds are rainfed but underground water is pumped into them whenever needed.

Secchi Disk Depth (SDD). The Secchi disk depth (SDD) of water in the study ponds was found to vary from 0.1 ± 0 m to 0.4 ± 0.2 m. The SDD of water in study pond -1, varied from 0.1 ± 0 m to 0.3 ± 0 m throughout the study period. The maximum SDD of water was observed in the month of January (1995) while it fell to 0.1 ± 0 m in September (1994). The SDD maintained an uniformity in the other months of the year (Tab -1). In study pond -2, the SDD of water varied from 0.1 ± 0 m to 0.4 ± 0.1 m throughout the study period. The highest SDD was recorded in December (1994) while the lowest value was observed in February (1995). In the month of March (1995) the SDD started to rise again. The SDD was found to show an uniform value during the study months (Tab -2). In study pond -3, the SDD was found to vary from 0.1 ± 0 m to 0.3 ± 0.1 m throughout the study period. The highest SDD was observed in the months of July and February (0.3 ± 0.1 m) while the lowest value was obtained in January (0.1 ± 0 m). The SDD of this study pond was found to be fairly uniform in other months of the study period (Tab -3). The SDD of water in study pond -4, was found to vary from 0.1 ± 0 m to 0.3 ± 0.1 m throughout the study period. The highest SDD was observed in September (0.3 ± 0.1 m) while the lowest value was recorded in December (0.1 ± 0 m). The pond maintained an uniform SDD depth in rest of the study months (Tab -4).

Total Dissolved Solids (TDS). The Total Dissolved Solids (TDS) of water in the study ponds was found to vary from 344.0 mg/l to 499.o mg/l. The TDS of water in study pond -1, varied from 353.0 mg/l to 489.5 mg/l throughout the study period. The maximum TDS value of water was observed in May (489.5 mg/l) while fell to 353.0 mg/l in September which rose again in June and July and November and February, 1995. The TDS of water maintained an uniformity in the months of August, October, December (1994) and January, March and April 1995(Tab-1). In study pond -2, the TDS value of water varied from 344.0 mg/l to 499.0 mg/l throughout the study period. The highest TDS value was recorded in October (499.0 mg/l) while the lowest value was observed in September (344.0 mg/l). The TDS was found to show an uniform value during the rest of the study months (Tab -2). In study pond -3, the highest TDS of water was observed in January (450.1 mg/l) while the lowest value was obtained in August (381.6 mg/l). The TDS value of this pond was found to be fairly uniform in other months of the year (Tab -3). The TDS of water in study pond -4, was found to vary from 351.3 mg/l to 470.6 mg/l throughout the study period. The highest TDS value was observed in December (470.6 mg/l) while the lowest value was recorded in April (351.3 mg/l). The pond maintained an uniform TDS value in rest of the study months. (Tab -4).

Electric Conductivity. The Electric conductivity of water in the study ponds was found to vary from 529.0 ± 32.0 μ moh/cm to 577.5 ± 38.5 μ moh/cm. The Electric conductivity of water in study pond -1, varied from 543 ± 46 μ moh/cm to 753 ± 9 μ moh/cm throughout the study period. The maximum

Electric conductivity of water was observed in May (753 ± 9 μ moh/cm) while fell to 543 ± 46 μ moh/cm in September which rose again in June to August and October to November (1994) and February (1995). The Electric conductivity maintained an uniformity in the months of December (1994) to January and March to April, 1995 (Tab -1). In study pond -2, the Electric conductivity of water varied from 529.0 ± 32.0 μ moh/cm to 767.0 ± 37.0 μ moh/cm throughout the study period. The highest Electric conductivity was recorded in October (767.0 ± 37.0 μ moh/cm) while the lowest value was observed in September (529.0 ± 32.0 μ moh/cm). The Electric conductivity was found to show an uniform value during the rest of the study months (Tab -2). In study pond -3, the highest Electric conductivity was observed in January (693.0 ± 47.0 μ moh/cm) while the lowest value was obtained in August (587.0 ± 2.0 μ moh/cm). The Electric conductivity of this study pond was found to be fairly uniform in other months of the year (Tab -3). The Electric conductivity in study pond -4, was found to vary from 541.0±45.0 to 724.0 ± 61.0 μ moh/cm. throughout the study period. The highest Electric conductivity was observed in December (724.0 ± 61.0 μ moh/cm.) while the lowest value was recorded in April (541.0 ± 45.0 μ moh/cm.). The pond maintained an uniform Electric conductivity in rest of the study months (tab -4).

Chemical Conditions.

Hydrogen Ion Concentration (p^H). The p^H of water in the study ponds was found to vary from 7.7 ± 0.1 to 8.9 ± 0.1. The p^H of water in the study pond -1, varied from 7.7 ± 0.1 to 8.7 ± 0.1 throughout the study period. The maximum p^H value of water was observed in the months of October and March to April 1995 (8.7 ± 0.1) which fell to 7.7 ± 0.1 in May (1994) It rose again in

November (1994) and maintained uniformity upto February 1995 (Tab -1). In study pond -2, the p^H of water varied from 7.8 ± 0.1 to 8.9 ± 0.1 throughout the study period. The highest p^H value was recorded in February to March 1995 (8.9 ± 0.1) while the lowest value of p^H was observed in May 1994 (7.8 ± 0.1). The p^H of water rose again in October and January (1995). The p^H was found show an uniform value during study months (Tab -2). In study pond -3, the p^H of water was found to vary form 8.2 ± 0.1 to 8.9 ± 0.1 throughout the study period. The highest value of p^H was observed in April (8..9 ± 0.1) while the lowest value was obtained in May (8.2 ± 0.1). The p^H started to rise again from September 1994 to March, 1995. The p^H of this study pond was found to be fairly uniform in other months of the year (Tab -3). The p^H of water in study pond -4, was also found to vary from 8.2 ± 0.1 to 8.9 ± 0.1 throughout the study period. The highest value was observed in February and April 1995 (8.9 ± 0.1) while the lowest value was recorded in may (8.4 ± 0.1). The p^H started to rise again and maintained high value in September to October and December (1994) to January (1995). The pond maintained an uniform p^H value in rest of the study months (Tab -4).

Free Carbondioxide (CO_2). The free CO_2 of water in all the study ponds was found to vary from zero (0.0 mg/l) to 34.7 ± 6.9 mg/l. The free CO_2 of water in study pond -1, varied from 2.8 ± 6.2 mg/l to 34.7 ± 6.4 mg/l throughout the study period. The maximum value was observed in the months of May, September, October, December and February (34.7 ± 6.4 mg/l) to April which fell to 2.8 ± 6.2 mg/l in August. The free CO_2 content maintained an uniform value in the months of June, July, November (1994) and January 1995 (Tab -1).

In study pond -2, the free CO_2 of water varied from 4.3 ± 9.5 mg/l to 32.5 ± 6.7 mg/l throughout the study period. The highest value of free CO_2 was recorded in May, September, December (32.5±6.7mg/l) and February and March while the lowest value was observed in April (4.3±9.5mg/l). The free CO_2 was found to show an uniform value during rest of the study months (Tab -2).

In study pond -3, the highest free CO_2 was observed in March (14.6 ± 15.2 mg/l) while zero value was obtained in the months of June, December and January (0 mg/l). In the months of September and February, the free CO_2 started to rise again. The free CO_2 of this study pond was found to be fairly uniform in other months of the year (Tab -3). The free CO_2 of water in study pond -4, was found to vary from zero (0.0 mg/l) to 5.4 ± 7.7 mg/l throughout the study period. The highest value of free CO_2 was recorded in January (5.4 ± 7.7 mg/l) while the absence of free CO_2 was observed in the months of June to September, December and February to April. The pond maintained an uniform free CO_2 in rest of the study months (Tab -4).

Carbonate alkalinity as ($CaCO_3$). The carbonate alkalinity of water in the study ponds was found to vary from zero (0.0 mg/l) to 17.2 ± 8.4 mg/l. The CO_3 alkalinity of water in the study pond -1, varied from zero (0.0 mg/l) to 17.2 ± 8.4 mg/l throughout the study period. The maximum CO_3 alkalinity of water was observed in the month of August (17.2 ± 8.4 mg/l) which fell to zero (value) in the months of May to July, September to December (1994) and February to April (1995). In the month of January, the CO_3 alkalinity started to mark a rise again (Tab -1). In study pond -2, the CO_3 alkalinity of water varied from zero (0.0 mg/l) to 15.2 ± 8.7 mg/l throughout the study period. The highest value was recorded in April (15.2 ± 8.7 mg/l) and the lowest in the months of May, June, July and December 1994 (0.0 mg/l).The CO_3 alkalinity value started to rise again and from the month of January (1995), the pond was found to show an uniform value of carbonate alkalinity in the rest of the study months (Tab -2). The carbonate alkalinity of water in study pond -3, was found to vary from 1.2 ± 1.6 mg/l to 8.0 ± 4.7 mg/l throughout the study period. The highest value of carbonate alkalinity was observed in January (8.0 ± 4.7 mg/l) while the lowest value was obtained in August (1.2 ± 1.6 mg/l). From the months of May, September and November to December (1994), the carbonate alkalinity started to rise again. The rest of the months, the CO_3 alkalinity value was found to be uniform (Tab -3). The carbonate alkalinity of water in study pond -4, was found to range from 1.8 ± 1.9 mg/l to 7.7 ± 1.8 mg/l throughout the study period. The highest value of carbonate alkalinity was observed in February, 1995 (7.7 ± 1.8 mg/l) while the lowest value was recorded in October (1.8 ± 1.9 mg/l). The carbonate alkalinity of this study pond was found to rise again from May and highest values were observed in August, September, and from December (1994) to April 1995 (Tab -4).

Biocarbonate alkalinity as ($CaHCO_3$). The biocarbonate alkalinity (HCO_3) of water in all the study ponds was found to range from 15.1 ± 4.5 mg/l to 445.2 ± 60.5 mg/l. The HCO_3 alkalinity of water in study pond -1, varied from 21.0 ± 1.7 mg/l to 403.0 ± 56.0 mg/l throughout the study period. The maximum HCO_3 alkalinity of water was observed in the month of April (403.0 ± 56.0 mg/l) which fell to (21.0 ± 1.7 mg/l) in July. It rose again from August (1994) and maintained a high value upto April (1995). The biocarbonate alkalinity maintained an uniformity in the months of May to July, 1994 (Tab -1). In study pond -2, the HCO_3 alkalinity of water ranged from 18.7 ± 2.5 mg/l to 356.7 ± 122.6 mg/l throughout the study period. The highest bicarbonate alkalinity was recorded in August (356.7 ± 122.6 mg/l) while the lowest value was observed in July (18.7 ± 2.5 mg/l). The biocarbonate alkalinity maintained almost an uniform value in May and June (1994). The HCO_3 alkalinity value started to rise again from August (1994) and maintained a high value till April - 1995 (Tab -2). In study pond -3, the HCO_3 biocarbonate alkalinity values varied from 15.1 ± 4.5 mg/l to 445.2 ± 60.5 mg/l. The highest value of carbonate alkalinity was observed in April (445.2 ± 60.5 mg/l) while the lowest value was obtained in June (15.1 ± 4.5 mg/l). The HCO_3 alkalinity value of this pond started to rise again from September (1994) to April (1995).The HCO_3 alkalinity of this pond was found to be fairly uniform in other months of the year (Tab -3). The HCO_3 alkalinity of water in study pond -4, had a range from 15.2 ± 3.2 mg/l to 336.6 ± 35.2 mg/l throughout the study period. The highest value was observed in April (336.6 ± 35.2 mg/l) while the lowest in July (15.2 ± 3.2 mg/l). The HCO_3 alkalinity contents of this pond started to rise again from August (1994) and maintained higher values till April (1995). During the rest of the study months the HCO_3 alkalinity values were found to be almost uniform.

Total Hardness (TH). The total hardness of water in all study ponds had ranged from 197.8 ± 28.0 mg/l to 608.8 ± 44.6 mg/l. The total hardness of water in study pond -1, varied from 200.0 ± 18.0 mg/l to 538.0 ± 47.0 mg/l throughout the study period. The maximum total hardness of water was observed in April (538.0 ± 47.0 mg/l) which fell to (200.0 ± 18.0 mg/l) in the months of May, August (200.0 ± 18.0 mg/l) and September (1994). It started to rise again from October (1994) and maintained upto April (1995). Uniform TH values were observed in other months (Tab -1). In study pond -2, the total hardness of water varied from 214.2 ± 43.1 mg/l to 609.2 ± 56.3 mg/l throughout the study period. The highest value was recorded in April (609.2 ± 56.3 mg/l) while the lowest value was observed in September (214.2 ± 43.1 mg/l). The total hardness of water was found to rise again from October (1994) and maintained higher values till April (1995). TH values were found to be uniform in rest of the study months (Tab-2). In study pond-3, the total hardness of water was found to vary from 228.7 ± 60.0 mg/l to 608.8 ± 44.6 mg/l during the study period. The highest value of total hardness was observe in April (608.8 ± 44.6 mg/l) while the lowest value was obtained in the months of July (228.7 ± 60.0 mg/l) and September (1994). The TH values started to rise again from the months of November 1994 (Tab-3). The total hardness of water in study pond-4, was found to vary from 197.8 ± 28.0 mg/l to 469.3 ± 110.0 mg/l throughout the study period. The highest value of total hardness was observed in April (469.3 ± 110.0 mg/l) while the lowest value was recorded in July (197.8 ± 28.0 mg/l). The total hardness of this study pond was found to rise from February and maintained a higher value till April (1995). The pond maintained an uniform total hardness in the rest of the study months (Tab-4).

Chloride (cl^-). The Chloride of water in all the study ponds was found to vary from 87.0 to 201.3 mg/l. The Chloride content of water in study pond-1, varied from 87.0 to 143.0 mg/l. The highest value of chloride was observed in the months of June, August (143.0 mg/l) 1994 and March to April (1995) which fell to 87.0 mg/l in December (1994). The Chloride values maintained an uniformity in the months of May, July, September, October (1994) and January to February (1995). In the month of November, the Chloride started to rise again (Tab-1). In study pond-2, the Chloride values of water varied from 103.6 mg/l to 191.7 mg/l throughout the study period. The highest Chloride was recorded in July (191.7 mg/l) while the lowest value was observed in March (103.6 mg/l). The Chloride COntent started to rise again in May, August, September and

November (1994). The Chloride values were found to show an uniform value in the rest of the study months (Tab-2). In study pond-3, the Chloride of water was found to vary from 103.4 mg/l to 201.3 mg/l during the study period. The highest value of Chloride was obtained in Juanuary (201.3 mg/l) and the lowest in July (103.4 mg/l). The Chloride content maintained an uniformity in the months of May to June and August to November (1994). In the month of December (1994) and from February to April (1995), the Chloride marked a rise again (Tab-3). The Chloride content of water in study pond-4, was found to range from 98.6 mg/l to 142.0 mg/l during the period of study. The highest value of Chloride was observed in October (142.0 mg/l) while the lowest value was recorded in May and January (98.6 mg/l). The pond maintained an uniform Chloride content in the rest of the study months (Tab-4).

Dissolve Oxygen (DO). The DO of water in the study ponds was found to vary from 4.0 ± 1.1 mg / L to 10.6 ± 3.5 mg/lthroughout the study period.

Pond -1: The DO content of water at this spot varied from 4.0 ± 1.1 mg/l to 7.6 ± 1.3 mg/l throughout the study period. The maximum DO value was observed in January (7.6 ± 1.3 mg/l) which fell to (4.0 ± 1.1 mg/l) in February and rose again in the months of May and July to October (1994). The DO maintained an uniform value in the months of June and November to December (1994) and from March to April -1995 (Tab-1).

Pond -2: At this study spot the DO content of water was found to vary from 5.0 ± 1.5 mg/l to 8.1 ± 1.1 mg/l throughout the study period. The highest value of DO was recorded in the months from August to October and January to February and April (8.4 ± 1.1 mg/l) while the lowest value was observed in

December (5.0 ± mg/l). The DO was found to show an uniform moderate value during the rest of the study months (Tab-2).

Pond -3: In study pond the DO content of water was found to vary from 5.7 ± 2.8 mg/l to 9.6 ± 1.4 mg/l throughout the study period. The highest value of DO was observed in September (9.6 ± 1.4 mg/l) and December while the lowest value was obtained in the months of November and February (5.7 ± 1.8 mg/l). In the months of January and April (1995) the value of DO started to rise again. The DO of this study pond was found to be moderately uniform in other months of the year (Tab-3).

Pond -4: The DO content of water in this study pond ranged from 6.3 ± 0.5 mg/l to 10.6 ± 3.5 mg/l throughout the study period. The highest value of DO was observed in September (10.6 ± 3.5 mg/l) while the lowest value was recorded in June (6.3 ± 0.5 mg/l). In the months of May, October and December (1994) to April (1995) the DO values registered arise gain. The pond maintained an uniform value of DO in rest of the study months (Tab-4).

Percentage Saturation of Oxygen. The percentage saturation of Dissolved Oxygen of water in the study ponds was found to very from 45% to 140% during the study period.

Pond -1: The percentage saturation of DO of water in this study pond, varied from 45% to 92% throughout the study period. The maximum percentage saturation of DO was observed in the month of August to September(92%) which fell to 45% in February and rose again in the months of May, July, October (1994) and January (1995).The percentage saturation of DO maintained an uniformity in the month of June, November to December (1994).

Biochemical Oxygen Demand (BOD_5). The Biochemical Oxygen Demand (BOD_5) of water in the study ponds had ranged from 2.3 mg/l to 16.8 mg/l during the period of investigation.

Pond -1: The BOD_5 in study pond-1, varied from 2.7 mg/l to 12.0 mg/l throughout the study period. The maximum BOD_5 value was observed in the months of August, 94 12.0 mg/l which fell to 2.7 mg/l in September to October (1994) and from February to April (1995) which rose again in the months of May to June (7.6 mg/l) and January (1995). The BOD_5 maintained an uniformity in the months of July and November to December 1994 (Tab-1).

Pond -2: In this study pond, the BOD_5 of water varied from 2.3 mg/l to 9.6 mg/l throughout the study period. The highest value of BOD_5 was recorded in July, August (9.6 mg/l) and October (1994) while the lowest value was observed in June 1994 (2.3 mg/l) and February to March (1995). The BOD_5 was found to show an uniform value during the study months (Tab-2).

Pond -3: At this study spot the BOD_5 value was found to range from 3.2 mg/l to 13.6 mg/l throughout the study period. The highest value was observed in June (13.6 mg/l), July, October, March and April, while the lowest value was obtained in the months of January and February (3.2 mg/l). In the months of May and August 1994, the BOD_5 value was found to rise again. The BOD_5 of this study pond was found to be almost uniform in other months of the year (Tab-3).

Pond -4: The BOD_5 of water in study pond-4, was found to very from 8.6 mg/l to 16.8 mg/l throughout the study period. The highest value of BOD_5 was observed in June and November (16.8 mg/l) while the lowest value was recorded in February and March (8.6 mg/l). In the months of July and August (1994), January and April (1995), the BOD_5 value was found to rise again. The pond maintained a moderately uniform value in rest of the study months (Tab-4).

Chemical Oxygen Demand (COD). The Chemical Oxygen Demand of water in the study ponds was found to range from 6.7 mg/l to 37.2 mg/l.

Pond -1: The COD of water in this study pond, was found to very from 7.2 mg/l to 22.5 mg/l throughout the study period. The maximum value of COD of water was observed in the months of May, June, August, 1994 (22.4 mg/l) and January (1995) which fell to 7.2 mg/l in October, 1994 and April, 1995. The value registered a rise again in July and November and December (1994). In the rest of the months the COD value were found to be fairly uniform (Tab-1).

Pond -2: In this study pond the COD of water varied from 6,7 mg/l to 20.7 mg/l throughout the study period. The highest value of COD was reCOrded in August (20.7 mg/l) while the lowest value was observed in June (6.7 mg/l). In the months of July and October 1994, the COD was found to rise again. The COD values were almost uniform during other months of the study period (Tab-2).

Pond -3: At this spot, the COD values varied from 8.7 mg/l to 28.7 mg/l during the study period. The highest value was observed in the months of June (28.7 mg/l), July and October in 1994 and March 1995 while the lowest value was obtained in January and February 1995 (8.7 mg/l). In the months of May, August, December 1994 and April 1995, the COD value was found to be fairly uniform (Tab-3).

Pond -4: The COD of water in this study pond, had a range from 17.3 mg/l to 37.2 mg/l during study period. The highest value of COD was observed in June (37.2 mg/l) while the lowest was recorded in March (17.3 mg /). The COD was found to rise again in the months of August, October and November 1994. Fairly uniform COD values were noted in rest of the study months (Tab-4).

Ammonium Nitrogen (NH_3-N). The ammonium nitrogen of water in the study ponds varied from zero value to 0.13 mg/l.

Pond -1: The ammonium nitrogen of water in this study pond, varied from a zero values to 0.13 mg/l throughout the study period. The maximum value of NH_3 -N was observed in January (0.13 mg/l) which fell to zero (0.0 mg/l) in April. It rose again in November 1994 (0.11 mg/l). The ammonium nitrogen maintained an uniformity in its content in other months of the study period (Tab-1).

Pond -2: At this spot, the NH_3-N content of water varied from a zero value to 0.12 mg/l during the study period. The highest value was recorded in December (0.12 $\pm$ 0 mg/l) while the lowest was observed in April (0.0 mg/l). It rose again in November 1994. The ammonium nitrogen was found to show moderately uniform values in rest of the study months (Tab-2).

Pond -3: In the pond-3, the NH_3-N of water was found to vary from a zero value to 0.13 $\pm$ 0 mg/l throughout the study months. The highest value was noted in December (0.13 $\pm$ 0 mg/l) while the lowest value was obtained in April (0.0 mg/l). Ammonium nitrogen content started to rise again from November. The NH_3-N of this study pond was found to be fairly uniform in other months of the year (Tab-3).

Pond -4: The ammonium nitrogen of water in this study pond, was found to vary from 0.0 mg/l to 0.12 ± 0. mg/l during the study period. The highest value of NH_3-N was observed in February (0.12 ± 0. mg/l) while the lowest value was recorded in April (0.0 mg/l) which started to rise again in January 1995. The NH_3-N values were almost uniform in the rest of the study months (Tab-4).

Phosphate (PO_4). The phosphate content of water in the study ponds was found to range from 0.01 mg/l to 0.7 mg/l during the period of investigation.

Pond -1: The phosphate of water in this study pond, varied from 0.1 mg/l to 0.7 mg/l throughout the study period. The maximum PO_4 value was observed in January and March (0.7 mg/l) which fell to 0.1 mg/l in May, July,and September. The PO_4 value was almost uniform in August, October (1994), February and April 1995 (Tab-1).

Pond -2: In study pond-2, the phosphate content of water varied from 0.02 mg/l to 0.1 mg/l throughout the study months. The highest value was recorded in the months from May to September and from November to January and also from March to April (0.1 mg/l) While the lowest value was observed in October (0.02 mg/l). The phosphate was found to rise again in the month of February 1995 (tab-2).

Pond -3: In this study spot, the phosphate content of water was found to vary from 0.01 mg/l to 0.3 mg/l throughout the study period. The highest phosphate value was observed in June and December 1994 (0.3 mg/l) While the lowest values was obtained in August, February (0.01 mg/l) and March (1995). The phosphate contents of this study pond was found to be fairly uniform in other months of the year. In the month of November (1994), The phosphate content started to rise again (Tab-3).

Pond -4: The phosphate content of water in this study pond, was found to range from 0.02 mg/l to 1.0 mg/l throughout the study period. The highest value of phosphate content was observed from May to August (1.0 mg/l) while the lowest value was recorded in March (0.02 mg/l). During October and November 1994, February and April 1995 the PO_4 value was almost uniform (0.2 mg/l). The pond maintained an uniform value of phosphate in rest of the study months (Tab-4).

Redox Potential (Eh). The Redox potential (Eh) of water in the study ponds varied from 0.22 mv to 0.36 mv during the study months.

Pond -1: The Redox Potential (Eh) of water in study pond-1, varied from 0.25 mv. to 0.36 mv. throughout the study period. The maximum Eh value was observed in May (0.36 mv) which fell to 0.25 mv in March and April. The Redox Potential values (Eh) maintained an uniformity in the months from June 1994 to March 1995 (Tab-1).

Pond -2: At this study spot, the Redox Potential (Eh) of water varied from 0.22 mv to 0.36 mv during the study time. The highest Eh value was recorded in May (0.36 mv) while the lowest Eh value was noted in the months from January to April 1995 (0.22 mv.). The Eh value was found to show an uniform level during the rest of the study months (Tab-2).

Pond -3: In this study pond ,the Redox potential (Eh) of water varied from 0.23 mv. to 0.31 mv. throughtout the study period.The highest value was observed in May (0.31mv) while the lowest value was obtained in the months of February and April 1995 (0.23 mv), The Redox Potential (Eh) of this study pond was found to be fairly uniform in other months of the year .(Tab-3) .

Pond -4: The Redox Potential (Eh) of water in this study pond, varied from 0.23 mv to 0.32 mv during the study period .The highest value was observed in July (0.32 mv) while the lowest value was recorded in the months of February and April (0.23 mv). The pond maintained an uniform Eh value in rest of the study months (Tab-4)

Redox Index (rH_2). The Redox Index (rH_2) of water in the study pond was found to very from 25.02 to 27.81 during the study period.

Pond -1: The Redox Index (rH_2) of water in study pond-1, varied from 25.82 to 27.81 throughout the study period. The maximum rH_2 value was observed in May (27.81) which fell to 25.82 in the months from September 1994 to April 1995. The rH_2 value was almost uniform in the period from June to August 1994 (Tab-1).

Pond -2: At this study site, the Redox Index value (rH_2) of water varied from 25.39 to 27.67 throughout the study period . The highest rH_2 value was recorded in May (27.67) while the lowest value was observed in the months from October 1994 to April 1995 (26.02). The rH_2 value was found to show an uniform level during the rest of the study months (Tab-2).

Pond -3: In this study pond, the rH_2 value was found to vary from 25.02 to 27.09 throughout the study period. The highest rH_2 value was observed in May and July to August (27.09) while the lowest value was obtained in the month of January (25.02). The rH_2 value of this study pond was found to be fairly uniform in other months of the year (Tab-3).

Pond -4: Redox Index value (rH_2) of water in study pond-4, was found to vary from 25.73 to 27.23 throughout the study period. The highest rH_2 value was noted in May, July (27.23) and August while the minimum value was recorded in the months from September 1994 to April 1995(Tab-4).

Gross Primary Productivity (GPP). The Gross Primary Productivity (GPP) of water from in study ponds was found to vary from 0.1 mg C/l/h to 0.4 mg C/l/h during the period of investigation.

Pond -1: The Gross Primary Productivity (GPP) of water in this study pond, ranged from 0.2 mg C/l/h to 0.4 mg C/l/h throughout the study period . The maximum value of GPP was observed in the months of January to March (0.4 mg C/l/h) which fell to 0.2 mg C/l/h in May and continued in June, September, November and December 1994. The GPP maintained uniformity in the months of July to August, October 1994, February and April 1995 (Tab-1).

Pond -2: In this study pond, the GPP of water varied from 0.1 mg C/l/h to 0.4 mg C/l/h throughout the study period. The highest value was recorded in July (0.4 mg C/l/h) and August 1994 and January 1995, while the lowest value was observed in December 1994 (0.1 mg C/l/h). This value was almost uniform in rest of the study months (Tab-2).

Pond -3: In this study pond, the GPP value varied from 0.2 mg C/l/h to 0.4 mg C/l/h throughout the study period. The highest value was observed in the months of May (0.4 mg C/l/h) and July while the lowest value was obtained in the months of November (0.2 mg C/l/h) and April. The GPP of this study pond was found to be fairly uniform in other months of the year (Tab-3).

Pond -4: The GPP values at this study pond, varied from 0.2 mg C/l/h to 0.4 mg C/l/h throughout the study period. The highest value was observed in the months from July to September 1994 (0.4 mg C/l/h) while the lowest value was recorded in the months from February to March 1995 (0.2 mg C/l/h). The pond registered an uniform value of GPP in rest of the study months (Tab-4).

Net Primary Productivity (NPP). The Net Primary Productivity (NPP) of water in the study ponds was found to vary from 0.20 mg C/l/h to(0.21 mg C/l/h.

Pond -1: The NPP values in study pond -1, varied from 0.14 mg C/l/h to(0.14 mg C/l/h throughout the study period. The maximum value was observed in the months from February to March 1995 (0.14 mg C/l/h) which fell to (-0.14 mg C/l/h) in the months of June and from November to December 1994. It rose again in May, January and April 1995 (Tab-1).

Pond -2: In this study pond, the NPP value varied from 0.16 mg C/l/h to 0.21 mg C/l/h throughout the study period. The highest value was recorded in November (0.21 mg C/l/h) while the lowest value was observed in December (-0.16 mg C/l/h). The NPP was found to show an uniform value during the other study months (Tab-2).

Pond -3: In this study pond, the NPP was found to vary from -0.20 mg C/l/h to 0.11 mg C/l/h throughout the study period. The highest value was observed in October (0.11 mg C/l/h) and the lowest value was obtained in February (-0.20 mg C/l/h) . In July and November, December 1994 and January and March 1995, the NPP values was found nil again. The NPP of this study pond was found to be fairly uniform during rest of the study months (Tab-3).

Pond -4: The NPP in this study pond varied from -0.17 mg C/l/h to 0.13 mg C/l/h during the study period. The highest value was observed in May and December (0.13 mg C/l/h) while the lowest value was recorded in the months from February to March 0.17 mg C/l/h Uniform value of NPP in rest of the study months was noted at this site (Tab-4).

ZOOPLANKTON

The Zooplankton were represented by the members belonging to Copepoda, Clodocera and Rotifera. In all 38 genera of Zooplankton were recorded from the four study ponds of which 10 belonged to the Copepoda, 9 to Clodocera and 19 to Rotifera. Number of genera of Copepoda, Clodocera and the Rotifera varied from pond to pond during the period of study. Monthly and seasonal abundance of different genera of the Zooplankton groups were presented in tables P-1, -2, -3, -4; Zp. 1a, Zp. 2a, 3a, 3b, 5a, 5b. The Zooplankton were treated separately for each study pond.

Pond -1 : In all 27 genera of Zooplankton were observed in this study pond of which 8 genera belonged to Copepoda, 7 to Clodocera and 12 to Rotifera. As regards the number of the genera of Zooplankton under these three group, a low diversity is a phenomenon noted during the study period. In terms of the number of genera the Copepods consisted of 29.6%, Clodocera of 25.9% and Rotifers of 44.4% of the total Zooplankton. The genera of Copepoda were *Cleptocamptus, Cyclops, Merocyclops, Mesocyclops, Diaptomus, Paradiaptomus, Phyllodiaptomus* and *Neodiaptomus. Cyclops* was found to occur in higher abundance followed by *Diaptomus, Mesocyclops* and others. The Cadocerans were represented by *Alona, Bosmina, Daphnia, Diaphanosoma, Macrothrix, Moina* and *Sida*. The Cladocerans were dominated by *Daphnia* with highest abundance followed by *Diaphanosoma, Moina* and others. The Rotifers were *Asplanchna, Brachionus, Chromogaster, Filinia, Harringia, Keratella, Manfredium, Notholca, Philodina, Pompholyx, Rotaria* and *Trichocera.* As regards the monthly and seasonal abundance, *Brachionus* was found to be the dominant genus followed by *Keratella* and others. As regards the monthly occurrence, all genera except *Cyclops* of Copepoda were found to occur sporadically during the study period. Of the Clodocerans, *Daphnia* was of regular occurrence while others occurred sporadically. The Rotifers were of sporadic occurrence Table-1; Zp, 1a, 2a, Data on Table-1, Zp-1a, 2a, 3a, 3b 5a, 5b indicates that the genera of Zooplankton groups occurred with varying abundance during different seasons of the year. The Copopcds consisted of 12.64%; 25.69%, 45.43% and 17.98% of the total Zooplankton in the summer, monsoon, post-monsoon and winter seasons respectively. Similarly the Cladocerans consisted of 55.31%, 50.22%, 31.07% and 17.12% of the total Zooplankton population in the four seasons. The Rotifers consisted of 32.13%, 23.87%, 23.47% and 64.89% of the total Zooplankton population in the summer, monsoon, post-monsoon and winter seasons respectively.

Pond -2 : A total of 31 genera of Zooplankton were recorded from this study pond during the period of study. The Zooplankton comprised of 10 genera of Copepoda, 8 genera of Clodocera and 13 genera of Rotifera. The Rotifers dominated followed the Copepods and Clodecerans (41.9%, 32.2% and 25.8% respectively). The Cladocerans were represented by *Cleptocamptus, Cyclops, Merocyclops, Mesocyclops, Diaptomus, Heliodiaptomus, Paradiaptomus, Phylldiaptomus Naodiaptomus* and *Neodiaptomus. Cyclops* was found to occur in higher abundance (21615 to 138025 units/l) followed by *Diaptomus* (15770 to 30625 units/l) and others. All genera except *Cyclops* and *Diaptomus* were of sporadic occurrence throughout the year. The members of Cladocera were *Alona, Bosmina, Ceriodaphnia, Daphnia, Diaphanosoma Moina, Polyophemus* and *Sida.* The Cladoceranns were dominated by *Daphnia*

(23195 to 59915 units/l) followed by *Diaphanosoma* (8000 to 21074 units/l) and others. *Daphnia, Diaphanosoma* and *Moina* occurred throughout the study months while other genera of the group were of sporadic occurrence. The Rotifers were represented by *Asplanchna, Brachionus, Chromogaster, Cupelopagia, Dorystoma, Filinia, Harringia, Keratella, Phelodina, Pompholyx, Scaridium, Trichocera* and *Tripleuclamis. Brachionus* occurred in higher abundance (40260 to 79189 units/l) followed by *Keratella* (18360 to 193128 units/l) and others. All genera of the Rotifers were found to occur sporadically throughout the study months. Table 2, 2a, 3a, 3b, showing the seasonal abundance of individual genus and group of Zooplankton, indicate that the Copepods constituted of 46.6%, 15.15%, 46.8% and 23.4% of the total seasonal Zooplankton population in summer, monsoon, post-monsoon and winter respectively. Alongside, the cladocerans consisted of 23.7%, 30.5%, 23.9% and 20.7% of the total seasonal Zooplankton population in the four seasons respectively. The rotifers also consisted of 29.5%, 54.4%, 25.8% and 55.8% of the total seasonal Zooplankton in Summer, Monsoon, Post-Monsoon and Winter season respectively. Table-2b indicate that the rotifer with highest abundance (68376 to 246834 units/l) dominated the Zooplankton population with Copepods, rank second (38630 to 175135 units/l) followed by the Cladocerans (63512 to 91773 units/l). The highest total Zooplankton abundance was observed in the Winter (442213 units/l) followed by Summer (375454 units/l), Post-monsoon (264824 nits/l) and Monsoon (255918 units/l).

Pond- 3 : In all 18 genera of Zooplankton were recorded from this study ponds, of which 4 genera belonged to Copepoda, 6 to Clodocera and 8 to Rotifera. Compared to study pond-1 and pond-2. This habitat shows a poor plankton diversity in respect to the number of genera. The Copepods were represented by *Cleptocamptus, Cyclops, Mesocyclops and Diaptomus. Cyclops* dominated the Copepods with higher abundance (30578 - 46387 units/l) followed by *Diaptomus* (3548 - 13785 units/l) and others. *Cyclops* was found to occur in all study months while the other three genera were of highly irregular occurrence. The Cladocerans were represented by *Alona, Bosmina, Diaphnia, Diaphanosoma, Moina* and *Sida* of which only *Daphnia* with higher abundance (25500 - 45065 units/l) was of regular occurrence. *Diaphanosoam* ranked second in abundance (8346 - 44646 units/l) was of sporadic occurrence. The Rotifer genera were *Brachionus, Chromogaster, Filinia, Keratell, Notholca, Polyarthra, Rotaria* and *Trichocera.* All the eight genera of Rotifera occurred sporadically throughout the study. *Keratella* was in high abundance (24922 - 79513 units/l) followed by *Brachionus* (24548 - 52672 units/l). The total plankton abundance in different season indicate (Table-3a) that the Summer and Monsoon population abundance were uniformly high while the Post-monsoon and Winter population were comparatively lower but with almost uniform abundance values.

Pond -4 : During the entire study period, this study pond was devoid of Copepoda and Cladocera. In all 12 genera of Rotifera were found to occur regularly throughout the study months. The occurring genera were *Ascomorphella, Brachionus, Keratella, Notholca, Philodina, Platyas, Polyarthra, Pompholyx* and *Trichocera. Brachionus* was found to be in higher abundance (13789-99720 units/l) followed by *Harringia* (12879-63184 units/l), *Trichocera* (I0I54-54251 unit/l), *Keratella* (3971-48447 units/l) *Polyarthra* (16950-33078 units/l) and others. Summer abundance of Zooplankton was higher (424278 unit/l) followed by Post-monsoon (233468 unit/l), Monsoon (122378 unit/l) and Winters (I07953 unit/l). (Table- 4, 4a).

PHYTOPLANKTON

Monthly, seasonal and yearly abundance of different groups of phytoplankton have been studied. Percentage composition of the Phytoplankton groups have also been treated. The data were presented in tables 1, 1a, 1b, 2, 2a, 2b, 3, 3a, 3b, 4, 4a, 4b, 5, and 6 and groups were plotted with these data. Phytoplankton biota of the four study ponds are considered separately.

Pond-1 : A low diversity of phytoplankton in terms of the number of genera have been observed in this study spots. In all 33 genera of phytoplankton have been recorded from this pond of which 12 genera belonged to Chlorophyceae, 7 to Cyanophyceae, 10 to Bacillariophyceae, 3 to Euglenophyceae and 1 to Dinophyceae. As regards the number of genera of the Phytoplankton, Chlorophyceae comprised of 36.7% of the total Phytoplankton genera followed by Bacillariophyceae (30.3%), Cyanophyceae (21.2%), Euglenophyceae (9%) and Dianophyceae (3%). The Euglenoids were found to be in higher yearly abundance (24868 unit/l & 36.37%) followed by the Chlorophytes (16242 unit/l & 23 .75%), Cyanophytes (16159 uni/l & 23.63%), Bacillariophytes (10557 unit/l & 15.44%) and the Dinophytes (537 unit/l & 0.78%). The seasonal abundance of the Phytoplankton groups have been depicted in table 1a, 1b. The data shows that the Euglenoids ranked high in the summer (22835u/l) followed by Chlorophyceae (17979 u/l), Cyanophyceae (16411 u/l), Dinophyceae (1038 u/l) and Bacillariophyceae (9781 u/l). During the monsoon and post-monsoon period similar figures were obtained with slight variation while in the winter the Cyanophytes appeared in higher abundance (18004 u/l) followed by Euglenophyceae (16415 u/l), Chlorophyceae (13118 u/l), Bacillariophyceae (9494 u/l) and Dinophyceae with almost negligible appearance. The total abundance in the summer, monsoon, post-monsoon and the winter were 66044, 82225, 66123 and 57161 units/l respectively. The 12 genera of Chlorophyceae were *Chlorella, Selenastrum, Ankistrodesmus, Crucigenia, Scenedesmus, Pediastrum, Actinastrum, Closterium, Cosmarium, Staurastrum, Ulothrix and Spiragyra.* The last two genera were found as surface floating scum. The Cyanophyceae were represented by *Microcystis, Spirulina, Oscillatoria, Anabaena, Anabaenopsis* and *Cylindrospermum.* The Bacillariophytes genera were *Brebissonia, Fragilaria, Eunotia, Gyrosigma, Navicula, Pinnularia, Gomphonema, Tabellaria, Cymbell*a and *Nitzchia.* Three genera of the Euglenoids were - *Euglena, Phacus* and *Trachelomonas* while the lone Dinophyte was the - *Ceratium.* As regards the yearly mean abundance, *Scenedesmus* ranked highest amongst the *Chlorophytes* followed by *Ankistrodesmus* and *Chlorella.* Amongst the Cyanophytes Microcystis was in high abundance followed by *Ocillatoria* while amongst the Bacillariophytes *Navicula* and *Pinnularia* were in higher abundance. Of the Euglenoids, Euglena was in higher abundance(23980 u/l) which is highest amongst all the Phytoplankton groups. Amongst the Chlorophytes, *Staurastrum, Ulothrix* and *Spirogyra* were found to appear sporadically during the study period. *Spirulina, Anabaenopsis* and *Cylindrospermum* were registered to be of sporadic appearance. Of the Bacillariophytes, *Brebissonia, Fragilaria, Gomphonema, Tabellaria Cymbella* and *Nitzchia* were found to occur sporadically during the study period. *Phacus* and *Trachelomonas* of Euglenophyceae and *Ceratium* of Dinophyceae were also found to occur sporadically throughput the study year. Seasonal occurrence of 12 genera of Chlorophyceae (Table-1a, 1b) shows that all genera were recorded in four seasons except *spirogyra* being absent in the post-monsoon. All the 7 genera of Cyanophyceae were recorded in the winter with the exception of *Spirulina* and *Cylindrospermum* in the summer, *Anabaenopsis* and *Cylindrospermum* in the monsoon and Spirulina in the post-monsoon. Of the 10 genera of the Bacillariophyceae 9 genera except *Brebissonia* were recorded in summer while Tabellaria was absent in the monsoon. *Cymbella* was not observed in the post-monsoon while *Gomphonema* and *Cymbella* were absent in the winter season. All 3 genera of Euglenophyceae were recorded in all the four seasons except *phacus* and *Trachelomonas* being absent in the post-monsoon period. *Ceratium* of Dinophyceae was recorded in all the four seasons with varying abundance.

Pond-2 : The total number of Phytoplankton genera was 26 of which 9 belonged to Chlorophyceae, 7 to Cyanophyceae, 6 to Bacillariophyceae, 3 to Euglenophyceae and 1 to Dinophyceae. As to the number of genera is concerned, the Chlorophyceae appears with 34.6% of the total genera followed by Cyanophyceae (26.9%), Bacillariophyceae (23%), Euglenophyceae (11.5%) and the Dinophyceae (3.8%). The yearly abundance data (Tab 2, 2a, 2b) show that the Chlorophyceae ranked high (35858 u/l), followed by Bacillariophyceae (28089 u/l), Euglenophyceae (24757 u/l), Cyanophyceae (24086 u/l) and Dinophyceae (3444 u/l) and constituted of 30.84%, 24.17%, 21.29%, 20.72% and 2.96 % of the total Phytoplankton respectively. The seasonal abundance data (Tab 2a, 2b) indicate that the Chlorophytes appeared with higher abundance in the post-monsoon (42177 u/l) and winter (41863 u/l). The Cyanophytes showed higher abundance in the monsoon (24524 u/l) and winter (27754 u/l) period while the Bacillariophytes appeared to with higher abundance in the post-monsoon (49802 u/l). The Euglenophytes showed lower abundance in the Winter while they appeared with moderately high abundance in the other seasons. The Dinophytes were absent during the Summer and Monsoon and found to present in the Post-monsoon and Winter with higher abundance in the Winter (11085 u/l). The 9 genera of Chlorophyceae were *Ankistrodesmus, Scenedesmus, Pediastrum, Crucigenia, Gloeotaenium, Actinastrum, Closterium, Cosmarium* and *Micrasterias.* As regards to the yearly mean abundance, Actinastrum ranked highest followed by *Closterium,* Ankistrodesmus, *Scenedesmus, Crucigenia* and others. The Cyanophytes were represented by seven genera which were *Microcystis, Anabaenopsis, Anabaena, Spirulina, Oscillatoria, Lyngbya* and *Cylindrospermum. Oscillatoria* was found to be in higher abundance followed by *Microcystis, Anabaena* and others. Bacillariophyceae was represented by *Fragilaria, Brebissonia, Gomphonema, Navicula, Pinnularia* and *Cymbella. Navicula* was in higher annual abundance followed by *Fragilaria, Pinnularia* and others. The Euglenoids were represented by three genera- *Euglena, Phacus* and *Trachelomonas,* of which *Euglena* was always found to be in highest abundance amongst the other phytoplankton groups. Ceratium the only genus of Dinophyceae was spotted during the period from October to February with lower abundance. The total seasonal abundance of the Phytopplankton biota shows that (Table 2a, 2b) highest abundance was achieved in the post-monsoon (145523 u/l), followed by the Winter (116341 u/l), Summer (107883 u/l) and Monsoon (92858 u/l). Of the chloroplyceae *Ankistrodesmus, Gloeotaenium, Actinastrum* and *Micrasterias* registered sporadic appearance amongst the Blue- green algae, *Microcystis, Anabaenopsis Spirulina, Lingya* and *Cylindrospermum* showed sporadic appearance during the study period.

Brebissonia, Gomophonema and Cymbella were also found to be of sporadic appearance. *Phacus* and *Trachelomonas* of Euglenophyceae and ceratium of Dinophyceae were also recorded with sporadic occurrence. The seasonal occurrence of different Phytoplankton genera belonging to different groups were depicted in Table 2a, 2b. The data show that all 9 genera of the Chlorophytes were recorded in Summer and Post-monsoon, while *Gloeotaenium* and *Micrasterias* were absent in the Monsoon and *Ankistrodesmus* and *Micrasterias* were not recorded in the Winter. All the 7 genera of the Cyanophytes were recorded during the Summer, Monsoon and Winter, while *Anabaenopsis, Spirulina* and *Cylindrospermum* were not recorded in the Post-monsoon period 6 genera of the Bacillariophyceae were recorded during all the four seasons except *Gomphonema* being about in the Monsoon. The 3 genera of Euglenophyceae were found to occur in all the seasons while only Trachelomonas was absent in the Monsoon. *Ceratium* of Dinophyceae was spotted in the Post-monsoon and Winter season only.

Pond -3 : In all 30 genera of Phytoplankton were recorded from this study pond, of which 11 genera belonged to the Chlorophyceae, 7 to Cyanophyceae, 10 to Bacillariophyceae and 2 to Euglenophyceae. No Dinophyte was recorded from this pond during the period of study. As regards the total number of genera the Phytoplankton biota, Chlorophyceae comprised of 36.7% followed by Bacillariophyceae (33.3%), Cyanophyceae (23.3%) and the Euglenophyceae (6.6%). The yearly abundance of different groups of Phytoplankton shows that Cyanophytes ranked highest (39347 u/l) followed by Bacillariophyceae (27290 u/l), Euglenophyceae (14639 u/l) and Chlorophyceae (13098 u/l) with a percentage composition of 41.7%, 28.9%, 15.5% and 13.87%

of the total Phytoplankton respectively (Table 3a, 3b). The seasonal abundance of different groups of Phytoplankton were depicted in Table 3a, 3b. The data show that the Chlorophytes were in moderately high abundance during the Summer (19703 u/l) and Monsoon (17932 u/l). The Chlorophytes registered lower abundance during the Post-monsoon and Winter periods. The Cyanophytes registered higher abundance during the Summer (46382 u/l) and Post-monsoon (41194 u/l) with moderately high abundance in Monsoon (33529 u/l) and Winter (35946 u/l) also. The Bacillariophytes showed highest abundance during the Winter (37208 u/l) and during the Summer, Monsoon and the Post-monsoon they registered almost uniform abundance values. The Euglenoids showed highest abundance during the Post-monsoon (28928 u/l) and Summer (23781 u/l) with low abundance in the other seasons. The Cyanophytes appeared to be with highest seasonal abundance followed by the Bacillariophyceae, Euglenophyceae and Chlorophyceae during the study period. The highest total seasonal phytoplankton was recorded in Summer (114396 u/l) followed by Post-monsoon (105668 u/l), Winter (83704 u/l) and the Monsoon (72746 u/l). The Chlorophyceae was represented by *Eudorina, Scenedesmus, Pediastrum, Chlorella, Tetraedron, Selenastrum, Ankistrodesmus, Crucigenia, Staurastrum, Euastrum* and *Cosmarium, Scenedesmus* was found to be in higher abundance amongst the Chlorophyceae followed by other genera of the group. It was noted that all the 11 genera of this group were found to occur sporadically in this pond during the entire study period. The yearly mean (Table 3a, 3b) abundance of these genera showed lower individual abundance values. The Cyanophytes were represented by *Microcystis, Spirulina, Oscillatoria, Anabaenopsis, Nodularia, Arthrospira* and *Cylindrospermum. Oscillatoria* was recorded with highest abundance (29249 u/l) followed by

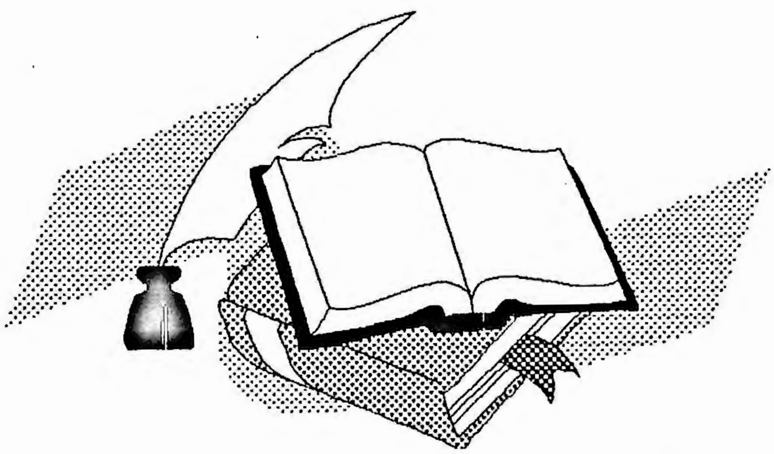
Microcystis Anabaenopsis and others. All the Cyanophycean genera except *Oscillatoria* were recorded with sporadic appearance during the period of study. The Bacillariophytes were represented by *Navicula, Fragilaria, Synedra, Gyrosigma, Eunotia, Achnanthes, Cymbella, Nitzschia* and T*abellaria*. Of these *Fragilaria* apeared to be in higher abundance followed by *Pinnularia* and *Navicula, Fragilaria* and *Pinnularia* were recorded every month during the study period while the rest of the genera were found to be of sporadic appearance. The Eugenoids had only *Euglena* and *phacus* in record, Euglena ranking high with respect annual abundance. Both the genera were of sporadic occurrence. The seasonal occurrence of all the 11 genera of Chlorophyceae (Table - 3a, 3b) shows that all genera were recorded in the Summer with varying abundance values but *Eudorina, Tetraedron, Selenastrum* and *Staurastrum* were not recorded during the Monsoon season. During the Post-monsoon only four genera i.e. *Scenedesmus, Ankistrodesmus, Crucugenia* and *Cosmarium* were recorded while *Eudorina, Chlorella, Tetraedron, Selenastrum* and *Staurastrum* were found to occur in the winter. Of the 7 genera of the Cyanophytes, all were recorded in the Summer while *Anabaenopsis, Nodularia* and *Arthrospira* were absent during the Monsoon. *Spirulina* was found to be absent in the Post-monsoon, while *Nodularia* and *Cylindrospermum* were not recorded in the Winter. All 10 genera of Bacillariophyceae were recorded in the Winter while *Synedra* was not recorded in the Summer. During the Monsoon *Synedra, Cymbella* and *Tabellaria* were absent. In the Post-monsoon *Gyrosigma, Achnanthes* and *Nitzchia* were not recorded. Of the Euglenoids, *Phacus* occurred in all the four seasons but *Euglena* was absent only in Monsoon.

Pond-4 : In all 30 genera of Phytoplankton were recorded from this study spot, of which 11 genera belonged to Chlorophyceae, 8 to Cyanophyceae, 9 to Bacillariophyceae and 2 to Euglenophyceae. No member of Dinophyceae was recorded from this pond. As regards the total number of genera, Chlorophyceae constituted of 36.7% followed by Bacillariophyceae (30%), Cyanophyceae (26.6%) and Euglenophyceae (6.6%). As regards the yearly abundance and percentage of differnt groups of phytoplankton, Cyanophyceae ranked high above others (34334u/l) others followed by Bacillariophyceae (24365 u/l), Euglenophyceae 21124 u/l) and the Chlorophyceae (16122 u/l), and the percentage of composition being 35.78%, 25.39%, 20.01% and 16.8% respectively (Table 4, 4a, 4b). Data on seasonal abundance of different groups of phytoplankton is presented in table 4a, 4b, which indicate that the Chlorophytes were of high abundance during the Winter (26603 u/l) with moderately high abundance in the Post-monsoon (20218 u/l) while in the Summer and Monsoon, they were found to be with lower abundance values. The Cyanophytes showed uniformly high abundance ranging from 32008 to 38698 u/l in all the seasons.The Bacillariophytes recorded highest abundance (55590 u/l) in the Winter which lower abundance was recorded in other seasons. The Euglenoids appeared with high abundance (28925 u/l) in the Monsoon while they maintained a moderate value in other seasons. The total seasonal abundance was recorded in the Winter (134057 u/l) followed by Post-monsoon (85478 u/l), Summer (85473 u/l) and Monsoon (77776 u/l). The Chlorophytes were represented by *Chlorella, Actinastrum, Crucigenia, Ankistrodesmus, Selenastrum, Scenedesmus, Pediastrum, Staurastrum, losterium, cosmarium,* and *Micrasterias. Ankistrodesmus,* and *Crucigenia* were found to occur throughout the study year but all other genera Occurred sporadically. *Ankistrodesmus* showed higher annual abundance followed by *Chlorella, Crucigenia, Selenastrum* and others of this group. The Cyanophytes were represented by *Microcystis, Spirulina, Oscillatoria, Lyngbya, Anabaena, Gloeotrichia, Cylindrospermum* and *Nodularia.* All these genera except

Oscillatoria occurred sporadically throughout the study period. *Oscillatoria* was found to be in higher annual abundance (9967 u/l) followed by *Micracystis, Anabaena* and others. Members of Bacillariophyceae occurring during the period of study were *Rhopalodia, Navicula, Pinnularia, Synedra, Gyrosigma, Eunotia, Rhizosolenia, Melosira* and *Achnanthes*. Synedra although appearing sporadically, showed higher abundance annually followed by *Pinnularia, Navicula, Eunotia* and others. All the genera of this group except *Pinnularia* were found by occur sporadically throughout the study period. Euglenophyceae was represented by sporadic appearance of Euglena and *phacus. Euglena* occurred with high annual abundance (20688 u/l) while *phacus* was of negligible occurrence. The seasonal occurrence of Chlorophytes shows (Table-4a, 4b) that of the 11 genera *Chlorella* was not recorded in the Summer while *Actinastrum, Selenastrum Pediastrum, Closterium, Cosmarium* and *Micrasterias* were abemt in the Monsoon. In the Post-monsoon *Staurastrum, Closterium* and *Micrasterias* were not recorded while all the 11 genera were observed in the Winter. Amongst the 8 Cyanphyte genera *Spirulina* was not recorded during the Summer while *gloeotrichia* and *Nodularia* did not occur in the Monsoon. In the Post monsoon *Cylindrospermum* and *Noclularia* were not spotted while *Anabaena* was found to be absent in the Winter except other genera. Summer was marked by the presence of all 9 genera of Bacillariophyceac, but *Rhopalodia, Navicula, Rhizosolenia* and *Achnanthes* were absent in the Monsoon period. During the Post- monsoon all genera except *Rhizosolenia* and *Achnanthes* were present while in the Winter only *Achnanthes* was not spotted. The two Euglenoid genera *Euglena* and *phacus* were observed in all seasons except *Phacus* disappearing only in the Monsoon. To see the interrelationship between the physico-chemical parameters and that between the phyto- and zooplankton, the correlation quotient (r) has been calculated and the results were presented in table 1r, 2r, 3r and 4r.

CHAPTER -4

DISCUSSION



DISCUSSION

Studies of the physico-chemical characteristics of the four study ponds reveal that the physico-chemical variables showed monthly and seasonal changes. Sometimes spatial or sudden changes of the variables were also noticed in the study ponds.

Temperature

Air and water temperature plays significant role in physico-chemical, metabolic and physiological behaviour of aquatic bodies. Changes in temperature affects many physiological processes including density of water and thermal stratification (Lund and Talling, 1957). Temperature may be less important as a factor in unpolluted water body, because of the wide range of temperature tolerance of aquatic organisms. But in a polluted pond or river system, temperature changes may result in increased metabolism of aquatic organisms which may have a profound effect on DO and BOD affecting the aquatic biota including the fishes (Land and Talling, 1957, Palharya *et. al.*, 1993).

Solubility of oxygen is dependant upon the prevailing water temperature. With the increase in water temperature, the solubility of oxygen is reduced causing deoxygenation. Temperature fluctuation may also be caused by the activities of micro-organisms (Willen, 1955; Hutchinson, 1957; Welch, 1948, Trivedy, 1990).

During the period of study in the four ponds, the air temperature variation was almost similar as the study ponds were situated in the same place and spread over a radious of 250 meters. The diurnal and monthly fluctuations were found to be almost similar in the study ponds with some deviations depending upon the average depth of water in the respective ponds. Seasonal changes were apparent in the study ponds. Maximum values of water temperature were observed in the Summer season and minimum in the Winter, corresponding with the atmospheric temperature. During the Monsoon and the Post-monsoon period, the air as well as water temperature were found to be similar with slight fluctuation. During the Summer the water temperature was higher because of low average depth, clean atmosphere and greater sunshine hours. Range of fluctuation of water temperature was minimum probably because of rainfall, frequent clouds and minimum sunshine hours in the rainy months. Similar views were also held by V yas (1968) and Palharya *et. al.*(1993). In the present study the seasonal temperature of water ranged from 29-31.8^{0}C in Summer, 28-28.9^{0}C in Monsoon, 24.1-30.4^{0}C in Post-monsoon and 19.3-23.9^{0}C in the Winter in pond-1., while it ranged from 31.8-32.8^{0}C, 29.7 - 32.1^{0}C, 23.1 - 31.0^{0}C and 18.4 - 24 ^{0}C in the Summer, Monsoon, Post-monsoon and Winter respectively in pond-2. The temperature in pond -3 ranged from 29.3 - 32.5 ^{0}C in Summer, 29.8 - 31.9 ^{0}C in Monsoon, 22.9 - 29.2 in Post-monsoon and 19-24.3 ^{0}C in the Winter, while in pond -4, it ranged from 29.4 - 32.5 ^{0}C, 29.7 - 31.6 ^{0}C, 23 -29.6 ^{0}C and 19.1 - 24 ^{0}C in Summer, Monsoon, Post-monsoon and Winter respectively. Similar results were obtained by Srivastava (1956) Khanna (1993), Badal & Singh (1981), Moitra and Bhattacharya (1965), Das & Pandey (1978) and many other scientist.

Average Depth

Average depth of water in study ponds showed slight variations, as the water level exhibited minimum fluctuation. All the ponds are fed with the water of deep tube well pump at regular intervals to keep the level upto desired mark. Pond-1 is a shallow habitat while pond -3 is the deepest amongst the study ponds. The data in tables 1, 2, 3 and 4 indicate that the water level did not show any appreciable decline throughout the year except a rise in the monsoon period. The seasonal ranges of average depth in pond-1 were 1-1.1, 1-1.2, 0.9 - 1.2 and 1- 1.1 metres in Summer, Monsoon, Post-monsoon and Winter respectively, while in pond -2, the average depth varied from 1.4-1.8, 1.5 - 1.8, 1.4 - 1.5 and 1.4 - 1.6 metres in the four seasons respectively. In pond -3, the average depth was noticed to range from 1.8 - 2.2, 2.1 - 2.3, 1.7 - 2.0 and 1.7 - 1.9 metres in Summer, Monsoon, Post-monsoon and Winter respectively. Similarly in Pond - 4, it ranged from 1.6 - 1.9, 1.6 - 2, 1.4 - 1.5 and 1.4 and 1.7 metres in the four seasons respectively. In water bodies fed regularly with pumped water monthly and seasonal changes are seldom observed with noteworthy uphill downhill peaks. The present study ponds have been found to show such phenomenon. Thermal stratification in the study ponds could not be observed as the water in the pond are occasionally agitated by aerator or hard lime across resulting in the thorough mixing of the water. This resulted in a temperature equilibrium in the study ponds at all depths.

Secchi disk depth

Secchi disk depth of the study ponds also exhibited striking similarity in having similar values throughout the year, Although monthly variations were noted, seasonal variations were found to be of very short range. In all the study ponds very low SDD values were noted because of turbidity caused by regular changing of the pond water with various organic and inorganic materials used for fertilization of these culture ponds. Regular and frequent agitation of the water might have also contributed to this high turbidity or low value of SDD or light penetration into the study waters. The suspended particles, soil, silt particles, decomposed or undecomposed organic matter, total dissolved solids as well as abundance of the microflora and micro-founa, are regarded as main source of turbidity in water which interfere with the penetration of light. (Gautom, 1990). These reasons may be attributed to the low values of light penetration in the present study pond. The seasonal ranges of the SDD values were very narrow in all the study ponds as depicted in (Tables 1, 2, 3 and 4).

Total dissolved solid

Total dissolved solid or TDS are caused by suspended particles inside the water body influencing its turbidity and light penetration. (Gautom, 1990, Tripathy and Pandey, 1990, Palharya *et. al.* 1993, Khanna, 1993). Palnkton also show a striking parallelism with suspended solids. Consequently the higher abundanced of total plankton in the study ponds may be one of the reasons for higher TDS values. Similar views were also expressed by Tripathy and Pandey, 1993 and Singh, 1995. The fluctuation of TDS values in the four study ponds may be attributed to the above reasons although higher TDS values are often encountered in the rainy season which may be due to the run off water reaching the ponds. As the study pond water is regularly and frequently agitated for oxygenation, there is less chance left for the suspended particles to settle down on the bottom, thereby leaving the water permanently turbid. Lower values of phytoplankton and lower rate of primary productivity may be caused due to the permanent turbidity in the study waters. Similar views were expressed by David, 1965, Motwani *et. al.*1956, Verma and Sukla, 1969, Sharma, 1981 and Tripathy and Pandey, 1993. Ganzalves and Joshi (1946) observed that total solids varied in proportion to the temperature and rarely varied inversely to the water level. Seasonal fluctuation of TDS values in the four study ponds were depicted in Tables 1, 2, 3 and 4. In Pond -1, the seasonal TDS values ranged from 420.2 - 489.5, 454.7 - 494, 353 - 488.3 and 440.4 - 484.3 mg/l in the Summer, Monsoon, Post-monsoon and the Winter respectively; while in pond-2, the values were found to range from 404.3 - 436.2, 383 - 455, 435 - 499 and 406.3 - 482 mg/l, in the four seasons respectively. In pond -3 the TDS values ranged from 397.2 - 445.9, 381.6 - 419.3, 387.7 - 448.5 and 441.7 - 450.1 mg/l in the Summer, Monsoon, Post-monsoon and the Winter respectively; while in pond -4, the values ranged from 351.3 - 378.6, 354.9 - 403.3, 370.8 - 404.6 and 397.5 - 470.6 mg/l in the four season respectively. It appears from the seasonal TDS values in the study ponds that a common factor complex may be at play for their striking similarly.

Electric conductivity

The Electric conductivity of water depends upon the concentration of ions and its nutrient status. Conductivity of the study ponds is a characteristics associated with the dissolved materials or solutes concentration present in the study waters. During the present investigation the conductivity values were always high (543 - 753 μ moh/cm in pond -1, 422 - 767 μ moh/cm in pond -2, 585 - 693 μ moh/cm in pond -3 and 541 - 724 μ moh/cm in pond -4). The conductivity values in all the study ponds showed a regular pattern of monthly and seasonal fluctuation during the study time. The higher values of electric conductivity indicate that all the study ponds had higher concentration of dissolved materials or solutes. Similar views were expressed by Gautom (1990), Trivedy *et. al.* (1990) and many other scientists. During the present study the higher conductivity values may be due to addition of considerable quantity of minerals and charging materials throughout the whole year. Trivedy (1990) expressed similar views. The seasonal fluctuation of the conductivity values in pond -1, ranged from 647 - 753, 700 - 751, 543 - 752 and 678 - 745 μ moh/cm. in Summer, Monsoon, Post-monsoon and Winter respectively, while in pond -2, the values were 422 - 671, 443 - 700, 529 - 767 and 677.5 - 741 μ moh/cm in the four seasons respectively. Similarly, the E. C. values ranged in pond -3, from 611 - 686, 587 - 645, 597 - 690 and 680 - 693 μ moh/cm and in pond -4, seasonal ranges were 541 - 583, 546 - 621, 571 - 623 and 612 - 724 μ moh/cm in Summer, Monsoon, Post-monsoon and Winter seasons respectively. In pond -4, highest conductivity values were recorded in the Winter while those in other seasons were found to be uniform but high. The present investigation testifies that the study ponds remain uniformly rich in higher concentration of dissolved material or solute throughout the whole study year indicating their abundant nutrient status.

Hydrogen ion Concentration (p^H)

The p^H or hydrogen ion concentration is one of the most important variables that controls the aquatic environment. All chemical and biological reactions are dependent upon the hydrogen ion concentration of the reaction system (Ghosh & Sharma, 1987; Gautom, 1990; Trivedy, 1990; Tripathy & Pandey, 1993, Palharya *et. al.*1993). Sreenivasan (1977) expressed the view that there is a direct relationship amongst the hardness, alkalinity and growth of phytoplankton consequent upon the changes in the p^H in water. Anderson (1961), Jonassan (1969), King (1972), Patil (1982), Singhi (1986), Palharya *et. al.*(1993) viewed p^H value as an important factor in maintaining the carbonate and bicarbonate system in a body of water which plays a vital role in the formation of algal blooms. Valladolid *et. al.* (1954) observed that an alkaline p^H

provides an optimum condition for congenial growth of the plankton biota. The present study reveals that the p^H value of the water of four study ponds were relatively higher throughout the year. The pattern of monthly and seasonal fluctuation of p^H values in the study ponds are found to be regular, maintaining an uniform value. No season is marked as having highest p^H values than the other. As a matter of fact, high p^H values were found to be maintained in the four seasons which can be attributed to moderately high productivity in the standing water of the study ponds in having ability to utilize carbon from carbonate, sulphur from sulphate, nitrogen from nitrate, phosphorus from phosphate thereby converting them into hydroxyl ion with an increase in the p^H, keeping the total alkalinity and hardness values of water nearly constant (Zafar, 1966). These reasons may be at play in the study ponds having higher p^H values and moderately constant high hardness and total alkalinity values. The moderately lower p^H value in the Summer season in the four study ponds may be probably due to high turbidity and higher temperature in the Summer, might have enhanced the microbial activity causing higher production of CO_2 and reducing the p^H. Khalaf and Macdonald (1975) also established that at high turbidity and high water temperature, photosynthetic process is impared considerably leading to accumulation of CO_2 that causes lowering of the p^H level by forming carbonic acid. The above factors might be at play in the present study ponds in the Summer period as evidenced by the CO_2 and temperature values during the study period. However, as the average value of p^H is concerned, the four study ponds were always alkaline in nature and p^H value never came down to less than 7.7. The seasonal changes of the p^H values in pond -1 ranged from 7.7 - 8.7, 8.3 - 8.5, 8.5 - 8.7 and 8.6 in the Summer, Monsoon, Post-monsoon and Winter respectively; while in pond -2 , the values ranged from 7.8 - 8.9, 8.2 - 8.4, 8.4 - 8.7 and 8.7 - 8.9 in the four seasons respectively. In study pond -3, the p^H value never came down below 8.2 during the study period, the seasonal range being 8.2 - 8.9, 8.3 - 8.4, 8.6 and 8.6 - 8.8 in Summer, Monsoon, Post-monsoon and Winter respectively; on the other hand pond -4, showed similarly higher alkaline nature in having a seasonal range of 8.4 - 8.9, 8.1 - 8.5, 8.5 - 8.6 and 8.6 - 8.9 in the four seasons respectively. Zafar (1964), Buck and Rankin (1972) and Gautom (1990) expressed the view that during the Summer and Monsoon months the p^H values remain lower, and higher during the Winter. The higher values of p^H in Winter is thought to be due to increased photosynthesis activity by the phytoplankton and other hydrophytes. Lakshminarayana *et.al.*(1963), Nautiyal (1984), Doyle (1964) and Badalex &S Singh (1981) supported this fact by their respective findings. They held that lower values of p^H during the Summer and Monsoon months was due to decreased photophythetic activity caused by high turbidity affecting penetration of light and the phytoplankton populations. The above causes are prevented in the present study ponds but on the contrary the p^H level remained constantly high in all the seasons of the study year. This fact may be explained by the phenomenon of over charging of the study ponds with lime at frequent intervals resulting in higher alkalinity values. The factors stated above are to taken into consideration in explaining the striking behaviour of p^H values in the study ponds.

Free CO_2

Carbon-dioxide in a water system is generally derived from various sources e.g. the atmosphere, respiration of plants and animals, bacterial decomposition of organic matter in suspension and in bottom, inflow of ground water which seep into the ponds, lakes and streams, and from within the water itself in combination with other substances mainly calcium and magnesium, Hutchinson (1957), Golterman (1975) and Jhingran (1975). Free CO_2 combines with water chemically and forms carbonic acid which affects the p^H content of water. Carbonic acid dissociates partly and produce (H^+) and bicarbonate (HCO^-_3) ions. The bicarbonate ions dissociate further forming more hydrogen and carbonate ions. Mostly the carbon-dioxide is always present in the form of HCO_3 and CO_3. When the p^H is low, the combined carbon-dioxide is converted into the free form and when there is an increase in the bicarbonate and carbonate, water becomes alkaline and resists hydrogen ions. The CO_2. p^H and alkalinity are directly related to each other, since the p^H depends upon the free carbon-dioxide and the bicarbonate-carbonate level (Michael, 1964; Golterman 1975; Kern, 1960; Emerson *et. al.*,1973 and Hutchinson, 1957). The higher growth of phytoplankton and other hydrophytes cause the enhanced uptake of CO_2, HCO_3 and CO_3, thereby increasing of p^H of water (Hutchinson, 1957, Stumn and Morgan, 1970) Free CO_2 occurs in water as dissolved gas, carbonic acid, carbonates and bicarbonates of calcium and magnesium. All these substances are in chemical equilibrium with one another (Hutchinson, 1957). The absence of free CO_2 may be either due to its complete utilization in photosynthesis or may be due to inhibition by the presence of appreciable amount of carbonates in water (Srinivasan, 1965; Sahai and Sinha, 1969).

Comparatively maximum value of free CO_2 was noted in the study pond -1, (2.8 - 34.7 mg/l) with highest value in the Summer (21.5 - 34.7 mg/l) followed by Winter (15.7 - 33.2 mg/l), Post-monsoon (23 - 26.7 mg/l) and Monsoon (2.8 - 10.1 mg/l). Highest value in Summer and moderate high values in the Post-monsoon and Winter may be due to high rate of decomposition of organic matter by microbes, decreased of photosynthetic activity for low abundance of phytoplankton, and high rate of respiration by the biota therein. Consequently, the zooplankton was higher than that of the phytoplankton in the Summer, Monsoon, Post-monsoon and Winter resulting in higher rate of respiration raising the free CO_2 content in the study pond. The lower value of free CO_2 in the Summer may be probably due to reduced rate of decomposition of organic matters. Similar views were expressed by Adoni (1985), Sinha (1988), Pandey *et.al.* (1988) and Hegde and Bharti (1985). In study pond -2, the monthly and seasonal peaks are noteworthy although the CO_2 content registered a moderately low value compared to pond -1. The seasonal range was found to be from 4.3 - 14.7, 8.2 - 8.9, 8.3 - 19 and 4.9 - 32.5 mg/l in the Summer, Monsoon, Post-monsoon and the Winter. In pond-3, the free CO_2 content showed noticeable fluctuations in the consecutive study months. The seasonal fluctuation ranged from 1 - 14.6, 0 - 4.3, 2.9 - 6.3 and 0 - 6.4 mg/l in the Summer, Monsoon, Post-monsoon and the Winter respectively, while in pond -4, the CO_2 values ranged from 0 - 2.3 mg/l in Summer, zero in Monsoon, 0 - 4.3 mg/l in Post-monsoon and 0 - 5.7 mg/l in the Winter.

Carbonate alkalinity

The values of CO_3 alkalinity as depicted in Tables 1, 2, 3 and 4 indicates that the four ponds under study, were very low. In pond -1, the CO_3 alkalinity values were found to vary from month to months and season to season. The seasonal fluctuation ranged from 0 - 17.2 mg/l in the Monsoon, and 0 - 2.8 mg/l in the Winter, with zero values recorded in the Summer and Post-monsoon. Khan and Siddiqui (1970), and Trivedy (1982) expressed the view that the fluctuations in CO_3 alkalinity values were mainly due to photosynthetic activity of aquatic plants and phytoplankton. Bhatnagar and Sharma (1973) observe that the presence of carbonate alkalinity is an indication of higher rate of carbon assimilation. Zero value of CO_3 alkalinity in the Summer and Post-monsoon in the study pond -1, may be probably due to the reduced photosynthesis rates and higher number of microorganisms, resulting into higher concentration of free CO_2. Consequently the contents of CO_3 in this study pond in Summer and Post-monsoon were 21.5 - 34.5 mg/l and 23 - 26.7 mg/l. Similar results were obtained by Zafar (1966) and Braj Nandan (1985). Similarly, the seasonal CO_3 alkalinity values ranged in p -2, from 0 - 15.2, 0 - 4.8, 0.9 - 2.8 and 0 - 10.8 mg/l in Summer, Monsoon, Post-monsoon and Winter seasons. In study pond -3, a very low CO_3 alkalinity value was noted with no zero value in any month or season. The seasonal fluctuations ranged from 1.8 - 4.8, 1.2 - 1.8, 1.7 - 3.3 and 1.4 - 8 mg/l in the four seasons respectively; while in study pond -4, these values ranged from 4.9 - 6.6, 2.7 - 5.8, 1.8 - 4.8 and 4.3 - 7.7 mg/l in the four seasons respectively. The lower value of CO_3 alkalinity or phenolphthalein alkalinity in the study ponds are indication of lower rates carbon assimilation (Tripathy and Pandey, 1993).

Bicarbonate alkalinity

During the present study, the bicarbonate alkalinity showed two distinct high peaks in the Summer and Winter seasons. The Monsoon and Post-monsoon periods experienced moderately lower values compared to Summer and Winter. All the four study ponds exhibited the similar phenomenon. Similar results were obtained by Alikhuni (1957) and Basu *et. al.* (1970) in their works. The accumulation of large quantity of bicarbonate during the Summer and Winter months associated with excess quantity of free carbon-dioxide produced in the process of decomposition may be the reasons for higher values of bicarbonate alkalinity in the four study ponds in Summer and Winter. Munawar (1970), Ruttner (1953), Saha and Pandit (1986), Sunder (1988), Hegde and Bharati (1985) expressed similar views in connection with their works. They also opined that high values of bicarbonate of calcium and magnesium in summer could be the reason for high bicarbonate alkalinity values when the water temperature was also high, while the Winter peak was due to increased activity of the phytoplankton. Bicarbonate content in the present study ponds could be also governed by the above factors also. Mention may be made of the liming of the ponds at the rate of the 750 kg/ha/year in first culturable year followed by 2300 kg/ha./year in second culturable year (personal communication from the hatchery authority). The liming may be regarded as one of the causes of higher alkalinity in the study ponds. Lower carbonate values in the Monsoon and Post-monsoon months were may be due to dilution effect and conditions less congenial for the photosynthetic conversion to carbonate. Rao (1970), Trivedy (1982), Braj Nandan (1985), Hegde and Bharti (1985) and Chakrabarty *et.al.* (1966) also reported similar results in their works and expressed the view that dilution is an important factor in lessening the bicarbonate alkalinity of water. In the present study pond -1, the seasonal bicarbonate values were found to range from 30.5 - 403, 21 - 49, 114 - 163.3 and 184 - 301.2 mg/l in Summer, Monsoon, Post-monsoon and Winter seasons. In study pond -2 the values varied from 21.2 - 356.7, 18.7 - 41.3, 109.7 160.5 and 171.4 - 290.1 mg/l in the four seasons respectively. Similarly, in pond -3 the seasonal range of the bicarbonate values were 25.6 - 445.2, 15.1 - 81.3, 113.8 - 134.8 and 156.4 - 283.7 mg/l in the four seasonal respectively. In pond -4, comparatively lower seasonal bicarbonate values were obtained which ranged from 21.3 - 366.6, 15.2 - 78, 102 - 130.4 and 133.5 - 253.3 mg/l in the Summer, Monsoon, Post-monsoon and the Winter periods. The higher values of the bicarbonate alkalinity in the present study showed that all the study ponds possessed hard water throughout the period of investigation indicating their highly eutrophic nature. Many workers including Blume (1957), Barret (1953), Vass *et.al.* (1977), reported similar findings in their respective investigations.

Total hardness

Total hardness denotes the quality of water. In general, the hardness of water is mainly due to the presence of calcium and magnesium salts as bicarbonates, carbonates, sulphates and chloride and also cations of iron, manganese and strontium contribute to it. Hardness may be temporary due to bicarbonate and carbonate salts of the cations or permanent mainly due to sulphates and chlorides of metals i.e. calcium and magnesium (APHA - 1987). Since calcium and magnesium are principal cations causing hardness to water, the hardness may be expressed as their $CaCO_3$ equivalent. According to APHA (1987) and Bridge and Judy (1911) - soft water contains small amount of Ca ++ and mg++ in solution having bound CO_2 not exceeding 5 mg/l; a medium class water which contains bound CO_2 ranging from 5 - 22 mg/l and hard water which contains more than 22 mg/l of bound CO_2 and even exceed 50 mg/l. Ruttner (1953) and Wetzel (1975) said that the total hardness is the total amount of alkaline earths present without reference to the particular anions to which they are bound. Calcium ions are one of the most important components of the plant tissues and participate in various cellular metabolism, including the translocation of carbohydrates and also facilitate the availability of other ions, Wetzel (1975) and Livingtone (1963).

Magnesium is required by chlorophyllous plants as the magnesium-porphyrin component of the chlorophyll molecules and as co-factor for various enzymatic transformation within the cell, especially in the transphosphorylation in algal, fungal and bacterial cells (Wetzel, 1975; Palharya *et.al.*, 1993; APHA, 1987; Hutchinson, 1957 and Ruttner, 1953).

During the present investigation, the total hardness values showed monthly and seasonal fluctuation. The seasonal fluctuation were noteworthy. In all the study ponds, the total hardness values were very high in the Summer and Winter months while the Monsoon and Post-monsoon values were moderately high also. The Summer and Winter peaks may be due to high water temperature and low water levels respectively. Dilution caused by rain water might be responsible in lowering the hardness values in the Monsoon and Post-monsoon seasons. Similar views were held by Munawar (1970), Moss (1973), Sreenivasan (1974), Patil (1982) and Azmal and Din (1988). Higher values of total hardness in the study ponds may probably be due to rapid oxidation of organic matter in the pond water. Consequently, the study ponds are regularly charged with cow dung, bran, oil cake and blood for the stocking brood fish at the rate of 2-3% of the total body weight of total fish stock per day. As a matter of fact, brood fish stock density in the study ponds is more than 10 metric tone/ha/year. To support this over stacking higher amount of organic matter is used in the ponds as food supliments. Palmer (1967), Olaniya and Saxena (1977), Singh and Bhowmick (1985), Rai (1974) and Dutta (1988) also expressed the views that rapid oxidation of organic matter may raise the vales of hardness especially calcium hardness.

During the present investigation the seasonal variation of total hardness in pond - 1, was found to be 209 - 538; 200 - 295; 209 - 285 and 386 - 467 mg/l; in pond -2, the values ranged from 285.5 - 609.2, 226.2 - 307, 214.2 - 317.7 and 414.6 - 487 mg/l; in pond -3, the values ranged from 240.2 - 608.8, 228.7 - 273, 238.7 - 271.7 and 424 - 466.2 mg/l while in pond -4, they ranged from 263 - 469.3, 197.8 - 278, 216 - 232 and 317.3 - 372.2 mg/l in the Summer, Monsoon, Post-monsoon and Winter seasons respectively. According to Klein (1956), Sawyer (1960) and Sinha (1988) water with 50 - 150 mg/l hardness content is moderately hard; 150 - 300 mg/l hardness content is hard; while a hardness value above 300 mg/l is considered to be very hard. Based with the above rating, the present study ponds were having moderately hard to very hard water.

Chloride

Chlorides in the form of Chloride ions are one of the major inorganic anions present in natural waters. Waters containing 250 mg/l of Chloride of sodium may have a detectable salty taste. The typical salty taste may be absent in a water containing as much as 1000 mg/l Chloride when the cations are calcium and magnesium (APHA, 1987). Ganapati (1943), Moyle (1956) and Zafar (1964) described Chloride as an indicator of pollution. During the present investigations all the four study ponds showed moderately high and uniform values of Chloride content. Monthly and seasonal fluctuations were of short range throughout the study year. Regular charging of the study ponds with organic feed for brood fishes may be one of the reasons for such higher values of Chloride in the ponds. Zafar (1964), Rao (1971) Prasad and Qayyum (1976), Sunder (1988), Azmal (1988) and Singhi (1986) reported higher content of

Chloride of organic origin in their works. Munawar (1970) Bhatnagar and Sharma (1973), Trivedy (1982) and Adoni (1985) suggested that higher concentration of Chloride in water is an index of pollution of animal or organic origin and there is a direct correlation between Chloride concentration and pollution levels. Thresh *et.al.* (1944) also held that high Chloride content are indications of a large amount of organic matter in the water. Krul Liefrinck (1966) held that about 50 mg/l of Chloride content in natural or culture water indicates medium level of pollution. The present study ponds can, therefore, be termed as moderately polluted as far as the Chloride values in the study months and seasons are concerned. The seasonal range of Chloride values in pond -1 were from 112 - 131, 103 - 143, 99 - 109 and 87 - 107 mg/l in Summer, Monsoon, Post-monsoon and the Winter respectively; while the values ranged from 103.6 - 138.7, 121.6 - 191.7, 129.8 - 146.7 and 104.6 - 121.7 mg/l in pond -2 in the four seasons respectively. Pond -3 registered, comparatively high Chloride values than the other three ponds and the seasonal values were found to range from 132.4 - 156.7, 103.4 - 142, 107.5 - 132.7 and 178 - 201.3 mg/l in Summer, Monsoon, Post-monsoon and Winter period respectively. Comparatively lower monthly and seasonal values were obtained in study pond -4 which ranged from 98.6 - 121.6, 109.2 - 137, 113.6 - 142 and 93.4 - 121 mg/l in the four seasons. As regards the obtained values of Chloride in the study ponds, no particular season could be termed as having uphill or downhill peaks during the period of investigation. However, there have no definite pattern of fluctuation of the Chloride values in the study ponds. As for the moderate value of Chloride is concerned in the study ponds, the level could be termed as of biological importance, a view expressed by many workers including

Jayangouder (1964), Lakshminarayana (1965), Gonzalves and Joshi (1946) and Venkateswarlu (1969).

Dissolved Oxygen

Dissolved Oxygen (DO) is one of the most important chemical factor in water which reflects the physical and biological processes prevailing in a body of water. It is also very important in the assessment of water quality standards. The presence of DO is essential to maintain all forms of life in water. The main source of DO in water is the diffusion from the atmosphere and the photosynthetic activity of the hydrophytes including the phytoplankton. A running water contains relatively higher concentration of DO under natural condition than a standing water system (Welch, 1952). DO level in water comes down in a water body due to respiration of the biota, decomposition of organic matter, addition or inflow of oxygen deficient waste water or effluent, inorganic reductants such as hydrogen sulphide, ammonia, nitrates, ferrous ion and other oxidizable substances (Welch, 1952, Wetzel, 1975, Hutchinson, 1957 and Trivedy, 1984). Generally low DO concentration is associated with contamination of water by organic matter and sometimes oxygen totally disappears from water giving rise to a condition of anoxia. Generally the changes in the DO concentration in different seasons is directly or indirectly governed by the changes or fluctuations of water temperature and BOD. Solubility of oxygen increases with the decreases of water temperature and solubility of oxygen is low at higher temperature. Quadri and Shah (1984) recorded DO pulses in the Winter and Summer. During the present investigation seasonal and spatial or sudden changes in DO concentration in pond -2, p -3 and pond -4 have been noticed. Winter pulses of DO concentration may be attributed to the low water temperature facilitating increased solubility of oxygen. Thomas (1966) reported similar findings. The Summer, Monsoon and Post-monsoon pulses and spatial rises in DO concentration may be due to the photosynthetic release of oxygen by phytoplankton. Consequently, the abundance of phytoplankton during these seasonal in the study ponds was quite conspicuously high. Similar views were expressed by Ray *et.al.*(1966), Vass *et.al.*(1977), Rajesh (1981), Chakrabarty *et.al.*(1976), Pahwa and Mehrotra (1966), Agrawal *et.al.*(1976), Rai (1978), Rao (1979), Nicholas (1970), Patil (1982) and Hannan (1979). The present study ponds are occasionally agitated by drawing nets and other physical methods which may regarded as an important reason for moderately high to higher values of DO content. In some monthly samples, comparatively lower values of DO concentration have been recorded which may be due to high rate of consumption of DO for organic decomposition and also for high respiratory activities by the biota specially the phyto- and zooplankton. Consequently, the abundance of zooplankton was found to supersede the monthly and seasonal abundance of the phytoplankton in the study ponds. Similar views were also held by Hutchinson (1967), Moss (1972), Brezonic and Fox (1972), Morrissetle and Manivic (1978) and McColl (1952). In study pond -1 the DO values had a annual range from 4 - 7.6 mg/l with a percentage saturation of oxygen (P.C. Sat) value of 45 to 92, which indicates that the pond water always remained undersaturated, although the undersaturation did not come below 45%. This range of DO content and saturation values are indication of highly eutrophic nature of the study pond. This view is supported by many scientists including Lakshminarayana (1965), Jayangauder (1964), Munawar (1970), Zafar (1966), Pahwa and Mehrotra (1966) and Venkateswarlu (1969). The seasonal range of DO content in pond -1 were from 5.4 - 6.1, 5.2 - 6.8, 5.7 - 6.9 and 4 - 7.6 mg/l with saturation values of 70 - 82, 68 - 92, 69 - 92 and 45 - 86% in the Summer, Monsoon, Post-monsoon and Winter seasons respectively.

Monthly DO concentration in pond -2 showed a uphill and downhill values with peaks in August, September, October and April. Lower values of DO content was recorded in December. The annual range of DO values were found to be from 5 to 8.4 with a saturation value ranging from 53 - 114.4%, which indicate conditions of undersaturation and supersaturation in this study pond. According to Lakshminarayana (1965) a saturation value above 40% is indicative of nearly stressed condition but not harmful to the biota, while values above it reaching upto 100% saturation are indicative of eutrophic condition of water yielding high productivity. Supersaturation values were reached in April (Summer), August (Monsoon, 105%) and September and October (Post-monsoon, 113% and 104%). The seasonal values of DO content ranged from 6 - 8.4 mg/l (83 - 114.4% saturation) in Summer, 6.1 - 7.6 mg/l (80 - 105% saturation) in Monsoon, 6.8 - 8.4 mg/l (81 - 113% saturation) in Post-monsoon, and 5 - 7.9 mg/l (53.2 - 86.5% saturation) in the Winter. Lower values of DO concentration in the Winter might be due to high rate of decomposition of bottom organic matter associated with higher rate of utilization of oxygen for respiration of the biota. Consequently, the phytoplankton and zooplankton abundance were high in the Winter in comparison to the other seasonal (116341 unit/l and 442213 unit/l respectively). Ellis (1973) and Elmore (1961) opined that high concentration of suspended matter which imports turbidity in water is an important reason for low value of DO concentration. Consequently the lower value of DO was associated with high turbidity and high TDS value of water in Winter season in this study pond.

A regular pattern of seasonal fluctuation of the DO concentration was noticed in study pond -3. Monthly and seasonal values were conspecuously high with sudden fall in November when the DO content came down to 5.9 mg/l. The annual range of DO content was found from 5.7 to 9.6 mg/l and saturation value ranged from 69.2 - 126%, which clearly indicates that the DO values of water of this study pond -3, did not come below 5.7 mg/l with a percentage of saturation never fell below 69.2%. Supersaturation was found to reach in April (Summer, 114.2% saturation), May (Summer, 105.4% saturation), June (monsoon, 101.9% saturation), September (Post-monsoon, 126% saturation) and December (Winter, 101.2% saturation).

The seasonal range of DO values were 7.1 - 8.3 mg/l (93.4 - 114.2 % sat.) in Summer, 7 - 7.7 mg/l (95.5 - 101.9 % sat.) in Monsoon and 5.7 - 9.6 mg/l (70 - 126 % sat.) Post-monsoon, 5.9 -9.6 mg/l (69.2 - 101.2% sat.) in the Winter. This study pond is comparatively large and constant wind action producing surface waves might be one of the reasons for high value of oxygen in water. Moreover, the abundance of phytoplankton was also found to be comparatively high throughout the study year.

The DO concentration in pond -4 followed a uphill and downhill pattern throughout the year. Peaks of DO concentration were observed in September (10.6 mg/l and 140% sat.), October (7.9 mg/l and 101.2% sat.), February (8.2 mg/l and 100% sat.), March (7.2 mg/l and 101% sat.) and in April (8.2 mg/l and 113% sat.). The annual range of DO concentration in this study pond varied from 6.3 to 10.6 mg/l and the percentage saturation varied from 77.5 and 140 %. The DO concentration level was always found to be below 6.5 mg/l did not rise up above 10.6 mg/l during the study months which indicate the eutrophic to hypertrophic nature of the study pond. Moreover, similar reasons like pond-3 may have also prevailed here for a higher value of DO concentration. DO concentration reached supersaturation twice in Post-monsoon (140% in September and 101.2% in October), once in Winter (101% in March) and once in Summer (113% in April). Moreover, 100% sat. was observed in February. The Seasonal variation of DO concentration in this study pond were 7.1 - 8.2 mg/l with 97.4 - 113 % sat. values in the Summer; 6.3 - 6.7 mg/l with 83.7 - 91% sat. values in the Monsoon, 6.5 - 10.6 mg/l with 77.5 - 140% sat. values in the Post-monsoon and 7.9 - 8.2 mg/l with 88 - 100% sat. in the Winter. The Post-monsoon, Winter and Summer DO maxima with supersaturation were conspecuous, the maginitude of undersaturation was low during the study period.

Biochemical Oxygen Demand (BOD)

Biochemical oxygen demand (BOD) is the amount of oxygen required for the oxidation of organic matter by bacteria in the water body. It, therefore, indicates the amount of organic matter present in the water systems. BOD is of immense importance in the assessment of water quality. Monthly and seasonal values of BOD appears to be a function of changes in the magnitude of dilution, quantity of the organic matter and the activities of micro organisms which carry out decomposition of carbonaceous and nitrogenous matter. precisely the BOD values of a water body are indicative of the amount of biodegradable organic matter at a particular time as it varies with further addition of organic matter into water through various agencies. During the present investigation, the BOD_5 level in the study ponds were found to be of moderate values. In pond -1, the BOD values were found to have a short range of variation in the consecutive sampling months. Seasonal values also varied with a short range. Compared to others study ponds the BOD_5 level in this pond was found to be low and within the limit of acceptance in many occasions. The seasonal changes were found to range from 2.7 - 6.9 mg/l in the Summer, 5.4 -12 mg/l in the Monsoon, 3.1- 4.9 mg/l in the Post-monsoon and 3.2 - 7 mg/l in the Winter. The findings indicate that the pond water contained relatively small amount of biodegradable organic matter. The study pond -2 also was found to contain relatively small amount of biodegradable organic matter, and the seasonal values varied from 2.5 - 3.7 mg/l in Summer, 2.3 - 9.6 mg/l in Monsoon, 3.9 - 8.7 mg/l in Post- monsoon and 2.9 - 3.7 mg/l in the Winter. However, the highest BOD_5 value was noted in the Post-monsoon and Winter probably due to the accumulation of more organic matter that led to increased metabolic activities.. Monsoon and Winter rises of BOD value was also reported by Robert (1969), Richard (1966), Voznaya (1981) and Golterman (1983). Comparatively high BOD values were obtained from pond -3 with highest value in the Monsoon and Post-monsoon. The Summer values were relatively high but the Winter values were low. However, the BOD values show a moderately high level of organic matter present in this study pond. The seasonal variations of BOD values in this study pond were found to be from 9 - 11.6 mg/l in Summer, 9.4 - 13.6 mg/l in Monsoon, 6.7 - 12.8 mg/l in Post-monsoon and 3.2 - 7.6 mg/l in the Winter. Study pond -4 showed comparatively higher amount of biodegradable organic matter throughout the study year. Higher values were noticed in the Monsoon and Post-monsoon indicating relatively large amount of biodegradable organic matter. However, the Summer and Winter values were also comparatively high. The seasonal values of BOD in the study pond were found to range from 8.6 - 13 mg/l in Summer, 13.2 - 16.8 mg/l in Monsoon, 12.4 -16.8 mg/l Post- monsoon and 9.3 - 13.6 mg/l in the Winter. COD - BOD or P values were also calculated which were 4.4, 8.2, 4.6 and 7.4 in pond -1 in Summer, Monsoon, Post-monsoon and Winter respectively, while in pond - 2 the 'P' values were 4.3, 7.6, 4.4 and 5.4 in the four seasons respectively. In pond -3 the 'P' values were 11.2 in Summer, 14 in Monsoon, 14.4 in Post-monsoon and 8.4 in the Winter. In study pond - 4, The 'P' values were found to be 10.8 in Summer, 19.2 in Monsoon, 15.3 Post-monsoon and 11.2 in the Winter. This study pond appeared to have comparatively higher 'P' values than the other three study ponds. High BOD, COD, P^H and P values indicate higher amount of organic matter, (Goutam 1990). Study pond-4 is, therefore rated as having higher amount of organic matter amongst the four study ponds.

Chemical Oxygen Demand (COD) :

The COD is an indication of total organic matter (including biodegradable and non-biodegradable) present in the water of ponds. It may be defined as the measure of oxygen which is required in oxidizing the organic compounds present in water by means of chemical reactions involving oxidizing substances. (Swarup *et. al.*, 1992). An increase in the COD values indicate an increase in the biodegradable and non-biodegradable organic matters in water.

During the period of investigation, the study ponds indicated a comparative by lower load of non-biodegradable and biodegradable organic matters. In all monthly samplings in the study ponds, the COD value was within the permissible limit of tolerance (45 - 75 mg/l) set by ISI (Trivedy, 1990). The COD values of the study ponds were comparatively low and the 'P' values (COD- BOD) were also comparatively low.

The COD values in pond -1 were found to have a seasonal range from 7.5 - 15 mg/l in Summer, 11.9 - 22 mg/l in Monsoon, 7.2-10.6 mg / l in Post-monsoon and 9.8-15.2 mg / l in the winter with a 'P' value of 6.4, 8.2, 4.6 and 7.4 respectively. In pond -2, the COD values varied from 6.4 - 8.4 mg/l in Summer, 6.7 - 20.7 mg/l in Monsoon, 8.2 - 12.8 mg/l in Post-monsoon and 7.3 - 10.1 mg/l in the Winter and the 'P' values were 4.3, 7.6, 4.4 and 5.4 respectively. Study pond-3 registered a comparatively higher value of COD in comparison to study pond -1 and 2. The COD value in this pond were found to range from 19.6 - 26.3 mg/l in Summer, 22.3 - 28.7 mg/l in Monsoon, 14.5 - 27.7 mg/l in Post-monsoon and 8.7 - 18.9 in the Winter with the 'P' values of 11.2, 14, 11.4 and 8.4 in study seasons respectively. Study pond -4 had always highest COD value than the other three study ponds. The season range of COD values were 17.3 - 25.9 mg/l in Summer, 31.2 - 37.2 mg/l in Monsoon, 26.2 - 33.6 mg/l in Post-monsoon and 20.7 - 24.8 mg/l in the Winter with corresponding 'P' values were 10.8, 19.2, 15.3 and 11.2 in this study pond. Moderately high P^H value with lower BOD, COD and 'P' values are indications of organic load within the limit of tolerance in the ponds. Similar views were also expressed by Gautom (1990), Trivedy (1990), Ghose and Sharma (1989), and Khanna (1993). Lakshminarayana (1965) and Jayanguder (1964) are of opinion that water bodies with these values of P^H, BOD and COD with higher DO values are eutrophic in nature. The present study ponds, therefore, can be termed as eutrophic or highly productive in nature. Consequently the stock density of brood fishes of exotic origin was as high as 10 metric tones/ha./year (personal communication from the hatchery authorities). This productivity was rated as very high in the study ponds in terms of exotic varieties of brood and stock fishes. (Hatchery authorities).

Ammonia (NH_3 - N) :

Ammonia is liberated in water as an end product of decomposition of organic matter and also as an excretory product of aquatic animals. Waste matter of domestic and industrial origin is rich in nitrogen organic matter which increases the ammonia load in water and raises the toxic level in some accasions (Swarup *et. al.* 1992). During the present investigation, the NH_3 - N level was found to be in a very low level and ranged from a zero value to 0.2 mg/l. The level of tolerance is known to be 0.05 mg/l for the existing biota (Ghose & Sharma, 1989). This indicates the NH_3 - N values exceeded the tolerance limit in many occasions in the study ponds. Any clear or definite pattern of fluctuation of NH_3 - N values have not been observed in the study ponds. However, the regular charging of the ponds with organic matter as fish feed may be the probable reason such rises in the NH_3 - N values. The Winter and Monsoon values were comparatively high in the four ponds. Higher Winter, Summer and Monsoon values were also reported by Trivedy (1990) and Ghose and Sharma (1985) Ghose and Sharma (1989) reported an average value of 0.11 mg/l in less polluted waters. The present ponds may also, therefore be class as less polluted, although in some cases the limit of tolerance have been surpassed in the ponds.The seasonal values of NH_3 - N in pond -1 were found to range from 00 - 0,10 mg/l in Summer, 0 - 0.10 mg/l in Monsoon, 0.10 - 0.11 mg/l in Post-monsoon and 0.10 - 0.13 mg/l in the Winter; while in pond -2 the values varied from 0 - 0.10 mg/l, 0 - 0.10 mg/l, 0.1- 0.2 mg/l and 0.03 - 0.10 mg/l in four seasons respectively. In study pond -3, the NH_3 - N values ranged from 0 - 0.10 mg/l, 0 - 0.10 mg/l, 0.10 - 0.11 mg/l and 0.10 - 0.13 mg/l in Summer, Monsoon, Post-monsoon and Winter respectively. Similarly the values varied from 0 - 0.10 mg/l, 0 - 0.10 mg/l, 0.02 - 0.2 mg/l and 0.10 - 0.2 mg/l in study pond -4 respectively.

Phosphate (PO_4) content

The phosphate in one of the major nutrients essentially required by plant. It is an essential component of life. Phosphate is used by phytoplankton and stimulates plant growth when in excess of critical concentration. In waters PO_4 occurs as complex or inorganic water-soluble form and also in organic bound form. During the present investigation the inorganic PO_4 content was found to vary from pond to pond in different seasons. The PO_4 values ranged from 0.01 to 1 mg/l in the study ponds. The average value of phosphate in pond -1 reveal that the level of phosphate was high in the Winter (0.7 mg/l) and Summer (0.7 mg/l). Similar values were reported by Gautom (1990) in his investigations. The seasonal values ranged from 0.1 - 0.7 mg/l in Summer, 0.1 - 0.2 mg/l in Monsoon and Post-monsoon and 0.1 - 0.7 mg/l in the Winter. In pond -2, the PO_4 values ranged from 0 - 0.1, 0 - 0.1, 0.1 - 0.2 and 0.03 - 0.1 mg/l in Summer, Monsoon, Post-monsoon and Winter respectively, while in study pond -3, the seasonal PO_4 values were found to range from 0.03 - 0.1, 0.03 - 0.3, 0.1 - 0.2 and 0.01 - 0.3 mg/l respectively. In study pond -4, Summer and Monsoon values were comparatively high then the other season. The values ranged from 0.02 - 0.4 mg/l in Summer, 0.3 - 1.0 mg/l in Monsoon, 0.02 - 0.2 mg/l in Post-monsoon and 0.1 - 0.2 mg/l in the Winter. Phosphate level of extent present in the study ponds indicate their high trophic nature. Lakshminarayana (1965) and Jayangader (1964) eprssed similar views and opined that PO_4 is of immense need forming the nutrients of Biological importance.

Oxidation-reduction potential and oxidation reduction index (Eh and rH_2)

In a body of water or aquatic ecosystem where biological metabolism is going on, there is a continual change in the ration between the materials in reduced form and the materials in oxidized form. If the watery habitat that possesses organic material the concentration of reduced form is higher which results in lower values of Eh and rH_2. But after a short time when the material degrades, the water body starts to attain it original form and the Eh and rH_2 values increases. In case of continuos addition of the organic material, a continuous decrease in the Eh and rH_2 values occur (Voznaya, 1981; Gautom, 1990 and Warner, 1966). Lower values of Eh and rH_2 indicate the presence of higher amount of organic matter. The decomposition of the organic matter complex redox reactions resulting in the heterotrophic activities i.e. respiration succeeded by NO_3 reduction, fermentation, SO_4 reduction, CO_2 reduction etc. accompanied by microbial succession occur, lower as the Eh & rH_2 level. The neutral point of rH_2 is 28 (Voznaya, 1981).

In the present study ponds, the Eh values were found to be lower throughout the study period with lower ranges of seasonal variations. In pond -1, the seasonal Eh values were found to be almost similar and ranged from 0.25 to 0.35 mv. Similarly in pond -2, the values varies from 0.22 to 0.35 mv. In pond -3, the Eh values were found to range from 0.23 to 0.31 mv. The Eh values were lowest in the Summer and Winter indicating the organic load in study pond. Similar Summer and Winter low values were obtained by Voznaya (1981). In study pond -4 the Eh values varied annually from 0.23 to 0.32 mv., while the Summer and Winter values were comparatively lower than the Monsoon and Post-monsoon.

The rH_2 values in pond -1, were found to have an annual variation from 25.8 to 27.8 indicating lower load of organic matter. The seasonal values were found to be fairly uniform. The seasonal values were 26.2 - 27.8 in Summer, 26 - 26.6 in Monsoon, 25.8 - 26.3 in Post-monsoon and 26.1 in the Winter. Similarly in pond -2, the rH_2 values were also found to be uniform each month and season as well. The variation of rH_2 values ranged from 25.3 - 27.6, 26.4 - 27.09, 26 - 26.4 an 25.7 -26.02 in the Summer, Monsoon, Post-monsoon and Winter respectively. The values were slightly below the neutral indicating comparatively small amount of organic matter (Voznaya, 1981). Uniformly higher rH_2 values were also recorded from study pond -3 and the range of variation were from 25.7 - 27, 25.7 - 26.4, 26.1 - 26.2 and 25 - 26.1 in the Summer, Monsoon, Post-monsoon and Winter seasons respectively, indicating relatively lower load of organic matter in the pond water. In study pond -4, lower values of rH_2 in the Summer indicated higher load on organic matter. Winter values were comparatively low. The seasonal variation of rH_2 values were found to range from 15.8 - 26.4 in the Summer, 26.3 - 27.2 in Monsoon, 26.02 - 26.3 in Post-monsoon and 25.7 - 26.1 in the Winter period.

Low Eh, rH_2 and low BOD, COD, P^H and P values indicate higher amount of organic matter in an aquatic body (Gautom, 1990). In the present study, moderately low values of Eh and rH_2 and moderately high value of P^H, P, BOD, COD and DO are indication of presence of organic matter in the four study ponds. Coupled with the NH_3 - N and PO_4 values the whole physico-chemical variables together formed a factor complex of nutrient status of biological importance imparting a eutrophic to hypertrophic nature to the study ponds.

ZOOPLANKTION

A Total of 38 genera of zooplankton were recorded from the four study ponds during the study period, of which 10 genera belonged to Copepoda, 9 to Cladocera and 19 to Rotifera. Pond-1, 2 and 3 were characterized by the presence of the Copepods, Cladoceran and the Rotifers. But the rotifers were found to occur in pond-4 only. The other two groups were not encountered in this pond during the study period. All the Zooplankton members occurred sporadically in the study ponds and a definite pattern of succession could not be noticed. The feeding habit of the exotic brood fishes may be the reason for such appearance of the zooplankton member. The occurrence of different genera of zooplankton have been depicted in Table - 1, 2, 3 & 4.

A total of 27 genera of zooplankton were recorded from pond-1, of which 8 genera belonged to Copepoda, 7 to Cladophera and 12 to Rotifera. Pond -2 was represented by 31 genera of which 10 belonged to copepoda, 8 to cladocera and 13 to rotifera. In pond -3 only 18 genera of zooplankton were noticed of which 4 belonged to the copepoda, 6 to cladocera and 8 to rotifera. Study pond -4 was represented by 12 genera of rotifers only. The reason for the absence of copepods and cladocerans could not be ascertained. It may so happen that the feeding habit of the brood fish silver carp; similar views were expressed by Kumer, 1992 & Biswas, 1996 and the water chemistry played a role for such disappearance. Higher values of turbidity, TDS, conductivity, HCO_3 alkalinity, total hardness and super saturation of oxygen throughout the study period may probably have created a factor-complex uncogenial for the members of the copepods and cladocerans (Jayangauder, 1964).

The seasonal abundance values in pond -1 indicate that the copepods were in their peaks in the Monsoon, while cladocerans showed their peaks in Summer and Monsoon. The rotifers were in their peak in the Winter and Maintained almost uniform density in the other seasons. In study pond -2, the copepoda had a peak in Summer, while the rotifers had two peaks - one in monsoon and the other in Winter. Similar Summer and Winter peaks were reported by Jayangauder (1964) and Lakshminarayana (1965). The cladocerans showed a uniform population density throughout the study period in this study pond -2. In study pond -3, the copepods had a high peak in the Post-monsoon, while the cladocerans had two peaks, one in Summer and one in Post-monsoon. The cladocerans density was almost uniform in the Monsoon and Winter. The rotifers were in high peaks in the Summer and Monsoon, with a comparatively high population density in the Winter & Post-monsoon. Pond -4 was represented by the rotifers only where *Brachionus* was found to be the dominant genus followed by *Harringia, Trichocera Philodina* and others. A very low population density was exhibited by *Platyias* and *Notholca*. It is noteworthy that all the 12 genera of rotifera were found to occur in all monthly samples in pond -4, but they were only of sporadic appearance in other study ponds. The rotifers, are therefore tolerant to varying degree of physico-chemical and biological condition. Arora (1966) observed that the rotifers occur in eutrophic waters in high abundance. Summer and Winter pulses of rotifers were reported by George (1966). Arora (1966), Thunmark (1945), Lilieroth (1950) and Berzins (1949) designated a large number of rotifer genera including *Brachionus, Keratella* and *Filinia* as indicators of eutrophic or polluted waters. Considering the occurrence of large number of genera of rotifera including *Brachionus, Keratella* and *Filinia*, in the four study ponds in varying density throughout the study period, the study ponds can be indicated as eutrophic in nature. The study ponds may be marked as having lower level of pollution based on the values of the redox characteristics including the P^H, DO, BOD, COD, Eh and rH_2 and also the higher conductivity and chloride values (Gautam, 1990).

The seasonal abundance and percentage composition of phyto- and zooplankton in the four study ponds were depicted in Table -7. The data show that the zooplankton population density was always higher than that of the phytoplankton in all study seasons in the four ponds. In pond -1, the zooplankton constituted of 58.2 %, 58.3 %, 82.6 % and 90.5 % of the total plankton population in Summer, Monsoon, Post-monsoon and Winter respectively. In pond -2, the zooplankton density was 77.7 %, 73.2 %, 64.5 % and 79.2 % of the total plankton population in the respective seasons. In study pond -3, the zooplankton were represented by 67.2 %, 74.1 %, 56.4 % and 62.1 % of the total plankton population in Summer, Monsoon, Post-monsoon and Winter seasons respectively. In study pond -4, where only the rotifers occurred, the zooplankton density was 83.3 %, 61.2 %, 73.2 % and 44.6 % of the total plankton population in the respective seasons. It appears that the phytplankton density superceded the zooplankton density in the Winter in pond -4 only. The phytplankton and zooplankton seasonal ratio in pond -1 were 1 : 1.39, 1 : 1.39, 1 : 4.7 and 1 : 10 in Summer, Monsoon, Post-monsoon and Winter respectively while in pond -2, the ratio in the respective seasons were 1 : 3.5, 1 : 2.7, 1 : 1.8 and 1 : 3.8. In pond -3 the ratio in respective seasons were 1 : 3.7, 1 : 1.68, 1 : 2.2 and 1 : 1.28, while in study pond -4 they were 1 : 2.7, 1 : 2.6, 1 : 1.6 and 1 : 0.8.

Primary Productivity.

The dark and light bottle method of estimation of GPP and NPP (Gross primary productivity and Net primary productivity) showed that all the study ponds were moderately to highly productive varying in different seasons. In pond -1, the GPP and NPP values were high in Summer, whereas in P-2 the GPP and NPP values were high (mg C/l/h) in all the four seasons and the negative NPP values, indicated a high rate of respiration by the fishes, zooplankton and other biota. In pond -3, the GPP values were moderately high in the four study seasons and negative NPP values were noted in the Monsoon and Winter only. Pond -4 presented higher GPP values in Monsoon and Post-monsoon with moderately high values in Summer and Winter. Negative NPP values were noted once in the Summer and another in the Monsoon.

PHYTOPLANKTON

Biological parameters have enormous importance on ecological point of view. All forms of natural and artificial water bodies contain variety of organism, both plants and animals as their natural flora and fauna. Study of these biota and their interrelationship with the existing physico-chemical variables is necessary to properly evaluate the trophic status and productivity levels for suitable management. The level of pollution and response of the biota to such condition can also be assessed for necessary abetement of the polluted condition. The present investigation was undertaken to see the effect of present cultural practices on the phytoplankton and zooplankton organisms in the culture ponds. Consequently, the monthly and seasonal occurrence, abundance and percentage composition of the available phyto and zooplankton members have been studied. (Table P -1, 2, 3, 4, ZP -1a, ZP -2a, 3a, 3b, 5, 5b, P -1a, 2a, 3a, 4a, P -1b, 2b, 3b & 4b).

Noteworthy feature of the study ponds is the occurrence of the major group of the algae throughout the year. Some planktonic algal genera were found to occur all the year round, while there were some occurring only sporadically in some sampling months. No algal group had been found to appear as a dense visual bloom during the period of investigation, though some of the phytoplankton members were found to be in high abundance in different months and seasons as well. However, the study pond water remained slightly chemical undersaturated with DO during the study year, with exceptions in a few occasions when the water was found to be over saturated with oxygen. Anoxiating condition have were been found to occur in any study pond. The nutritive substances of biological importance i.e. Moderately high nitrogen indicated by the organic load of the ponds, phosphate content were notably high. The Monsoon and Post-monsoon periods with comparatively high water temperature, high limit of visibility, high P^H, DO, total alkalinity, total nitrogen, PO_4 might have provided favourable conditions for the growth of some phytoplankton member occurring in high abundance. It is noteworthy that the members of Chlorophyceae, Cyanophyceae, Bacillariophyceae and the Euglenophytes were in their peaks in different seasons and simultaneous peaks were observed in fewer occasions. The occurrence of a fewer number genera of indicates that the study ponds suffers from not having a wide variety of planktonic algae. As far as the monthly and seasonal abundance of phytoplankton is concerned, the study ponds herbour a quantitatively lower population abundance compared to a tropical or temperated water body. Given all the physico-chemical condition to a congenial level, the phytoplankton with respect to wider variety of members and monthly and seasonal abundance and percentage composition. But the present study ponds showed a poor variety of algal plankton and their abundance. It may be mentioned that the study ponds were used as stocking ponds for the exotic brood fishes with very high stock density. As a matter of fact, the exotic brood fishes including silvers and other carps are voracious phytoplankton feeders, and normally they consume much higher amount of plankton food than the indigenous variety of fishes. This type of feeding habit may have probably played in the study ponds for lowering the population density of the phytoplankton members. Moreover, the abundance of zooplankton population was always found to be high in all the ponds in corresponding seasons. Most of zooplanktons belonging to the copepoda, Cladecera and Rotifera are phytoplankton feeders. Their feeding pressure may also be regarded as a probable reason for such lower phytoplankton abundance in the study ponds. George (1966) reported similar situation in his study in India. Nauman (1927), Rao (1955), Yoshimura (1932), Zafar (1964), George (1966), Moyle (1946), Lakshminarayana (1965) and many other workers stressed that a body of water is eutrophic or highly productive characterized by it rich nitrogen, PO_4, total alkalinity, total hardness and DO contents. The present study ponds, thus, may be classed as eutrophic with respect to their content of the above parameters. Therefore, the lower population abundance and ununiform density of the phytoplankton may be due to the feeding pressure of the exotic brood fishes and other animal organism present in the study ponds. As has been stated in the observation chapter, the total number of genera of phytoplankton in pond -1 were 33, of which 12 belonged to the Chlorophyceae, 7 to Cyanophyceae, 10 to Bacillariophyceae, 3 to Euglenophyceae and 1 to Dinophyceae. As for the seasonal abundance of different group of phytoplankton algae in pond -1, the Summer, Monsoon, Post-monsoon and Winter abundance were 66044 unit/l (27.2 % Chlorophyceae, 24.8 %

Cyanophyceae, 14.8 % Bacillariophyceae, 34.5 % Euglenophyceae and 1.6 % Dinophyceae), 82225 unit/l (25.2 %, 19.8 %, 10.6 %, 43.2 % and 1.1 % Chlorophyceae, Cyanophyceae, Bacillariophyceae, Euglenophyceae and Dinophyceae respectively), 66123 unit/l (22.8 %, 18.3 %, 21.8 %, 36.7 % and 0.12 % Chlorophyceae, Cyanophyceae, Bacillariophyceae, Euglenophyceae and Dinophyceae respectively) and 57161 unit/l (22.9 %, 31.5 %, 16.6 %, 28.7 % and 0.22 % Chlorophyceae, Cyanophyceae, Bacillariophyceae, Euglenophyceae and Dinophyceae respectively) in this study pond respectively. It appears that the Euglenoids were numerically dominant followed by Chlorophyceae, Cyanophyceae, Bacillariophyceae, Euglenophyceae and the Dinophyceae. Similarly in pond -2, 26 genera of phytplankton were recorded in the study period of which 9 genera belonged to the Chlorophyceae, 7 genera to Cyanophyceae, 6 to Bacillariophyceae, 3 to Euglenophyceae and 1 to Dinophyceae. As regards to the seasonal abundance and percentage composition, the Chlorophyceae constituted of 30.2 %, 28.5 % 28.9 % of the total phytoplankton population in Summer, Monsoon, Post-monsoon and Winter respectively, while the Cyanophytes constituted of 22.2 %, 26.4 %, 11.2 % and 23 8 % of the total phytoplankton in the four consecutive seasons respectively. the Bacillariophytes constituted of 16.2 %, 19.7 %, 34.2 % and 24.4 % of the total phytoplankton in the Summer, Monsoon, Post-monsoon and Winter respectively, while the Euglenoids comprised of 31.4 %, 25 %, 23.7 % and 6.2 % of the total plankton in the consecutive seasons respectively. The Dinophytes were found to occur in the Post-monsoon (1.8 %) and Winter (9.5 %). In study pond -3, a total of 30 genera of phytoplankton occurred during the period of investigation of which 11 genera belonged to Chlorophyceae, 7 genera to Cyanophyceae, 10 to Bacillariophyceae, 2 to Euglenophyceae and no member of

Dinophyceae have been observed in this pond during the sampling period. The observation in the seasonal abundance shows that the Chlorophyceae constituted of 17.2 %, 24.6 %, 7.8 % and 6.8 % of the total phytoplankton population in the Summer, Monsoon, Post-monsoon and Winter seasons respectively. Similarly, the Cyanophytes constituted of 40.5 %, 46.1 %, 38.9 % and 42.9 % of the total phytoplankton in the respective season as well. The Cyanophytes were found to a dominant group on annual and seasonal basis followed by the Bacillariophytes, Chlorophytes ad Euglenophytes. The Bacillariophytes constituted of 21.4 %, 28.1 %, 25.7 % and 44.5 % of the total population of in the respective seasons. In the study pond -4, 11 members of Chlorophyceae, 8 members of Cyanophyceae, 9 members of Bacillariophyceae and 2 members of Euglenophyceae were recorded during the study period. As regards the seasonal and percentage comparison is concerned, the Chlorophytes constituted of 11.5 %, 9.7 %, 23.6 % and 19.8 % of the total phytoplankton population in the Summer, Monsoon, Post-monsoon and Winter seasons respectively, while in the respective seasons, the Cyanophytes comprised of 45.2 %, 40.9 %, 37.4 % and 26.2 % of the total population of phytoplankton. The Bacillariophytes were found to constitute 15.5 %, 7.3 %, 20 % and 41.5 % in the total respective seasons, while the Euglenophytes constituted of 27.5 %, 37.2 %, 15 % and 12.5 % of the total phytoplankton population in the respective four seasons. The Cyanophytes were found to be seasonally dominant followed by Euglenophyceae, Bacillariophyceae, and Chlorophyceae. The monthly and seasonal abundance of different group and genera of phytoplankton have been stated in the observation chapter with a number of tables and charts, which indicate that a definite pattern of seasonal succession is not clearly observed in the study ponds.

CHAPTER -5

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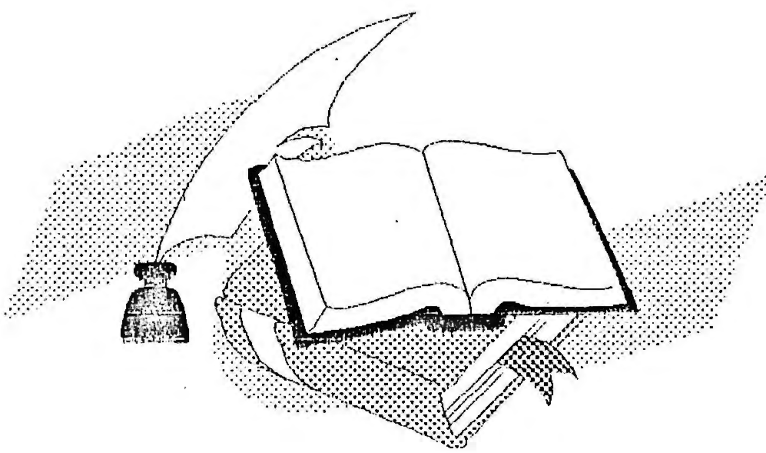

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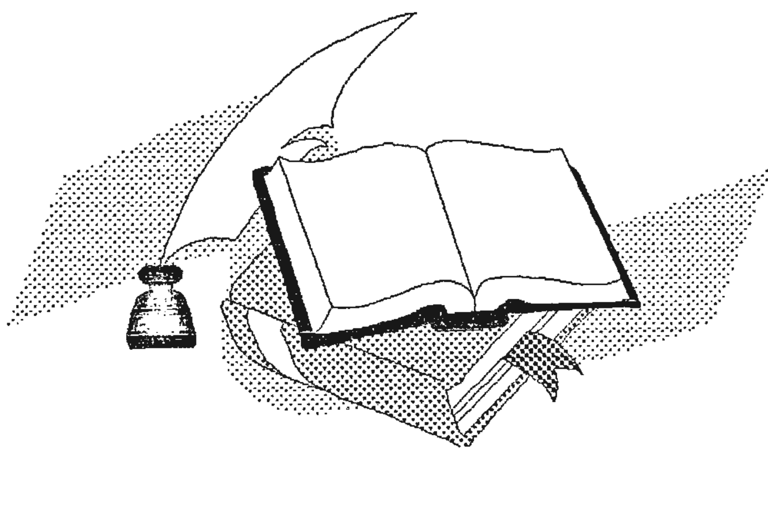
CHAPTER -6

APPENDIX



Physico-chemical condition of P_1 (Study pond-1), Tab-1

Factors	May '94	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	April '95
Air temp. C^0	34.8 ± 1.6	29.1 ± 2.9	32.1 ± 1.6	33.6 ± 2.9	30.3 ± 0.4	27.6 ± 1.2	23.1 ± 2.2	20.2 ± 2.9	17.5 ± 3.3	23.8 ± 2.5	32.4 ± 2.4	38.3 ± 1.7
Water temp. C^0	31.8 ± 0.9	28.9 ± 0.8	31.1 ± 0.7	31.5 ± 1.4	30.4 ± 0.6	27.7 ± 1.7	24.1 ± 2.4	19.3 ± 2	19.6 ± 1.3	23.9 ± 2.2	29.0 ± 1.7	30.8 ± 1.3
Av. depth .m.	1.1 ± 0.1	1.1 ± 0.1	1.1 ± 0.1	1.2 ± 0	0.9 ± 0	0.9 ± 0	1.2 ± 0	1.0 ± 0.1	1.0 ± 0	1.0 ± 0.1	1.0 ± 0.1	1.1 ± 0.1
S. D. depth. m.	0.2 ± 0	0.2 ± 0	0.2 ± 0	0.2 ± 0	0.1 ± 0	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0	0.3 ± 0	0.2 ± 0	0.2 ± 0	0.2 ± 0
T. D. S. mg/l	489.5	494.3	484.3	454.7	353.0	456.0	488.8	450.5	440.4	484.3	444.0	420.2
E. cond. µ moh/cm	753 ± 9	751 ± 37	745 ± 2	700 ± 7	543 ± 46	702 ± 66	752 ± 14	693 ± 46	678 ± 39	745 ± 14	683 ± 62	647 ± 38
pH	7.7 ± 0.1	8.3 ± 0.1	8.3 ± 0.1	8.3 ± 0.1	8.5 ± 0.1	8.7 ± 0.1	8.6 ± 0.1	8.6 ± 0.1	8.6 ± 0.1	8.6 ± 0.2	8.7 ± 0.1	8.7 ± 0.1
Free CO_2 mg/l	21.5 ± 6.0	9.7 ± 3.8	10.1 ± 6.8	2.8 ± 6.2	26.7 ± 14.4	23.5 ± 6.7	13.0 ± 3.3	27.3 ± 3.6	15.7 ± 15	33.2 ± 8.6	34.7 ± 6.4	28.0 ± 4.7
CO_3 Alk. mg/l	0 ± 0	0 ± 0	0 ± 0	17.2 ± 8.4	0 ± 0	0 ± 0	0 ± 0	0 ± 0	2.8 ± 4.0	0 ± 0	0 ± 0	0 ± 0
HCO_3 alk. mg/l	30.5 ± 8.0	23.5 ± 3.2	21.0 ± 1.7	49.0 ± 24.0	114.1 ± 14.4	165.3 ± 4.3	135.0 ± 26.0	184.0 ± 22.0	231.0 ± 16.1	301.2 ± 39.0	346.3 ± 30.0	403.0 ± 56.0
Total hardness mg/l	209.0 ± 13.3	295.0 ± 48.1	287.0 ± 60.0	200.0 ± 18.0	209.0 ± 26 .0	267.0 ± 36.2	285.0 ± 31.0	386.0 ± 113.0	467.3 ± 31.0	440.0 ± 95.0	429.0 ± 50.0	538.0 ± 147.0
Chloride mg/l	112.0	121.0	103.0	143.0	102 .0	109.0	99.0	87.0	107.0	107.0	122.0	131.0
DO mg/l	6.1 ± 1.1	5.2 ± 0.8	6.3 ± 0.7	6.8 ± 0.8	6. 9 ± 1. 0	6.3 ± 0.1	5.7 ± 0.9	5.4 ± 0.9	7.6 ± 1.3	4.0 ± 1.1	5.4 ± 1.4	5.4 ± 1.3
% of sat O_2	82.0	68.0	86.0	92.0	92.0	81.0	69.0	60.0	86.0	45.0	70.0	73.0
BOD_5 mg/l	6.9	7.6	5.4	12.0	3.4	3.1	4.9	5.6	7.0	3.2	3.1	2.7
COD mg/l	15.3	18.8	11.9	22.5	8.4	7.2	10.6	12.2	15.2	9.8	8.5	7.4
NH_3-N mg/l	0.10 ± 0	0.10 ± 0	0.10 ± 0	0.10 ± 0	0. 10 ± 0	0.10 ± 0	0.11 ± 0	0.10 ± 0	0.13 ± 0	0.10 ± 0	0.10 ± 0	0 ± 0
PO_4 mg/l	0.1	0.1	0.1	0.2	0. 1	0.2	0.1	0.1	0.7	0.2	0.7	0.2
Eh mv	0.36	0.29	0.29	0.29	0. 27	0.25	0.25	0.26	0.26	0.26	0.25	0.25
rH_2	27.81	26.60	26.60	26.60	26.31	26.02	25.82	26.17	26.17	26.17	26.02	26.02
GPP mg C/l/h	0.2	0.2	0.3	0.3	0.2	0.3	0.2	0.2	0.4	0.3	0.4	0.3
NPP mgC/l/h	0.10	-0.10	0.04	0.02	0.04	0.03	-0.11	-0.14	0.10	0.12	0.14	0.08

Physico-chemical condition of P_2 (Study pond-2), Tab-2

Factors	May '94	June'94	July'94	Aug'94	Sep'94	Oct'94	Nov'94	Dec'94	Jan'95	Feb'95	March'95	April'95
Air temp. C^0	34.8± 1.6	28.6± 2.4	32.0± 1.6	33.6± 2.9	30.3± 0.4	27.6± 1.2	23.1± 2.3	20.2± 2.9	17.5± 3.3	23.8± 2.5	32.6± 2.4	38.7 ± 1.9
Water temp. C^0	32.8± 0.9	29.7± 0.8	31.0± 0.6	32.1± 1.2	31.0± 0.7	27.4± 1.6	23.1± 1.6	18.4± 1.6	18.5± 1.8	24.0± 2.4	29.2± 2.8	31.8 ± 1.7
Av. depth. M.	1.7± 0.1	1.6± 0.1	1.5± 0.1	1.8± 0	1.5± 0	1.4± 0	1.4± 0	1.4± 0	1.6± 0	1.4± 0	1.4± 0	1.8 ± 0.1
S. D. depth .M	0.2± 0.1	0.2± 0.1	0.2± 0.1	0.2± 0.1	0.2± 0.1	0.2± 0.1	0.2± 0.1	0.4± 0.1	0.2± 0	0.1± 0	0.3± 0.1	0.2 ± 0
T. D. S. mg/l	404.3	418.0	455.0	383.0	344.0	499.0	435.0	482.0	440.4	406.9	436.2	408.9
E. cond.µ moh/Cm	422.0± 16.0	443.0± 27.0	700.0± 6.0	589.0± 0	529.0± 32.0	767.0± 37.0	669.0± 69.0	741.0± 44.0	677.5± 38.5	709.0± 19.0	671.0 ± 60.0	629.0 ± 115.0
pH	7.8± 0.1	8.2± 0.2	8.4± 0.3	8.2± 0.1	8.4± 0.1	8.7± 0.1	8.7± 0.1	8.7 ± 0.2	8.8 ± 0.1	8.9 ± 0.1	8.9 ± 0.1	8.8 ± 0.2
Free CO_2 mg/l	14.7± 4.9	8.2± 2.0	8.9± 8.6	8.6± 7.5	19.0± 11.7	8.3± 10.7	11.3± 10.4	32.5± 6.7	4.9± 5.8	13.1± 18.8	12.2 ± 10.3	4.3 ± 9.5
CO_3 alk. mg/l	0 ± 0	0 ± 0	0 ± 0	4.8± 6.8	0.9± 2.1	2.7± 3.4	2.8± 4.1	0 ± 0	7.3± 8.0	10.8± 9.1	5.3 ± 7.6	15.2 ± 8.7
HCO_3 alk. mg/l	21.2± 2.3	18.8± 1.7	18.7± 2.5	41.3± 22.4	109.7± 15.1	160.5± 13.1	141.3± 21.2	171.4± 16.6	195.3± 21.5	290.1± 48.1	329.7 ± 4.2	356.7 ± 122.6
Total hardness mg/l	285.5± 98.8	307.0± 32.1	227.5± 41.3	226.2± 21.0	214.2± 43.1	317.7± 36.8	311.0± 20.4	414.6± 112.1	487.0± 63.0	464.8± 24.7	465.2 ± 63.0	609.2 ± 56.3
Chloride mg/l	138.7	121.6	191.7	133.7	136.9	129.8	146.7	104.6	121.7	120.6	103.6	136.6
DO mg/l	6.0± 1.1	6.1± 1.0	6.3± 1.0	7.6± 1.2	8.4± 1.1	8.1± 0.4	6.8± 1.4	5.0± 1.5	7.9 ± 0.8	7.1 ± 1.8	6.8 ± 1.6	8.4 ± 1.1
% of sat O_2	83.0	80.0	85.3	105.0	113.0	104.0	81.0	53.2	86.5	85.5	90.0	114.4
BOD_5 mg/l	3.2	2.3	8.5	9.6	3.9	8.7	3.6	3.7	3.4	2.9	2.5	3.7
CODmg/l	7.3	6.7	14.5	20.7	8.7	12.8	8.2	10.1	8.7	7.3	7.1	8.4
NH_3-N mg/l	0.10±0	0.10±0	0.10±0	0.10±0	0.10±0	0.10±0	0.11±0	0.12 ± 0	0.10± 0	0.10± 0	0.10 ± 0	0
PO_4 mg/l	0.1	0.1	0.1	0.1	0.1	0.02	0.1	0.1	0.1	0.03	0.1	0.1
Eh. mv	0.35	0.31	0.28	0.31	0.28	0.25	0.25	0.25	0.24	0.23	0.22	0.24
rH_2	27.67	27.09	26.46	27.09	26.46	26.02	26.02	26.02	25.88	25.73	25.39	25.88
GPP mgC/l/h	0.3	0.3	0.4	0.4	0.3	0.3	0.3	0.1	0.4	0.3	0.2	0.3
NPP mgC/l/h	-0.0.3	0.10	-0.10	0.10	0.01	0.01	0.21	-0.16	0.05	0.15	-0.07	0.02

Physico-chemical condition of P_3 (Study pond-3), Tab-3.

Factors	May '94	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	March	April '95
Air temp. C^0	33.8 ± 1.8	30.4 ± 2.5	30.2 ± 1.2	32.6 ± 2.0	28.5 ± 0.9	27.4 ± 1.9	22.8± 16	19.3± 21	19.0 ± 3.6	24.3 ± 2.6	32 .6± 1.7	35.1 ± 0.8
Water temp. C^0	32.4 ± 1.3	29.8 ± 1.0	31.1 ± 0.4	31.9 ± 1.0	29.2 ± 0.6	29.0 ± 1.3	22.9 ± 12	19.0 ± 1.1	20.1 ± 1.2	24.3 ± 1.2	29.3 ± 0	32.5 ± 1.0
Av. depth .m.	2.2 ± 0.1	2.1 ± 0	2.1 ± 0.1	2.3 ± 0.1	1.7 ± 0.4	2.0 ± 0	1.7± 0.1	1.7 ± 0.2	1.9 ± 0	1.8 ± 0.1	1.8 ± 0.2	2.0 ± 0.2
S. D. depth. m.	0.2 ± 0	0.2 ± 0	0.3 ± 0	0.2 ± 0	0.2 ± 0	0.2 ± 0	0.2 ± 0	0.2 ± 0	0.1 ± 0	0.3 ± 0.1	0.2 ± 0	0.2 ± 0
T. D. S. mg/l	397.2	412.1	419.3	381.6	387.7	389.4	448.5	447.9	450.1	441.7	445.9	423.2
E. cond. µ moh/cm	611.0 ± 5.0	634.0 ± 18.0	645.0 ± 7.0	587.0 ± 2.0	597.0 ± 36.0	599.0 ± 0	690.0 48.0	689.0± 73.0	693.0± 47.0	680.0 ± 37.0	686.0 ± 45.0	651.0± 137.0
pH	8.2 ± 0.1	8.5 ± 0.1	8.4 ± 0.1	8.4 ± 0.1	8.6 ± 0.2	8.6 ± 0.1	8.6 ± 0.1	8.6 ± 0.1	8.7± 0.1	3.8 ± 0.1	8.7 ± 0.1	8.9 ± 0.1
Free CO_2 mg/l	1.3 ± 3.1	0± 0	2.8± 4.1	4.3 ± 6.1	6.3 ± 4.0	2.9 ± 4.5	3.8 ± 7.5	0±0	0 ± 0	6.4 ± 7.0	14.6 ± 15.2	1.0 ± 2.3
CO_3 Alk. mg/l	4.8 ± 2.3	1.8 ± 1.1	1.3 ± 1.6	1.2 ± 1.6	3.2 ± 2.4	1.7 ± 1.2	3.3 ±2.4	4.3± 1.7	8.0 ± 4.7	1.4 ± 1.7	1.8 ± 1.9	2.7 ± 1.7
HCO_3 alk. mg/l	25.6± 6.5	15.1 ± 4.5	16.7 ± 2.3	81.3 ± 30.4	113.8 ± 10.9	134.8 ± 38.6	114 2 ± 34.2	156.4± 31.1	218.8 ± 12.9	283.7 ± 51.4	298.2 ± 60.5	445.2 ± 60.5
Total hardness mg/l	240.2 ± 102.3	273.0 ± 54.0	228.7 ± 60.0	246.8 ± 22.7	238.7 ± 32.0	247.5 ± 27.0	271.7± 18.0	434.3 ± 31.0	424.0 ± 25.0	466.2 ± 50.5	500.0 ± 24.4	608.8 ± 44.6
Chloride mg/l	132.4	142.0	103.4	113.6	107.5	132.1	121.6	188.7	201.3	178.0	140.7	156.7
DO mg/l	7.7 ± 1.0	7.7 ± 1.2	7.3 ± 1.3	7.0 ± 0.9	9.6 ± 1. 4	6.8 ± 2.2	5.9± 1.3	9.1 ± 1.1	8.2 ± 0.9	5.7 ± 2.8	7.1 ± 1.8	8.3 ± 2.8
% of sat O_2	105.4	101.9	98.9	95.5	126.0	89.1	70.0	101.2	93.0	69.2	93.4	114.2
BOD_5 mg/l	9.0	13.6	13.0	9.4	6.7	12.8	7.4	7.6	3.4	3.2	11.6	10.6
COD mg/l	19.6	28.7	25.8	22.3	14.5	27.7	16.5	18.9	9.3	8.7	26.3	20.8
NH_3-N mg/l	0.1 ± 0	0.10 ± 0	0.10 ± 0	0.10 ± 0	0. 10 ± 0	0.10 ± 0	0.11± 0	0.13 ± 0	0.1 ± 0	0.1 ± 0	0.1 ± 0	0±0
PO_4 mg/l	0.1	0.3	0.1	0.03	0. 1	0.1	0.2	0.3	0.1	0.01	0.03	0.1
Eh mv	0.31	0.27	0.28	0.28	0. 26	0.26	0.26	0.26	0.25	0.23	0.25	0.23
rH_2	27.09	25.71	26.46	26.46	26.17	26.17	26.17	26.17	25.02	25.52	26.02	25.73
GPP mg C/l/h	0.4	0.3	0.4	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.2
NPP mg C/l/h	0.03	0.03	0.10	-0.01	0.02	0.11	0.10	0.10	0.10	-0.20	0.10	0.03

Physico-chemical condition of P_4 (Study pond-4, Tab-4.

Factors	May '94	June'94	July'94	Aug'94	Sep'94	Oct'94	Nov'94	Dec'94	Jan'95	Feb'95	March'95	April'95
Air temp. C^0	33.8± 1.8	30.4± 2.5	30.2± 1.2	32.6± 2.0	28.5± 0.9	27.4± 1.9	22.8± 1.6	19.3± 2.1	19.0 ± 3.6	24.4 ± 2.6	32 .6± 1.7	35.1 ± 0.8
Water temp. C^0	32.5 ± 0.9	29.7± 0.8	30.9± 0.6	31.6± 1.0	29.6± 1.4	28.7± 1.7	23.0± 1.4	19.1± 1.2	20.3 ± 1.2	24.4 ± 1.8	29.4 ± 1.9	32.6 ± 0.9
Av. depth. m.	1.6± 0.1	1.6± 0	1.8± 0.	2.0± 0	1.4± 0.2	1.4± 0	1.5± 0	1.7± 0.3	1.4± 0	1.4 ± 0	1.6± 0.1	1.9 ± 0.2
S. D. depth .m.	0.2± 0	0.2± 0	0.2± 0.	0.2± 0.	0.3± 0.1	0.2± 0	0.2± 0	0.1±0	0.2 ± 0	0.2 ± 0	0.2 ± 0	0.2 ± 0
T. D. S. mg/l	362.7	382.5	403.3	354.9	380.3	370.8	404.6	470.6	397.5	451.4	378.6	351.3
E. cond. µ moh/Cm	553.0± 0	589.0± 28.0	621.0± 5.0	546.0± 1.0	585.0± 31.0	571.0± 10.0	623.0± 102.0	724.0± 61.0	612.0 ± 25.0	695.0 ± 9.0	583.0 ± 10.0	541.0 ± 45.0
pH	8.4± 0.1	8.5± 0.1	8.1± 0.1	8.4± 0.1	8.6± 0.1	8.6± 0.1	8.5± 0.1	8.6 ± 0.1	8.7± 0.1	8.9 ± 0.2	8.8± 0.1	8.9 ± 0.1
Free CO_2 mg/l	2.3± 5.2	0± 0	0± 0	0± 0	0± 0	4.0± 4.4	4.3± 1.5	0± 0	5.4 ± 0.7	0± 0	0± 0	0± 0
CO_3 alk. mg/l	4.9 ± 3.3	2.7 ± 1.2	2.3± 1.4	5.8± 1.8	4.8± 2.5	1.8± 1.9	2.5± 2.0	5.3± 2.3	4.3±3.4	7.7 ± 1.3	6.6± 0.9	6.6 ± 2.2
HCO_3 alk mg/l	21.3± 2.2	16.3± 4.5	15.2± 3.2	78.0± 22.2	113.8± 12.0	130.4± 6.5	102.0± 17.4	133.5± 26.0	174.0 ± 5.1	251.3 ± 25.3	251.0 ± 34.5	336.6 ± 35.2
Total hardness mg/l	268.0± 1.0	272.0± 28.4	197.8± 28.0	221.0± 16.3	216.0± 16.4	232.0± 6.0	228.3± 15.0	340.3± 22.0	317.3± 46.4	377.2 ± 24.0	409.0 ± 37.6	469.3 ± 110.0
Chloride mg/l	98.6	132.0	137.0	109.2	115.6	142.0	137.0	121.0	98.6	93.4	110.6	12[illegible].6
DO mg/l	7.2± 1.0	6.3± 0.5	6.4± 0.5	6.7± 0.8	10.6± 3.5	7.9± 1.4	6.5± 1.8	7.9± 1.3	7.9± 0.7	8.2 ± 1.5	7.7± 1.1	8.2 ± 1.3
% of sat O_2	97.4	83.7	86.5	91.6	140.0	101.2	77.5	88.0	90.0	100.0	101.0	113.0
BOD_5 mg/l	12.6	16.8	13.2	14.7	12.4	12.5	16.8	12.7	13.6	9.3	8.6	13.0
COD mg/l	25.8	37.2	26.6	31.2	26.2	27.3	33.6	22.8	24.3	20.[illegible]	17.3	25.5
NH_3-N mg/l	0.10±0	0.10±0	0.10±0	0.10±0	0.10±0	0.10±0	0.1±0	0.1 ± 0	0.11± 0	0.12± 0	0.1 ± 0	0 ± 0
PO_4 mg/l	0.4	0.3	0.7	1.0	0.1	0.02	0.2	0..	0.1	0.2	0.02	0.2
Eh. mv	0.28	0.27	0.32	0.28	0.26	0.25	0.27	0.26	0.25	0.23	0..24	0.23
rH_2	26.46	26.31	27.23	26.46	26.17	26.02	26.31	26.17	26.02	25.73	25.88	25.75
GPP mgC/l/h	0.3	0.3	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.3
NPP mgC/l/h	0.12	-0.04	-0.17	0.03	0.09	0.05	0.09	0.13	-0.02	-0.16	-0.17	-0.05

Post-monsoon

winter

Table-1: Seasonal Variation of Physico-Chemical and Biological conditions in the study Pond-1, during the Study Period.

Parameters	Summer March-May	Monsoon June-Aug	Post-Monsoon Sept-Nov	Winter Dec-Feb
Air Temp. C	32.4-38.3	29.1-33.6	23.1-30.3	17.5-23.8
Water Temp. C	29.0-31.8	28.9	24.1-30.4	19.3-23.9
Av. depth M	1.0-1.1	1.0-1.2	0.9-1.2	1.0-1.1
S D depth M	0.2-0.2	0.2-0.2	0.0-0.2	0.2-0.3
TDS mg/l	420.2-489.5	454.7-49.4	353.0-488.3	440.4-484.3
E. Cond.µ moh/cm	647-753	700-751	543-752	678-745
p^H	7.7-8.7	8.3-8.83	8.5-8.7	8.6-8.6
Free CO_2 mg/l	21.5-34.7	2.8-10.1	23-26.7	15.7-33.2
CO_3 Alk. mg/l	00	0-17.2	00	0-2.8
HCO_3 Alk. mg/l	30.5-403.	21-49	114.1-163.3	184.-301.2
T. hardness mg/l	209-538	200-295	209-285	386-467
Chloride mg/l	112-131	103-143	99-109	87-107
DO mg/l	5.4-6.1	5.2-6.8	5.7-6.9	4-7.6
% Sat of 02	70-82	68-92	69-92	45-86
BOD_5 mg/l	2.7-6.9	5.4-12	3.1-4.9	3.2-7
COD mg/l	7.4-15	11.9-22	7.2-10.6	9.8-15.2
NH_3-N mg/l	0-0.10	0-0.10	0.10-0.11	0.10-0.13
PO_4 mg/l	0.1-0.7	0.1-0.2	0.1-0.2	0.1-0.7
Eh mv.	0.25-0.35	0.29	0.25-0.27	0.26
rH^2	26.2-27.8	26-26.6	25.8-26.3	26.1
GPP mg C/l/h	0.2-0.3	0.2-0.3	0.2-0.2	0.2-0.4
NPP mg C/l/h	0.08-0.10	-0.1-0.04	-0.11-0.04	-0.14-0.12
Phytoplankton uni/l	66044	82225	66123	57161
Zooplankton unit/l	91923	114981	313183	541917
Phyto. :Zoo.	1: 1.39	1: 1.39	1: 4.74	1: 10
'P' value	6.4	8.2	4.6	7.4

Table.2 : Seasonal variation of Physico-chimical and Biological conditions in the study pond-2, during the study period.

Parameters	Summer March-May	Monsoon June-Aug	Post-Monsoon Sept-Nov	Winter Dec-Feb
Air Temp. C	32.6-38.7	28.6-33.6	23.3-30.3	17.5-23.8
Water Temp. C	31.8-32.8	29.7-32.1	23.1-31.0	18.4-24.0
Av. depth M	1.4-1.8	1.5-1.8	1.4-1.5	1.4-1.6
S D depth M	0.2-0.3	0.2	0.2	0.1-0.4
TDS mg/l	404.3-436.2	383.0-455	435-499	406.3-482.0
E. Cond.μ moh/cm	422-671	443-700	529-767	677.5-741
p^H	7.8-8.9	8.2-8.4	8.4-8.7	8.7-8.9
Free CO_2 mg/l	4.3-14.7	8.2-8.9	8.3-19	4.9-32.5
CO_3 Alk. mg/l	0-15.2	0-4.8	0.4-2.8	0-10.8
HCO_3 Alk. mg/l	21.2-356.7	18.7-41.3	109.7-160.5	171.4-290.1
T. hardness mg/l	285.5-609.2	226.2-307	214.2-317.7	414.6-487
Chloride mg/l	103.6-138.7	121.6-191.7	129.8-146.7	104.6-121.7
DO mg/l	6.0-8.4	6.1-7.6	6.8-8.4	5-7.9
% Sat of 0_2	83.0-114.4	80.0-105.0	81.0-113.0	53.2-86.5
BOD_5 mg/l	2.5-3.7	2.3-9.6	3.9	8.7
COD mg/l	6.4-8.4	6.7-20.7	8.2-12.8	7.3-10.1
NH_3-N mg/l	0-0.1	0.1	0.1-.11	0.10-0.12
PO_4 mg/l	0-0.1	0.1	0.1-0.2	0.03-0.1
Eh mv.	0.22-0.35	0.28-0.31	0.25-0.28	0.23-0.25
rH^2	25.39-27.67	26.46-27.09	26-26.46	25.73-26.02
GPP mgC/l/h	0.2-0.3	0.3-0.4	0.3	0.1-0.4
NPP mgC/l/h	-0.07-0.02	-0.01-0.1	0.1-0.21	-0.16-0.15
Phytoplankton uni/l	107883	92858	145523	116341
Zooplankton unit/l	375451	255918	264824	442213
Phyto. : Zoo.	1: 3.48	1: 2.75	1: 1.82	1: 3.8
'P' value	4.3	7.6	4.4	5.4

Table-3 Seasonal Variation of Physico-Chemical and Biological conditions in the study Pond-3, during the study period.

Parameters	Summer March-May	Monsoon June-Aug	Post-Monsoon Sept-Nov	Winter Dec-Feb
Air Temp. C	32.6-35.1	30.2-32.6	22.8-28.5	19-24.3
Water Temp. C	29.3-32.5	29.8-31.9	22.9-29.2	19-24.3
Av. depth M	1.8-2.2	2.1-2.3	1.7-2.0	1.7-1.9
S D depth M	0.2	0.2-0.3	0.2	0.1-0.3
TDS mg/l	397.2-445.9	381.6-419.3	3387.7-448.5	441.7-450.1
E. Cond.μ moh/cm	611.-686	587-645	597-690	680-693
p^H	8.2-8.9	8.3-8.4	8.6	8.6-8.8
Free CO_2 mg/l	1-14.6	0-4.3	2.9-6.3	0-6.4
CO_3 Alk. mg/l	1.8-4.8	1.2-1.8	1.7-3.3	1.4-8
HCO_3 Alk. mg/l	25.6-445.2	15.1-81.3	113.8-134.8	156.4-283.7
T. hardness mg/l	240.2-608.8	228.7-273	238.7-271.7	424-466.2
Chloride mg/l	132.4-156.7	103.4-142	107.5-132.1	178.-201.3
DO mg/l	7.1-8.3	7-7.7	5.9-9.6	5.7-9.1
% Sat of 0_2	93.4-114.2	95.5-101.9	70-126	69.2-101.2
BOD_5 mg/l	9-11.6	9.4-13.6	6.7-12.8	3.2-7.6
COD mg/l	19.6-26.3	22.3-28.7	14.5-27.7	8.7-18.9
NH_3-N mg/l	0-0.10	0.1	0.10-0.11	0.1-0.13
PO_4 mg/l	0.03-0.1	0.03-0.3	0.1-0.2	0.01-0.3
Eh mv.	.23-.31	.27-.28	0.26	.23-.26
rH^2	25.73-27	25.7-26.4	26.17	25.-26.1
GPP mgC/l/h	0.2-0.4	0.3-0.4	0.2-0.3	0.3
NPP mgC/l/h	0.03-0.10	-0.01-0.10	0.02-.11	-0.02-0.1
Phytoplankton uni/l	114396	72746	105668	83704
Zooplankton unit/l	424278	122378	233468	107953
Phyto. : Zoo.	1: 3.71	1: 1.68	1: 2.21	1: 1.28
'P' value	11.2	14	11.4	8.4

Table. 4 Seasonal Variation of Physico-Chemical and Biological conditions in the study Pond-4, during the study period.

Parameters	Summer March-May	Monsoon June-Aug	Post-Monsoon Sept-Nov	Winter Dec-Feb
Air Temp. C	32.6-35.1	30.2-32.6	22.8-28.5	19-24.4
Water Temp. C	29.4-32.5	29.7-31.6	23.0-29.6	19.1-24.0
Av. depth M	1.6-1.9	1.6-2	1.4-1.5	1.4-1.7
S D depth M	0.2	0.2	0.2-0.3	0.1-0.2
TDS mg/l	351.3-378.6	354.9-403.3	370.8-404.6	397.5-470.6
E. Cond.μ moh/cm	541-583	546-621	571-623	612-724
P^H	8.4-8.9	8.1-8.5	8.5-8.6	8.6-8.9
Free CO_2 mg/l	0-2.3	0	0-4.3	0-5.7
CO_3 Alk. mg/l	4.9-6.6	2.7-5.8	1.8-4.8	4.3-7.7
HCO_3 Alk. mg/l	21.3-366.6	15.2-78	102-130.4	133.5-253.3
T. hardness mg/l	263-469.3	197.8-278	216-232	317.3-372.2
Chloride mg/l	98.6-121.6	109.2-137	113.6-142	93.4-121
DO mg/l	7.1-8.2	6.3-6.7	6.5-10.6	7.9-8.2
% Sat of 0_2	97.4-113	83.7-91.0	77.5-140	88.0-100
BOD_5 mg/l	8.6-13	13.2-16.8	12.4-16.8	9.3-13.6
COD mg/l	17.3-25.9	31.3-37.2	26.2-33.6	20.7-24.8
NH_3-N mg/l	0.0-0.10	0.10	0.1	0.10-0.12
PO_4 mg/l	0.02-0.40	0.3-1.0	0.02-0.2	0.1-0.2
Eh mv.	0.23-0.28	0.27-0.32	0.25-0.27	0.23-0.26
rH^2	15.88-26.46	26.31-27.23	26.02-26.31	25.73-26.17
GPP mgC/l/h	0.2-0.3	0.3-0.4	0.3-0.4	0.2-0.3
NPP mgC/l/h	-0.05-0.12	0.04-0.17	0.05-0.09	0.02-0.16
Phytoplankton uni/l	85473	77776	85478	134057
Zooplankton unit/l	234049	208150	136820	136957
Phyto. : Zoo.	1:2.73	1: 2.67	1: 1.60	1: 1.02
'P' value	10.8	19.2	15.3	11.2

Tab.1. Abundance of Zooplankton: unit/l in P-1

Name of the Gen.	May-94	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Copepoda								
Cleptocamptus					2417		54563	
Cyclops	10698	15202		39023	27627	25555	114219	34792
Merocyclops						691	48001	
Mesocyclops	3626	2064		8806		1209	66390	4230
Diaptomus	7882	1877		14072	20288	9583	62904	7252
Paradiaptomas						604	19511	1554
Phyllodiaptomus				8104			13813	
Neodiaptomus						863	14936	
Total = 8 genera	22206	19143		70005	50332	38505	394337	47828
Cladocera								
Alona				6734		7770	6130	
Bosmina						1986	3885	
Daphnia	23836	29279	16921	62680	44116	28922	90305	17698
Diaphanosoma	1689	7695	7856	17439	11655	10187	47553	
Macrothrix						989	1727	
Moina	49549	1689	4748	16403	2762	7252	23310	2800
Sida	40165			1813			3367	2417
Total = 7 genera	115239	38663	29525	105069	58533	57106	176277	22915
Rotifera								
Asplanchinopus								
Brachionus	176615	62500	13295	3626	28835	12259	119787	15972
Chromogaster	48236							
Filinia								
Harringia						863		
Keratella	94220		950	1986	32116	7425	10915	7030
Manfredium						1813		
Notholca								
Philodina							2590	777
Pompholyx					2331			
Rotaria							1727	
Trichocerca								6825
Total = 12 gen.	319071	62500	14245	5612	63282	22360	129019	30604
Grand Total = 27 gen.								

Continued

Tab.1. Abundance of Zooplankton: unit/l in P-1

Name of the Gen.	Jan-95	Feb	Mar	Apr	Total	Y.mean
Copepoda						
Cleptocamptus	6561	3540	950		68031	5669
Cyclops	106017	28317	6302	1295	409047	34087
Merocyclops	12432				61124	5094
Mesocyclops	12432				98752	8230
Diaptomus	17008	45066	6820		192752	16063
Paradiaptomas	7252	1468			30389	2533
Phyllodiaptomus	2849	1640			26406	2201
Neodiaptomus	3539	1813			21151	1763
Total = 8 genera	168090	81844	14072	1295	907657	75638
Cladocera						
Alona	3108	21497			45239	3770
Bosmina	2763				8634	720
Daphnia	76664	61901	20375	1640	474337	39528
Diaphanosoma	19252	25037	10705	863	159931	13328
Macrothrix	863				3579	298
Moina	2762	39109	2676		153060	12755
Sida	2417			1036	51215	7268
Total = 7 genera	107829	147544	33756	3539	895995	77217
Rotifera						
Asplanchinopus	4921				4921	410
Brachionus	133644		3281	8288	572102	47675
Chromogaster					48236	4020
Filinia	3194		950		4144	346
Harringia					863	72
Keratella	869635	863		5180	1030320	85860
Manfredium					1813	151
Notholca		863			863	72
Philodina					3367	281
Pompholyx	7252				9583	799
Rotaria					1727	144
Trichocerca	3971				10796	900
Total = 12 gen.	1022617	1726	4231	13468	1688735	140730
Grand Total						

Tab.2. Abundance of zooplankton Unit/l in P-2

Name of the Gen.	May-94	Jun-94	Jul-94	Aug-94	Sep-94	Oct-94	Nov-94	Dec-94
Copepoda								
Cleptocamptus	4504	1501					12518	
Cyclops	31532	29843	17267	17735	27281	17094	110334	27195
Merocyclops						8202	77787	
Mesocyclops			2417			6388	63541	690
Diaptomus	50025	18393	13362	12864	6389	9928	21497	1554
Heliodiaptomus								
Paradiaptomas			2504				8719	
Phyllodiaptomus						2072	6043	
Naodiaptomus						5094		
Neodiaptomus	5443					4230	2417	
Total = 10 genera	91504	49737	35550	30599	33670	53008	302856	29439
Cladocera								
Alona	22897						9669	1813
Bosmina						8374	12432	
Ceriodaphnia		1126	2245					
Daphnia	72447	79768	39454	32202	25468	18734	25382	135716
Diaphanosoma	42417	17642	11050	32116	5439	14331	4230	6561
Moina	9572	6757	5612	4058	5266	7079	14331	17353
Polyphemus							10964	
Sida	35660		1381	691		31598	6907	4921
Total = 8 genera	182993	105293	59742	69067	36173	80116	83915	166364
Rotifera								
Asplanchna	6569		3194					
Brachionus	130068	2815	120608	114145	29958	29699	61124	
Chromogaster	51239							
Cupelopagis				691				
Dorystoma			604	2590				
Filinia			13295	2244				
Harringia			604					
Keratella	61561	39720	57671	58189	45670	4662	4748	
Philodina					2245		2417	
Pompholyx				691	691	12432		
Scaridium					863			
Trichocera								
Tripleuchanis				691				
Total = 13 genera								
Grand Total = 31 gen								

Continued

Tab.2. Abundance of zooplankton Unit/l in P-2

Name of Species	Jan.95	Feb. '95	March, '95	April, '95	Total	Y.mean
Copepoda						
Cleptocamptus	6216	2331	4921	2331	34322	2860
Cyclops	32634	27972	27368	355176	721431	6012
Merocyclops	21065				107054	58921
Mesocyclops	21238	13123			107397	8950
Diaptomus	23655	22101	23990	17871	221629	18469
Heliodiaptomus	13036	7943			20979	2248
Paradiaptomus	8461	13986	604	1640	35914	2993
Phyllodiaptomus					8115	676
Naodiaptomus	5439	12259			22792	1899
Neodiaptomus	6302				18392	1533
Total = 10 gen	138046	99715	56883	377018	1298025	104560
Cladocora						
Alona	690				35069	2922
Bosmina	3885				24691	2058
Ceriodaphnia					3371	281
Daphnia	37382	6648	46361	5957	525519	43793
Diaphanosoma	16835	34188	20806		205615	13135
Monia	7597		6302	3194	87121	7260
Polyphemus	2590				13554	1129
Sida	1640			2417	85215	7101
Total	70619	40836	73469	11568	980155	77679
Rotifera						
Asplanchna	4317				14080	1173
Brachionus	115255		48433	20202	672307	56026
Chromogaster					57887	4824
Cupelopagis					691	58
Dorystoma					2590	266
Filinia					22791	1899
Harringia					604	50
Keratella	579383			14849	866453	72204
Philodina					4662	389
Pompholyx	26072				39886	3324
Scaridium					863	72
Trichocora	3281				3281	274
Tripleuchanis					691	58
Total					140577	
Grand Total 31 gen						

Tab -3 : Abundance of Zooplankton unit/l in Pond -3.

Name of Species	May,94	Jun, '94	July, '94	Aug. '94	Sept'94	Oct. '94	Nov. '94	Dec. '94
Copepoda								
Cleptocamptus			8633	1036				
Cyclops	40728	18956	49296	23483	54570	43339	33152	27368
Mesocyclops	5067		3798					
Diaptomus	3566		41354			23224	10015	
Total = 4 gen	49361	18956	103081	24519	54570	66563	43167	27368
Cladocera								
Alona			96175					
Bosmina								
Daphnia	88401	10886	41526	24087	42735	30388	56462	24346
Diaphanosoma	108296		32548			63109	16136	
Moina	11824		8288	949				
Sida	7132		863					
Total = 6 gen	215653	10886	179400	25036	42735	93497	72598	24346
Rotifera								
Brachionus	99654	8671	90823	18130	32720	92808	17267	34102
Chromogaster	45608				1209			
Filinia			2676	1122	20806	863		
Keratella	82770	95909		29094	46447	175084	17008	42994
Notholca			10964	1036				
Polyarthra			4144		2245			
Rotaria								1036
Trichocerca						66477		1899
Total = 8 gen	228032	104580	108607	49382	103427	335232	34275	80031
Grand total = 18 gen								

Continued

Tab -3 : Abundance of Zooplankton unit/l in Pond -3.

Name of Species	Jan. 95	Feb. '95	March,'95	April, '95	Total	Y. mean
Copepoda						
Cleptocamptus					9669	806
Cyclops	29612	37317	38504	14935	411260	34272
Mesocyclops					8865	739
Diaptomus	16231		7079		101469	8456
Total = 4 gen	45843	37317	45583	14935	531263	40673
Cladocera						
Alona					96175	8015
Bosmina		9410	2331		11741	978
Daphnia	30994	38246	29267	17526	434864	36239
Diaphanosoma	25037		22447	3194	270767	22564
Moina	7511			1468	30040	2503
Sida	3281		690		11966	997
Total = 6 gen	66823	47656	54735	22188	855553	71296
Rotifera						
Brachionus	39541		34533	23828	492077	41006
Chromogaster					46817	4902
Filinia					25467	2123
Keratella	31771		8633	4662	534372	44531
Notholca					12000	1000
Polyarthra					6389	533
Rotaria					1036	86
Trichocerca					68376	5698
Total = 8 gen	71312	0	43166	28490	1186534	99879
Grand total = 18 gen						

Tab - 4 : Abundance of Zooplankton unit/l Pond p-4.

Name of Species	May, '94	June'94	July,'94	Aug, '94	Sept, '94	Oct, '94	Nov, '94	Dec, '94
Rotifera								
Ascomorphella	10885	6569	4403	6569	30389	17612	12518	2815
Brachionus	184683	5537	16231	19598	22792	160666	12545	18475
Chromogaster	45230	2815	15022	4403	2158	5784	10225	3367
Filinia	4880	3126	9505	1640	4040	8892	2935	1554
Harringia	40540	6180	22706	9722	42130	61297	65404	16178
Keratella	140203	2223	23542	13978	18216	15885	1554	5266
Notholca	1381	691	863	518	691	604	863	691
Philodina	25901	8921	4230	10221	28577	27540	12680	15108
Platyias	691	863	604	604	518	691	691	518
Polyarthra	58745	1313	27798	24432	1899	25555	23396	42217
Pompholyx	39602	13513	45555	1381	28576	7856	4489	7079
Trichocerca	73565	15774	29009	7079	2935	23914	13900	3367
Total	626306	67525	199468	100145	182921	356296	161200	116635

Tab - 4 : Abundance of Zooplankton unit/l Pond p-4.

Rotifera	Jan.95	Feb. '95	March, '95	April, '95	Total	Y.mean
Ascomorphella	9842	2815	19080	39713	163210	13600
Brachionus	2935	31501	84261	30217	589441	49120
Chromogaster	12691	604	23342	13036	138677	11556
Filinia	8892	4880	31000	2935	84279	7023
Harringia	16912	13727	65872	92031	452699	37725
Keratella	1381	5266	3453	1684	232651	19388
Notholca	660	863	1381	863	10013	835
Philodina	30314	12000	25555	65700	266747	22229
Platyias	[illegible]18	518	863	518	7942	660
Polyarthra	1381	10619	15799	24691	257845	21487
Pompholyx	6216	6648	14331	10015	185261	15438
Trichocerca	7079	20030	85736	3454	285842	23830
Total	99110	109471	370673	284857	2674607	222881

Tab. ZP, 1a. Seasonal abundance of different genara and groups of Zooplankton (unit/l) and seasonal percentage in parenthesis of Pond -1.

Zooplankton genera	Summer	Monsoon	Post-Monsoon	Winter
	March- May	Jun-Aug	Sept-Nov	Dec-Feb
Copepoda				
Cleptocamptus	317		1899	3367
Cyclops	5198	18135	55800	56375
Merocyclops			14564	4144
Mesocyclops	1209	3623	22533	5554
Diaptomas	4901	5316	30925	23109
Paradiaptomas			6705	3425
Phyllodiaptomus		2701	4604	1496
Neodiaptomus			5266	1784
Total = 8				
Total seasonal abundance	11625	29775	142296	974770
	(12.64)	(25.89)	(45.43)	(17.98)
CLADOCERA				
Alona		2245	4633	8201
Bosmina			1957	921
Daphnia	15284	36293	54474	52088
Diaphanosona	4419	10997	23132	14763
Macro Thrix			905	322
Moina	17408	7613	11108	14890
Sida	13734	605	1123	1611
Total = 7 gen				
Total seasonal abundance	50845	57753	97332	92796
	(55.31)	(50.22)	(31.07)	(17.12)

Continued

Tab. ZP, 1a. Seasonal abundance of different genara and groups of Zooplankton (unit/l) and seasonal percentage in parenthesis of Pond-1.

Zooplankton genera	Summer	Monsoon	Post-Monsoon	Winter
	March- May	Jun-Aug	Sept-Nov	Dec-Feb
ROTIFERA				
Asplanchna				1641
Brachionus	9743	26474	53627	49872
Chromogaster	16079			
Filinia	317			1065
Harringia			288	
Keratella	3314	979	16819	292509
Manfredium			605	
Notholca				288
Philodina			863	259
Pompholyx			777	2418
Rotaria			576	
Trichocera				3599
Total = 12 gen.				
Total seasonal abundance	29453	27453	73555	351651
	(32.13)	(23.87)	(23.48)	(64.89)
Total Zooplankton	91923	114981	313183	541917

Tab. - ZP, 2a Seasonal abundance of different genera and groups of zooplankton (unit/l) and seasonal percentage in parenthesis of pond-2.

Class & genera of Zooplankton	Summer March-May	Monsoon Jun-Aug	Post-monsoon Sept-Nov	Winter Dec-Feb
Copepoda				
Cleptocamptus	3919	501	7173	2849
Cyclops	138025	21615	51570	29267
Merocyclops			28663	7022
Mesocyclops		806	23400	26302
Diaptomas	30629	14873	12605	15770
Heliodiaptomus				6993
Paradiaptomus	748	835	2906	7403
Phyllodiaptomu			2705	
Naodiaptomus			1698	5899
Neodiaptomus	1814		2216	2101
Total = 10 genera	175135	38630	132936	103606
Cladocera				
Alona	7632			
Bosmina			6935	1296
Ceriodaphnia		1124		
Daphnia	41588	50475	23195	59915
Diaphanosoma	21074	20269	8000	19195
Monia	6356	5476	8892	8317
Polyphemus			3655	863
Sida	12692	691	12835	2187
Total = 8 gn	89342	78035	63512	91773
	(23.7)	(30.5)	(23.9)	(20.7)
Rotifera				
Asplanchna	2190	1065		1439
Brachionus	66234	79189	40260	38418
Chromogaster	17080		2216	
Cupelopasis		231		
Dorystoma		1065		
Filinia		5180	1324	1094
Harringia		202		
Keratella	25470	51860	18360	193128
Philodina			1554	
Pompholyx		230	4374	8691
Scaridium			288	
Trichorocera				1094
Tripleuchlamis		231		
Total =13 gn	110974	139253	68376	246834
	(29.5)	(54.4)	(25.8)	(55.8)
Total seasonal plankton	375451	255918	264824	442213

Tab. -ZP, 3a. Seasonal abundance of different genera and groups of zooplankton (unit/l) and seasonal percentage in parenthesis of pond-3.

Class & genera	Summer March- May	Monsoon June-Aug.	Post-Monsoon Sept-Nov.	Winter Dec-Feb.
Copepoda				
Cleptocamptus		3223		
Cyclops	31389	30578	43687	31433
Mesocyclops	1689	1266		
Diaptomas	3548	13785	7741	8749
Total = 4 gen				
Total seasonal abundance	36626	48852	51428	40182
	(15.64)	(23.46)	(35.58)	(29.34)
Cladocera				
Alona		32058		
Bosmina	777			3137
Daphnia	45065	25500	43195	31195
Diaphanosoma	44646	10849	26415	8346
Moina	4431	3079		2504
Sida	2607	288		1094
Total = 6 gen				
Total seasonal abundance	97526	71774	69610	46276
	(41.68)	(34.48)	(50.87)	(33.78)
Rotifera				
Brachionus	52672	39208	47598	24548
Chromogaster	15203		403	
Filinia		1266	7223	
Keratella	32022	41668	79513	24922
Notholca		4000		
Polyarthra		1382	748	
Rotaria				346
Trichocerca			22159	633
Total = 8 gen				
Total seasonal abundance	99897	87524	15764	50499
	(42.68)	(42.04)	(11.52)	(36.87)
Total Zooplankton	234049	208150	136820	136957

Tab.- ZP, 4a. Seasonal abundance of different genera and groups of zooplankton (unit/l) and seasonal percentage in parenthesis of pond-4.

Class	Summer March- May	Monsoon June-Aug.	Post-Monsoon Sept-Nov.	Winter Dec-Feb.
Rotifera				
Ascomorphella	23226	5847	20173	5157
Brachionus	99720	13789	65334	17637
Chromogaster	27203	7413	6056	5554
Filinia	12938	4757	5289	5109
Harringia	63148	12869	56277	15606
Keratella	48447	13248	11885	3971
Notholca	1208	690	719	720
Philodina	39052	7790	22932	19141
Platyias	691	690	633	629
Polyarthra	33078	17848	16950	18072
Pompholyx	21316	20150	13640	6648
Trichocerca	54251	17287	13580	10159
Total Seasonal Abundance	424278	122378	233468	107953

Tab. ZP, 1b. Seasonal abundance of different groups of Zooplankton and total abundance (unit/l) in Pond-1.

Zooplankton Groups	Summer March-may	Monsoon June-Aug	Post-Monsoon Sept-Nov	Winter Dec-Feb
Copepoda	11625 (12.65)	29775 (25.9)	142296 (45.44)	97470 (17.99)
Cladocera	50845 (55.31)	57753 (50.23)	97332 (31.08)	92796 (17.12)
Rotifera	29453 (32.04)	27453 (23.88)	73555 (23.49)	351651 (64.9)
Total Zooplankton	91923	114981	313183	541917

Tab. ZP, 2b. Seasonal abundance of different groups of Zooplankton and total abundance (unit/l) in Pond-2.

	Summer	Monsoon	Post-monsoon	Winter
Zooplankton Groups	March-may	Jun-Aug	Sept-Nov	Dec-Feb
Copepoda	175135 (46.6)	38630 (15.1)	132936 (46.8)	103606 (23.4)
Cladocera	89342 (23.7)	78035 (30.5)	63512 (23.9)	91773 (20.8)
Rotifera	110974 (29.5)	139253 (54.4)	68376 (25.8)	246834 (55.8)
Total Zooplankton	375451	255918	264824	442213

Tab.ZP, 3b. Seasonal abundance of different groups of Zooplankton and total abundance (unit/l) in Pond-3.

Zooplankton Groups	Summer	Monsoon	Post-Monsoon	Winter
	March- May	Jun-Aug	Sept-Nov	Dec-Feb
Copepoda	36626 (15.65)	48852 (23.47)	51928 (37.59)	40182 (29.34)
Cladocera	97526	71774	69610	46276
	(41.67)	(34.48)	(50.88)	(33.79)
Rotifar	99897	87524	15764	50499
	(42.68)	(42.05)	(11.52)	(36.87)
Total Zooplankton	234049	208150	136820	136957

Tab. ZP, 4b. Seasonal abundance of different groups of Zooplankton and total abundance (unit/l) in Pond-4.

Zooplankton group[	Summer	Monsoon	Post-Monsoon	Winter
	March- May	Jun-Aug	Sept-Nov	Dec-Feb
Copepoda	-	-	-	-
Cladocera	-	-	-	-
Rotifera	424278	122378	233468	107953
Total Zooplankton	424278	122378	233468	107953

Tab. Zp. 5a. Total Number of genara of different groups of Zooplankton and their percentage in parenthesis in four study ponds.

Class/Groups	Pond -1	Pond -2	Pond -3	Pond -4
Copepoda	8 (29.6)	10 (32.2)	4 (22.2)	-
Cladocera	7 (25.9)	8 (25.8)	6 (33.3)	-
Rotifera	12 (44.4)	13 (41.9)	8 (44.4)	12 (100)
Total No of Genera	27	31	18	12

Tab. Zp-2, 5b. Occurrence of different groups of Zooplankton in Four Study Ponds.

Group & Genera	Pond-1	Pond-2	Pond-3	Pond-4
COPEPODA				
Cleptocamptus	+	+	+	-
Cyclops	+	+	+	-
Merocyclops	+	+	-	-
Mesocyclops	+	+	+	-
Diaptomus	+	-	+	-
Heliodiaptomus	-	+	-	-
Paradiaptomus	+	+	-	-
Phyllodiaptomus	+	+	-	-
Naodiaptomus	-	+	-	-
Neodiaptomus	-	+	-	-
10 gen.	-	+	-	-
Clodocera				
Alona	+	+	+	-
Bosmina	+	+	+	-
Ceriodaphnia	-	+	-	-
Daphnia	+	+	+	-
Diaphanosoma	+	+	+	-
Moina	+	+	+	-
Polyphamus	-	+	-	-
Sida	+	+	+	-
Macrothrix	+	-	-	-
Total = 9 gen.				
Rotifera				
Ascomorphella	-	-	-	+
Brachionus	+	+	+	+
Chromogaster	+	+	+	+
Filinia	+	+	+	+
Harringia	+	+	+	+
Keratella	+	+	+	+
Asplanchna	+	+	-	-
Notholca	+	-	+	+
Philodina	+	+	-	+
Platias	-	-	-	+
Polyarthra	-	-	+	+
Pompholyx	+	+	-	+
Trichocera	+	+	+	+
Cupelopagis	-	+	-	-
Dorystoma	-	+	-	-
Scaridium	-	+	-	-
Tripleuchlanis	-	+	-	-
Rotaria	+	-	+	-
Manfredium	+	-	-	-
Total = 19 gen.				
Grand Total = 38 gen.				

+ Present, - Absent

Tab.1: Abundance of Phytoplankton unit/l in P-1 (Pond-1).

Name of the Genera.	May-94	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Chlorophyceae								
Chlorella	1689	1895	3095	4317	8288	6116	1310	812
Sclenastrum	3166	1800	1123	1210	620	466	318	968
Ankistrodesmus	9816	12178	8004	6617	5333	6267	1322	4281
Crucigenia	1689	915	764	712	345	590	1210	1666
Scenedesmus	1332	1210	1333	936	855	910	1236	1810
Pediastrum	1877	2110	1318	966	688	690	775	495
Actinastrum	1701	1210	995	2590	683	1124	647	1124
Closterium	1200	900	1123	672	792	813	775	490
Cosmarium	678	666	815	332	466	540	1120	1470
Staurastrum	1600	875	227	590	417	224		
Ulothrix	378	283			210	190		
Spirogyara	289	300	187					389
Total Gen = 12	25415	24342	18984	18942	18697	17930	8713	13505
Cyanophyceae								
Microcystis	15390	5686	2763	8029	1813	9410	7710	8892
Merismopidia	2081	1828	2334	1667	1210	1363	836	775
Spirulina			2590	863				
Oscillatoria	3881	9384	3566	2104	1875	1124	5122	1890
Anabaena	4330	3677	4500	2600	1360	1446	768	813
Anabaenopsis					816	790	236	285
Cylindrospermum							436	444
Total gen.=7	25682	20575	15753	15263	7074	14133	15108	13099
Bacillariophyceae								
Brebissonia				1890			2555	
Fragilaria	330			4400	1139	1519	985	817
Eunotia	2330	1420	1124	876	936	2311	2014	1800
Gyrosigma	1390	931	875	668	333	614	214	246
Navicula	4008	3667	2100	1790	4666	7892	2336	1818
Pinnularia	1210	890	718	310	2871	1800	1314	1714
Gomphonema			818	790	416			
Tabellaria	1686				910	1208	1366	
Cymbella	510	770	331	910				
Nitzschia	280	260	240	566	718	2118	2310	1800
Total gen = 10	11744	7938	6206	12200	11989	17462	13094	8195
Euglenophyceae								
Euglena	26504	51368	37641	15022	3367	25343	44286	9561
Phacus	812	623	210					
Trachelomonas	1227	1330	890	701				
Total gene.= 3	28543	53321	38741	15723	3367	25343	44286	9561
Dinophyceae								
Ceratium	770	886	1210	618	233			

Continued

Tab.1: Abundance of Phytoplankton unit/l in P-1 (Pond-1).

Name of the Genera.	Janu. '95	Feb.	March	April	Yearly mean
Chlorophyceae					
Chlorella	1210	978	461	795	2581
Sclenastrum	612	318	789	446	986
Ankistrodesmus	3761	4754	1541	6129	5852
Crucigenia	985	120	310	818	844
Scenedesmus	1444	1232	1610	1012	1244
Pediastrum	666	365	485	933	947
Actinastrum	1072	1813	768	433	1180
Closterium	314	1440	795	718	836
Cosmarium	1690	664	888	714	837
Staurastrum		444	614	890	490
Ulothrix		333	266	246	159
Spirogyara	835	795	444	416	305
Total gen. = 12	12589	13256	8971	13550	16242
Cyanophyceae					
Microcystis	13123	8374	7079	8479	8104
Merismopidia	886	1126	675	885	1214
Spirulina	9497				1079
Oscillatoria	3123	4826	1372	1494	3313
Anabaena	945	1224	886	1366	1993
Anabaenopsis			667	208	250
Cylindrospermum	367	120			114
Total gen.= 7	27941	15670	10679	12932	16159
Bacillariophyceae					
Brebissonia	3392	3436			939
Fragilaria	1210	444			903
Eunotia	766	995	1667	1390	1469
Gyrosigma	229	1780	1690	4890	1155
Navicula	1736	2536	1123	2114	2982
Pinnularia	1510	1430	910	818	1291
Gomphonema			266	686	248
Tabellaria		818	610	455	588
Cymbella			188	790	291
Nitzschia					691
Total gen = 10	8843	11440	6454	11313	10557
Euglenophyceae					
Euglena	6553	30716	10267	27134	23980
Phacus	921	679	395	780	368
Trachelomonas		816	512	771	520
Total gene=3	7474	32211	11174	28685	24868
Dinophyceae					
Ceratium		390	1120	1223	537

Tab.2: Abndance of Phytoplankton unit/l in P-2 (Pond-2).

Name of the Genera.	May-'94	June	July	Aug.	Sept	Oct.	Nov.	Dec.
Chlorophyceae								
Ankistrodesmus	11732	9339	8778	4495	1923	2014	2168	
Scenedesmus	3215	2890	7115	3229	4983	4185	3108	7173
Pediastrum	976	695	837	366	366	604	812	927
Crucigenia	1192	1638	2158	1485	3185	1890	2127	7201
Gloeotaenium	366						712	927
Actinastrum	1816	1632	11639	13732	25692	24310	39713	18310
Closterium	1378	1112	908	896	712	1195	2329	6043
Cosmarium	6667	1833	2401	3192	886	366	612	1606
Micrasterias					817	1837		
Total gen.= 9	27342	19139	33836	27395	38564	36401	51581	42187
Cyanophyceae								
Microcystis	13138	14557	6561	3022			3022	6734
Anabaenopsis	1212	938	1038					2725
Anabaena	2181	3189	3146	3684	1176	895	1640	1492
Spirulina	1000	1580	966					1184
Oscillatoria	13382	11298	7479	7833	6804	6185	28749	17621
Lyngbeya	666	892	766	366	366			
Cylindrospermum	1220	1318	4932					
Total gen.=7	32799	33772	24888	14905	8346	7080	33411	29756
Bacillariophyceae								
Fragilaria	3352	5133	8270	1390	8876	11867	4144	3985
Brebissonia			1832	9345	6133	5977	7770	1392
Gomophonema	1501					3986	6826	4826
Navicula	8390	6381	1780	1923	9395	10890	9332	11483
Pinnularia	4500	3550	4813	4453	11332	12690	6795	5833
Cymbella	778	1223	1190	3816	4918	10082	18389	4372
Total gen.= 6	18521	16287	17885	15927	40654	55492	53256	31891
Euglenophyceae								
Euglena	68994	15415	24603	27368	59584	22015	19851	2899
Phacus	7161	1312	932				824	792
Trachelomonas							1392	1182
Total gen.= 3	76155	17227	25535	27368	59584	22015	22067	4873
Dinophyceae								
Ceratium						1297	6775	3998

Continued

Tab. 2: Abundance of PhytoPlankton Unit/l in P-2 (Pond-2).

Name of the Genera.	Janu.'95	Feb.	March	April.	Yearly mean
Chlorophyceae					
Ankistrodesmus			13818	17229	5958
Scenedesmus	6336	920	865	692	3726
Pediastrum	4230	1132	1307	1640	1158
Crucigenia	3083	9211	4371	2114	3305
Gloeotaenium	732	612			279
Actinastrum					11404
Closterium	18178	34188	9116	9876	6994
Cosmarium	2300	2481	3115	1930	2282
Micrasterias			865	3540	588
Total gen.= 9	34859	48544	33457	37021	35858
Cyanophyceae					
Microcystis	13278	9324	3885	5784	6609
Anabaenopsis	1390	890	1080	1718	916
Anabaena	1785	1295	2935	4948	2364
Spirulina	936				472
Oscillatoria	11309	19770	9678	7849	12330
Lyngbeya		1823	1327	1092	608
Cylindrospermum		712	366	895	787
Total gen.=7	28698	33814	19271	22286	24086
Bacillariophyceae					
Fragilaria	6046	10032	13097	1130	6444
Brebissonia				1480	2411
Gomophonema	7894			1392	2202
Navicula	17864	2538	2749	1813	7045
Pinnularia	4837	4136	5449	6795	6265
Cymbella					373
Total gen.= 6	36641	16706	21295	12610	28098
Euglenophyceae					
Euglena	8229	5617	12820	11397	23274
Phacus	368	368			980
Trachelomonas	1294	889	914	368	503
Total gen.= 3	9891	6874	13734	11765	24757
Dinophyceae					
Ceratium	11390	17865			3444

Tab. 3: Abundance of Phytoplankton unit/l in P-3 (Pond-3).

Name of the Genera.	May'94	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Chlorophyceae								
Eudorina	10442							
Scenedesmus	1566	8310	7762	6406	2465	3145	6912	
Pediastrum	1850	3210	3406					
Chlorella	600	1838	1766	950				
Tetraedron								666
Selenastrum								1478
Ankistrodesmus	1124	7821	6183				4485	
Crucigenia	850	666	1310	950	1590	1006	986	
Staurastrum								950
Euastrum	1350	1145	1090					
Cosmarium				2124	2208	1376	850	
Total gen =11	17782	22990	21517	10430	6263	5527	13232	3094
Cyanophyceae								
Microcystis	6757	13138	5871	2763		5957	3194	8029
Spirulina			1136					1535
Oscillatoria	53885	14170	31648	27273	48331	13770	20293	37883
Anabaena						9931	9928	1034
Nodularia						2310	3972	
Arthrospira						850		
Cylindrospermum	1310	818	1375	2050	2050	2148	850	
Total gen.= 7	61952	28126	40030	32426	50381	34966	38237	48481
Bacillariophyceae								
Navicula	3810	2390	2270	2180	5886	4395	10964	11735
Fragilaria	10308	11395	14812	1460	1095	4890	7810	18315
Synedra					3810	2306	2018	1986
Gyrosigma			4836					
Eunotia	1550	1780				2310		
Achnanthes	980	1175	666					
Cynobella	2850					880	1776	1322
Nitzschia				8390				1392
Tabellaria	950					666	950	1234
Pinnularia	3245	2817	2146	4832	6790	11850	13210	9332
Total genera =10	23693	19557	24730	16862	17581	27297	36728	45316
Euglenophycae								
Euglena	12790				30130		53527	
Phacus	3300	2700				1800	1327	850
Total gen.= 2	16090	2700			30130	1800	54854	850
Grand Total								

Continued

Tab. 3: Abundance of Phytoplankton unit/l in P-3 (Pond-3).

Name of the Genera.	Jan- '95	Feb.	March	April	Yearly mean
Chlorophyceae					
Eudorina	885	676	950	14763	2310
Scenedesmus			2185	950	3309
Pediastrum		846	950	1554	985
Chlorella	2718	4168	2590		1219
Tetraedron	950	890	333	850	308
Selenastrum	1710	1500	666		446
Ankistrodesmus				1950	1797
Crucigenia			1785	1986	911
Staurastrum	666			2440	338
Euastrum			1636	1246	539
Cosmarium				4508	922
Total gen. =11	6929	8080	11095	30247	13098
Cyanophyceae					
Microcystis	3453			5698	4564
Spirulina			1150	1987	484
Oscillatoria	12742	39109	32030	19850	29249
Anabaena	2378	666	850	950	2145
Nodularia				950	603
Arthrospira	1000	1500	4985	7890	1352
Cylindrospermum				850	983
Total gen.= 7	19573	41275	39015	38175	39347
Bacillariophyceae					
Navicula	6495	950	1227	1590	4491
Fragilaria	12795	4667	6575	5780	8325
Synedra	1350				956
Gyrosigma	3880	7310	6660	2476	2097
Eunotia		4876	6870	2470	1656
Achnanthes	790	936	1092	1277	577
Cynobella	975	1646			788
Nitzschia	1485	950	2185	4322	1561
Tabellaria					317
Pinnularia	8865	7800	2480	4895	6522
Total genera =10	35420	37685	27089	25810	27290
Euglenophycae					
Euglena		13123	29267	25986	13736
Phacus	850				903
Total gen.= 2	850	13123	29267	25986	14639
Grand Total					

Tab. 4: Abundance of Phytoplankton unit/l in P-4 (Pond-4).

Name of the Genera.	May- '94	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Chlorophyceae								
Chlorella	-	-	-	604	1732	1975	5890	6780
Actinastrum	-	-	-	-	-	2681	3906	4181
Crucigenia	1018	950	855	889	1276	1236	1390	1780
Ankistrodesmus	6732	8310	2243	1509	8501	4361	7310	8333
Sclenastrum	-	-	-	-	-	3681	3894	4754
Scenedesmus	1333	1810	1897	1776	1605	3110	4140	1308
Padiastrum	-	-	-	-	-	1468	-	-
Staurastrum	-	-	-	1830	-	-	-	-
Closterium	832	-	-	-	-	-	-	1127
Cosmarium	-	-	-	-	-	678	1814	998
Micrasterias	1236	-	-	-	-	-	-	-
Total gen= 11	11151	11070	4995	6608	13114	19180	28344	29261
Cyanophyceae		-	-	-	-	-	-	-
Microcystis	14264	9197	5957	-	-	-	9425	4748
Spiriluna	-	-	-	667	2334	9667	9000	2834
Oscillatoria	31193	1332	43458	17854	17637	13658	28045	23952
Lyngbeya	1727	1923	1332	668	1285	-	-	-
Anabaena	4330	3838	4338	2660	1308	978	-	-

Continued

Tab. 4: Abundance of Phytoplankton unit/l in P-4 (Pond-4).

Name of the Genera.	Jan-'95	Feb.	March	April	Yearly mean
Chlorophyceae					
Chlorella	9332	11431	-	-	3145
Actinastrum	1792	666	981	885	1258
Crucigenia	2636	2520	1930	1618	1508
Ankistrodesmus	2184	1462	1797	1578	4527
Sclenastrum	1506	956	636	333	1313
Scenedesmus	-	-	-	691	1473
Padiastrum	-	8978	850	675	998
Staurastrum	-	1446	732	333	362
Closterium	936	1004	813	2115	569
Cosmarium	676	333	966	1276	562
Micrasterias	2681	-	-	966	407
Total gen= 11	21743	28797	8705	10470	16122
Cyanophyceae	-	-	-	-	-
Microcystis	5526	4034	5957	12792	5992
Spiriluna	1676	7334	-	-	2793
Oscillatoria	36260	7580	9785	8847	9967
Lyngbeya	-	2327	2729	1732	1144
Anabaena	-	-	8310	7898	2805

Tab. 4: Abundance of Phytolankton unit/l in P-4 (Pond-4).

Name of the Genera.	May-94	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Glaeotricha	-	-	-			879	1804	2228
Cylindrospermum	-	-	-	2393				1032
Nodularia	961	-	-					813
Total gen.=8	52475	16290	55085	24242	22564	25182	48274	35607
Bacillariophyceae								
Rhopalodia	980	-	-				5612	6760
Navicula	1895	-	-		6776	6500	5525	13468
Pinnularia	2650	1628	1923	2122	1800	2346	8676	11398
Synedra	6895	11365	-				17114	21480
Gyrosigma	650	813	333	1669	1318			
Eunotia	950	1150	780	666				7876
Rhizosolenia	-	-	-				2406	1612
Melosira	1340	2185	1790	1827	980			486
Achnanthes	-	-	-					
Total gen.= 9	15360	17141	4826	6284	10874	8846	39333	63080
Euglenophyceae								
Euglena	39977	41923	25900	18953	39749			
Phacus	660	-	-			950		
Total gen. =2	40637	41923	25900	18953	39749	950		

Continued

Tab. 4: Abundance of Phytolankton unit/l in P-4 (Pond-4).

Name of the Genera.	Janu.	Feb.	March	April	Y. mean
Glaeotricha	827	1310	1004		671
Cylindrospermum	978	1013	669	723	567
Nodularia	666	333	1826	1346	495
Total gen.=8	45933	23931	30280	33338	34334
Bacillariophyceae					
Rhopalodia	4895	1736	2145		1844
Navicula	14770			2335	4273
Pinnularia	11340	17118	950	1156	5259
Synedra	11333	14680			6906
Gyrosigma		922	1105	776	632
Eunotia	9310	11400	12140	850	3760
Rhizosolenia				666	390
Melosira	1318	2766			1058
Achnanthes			878	1610	207
Total gen.= 9	52966	48622	17218	7393	24365
Euglenophyceae					
Euglena		48865	14884	12774	20688
Phacus		1255	956	1410	436
Total gen. =2		50120	15840	14184	

Tab.1a: Seasonal Abundance of different genera of Phytoplankton (unit/l) in pond-1.

Name of the Gen.	Summer	monsoon	Post -monsoon	Winter
Chlorophyceae	March -May	June -Aug.	Sept. -Nov.	Dec.-Feb.
Chlorella	979	3102	5238	1000
Sclenastrum	1467	1378	468	633
Ankistrodesmus	5829	8933	4307	4265
Crucigenia	939	799	715	924
Scenedesmum	1318	1156	1010	1495
Pediastrum	1098	1465	718	509
Actinastrum	968	1599	818	1336
Closterium	905	898	794	748
Cosmarium	761	605	709	1275
Staurastrum	1035	564	214	148
Ulothrix	297	95	133	112
Spirogyara	383	162		673
Total Gen = 12	15979	20756	15124	13118
Cyanophyceae				
Microcystis	10483	4593	6311	10130
Merismopidia	1193	1943	1136	929
Spirulina		1151		3166
Oscillatoria	2249	5018	2707	2380
Anabaena	2194	3592	1192	994
Anabaenopsis	292		614	95
Cylindrospermum			146	310
Total gen.=7	16411	16297	12106	18004
Bacillariophyceae				
Brebissonia		630	852	2276
Fragilaria	110	1467	1214	824
Eunotia	1796	1140	1754	1187
Gyrosigma	2657	825	387	752
Navicula	2415	2519	4965	2030
Pinnularia	979	639	1995	1552
Gomphonema	317	536	139	
Tebellaria	917		1661	273
Cymbella	496	670		
Nitzschia	94	355	1476	600
Total gen. = 10	9781	8782	14443	9494
Euglenophyceae				
Euglena	21302	34677	24332	15610
Phacus	662	278		533
Trachelomonas	871	530		272
Total gene.= 3	22835	35485	24332	16415
Dinophyceae				
Ceratium	1038	905	78	130
Total gen. =1	1038	905	78	130
T. S. Abun of Phyto	66044	82225	66123	57161

Tab. 2a: Seasonal Abundance of different genera of Phytoplankton (unit/l) in pond-2.

Genera of Phytoplankton	Summer	Monsoon	Post- monsoon	Writer
	March-May	June-Aug.	Sept.-Nov.	Dec.-Feb.
Chlorophyceae				
Ankistrodesmus	14260	7537	2035	-
Scenedesmus	1591	4113	4092	4810
Pediastrum	1308	633	594	2096
Crucigenia	2558	1760	2401	6498
Gloeotaenium	122		238	757
Actinastrum	605	9001	29905	6103
Closterium	6790	972	1412	19470
Cosmarium	3904	2475	615	2129
Micrasterias	1468		885	
Total gen. = 9	9 Gen	7 Gen	9 Gen	7 Gen
T. abun. of Chloro.	32606	26491	42177	41863
Cyanophyceae				
Microcystis	6702	8047	1007	5779
Anabaenopsis	1370	659		1669
Anabaena	3355	3340	1237	1524
Spirulina	334	849		1668
Oscillatoria	10303	8870	13913	16234
Lyngbeya	1028	675	122	608
Cylindrospermum	827	2084		274
Total gen. = 7	7 Gen	7 Gen	4 Gen	7 Gen
T. abun. of Cyano.	23919	24524	16279	27754
Bacillariophycae				
Fragilaria	5860	4931	8296	6688
Brebissonia	494	3726	6627	464
Gomphonema	965		3604	4238
Navicula	4317	3361	9873	10643
Pinnularia	5578	4272	10272	4934
Cymbella	259	2076	11130	1458
Total gen. = 6	6 Gen	5 Gen	6 Gen	6 Gen
T. abun. of Bacillario.	17473	18366	49802	28425
Euglenophyceae				
Euglena	31071	22629	33817	5582
Phacus	2387	748	275	510
Trachelomonas	427		464	1122
Total gen. = 3	3 Gen	2 Gen	3 Gen	3 Gen
T. abun. of Eugleno.	33885	23377	34556	7214
Dinophyceae				
Ceratium			2691	11085
Total gen. = 1	0	0	1	1
T. abun. of Dino.			2691	11085
T. S. Abun. of Phyto.	107883	92858	145523	116341

Tab. 3a: Seasonal Abundance of different genera of phytoplankton (unit/l) in pond-3.

Genera	Summer March-May	Monsoon June-Aug.	Post- monsoon Sept.-Nov.	Writer Dec.-Feb.
Chlorophyceae				
Eudorina	8712			521
Scenedesmus	1567	7493	4174	
Pediastrum	1452	2206		
Chlorella	1063	1518		2296
Tetraedron	394			836
Sclenastrum	222			1563
Ankistrodesmus	1025	4668	1495	
Cruscigenia	1541	975	1194	
Staurastrum	813			539
Euastrum	1411	364		
Cosmarium	1503	708	1478	
Total gen. = 11	11	7	4	5
T.S. abun. of Chloro.	19703	17932	8341	5755
Cyanophyceae				
Microcystis	4152	7258	3051	3828
Spirulina	1046	379		512
Oscillatoria	35255	24364	27465	29913
Anabaenopsis	600		6618	1359
Nodularia	317		2094	
Arthrospira	4292		283	334
Cylindrospermum	720	1528	1683	
Total gen. = 7	7	4	6	5
T.S. abun. of Cyano..	26382	33529	41194	35946
Bacillariophyceae				
Navicula	2209	2280	7082	6394
Fragilaria	7554	9223	4598	11926
Synedra			2713	1112
Gyrosigma	3045	1612		3730
Eunotia	3630	594	770	1626
Achnanthes	1116	614		574
Cymbella	950		885	1315
Nitzchia	2169	2797		1276
Tabellaria	317		539	412
Pinnularia	3540	3265	10618	8663
Total gen. : 10	9	7	7	10
T. S. abun. of Bacillario	24530	20385	27205	37028
Euglenophyceae				
Euglena	22681		27886	4375
Phacus	1100	900	1042	600
Total gen. = 2	2	1	2	2
T. S. Phyto.	23781	900	28928	4975
Grand Total	114396	72746	105668	83704

Tab. 4a: Seasonal Abundance of different genera of phytoplankton (unit/l) in pond-4.

Genera of different classes	Summer March-May	Monsoon June-Aug.	Post-Monsoon Sept.-nov.	Writer Dec.-Feb.
Chlorophyceae				
Chlorella		202	3199	9182
Actinastrum	622		2196	2213
Crucigenia	1522	898	1301	2312
Ankistrodesmus	3369	4021	6724	3993
Sclenastrum	111		2525	2406
Scenedesmus	675	1828	2952	436
Pediastrum	508		490	2993
Staurastrum	355	610		482
Closterium	1254			1023
Cosmarium	747		831	669
Micrasterias	734			894
Total gen. = 11	10	5	8	11
T. S. abun. Chloro	9897	7559	20218	26603
Cyanophyceae				
Microcystis	11004	5052	3142	4769
Spirulina		224	7001	3948
Oscillatoria	16608	20882	19780	22598
Lyngbeya	2063	1308	429	776
Anabaena	6846	3612	762	
Gloeotrichia	335		894	1455
Cylindrospermum	464	798		1008
Nodularia	1378			604
Total gen. = 8	7	6	6	7
T. S. abun. Cyano.	38698	31876	32008	35158
Bacillariophyceae				
Rhopalodia	1042		1871	4462
Navicula	1410		6267	9113
Pinnularia	1585	1891	4274	13286
Synedra	2298	3788	5705	15831
Gyrosigma	844	938	439	308
Eunotia	4647	865	-	9529
Rhizosolenia	222		802	9529
Melosira	447	1934	327	538
Achnanthes	829			2523
Total gen. = 9	9	5	7	9
T. S. abun. Bacillario.	13324	9416	19685	55590
Euglenophyceae				
Euglena	22545	28925	13250	16288
Phacus	1009		317	418
Total gen. = 2	2	1	2	2
T. S.abun. Eugleno	23554	28925	13567	16706
T. S. abun. of Phyto	85473	77776	85478	134057

Tab.1b: Seasonal abundance of different groups of phytoplankton in Pond-1 (unit/l). (P.C. composition in parenthesis).

Classes of Phytoplankton	Summer March-May	Monsoon June-Aug.	Post -monsoon Sep.-Nov.	Winter Dec. -Feb.
Chlorophyceae	17979 (27.2)	20756 (25.2)	15124 (22.9)	13118 (22.9)
Cyanophyceae	16411 (24.8)	16297 (19.8)	12106 (18.3)	18004 (31.5)
Bacillariophyceae	9781 (14.8)	8782 (10.7)	14443 (21.8)	9494 (16.6)
Euglenophyceae	22835 (34.6)	35485 (43.2)	24332 (36.8)	16415 (28.7)
Dinophyceae	1038 (1.57)	905 (0.1)	78 (0.1)	130 (0.2)
T. S. abun. of Phyto.	66044	82225	66123	57161

Tab.2b: Seasonal abundance of different groups of phytoplankton in Pond -2 (unit/l). (P.C. composition in parenthesis).

Classes of Phytoplankton	Summer March-May	Monsoon June-Aug.	Post-monsoon Sept.-Nov.	Writer Dec.-Feb.
Chlorophyceae	32606 (30.2)	26491 (28.5)	42177 (28.9)	41863 (35.9)
Cyanophyceae	23919 (22.2)	24524 (26.4)	16279 (11.2)	27754 (23.6)
Bacillariophyceae	17473 (16.2)	18366 (19.7)	49802 (34.2)	28425 (24.4)
Euglenophyceae	33885 (31.4)	23377 (25.2)	34556 (23.7)	7214 (6.2)
Dinophyceae	-	-	2691 (1.8)	11085 (9.5)
T. S. abun. of Phyto.	107883	92858	145523	116341

Tab.3b: Seasonal abundance of different groups of phytoplankton in Pond -3 (unit/l). (P.C. composition in parenthesis).

Classes of Phytoplankton	Summer	Monsoon	Post -monsoon	Writer
	March - May	June - Aug.	Sept. - Nov	Dec. - Feb.
Chlorophyceae	19703 (17.2)	17932 (24.7)	8341 (7.9)	5755 (6.9)
Cyanophyceae	46382 (40.5)	33529 (46.1)	41194 (38.9)	35446 (42.3)
Bacillariophyceae	24530 (21.4)	20385 (28.0)	27205 (25.7)	37208 (44.4)
Euglenophyceae	23781 (20.8)	900 (1.2)	28928 (27.3)	4975 (5.9)
Dinophyceae	-	-	-	-
T. S. abun. of Phyto.	114396	72746	105668	83704

Tab.4b: Seasonal abundance of different groups of phytoplankton in Pond -4 (unit/l). (P.C. composition in parenthesis).

Classes of Phytoplankton	Summer	Monsoon	Post-Monsoon	Writer
	March-May	June-Aug.	Sept.-Nov	Dec.-Feb
Chlorophyceae	9897 (11.5)	7559 (9.7)	20218 (23.6)	26603 (19.8)
Cyanophyceae	38698 (45.2)	31876 (40.9)	32008 (37.4)	35158 (26.2)
Bacillariophyceae	13324 (15.5)	9416 (7.3)	19685 (20.0)	55590 (41.5)
Euglenophyceae	23554 (27.5)	28925 (37.2)	13567 (15.8)	16706 (12.5)
Dinophyceae	-	-	-	-
T. S. abun. of Phyto.	85473	77776	85478	134057

Tab.5: Total Number of genera of phytoplankton belonging to different groups of algae in the study ponds (% composition in parenthesis).

Group/Classes	Pond-1	Pond-2	Pond- 3	Pond- 4
Chlorophyceae	12 (36.3)	9 (34.6)	11 (36.7)	11 (36.7)
Cyanophyceae	7 (21.2)	7 (26.9)	7 (23.3)	8 (26.6)
Bacillariophyceae	10 (30.3)	6 (23)	10 (33.3)	9 (30)
Euglenophyceae	3 (9)	3 (11.5)	2 (6.6)	2 (6.6)
Dinophyceae	1 (3)	1 (3.8)	-	-
T. Phyto. genera	33	26	30	30

Tab.6: Yearly abundance of different groups of phytoplankton in four ponds (units/l) and their % composition (in parenthesis).

Phytoplankton groups	Pond-1	Pond-2	Pond-3	Pond-4
Chlorophyceae	16242 (23.75)	35858 (30.84)	13098 (13.87)	16122 (16.8)
Cyanophyceae	16159 (23.63)	24086 (20.72)	39347 (41.7)	34334 (35.78)
Bacillariophyceae	10557 (15.44)	28089 (24.17)	27290 (28.9)	24365 (25.38)
Euglenophyceae	24868 (36.37)	24757 (21.29)	14639 (15.5)	21124 (20.01)
Dinophyceae	537 (0.78)	3444 (2.96)	-	-
Total Plankton	68363	116243	94374	95945

Tab.7. Seasonal abundance (unit-l) and percentage composition (in parenthesis) of phyto-zooplankton in four study ponds (p_1, p_2, p_3 & p_4).

Season	Plankton	Pond 1	Pond 2	Pond 3	Pond 4
Summer	Phyto plankton	66044 (41.8)	107883 (22.3)	114396 (32.8)	85473 (16.7)
March-May	Zoo Plankton	91923 (58.2)	375451 (77.7)	234049 (67.2)	424278 (83.3)
Monsoon	Phyto plankton	82225 (41.7)	92858 (26.6)	72746 (25.9)	77776 (38.8)
June-Aug.	Zoo Plankton	114981 (58.3)	255918 (73.4)	208150 (74.1)	122378 (61.2)
Post-monsoon	Phyto plankton	66123 (17.4)	145523 (35.5)	105668 (43.6)	85478 (26.8)
Sept.-Nov	Zoo Plankton	313183 (82.6)	264824 (64.5)	136820 (56.4)	233468 (73.2)
Winter	Phyto plankton	57161 (9.5)	116341 (20.8)	83704 (37.9)	134057 (55.4)
Dec-Feb.	Zoo Plankton	541917 (90.5)	442213 (79.2)	136957 (62.1)	107953 (44.6)

Tab.8. Comparative seasonal abundance of phyto-zooplankton in the study ponds (P_1, p_2, p_3 & p_4) unit/l.

Season	Plankton	Pond 1	Pond 2	Pond 3	Pond 4
Summer	Phytoplankton	66044	107883	114396	85473
March-May	Zooplankton	91923	375451	234049	424278
Monsoon	Phytoplankton	82225	92858	72746	77776
June-Aug.	Zooplankton	114981	255918	208150	122378
Post-monsoon	Phytoplankton	66123	145523	105668	85478
Sept.-Nov	Zooplankton	313183	264824	136820	233468
Winter	Phytoplankton	57161	116341	83704	134057
Dec-Feb.	Zooplankton	541917	442213	136820	107953

Tab-18

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	at	wt	av_d	sdd	tds	econ	ph	co2	co3	hco3	th	cl	do
1	34.8	31.80	1.10	.20	489.50	753.00	7.70	21.50	.00	30.50	209.0	112.00	6.10
2	29.1	29.90	1.10	.20	494.30	751.00	8.30	9.70	.00	23.50	295.0	121.00	5.20
3	32.1	31.10	1.10	.20	484.30	745.00	8.30	10.10	.00	21.00	287.0	103.00	6.30
4	33.6	31.50	1.20	.20	454.70	700.00	8.30	2.80	17.20	39.00	200.0	143.00	6.80
5	30.3	30.40	.90	.10	353.00	543.00	8.50	26.70	.00	114.1	209.0	102.00	6.90
6	27.6	27.70	.90	.20	456.00	702.00	8.70	23.50	.00	165.3	267.0	109.00	6.30
7	23.1	48.10	1.20	.20	488.00	752.00	8.60	13.00	.00	135.0	285.0	99.00	5.70
8	20.2	19.30	1.00	.20	450.50	693.00	8.60	27.30	.00	184.0	386.0	87.00	5.40
9	17.5	19.60	1.00	.30	440.40	678.00	8.60	15.70	2.80	231.0	467.3	107.00	7.60
10	23.8	23.90	1.00	.20	484.30	745.00	8.60	33.20	.00	301.2	440.0	107.00	4.00
11	32.4	29.00	1.00	.20	444.00	683.00	8.70	34.70	.00	346.0	429.0	122.00	5.40
12	38.3	30.80	1.10	.20	420.20	647.00	8.70	28.00	.00	403.0	538.0	131.00	5.40

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	o2	bod	cod	nh3	po4	eh	rh2	gpp	npp	tzp	tpp
1	82.00	6.90	15.30	.10	.10	.36	27.8	.20	.10	456596.0	92154.00
2	68.00	7.60	18.80	.10	.10	.29	26.6	.20	-.10	120309.0	107062.0
3	86.00	5.40	11.90	.10	.10	.29	26.6	.30	.04	48770.00	80894.00
4	92.00	12.00	22.50	.10	.20	.29	26.6	.30	.02	180686.0	65568.00
5	92.00	3.40	8.40	.10	.10	.27	26.3	.20	.04	172147.0	41360.00
6	81.00	3.10	7.20	.10	.20	.25	26.0	.30	.03	117931.0	74868.00
7	69.00	4.90	10.60	.11	.10	.25	25.8	.20	-.11	699633.0	81201.00
8	60.00	5.60	12.20	.10	.10	.26	26.1	.20	-.14	101347.0	44360.00
9	86.00	7.00	15.20	.13	.70	.26	26.1	.40	.10	1303536	56847.00
10	45.00	3.20	9.80	.10	.20	.26	26.1	.30	.12	231114.0	72967.00
11	70.00	3.10	8.50	.10	.70	.25	26.0	.40	.14	52059.00	111365.0
12	73.00	2.70	7.40	.00	.20	.25	26.0	.30	.08	18302.00	57703.00
13	.	.	.	.	.	.	.	.	.	.	.

Tab-18.

- - Correlation Coefficients - -

	AT	AV_D	BOD	CL	CO2	CO3
AT	1.0000	.2659	.0067	.6634*	-.0191	.1620
AV_D	.2659	1.0000	.5875*	.4101	-.6490*	.4474
BOD	.0067	.5875*	1.0000	.4024	-.8027**	.8002**
CL	.6634*	.4101	.4024	1.0000	-.2661	.6289*
CO2	-.0191	-.6490*	-.8027**	-.2661	1.0000	-.5754
CO3	.1620	.4474	.8002**	.6289*	-.5754	1.0000
COD	-.0062	.5709	.9735**	.4048	-.7620**	.7010*
DO	-.0471	-.0717	.3958	.0530	-.4712	.3807
ECON	-.1276	.5382	.2897	-.0173	-.3448	-.0146
EH	.3837	.3153	.4996	.1346	-.3334	.1441
GPP	-.0364	-.1809	-.0927	.3474	.1635	.1898
HCO3	-.0559	-.3107	-.6333*	.0846	.7438**	-.2791
NH3_N	-.6301*	-.1457	.3384	-.4194	-.2782	.1082
NPP	.3461	-.2792	-.2513	.3580	.4033	.0176
O2	.3406	.0391	.3859	.2734	-.5050	.4159
PH	-.3651	-.3800	-.5285	-.1216	.3949	-.1593
PO4	-.2228	-.2447	-.0745	.1969	.2478	.0603
RH2	.3969	.2401	.4632	.1458	-.2622	.1263
SDD	-.4338	.2132	.2842	.0702	-.2313	.1204
TDS	-.1237	.5357	.2970	-.0095	-.3532	-.0205
TH	-.2021	-.1465	-.4465	.0177	.5115	-.3127
TPP	.2866	.2927	.0467	.2947	-.0959	-.1561
TZP	-.6053*	.0884	.2322	-.2239	-.2445	.0452
WT	.3220	.5940*	.0121	.1283	-.3451	.0204

- - Correlation Coefficients - -

	COD	DO	ECON	EH	GPP	HCO3
AT	-.0062	-.0471	-.1276	.3837	-.0364	-.0559
AV_D	.5709	-.0717	.5382	.3153	-.1809	-.3107
BOD	.9735**	.3958	.2897	.4996	-.0927	-.6333*
CL	.4048	.0530	-.0173	.1346	.3474	.0846
CO2	-.7620**	-.4712	-.3448	-.3334	.1635	.7438**
CO3	.7010*	.3807	-.0146	.1441	.1898	-.2791
COD	1.0000	.2702	.3551	.5396	-.1170	-.6203*
DO	.2702	1.0000	-.4067	.1568	.1871	-.3699
ECON	.3551	-.4067	1.0000	.3250	-.0656	-.2906
EH	.5396	.1568	.3250	1.0000	-.3802	-.6610*
GPP	-.1170	.1871	-.0656	-.3802	1.0000	.5386
HCO3	-.6203*	-.3699	-.2906	-.6610*	.5386	1.0000
NH3_N	.3412	.3081	.2461	.1562	.0193	-.4880
NPP	-.2429	.0932	-.1932	.1073	.6770*	.4239
O2	.2649	.9126**	-.4032	.3115	.0951	-.4644
PH	-.5651	-.1599	-.3586	-.9950**	.4201	.7051*
PO4	-.0678	.2445	-.1542	-.3386	.8656**	.5301
RH2	.5068	.1512	.2852	.9939**	-.3318	-.6049*
SDD	.3025	.1570	.4747	-.0672	.5657	.1892
TDS	.3698	-.4138	.9990**	.3310	-.0789	-.3029
TH	-.3851	-.3612	-.0625	-.5606	.5467	.8727**
TPP	.1569	-.3463	.6188*	.2777	.1277	-.1406
TZP	.2214	.4793	.0948	.0176	.2199	-.0161
WT	-.0382	-.0310	.2061	.0758	-.3703	-.2662

* - Signif. LE .05 ** - Signif. LE .01 (2-tailed)

" . " is printed if a coefficient cannot be computed

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-- Correlation Coefficients --

	NH3_N	NPP	O2	PH	PO4	RH2
AT	-.6301*	.3461	.3406	-.3651	-.2228	.3969
AV_D	-.1457	-.2792	.0391	-.3800	-.2447	.2401
BOD	.3384	-.2513	.3859	-.5285	-.0745	.4632
CL	-.4194	.3580	.2734	-.1216	.1969	.1458
CO2	-.2782	.4033	-.5050	.3949	.2478	-.2622
CO3	.1082	.0176	.4159	-.1593	.0603	.1263
COD	.3412	-.2429	.2649	-.5651	-.0678	.5068
DO	.3081	.0932	.9126**	-.1599	.2445	.1512
ECON	.2461	-.1932	-.4032	-.3586	-.1542	.2852
EH	.1562	.1073	.3115	-.9950**	-.3386	.9939**
GPP	.0193	.6770*	.0951	.4201	.8656**	-.3318
HCO3	-.4880	.4239	-.4644	.7051*	.5301	-.6049*
NH3_N	1.0000	-.1389	.1023	-.1827	.2092	.1270
NPP	-.1389	1.0000	.1610	-.0481	.5456	.1705
O2	.1023	.1610	1.0000	-.3146	.0633	.3029
PH	-.1827	-.0481	-.3146	1.0000	.3740	-.9779**
PO4	.2092	.5456	.0633	.3740	1.0000	-.2953
RH2	.1270	.1705	.3029	-.9779**	-.2953	1.0000
SDD	.2051	.1355	-.0917	.0743	.5738	-.0569
TDS	.2460	-.2078	-.4064	-.3645	-.1608	.2911
TH	-.4325	.2837	-.5161	.5982*	.5284	-.5117
TPP	.1537	.1218	-.1841	-.2913	.1799	.2580
TZP	.4821	.0823	.1712	-.0401	.4380	-.0057
WT	-.0971	-.2543	.1504	-.1538	-.3614	-.0135

-- Correlation Coefficients --

	SDD	TDS	TH	TPP	TZP	WT
AT	-.4338	-.1237	-.2021	.2866	-.6053*	.3220
AV_D	.2132	.5357	-.1465	.2927	.0884	.5940*
BOD	.2842	.2970	-.4465	.0467	.2322	.0121
CL	.0702	-.0095	.0177	.2947	-.2239	.1283
CO2	-.2313	-.3532	.5115	-.0959	-.2445	-.3451
CO3	.1204	-.0205	-.3127	-.1561	.0452	.0204
COD	.3025	.3698	-.3851	.1569	.2214	-.0382
DO	.1570	-.4138	-.3612	-.3463	.4793	-.0310
ECON	.4747	.9990**	-.0625	.6188*	.0948	.2061
EH	-.0672	.3310	-.5606	.2777	.0176	.0758
GPP	.5657	-.0789	.5467	.1277	.2199	-.3703
HCO3	.1892	-.3029	.8727**	-.1406	-.0161	-.2662
NH3_N	.2051	.2460	-.4325	.1537	.4821	-.0971
NPP	.1355	-.2078	.2837	.1218	.0823	-.2543
O2	-.0917	-.4064	-.5161	-.1841	.1712	.1504
PH	.0743	-.3645	.5982*	-.2913	-.0401	-.1538
PO4	.5738	-.1608	.5284	.1799	.4380	-.3614
RH2	-.0569	.2911	-.5117	.2580	-.0057	-.0135
SDD	1.0000	.4670	.4844	.1477	.6458*	-.3125
TDS	.4670	1.0000	-.0668	.6328*	.0842	.2004
TH	.4844	-.0668	1.0000	-.1000	.1263	-.4097
TPP	.1477	.6328*	-.1000	1.0000	-.1402	.3257
TZP	.6458*	.0842	.1263	-.1402	1.0000	-.0158
WT	-.3125	.2004	-.4097	.3257	-.0158	1.0000

* - Signif. LE .05 ** - Signif. LE .01 (2-tailed)

" . " is printed if a coefficient cannot be computed

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Air T	Wat t	AV DEPT	SEC D D	TDS	ECOND	Ph	FCO2	CO3alk
34.8	32.8	1.7	0.2	404.3	622	7.8	14.7	0
28.6	29.7	1.6	0.2	418	643	8.2	8.2	0
32	31	1.5	0.2	455	700	8.4	8.9	0
33.6	32.1	1.8	0.2	383	589	8.2	8.6	4.8
30.3	31	1.5	0.2	344	529	8.4	19	0.9
27.6	27.4	1.4	0.2	499	767	8.7	8.3	2.7
23.1	23.1	1.4	0.2	435	669	8.7	11.3	2.8
20.2	18.4	1.4	0.4	482	741	8.7	32.5	0
17.5	18.5	1.6	0.2	440.4	677.5	8.8	4.9	7.3
23.8	24	1.4	0.1	406.9	709	8.9	13.1	10.8
32.6	29.2	1.4	0.3	436.2	671	8.9	12.02	5.3
38.7	31.8	1.8	0.2	408.9	629	8.8	4.3	15.2

O3 alk	Th	Chloride	Do	%Sato2	Bods	COD	NH3	PO4
21.2	285.5	138.7	6	83	3.2	7.3	0.1	0.1
18.8	307	121.6	6.1	80	2.3	6.7	0.1	0.1
18.7	227.5	191.7	6.3	85.3	5.8	14.5	0.1	0.1
41.3	226.2	133.7	7.6	105	9.6	20.7	0.1	0.1
109	214.2	136.9	8.4	113	3.9	8.7	0.1	0.1
160.5	317.7	129.8	8.1	104	8.7	12.8	0.1	0.02
141.3	311	146.7	6.8	81	3.6	8.2	0.11	0.1
171.4	414.6	104.6	5	53.2	3.7	10.1	0.12	0.1
195.3	487	121.7	7.7	86.5	3.4	8.7	0.1	0.1
290.1	464.8	120.6	7.1	85.5	2.9	7.3	0.1	0.03
329.7	465.2	103.6	6.8	90	2.5	7.1	0.1	0.1
356.7	609.2	136.6	8.4	114.4	3.7	8.4	0.1	0.1

EH mv	rH2	GPPmg	NPPmg	Tphyt	T-Zoo
0.35	27.67	0.3	-0.03	154817	523934
0.31	27.09	0.3	0.1	86425	197565
0.28	26.46	0.4	-0.1	102144	291268
0.31	27.09	0.4	0.1	85595	278907
0.28	26.46	0.3	0.01	147148	155918
0.25	26.02	0.3	0.01	122285	183888
0.25	26.02	0.3	0.21	167096	452816
0.25	26.02	0.1	-0.16	112705	264092
0.24	25.88	0.4	0.05	121479	945002
0.23	25.73	0.3	0.15	123803	140551
0.22	25.39	0.2	-0.07	88257	178785
0.24	25.88	0.3	0.02	83682	423637

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- - Correlation Coefficients - -

	AIR_T	AV_DEPT	BODS	CHLORID	CO3ALK	COD
AIR_T	1.0000	.5714	.1934	.3178	.1448	.1942
AV_DEPT	.5714	1.0000	.2053	.1619	.2938	.3055
BODS	.1934	.2053	1.0000	.3011	-.0971	.9143**
CHLORID	.3178	.1619	.3011	1.0000	-.2033	.3684
CO3ALK	.1448	.2938	-.0971	-.2033	1.0000	-.1253
COD	.1942	.3055	.9143**	.3684	-.1253	1.0000
DO	.2524	.2672	.3379	.0789	.5578	.1567
ECO2	-.0438	-.2285	-.1330	-.0664	-.3426	-.1312
ECOND	-.3555	-.6317*	-.0293	-.2620	.0291	-.1191
EH_MV	.3900	.5387	.1842	.3248	-.5535	.2440
GPPMG	.1695	.4770	.3995	.6249*	.1500	.4308
HCO3_ALK	-.0434	-.1990	-.3174	-.4847	.7942**	-.3951
NH3	-.5111	-.3974	-.1432	-.2585	-.2905	-.0614
NPPMG	-.1581	.1035	.0072	.0098	.3222	-.0665
PH	-.4152	-.5107	-.1689	-.3407	.5842*	-.2302
PO4	.2009	.4219	-.3044	.1347	-.2262	-.0217
RH2	.3629	.5645	.1980	.3074	-.5178	.2563
SATO2_PR	.5940*	.4325	.3951	.2203	.4349	.2480
SEC_D_D	-.1582	-.2294	-.1004	-.3984	-.3608	-.0026
T_ZOO	-.3147	.3547	-.1640	.0666	.1873	-.1181
TDS	-.4025	-.4790	.1594	-.0620	-.1629	.0455
TH	.0997	.2667	-.2057	-.2813	.3148	-.2211
TPHYT	-.3499	-.3452	-.1751	.1636	-.3148	-.3137
WATT	.9427**	.5195	.2482	.4082	-.0480	.2347

- - Correlation Coefficients - -

	DO	ECO2	ECOND	EH_MV	GPPMG	HCO3_ALK
AIR_T	.2524	-.0438	-.3555	.3900	.1695	-.0434
AV_DEPT	.2672	-.2285	-.6317*	.5387	.4770	-.1990
BODS	.3379	-.1330	-.0293	.1842	.3995	-.3174
CHLORID	.0789	-.0664	-.2620	.3248	.6249*	-.4847
CO3ALK	.5578	-.3426	.0291	-.5535	.1500	.7942**
COD	.1567	-.1312	-.1191	.2440	.4308	-.3951
DO	1.0000	.1341	-.3516	-.2615	.4827	.3427
ECO2	.1341	1.0000	-.4756	.0892	-.2799	-.1243
ECOND	-.3516	-.4756	1.0000	-.5812*	-.4196	.3953
EH_MV	-.2615	.0892	-.5812*	1.0000	.2998	-.8457**
GPPMG	.4827	-.2799	-.4196	.2998	1.0000	-.3669
HCO3_ALK	.3427	-.1243	.3953	-.8457**	-.3669	1.0000
NH3	-.5898*	.1747	.2800	-.1963	-.6860*	.0249
NPPMG	.3696	-.2109	-.3080	-.0082	.4416	.0069
PH	.2699	-.1209	.5698	-.9964**	-.2802	.8440**
PO4	-.2673	.1481	-.4441	.3196	.0000	-.2555
RH2	-.2497	.0571	-.5898*	.9964**	.3189	-.8411**
SATO2_PR	.9200**	.1416	-.4728	.0019	.5038	.1739
SEC_D_D	-.5197	.1804	.3531	-.1457	-.7426**	.0767
T_ZOO	.0733	-.3235	-.1044	.0193	.3766	-.0022
TDS	-.3737	-.4769	.8704**	-.3719	-.3087	.1111
TH	.1034	-.2530	.1806	-.3191	-.2523	.4503
TPHYT	-.0270	.3850	-.1838	.1368	-.0165	-.2110
WATT	.2641	.0531	-.4663	.5525	.3209	-.2795

* - Signif. LE .05 ** - Signif. LE .01 (2-tailed)

" . " is printed if a coefficient cannot be computed

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- - Correlation Coefficients - -

	NH3	NPPMG	PH	PO4	RH2	SATO2_PR
AIR_T	-.5111	-.1581	-.4152	.2009	.3629	.5940*
AV_DEPT	-.3974	.1035	-.5107	.4219	.5645	.4325
BODS	-.1432	.0072	-.1689	-.3044	.1980	.3951
CHLORID	-.2585	.0098	-.3407	.1347	.3074	.2203
CO3ALK	-.2905	.3222	.5842*	-.2262	-.5178	.4349
COD	-.0614	-.0665	-.2302	-.0217	.2563	.2480
DO	-.5898*	.3696	.2699	-.2673	-.2497	.9200**
ECO2	.1747	-.2109	-.1209	.1481	.0571	.1416
ECOND	.2800	-.3080	.5698	-.4441	-.5898*	-.4728
EH_MV	-.1963	-.0082	-.9964**	.3196	.9964**	.0019
GPPMG	-.6860*	.4416	-.2802	.0000	.3189	.5038
HCO3_ALK	.0249	.0069	.8440**	-.2555	-.8411**	.1739
NH3	1.0000	-.2513	.2029	.1874	-.1898	-.7120**
NPPMG	-.2513	1.0000	.0573	-.2244	.0408	.2598
PH	.2029	.0573	1.0000	-.3425	-.9857**	-.0056
PO4	.1874	-.2244	-.3425	1.0000	.2958	-.1449
RH2	-.1898	.0408	-.9857**	.2958	1.0000	-.0002
SATO2_PR	-.7120**	.2598	-.0056	-.1449	-.0002	1.0000
SEC_D_D	.7132**	-.7016*	.1172	.4111	-.1740	-.5155
T_ZOO	-.0180	.0965	-.0048	.3517	.0350	-.1020
TDS	.4201	-.3607	.3724	-.3318	-.3698	-.5001
TH	.1587	-.3278	.3115	.4199	-.3233	.0439
TPHYT	.2228	.2542	-.1507	-.1090	.1208	-.1388
WATT	-.6309*	-.0408	-.5770*	.1442	.5247	.6180*

- - Correlation Coefficients - -

	SEC_D_D	T_ZOO	TDS	TH	TPHYT	WATT
AIR_T	-.1582	-.3147	-.4025	.0997	-.3499	.9427**
AV_DEPT	-.2294	.3547	-.4790	.2667	-.3452	.5195
BODS	-.1004	-.1640	.1594	-.2057	-.1751	.2482
CHLORID	-.3984	.0666	-.0620	-.2813	.1636	.4082
CO3ALK	-.3608	.1873	-.1629	.3148	-.3148	-.0480
COD	-.0026	-.1181	.0455	-.2211	-.3137	.2347
DO	-.5197	.0733	-.3737	.1034	-.0270	.2641
ECO2	.1804	-.3235	-.4769	-.2530	.3850	.0531
ECOND	.3531	-.1044	.8704**	.1806	-.1838	-.4663
EH_MV	-.1457	.0193	-.3719	-.3191	.1368	.5525
GPPMG	-.7426**	.3766	-.3087	-.2523	-.0165	.3209
HCO3_ALK	.0767	-.0022	.1111	.4503	-.2110	-.2795
NH3	.7132**	-.0180	.4201	.1587	.2228	-.6309*
NPPMG	-.7016*	.0965	-.3607	-.3278	.2542	-.0408
PH	.1172	-.0048	.3724	.3115	-.1507	-.5770*
PO4	.4111	.3517	-.3318	.4199	-.1090	.1442
RH2	-.1740	.0350	-.3698	-.3233	.1208	.5247
SATO2_PR	-.5155	-.1020	-.5001	.0439	-.1388	.6180*
SEC_D_D	1.0000	-.0589	.4251	.5047	-.1888	-.3137
T_ZOO	-.0589	1.0000	.0782	.4625	.2319	-.3750
TDS	.4251	.0782	1.0000	.2904	-.0996	-.4969
TH	.5047	.4625	.2904	1.0000	-.3293	-.1418
TPHYT	-.1888	.2319	-.0996	-.3293	1.0000	-.2428
WATT	-.3137	-.3750	-.4969	-.1418	-.2428	1.0000

* - Signif. LE .05   ** - Signif. LE .01   (2-tailed)

" . " is printed if a coefficient cannot be computed

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a:\aziz2.sav

air_t	wat_t	av_dep	sec_d_d	tds	econd	ph	eco2	co3alk
33.80	32.40	2.20	.20	397.20	611.00	8.20	1.30	4
30.40	29.50	2.10	.20	412.10	634.00	8.50	2.00	1
30.20	31.10	2.10	.30	419.30	645.00	8.40	2.80	1
32.60	31.90	2.30	.20	381.60	587.00	8.40	4.30	1
28.50	29.20	1.70	.20	387.70	597.00	8.60	6.30	3
27.40	29.00	2.00	.20	389.40	599.00	98.60	2.90	1
22.80	22.90	1.70	.20	448.50	690.00	8.60	3.80	3
19.80	19.00	1.70	.20	447.90	689.00	8.60	4.00	4
19.00	20.10	1.90	.10	450.10	693.00	8.70	4.50	8
24.30	24.30	1.80	.30	441.70	680.00	8.80	6.40	1
32.60	29.30	1.80	.20	445.90	686.00	8.70	14.60	1.
35.10	32.50	2.00	.20	423.20	651.00	8.90	1.00	2.

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a:\aziz2.sav

	air_t	wat_t	av_dep	sec_d_d	tds	econd	ph	eco2	co3alk
1	33.80	32.40	2.20	.20	397.20	611.00	8.20	1.30	4.80
2	30.40	29.50	2.10	.20	412.10	634.00	8.50	2.00	1.80
3	30.20	31.10	2.10	.30	419.30	645.00	8.40	2.80	1.30
4	32.60	31.90	2.30	.20	381.60	587.00	8.40	4.30	1.20
5	28.50	29.20	1.70	.20	387.70	597.00	8.80	8.30	3.20
6	27.40	29.00	2.00	.20	389.40	599.00	98.60	2.90	1.70
7	22.80	22.90	1.70	.20	448.50	690.00	8.60	3.80	3.30
8	19 80	19.00	1.70	.20	447.90	689.00	8.60	4.00	4.30
9	19.00	20.10	1.90	.10	450.10	693.00	8.70	4.50	8.00
10	24.30	24.30	1.80	.30	441.70	680.00	8.80	6.40	1.40
11	32.60	29.30	1.80	.20	445.90	686.00	8.70	14.60	1.80
12	35.10	32.50	2.00	.20	423.20	651.00	8.90	1.00	2.70

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a:\aziz2.sav

	hco3_alk	th	chloride	do	sato2_pe	bods	cod	nh3	po4
1	25.60	240.20	132.40	7.70	105.40	9.00	19.60	.10	.01
2	15.10	243.00	142.00	7.70	101.90	13.60	28.70	.10	.03
3	16.70	228.70	103.40	7.30	98.90	13.00	25.80	.10	.01
4	81.30	246.80	113.60	7.00	95.50	9.40	22.30	.10	.03
5	113.60	238.70	107.50	9.60	126.00	6.70	14.50	.10	.01
6	134.80	247.50	132.10	6.80	89.10	12.80	27.70	.10	.01
7	114.20	271.70	121.60	5.90	70.00	7.40	16.50	.11	.02
8	156.40	434.30	188.70	9.10	101.20	7.60	18.90	.13	.03
9	218.80	424.00	201.80	8.20	93.00	3.40	9.30	.10	.01
10	283.70	466.20	178.00	5.70	69.20	3.20	8.70	.10	.01
11	298.20	500.00	140.70	7.10	93.40	11.60	26.30	.10	.03
12	445.20	608.80	156.70	8.30	114.20	10.60	20.80	.10	.01

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a:\aziz2.sav

	eh_mv	rh2	gpp_mg	npp_mg	tphyt	t_zoo	t_plankt
1	.31	27.09	.40	.03	550865.0	493846.0	1043911
2	.27	25.71	.30	.03	154842.0	134422.0	289264.0
3	.28	26.46	.40	.10	308555.0	386944.0	699643.0
4	.28	26.46	.30	-.01	75986.00	98937.00	174923.0
5	.26	26.17	.30	.02	513447.0	200732.0	714179.0
6	.26	26.17	.30	.11	143227.0	495292.0	638519.0
7	.26	26.17	.20	.10	277906.0	450040.0	427946.0
8	.26	26.17	.30	.10	386860.0	130745.0	518605.0
9	.25	25.02	.30	.10	137376.0	483978.0	321334.0
10	.23	25.52	.30	-.20	52232.00	84973.00	137205.0
11	.25	26.02	.30	.10	65528.00	143484.0	209012.0
12	.23	25.73	.20	.03	145126.0	65613.00	210739.0

- - Correlation Coefficients - -

	AIR T	AV DEP	BODS	CHLORIDE	CO3ALK	COD
AIR_T	1.0000	.6156*	.6324*	-.5886*	-.5252	.5804*
AV_DEP	.6156*	1.0000	.4744	-.3278	-.2170	.4640
BODS	.6324*	.4744	1.0000	-.5482	-.5606	.9832**
CHLORIDE	.5886*	.3278	.5482	1.0000	.5689	.5011
CO3ALK	-.5252	-.2170	-.5606	.5689	1.0000	-.5566
COD	.5804*	.4640	.9832**	-.5011	-.5566	1.0000
DO	-.0035	-.1311	-.0111	.1233	.4296	-.0318
ECO2	-.0232	-.4511	-.1226	.0396	-.1525	-.0397
ECOND	-.5791*	-.6090*	-.3990	.6509*	.3500	-.3828
EH_MV	.2955	.5813*	.3300	-.5062	.0577	.3598
GPP_MG	.1688	.4390	.1716	-.1995	.0076	.1811
HCO3_ALK	.0164	.3678	.2781	.5101	.0579	.2999
NH3	-.5633	-.4794	-.1719	.3663	.2252	-.0987
NPP_MG	-.0927	-.0517	.4454	-.1473	.3146	.4585
PH	-.0390	.0847	.3359	-.1051	-.1994	.3605
PO4	.0212	.0114	.2834	.0080	-.2430	.4130
RH2	.4828	.3773	.4092	-.6740*	-.2842	.4165
SATO2_PE	.4437	.1743	.2768	-.2221	.1296	.2213
SEC_D_D	.2417	.0499	.1896	-.3497	-.7341**	.1381
T_PLANKT	.0850	.1178	.1597	.3752	.2363	.1150
T_ZOO	-.2589	.0903	-.0117	-.1328	.4622	-.0382
TDS	-.5768*	-.6068*	-.3946	.6495*	.3478	-.3783
TH	-.0604	-.3578	-.2787	.6692*	.1534	-.2828
TPHYT	-.0064	-.1210	-.0579	-.2846	.3304	-.1054
WAT_T	.9661**	.6778*	.6434*	-.6952*	-.5465	.5770*

* - Signif. LE .05 ** - Signif. LE .01 (2-tailed)

" . " is printed if a coefficient cannot be computed

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- - Correlation Coefficients - -

	DO	ECO2	ECOND	EH_MV	GPP_MG	HCO3_ALK
AIR_T	-.0035	-.0232	-.5791*	.2955	.1688	.0164
AV_DEP	-.1311	-.4511	-.6090*	.5813*	.4380	-.3678
BOD5	.0111	.1226	.3990	.3390	.1716	.2781
CHLORIDE	.1233	.0396	.6509*	-.5062	-.1995	.5101
CO3ALK	.4296	-.1525	.3500	.0577	.0076	.0579
COD	-.0318	-.0397	-.3828	.3598	.1811	-.2999
DO	1.0000	-.1239	-.1764	.0860	.1036	-.0049
ECO2	-.1239	1.0000	.3344	-.3140	-.0292	.3205
ECOND	-.1764	.3344	1.0000	-.5183	-.3148	.4497
EH_MV	.0860	-.3140	-.5183	1.0000	.6825*	-.8402**
GPP_MG	.1036	.0292	.3148	.6825*	1.0000	.5934*
HCO3_ALK	-.0049	.3205	.4497	-.8402**	-.5934*	1.0000
NH3	.2698	-.0614	.4269	-.0309	-.1698	-.0399
NPP_MG	.3215	-.0201	.0834	.2761	.0000	-.2091
PH	-.1985	-.1364	-.3662	-.0310	-.0052	-.0507
PO4	-.0081	.3431	.1400	.1066	-.1562	[illegible]
RH2	.0010	-.1707	-.5412	.7909**	.4735	-.5499
SATO2_PE	.9839**	-.1717	-.4873	.2256	.1884	-.0513
SEC_D_D	.4145	.0102	.0643	.0133	.2928	.1035
T_PLANKT	.3136	-.3517	-.4018	.7058*	.5968*	-.5820*
T_ZOO	-.1571	-.2792	-.0465	.4501	.3059	-.4235
TDS	-.1776	.3331	1.0000**	-.5163	-.3149	.4490
TH	.0719	.3133	.6159*	-.7594**	-.4682	.9397**
TPHYT	.5395	-.3069	-.2553	.5760	.3813	-.4788
WAT_T	-.0235	-.1310	-.7190**	.3655	.2551	-.1215

* Signif. LE .05 ** Signif. LE .01 (2 tailed)

" . " is printed if a coefficient cannot be computed

- - Correlation Coefficients - -

	NH3	NPP_MG	PH	PO4	RH2	SATO2_PE
AIR_T	-.5633	-.0927	-.0390	.0212	.4828	.4437
AV_DEP	-.4794	-.0517	.0847	.0114	.3773	.1743
BOD5	.1719	.4454	.3359	.2834	.4092	.2768
CHLORIDE	.3663	-.1473	-.1051	.0080	-.6740*	-.2221
CO3ALK	.2252	.3146	-.1994	-.2430	-.2842	.1296
COD	-.0987	.4585	.3605	.4130	.4165	.2213
DO	.2698	.3215	-.1985	-.0081	.0010	.8839**
ECO2	-.0614	-.0201	-.1364	.3431	-.1707	-.1717
ECOND	.4269	.0834	-.3662	.1400	-.5412	-.4873
EH_MV	-.0309	.2761	-.0310	.1066	.7909**	.2256
GPP_MG	.1698	.0000	.0052	.1562	.4735	.1884
HCO3_ALK	-.0399	-.2091	-.0507	-.1516	-.5499	-.0513
NH3	1.0000	.2702	-.1180	.4244	.0877	-.0785
NPP_MG	.2702	1.0000	.2423	.1701	.1669	.2343
PH	-.1180	.2423	1.0000	-.2455	.0618	-.1457
PO4	.4244	.1701	-.2455	1.0000	.0668	-.0840
RH2	.0877	.1669	.0618	.0668	1.0000	.2210
SATO2_PE	-.0785	.2343	-.1457	-.0840	.2210	1.0000
SEC_D_D	.0663	.4910	.0515	.1372	.3033	.2347
T_PLANKT	.0692	.3378	.2092	-.4142	.6846*	.3666
T_ZOO	-.1218	.4993	.4015	-.4771	.2190	-.1994
TDS	.4288	.0861	-.3653	.1427	-.5381	-.4878
TH	.1478	-.1687	-.2277	.0053	-.5478	-.0475
TPHYT	.2975	.2324	-.1701	-.2536	.5996*	.5062
WAT_T	-.6526*	-.0891	.0896	-.1200	.5121	.4439

* Signif. LE .05 ** Signif. LE .01 (2 tailed)

" . " is printed if a coefficient cannot be computed

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- - Correlation Coefficients - -

	SEC_D_D	T_PLANKT	T_ZOO	TDS	TH	TPHYT
AIR_T	.2417	.0850	-.2589	-.5768*	-.0604	-.0064
AV_DEP	.0499	.1178	.0903	-.6068*	-.3578	-.1210
BOD5	.1896	.1597	.0117	.3946	.2787	.0579
CHLORIDE	-.3497	-.3752	-.1328	.6495*	.6692*	-.2846
CO3ALK	-.7341**	.2363	.4622	.3478	.1534	.3304
COD	.1381	.1150	-.0382	-.3783	-.2828	-.1054
DO	-.4145	.3136	-.1571	-.1776	.0719	.5395
ECO2	.0102	-.3517	-.2792	.3331	.3133	-.3069
ECOND	-.0643	-.4018	-.0465	1.0000**	.6159*	-.2553
EH_MV	-.0133	.7059*	.4501	-.5163	-.7594**	.5760
GPP_MG	.2928	.5968*	.3059	.3149	.4682	.3813
HCO3_ALK	-.1035	-.5820*	-.4235	.4490	.9397**	-.4788
NH3	-.0663	.0692	-.1218	.4288	.1478	.2975
NPP_MG	-.4910	.3378	.4993	.0861	-.1687	.2324
PH	-.0515	.2092	.4015	-.3653	-.2277	-.1701
PO4	-.1372	-.4142	-.4771	.1427	.0053	-.2536
RH2	.3033	.6846*	.2190	-.5381	-.5478	.5996*
SATO2_PE	-.2347	.3666	-.1994	-.4878	-.0475	.5062
SEC_D_D	1.0000	.0422	.2709	.0633	.0998	.0112
T_PLANKT	.0422	1.0000	.6359*	-.4013	-.5778*	.8691**
T_ZOO	-.2709	.6359*	1.0000	-.0465	-.4790	.3416
TDS	-.0633	-.4013	-.0465	1.0000	.6158*	-.2555
TH	-.0998	-.5778*	-.4790	.6158*	1.0000	-.4291
TPHYT	-.0112	.8691**	.3416	-.2555	-.4291	1.0000
WAT_T	.2840	.1941	-.1229	-.7173**	-.2425	.0389

* Signif. LE .05 ** Signif. LE .01 (2 tailed)

" . " is printed if a coefficient cannot be computed

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- - Correlation Coefficients - -

	WAT_T
AIR_T	.9661**
AV_DEP	.6778*
BOD3	.6434*
CHLORIDE	-.6952*
CO3ALK	-.5465
COD	.5770*
DO	-.0235
ECO2	-.1310
ECOND	-.7190**
EH_MV	.3655
GPP_MG	.2551
HCO3_ALK	-.1215
NH3	-.6526*
NPP MG	-.0891
PH	.0896
PO4	-.1200
PH2	.5121
SATO2_PE	.4439
SEC_D_D	.2840
T_PLANKT	.1941
T_ZOO	-.1229
TDS	-.7173**
TH	-.2425
TPHYT	.0389
WAT_T	1.0000

* Signif. LE .05 ** Signif. LE .01 (2 tailed)

" . " is printed if a coefficient cannot be computed

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Air T	Wat t	AV DEPT	SEC D D	TDS	ECOND	Ph	FCO2	CO3alk
33.8	32.5	1.6	0.2	362.7	558	8.4	2.3	4.9
30.4	29.7	1.6	0.2	382.5	589	8.5		2.7
30.2	30.9	1.8	0.2	403.3	621	8.1		2.3
32.6	31.6	2	0.2	354.9	546	8.4		5.8
28.5	29.6	1.4	0.3	380.3	585	8.6		4.8
27.4	28.7	1.4	0.2	370.8	571	8.6	4	1.8
22.8	23	1.5	0.2	404.6	623	8.5	4.3	2.5
19.3	19.1	1.7	0.1	470.6	724	8.6		5.3
19	20.3	1.4	0.2	397.5	612	8.7	5.4	4.3
24.4	24.4	1.4	0.2	451.4	695	8.9		7.7
32.6	29.4	1.6	0.2	378.6	583	8.8		6.6
35.1	32.6	1.9	0.2	351.3	541	8.9		6.6

HCO3 alk	Th	Chloride	Do	%Sato2	Bods	COD	NH3	PO4
21.3	268	98.6	7.1	97.4	12.6	25.8	0.1	0.4
16.3	272	132	6.3	83.7	16.8	37.2	0.1	0.3
15.2	197.8	137	6.4	86.5	13.2	26.8	0.1	0.7
78	221	109.2	6.7	91	14.7	31.2	0.1	1
113.8	216	113.6	10.6	140	12.4	26.2	0.1	0.1
130.4	232	142	7.9	101.2	12.5	27.3	0.1	0.2
102	228.3	137	6.5	77.5	16.8	33.9	0.1	0.2
133	340.3	121	7.9	88	12.7	22.8	0.1	0.1
174	217.3	98.6	7.9	90	13.6	24.8	0.1	0.1
251	377.2	93.4	8.2	100	9.3	20.7	0.1	0.2
251	409	110.6	7.7	101	8.6	17.3	0.1	0.02
336.6	469	121.6	8.2	113	13	25.9	0.1	0.2

EH mv	rH2	GPPmg	NPPmg	Tphyt	T-Zoo
0.28	26.46	0.3	0.12	69637	626306
0.27	26.31	0.3	-0.04	86424	67525
0.32	27.23	0.4	-0.07	90806	199468
0.28	26.46	0.4	0.03	56087	100145
0.26	26.17	0.4	0.09	86301	182921
0.25	26.02	0.3	0.05	54158	356296
0.27	26.31	0.3	0.09	115951	161200
0.26	26.17	0.3	0.13	127948	116635
0.25	26.02	0.3	-0.02	120642	99110
0.23	25.73	0.2	-0.16	151470	109471
0.24	25.88	0.2	-0.17	72043	3706673
0.23	25.75	0.3	-0.05	65385	284857

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- - Correlation Coefficients - -

	AIR_T	AV_DEPT	BODS	CHLORIDE	CO3ALK	COD
AIR_T	1.0000	.5270	-.0970	-.1150	.1641	.0803
AV_DEPT	.5270	1.0000	.2062	.0827	.1961	.1641
BODS	-.0970	.2062	1.0000	-.1965	-.6371*	.9440**
CHLORIDE	-.1150	.0827	-.1965	1.0000	-.1288	-.3052
CO3ALK	.1641	.1961	-.6371*	-.1288	1.0000	-.6315*
COD	.0803	.1641	.9440**	-.3052	-.6315*	1.0000
DO	-.1186	-.4173	-.4770	.1663	.3765	-.4698
ECOND	-.3938	-.0935	-.5125	.7693**	.3269	-.6590*
EH_MV	.1382	.3469	.4594	.0999	-.5810*	.4374
FCO2	-.9793*	-.8411	.3434	.1263	-.2768	.0653
GPPMG	.1552	.3896	.5206	.2155	-.4237	.4869
HCO3_ALK	-.0149	-.0389	-.5626	.1908	.6715*	-.5950*
NH3	-.2022	-.1624	-.5059	.0871	.5054	-.6059*
NPPMG	-.2394	-.0057	.0065	.7209**	-.0470	-.1546
PH	-.1317	-.3044	-.4936	-.1166	.6489*	-.4845
PO4	.4077	.6790*	.3328	.0311	-.1236	.4017
RH2	.1487	.3602	.4144	.1330	-.5675	.3918
SATO2_PR	.3032	-.1962	-.4402	.1208	.3586	-.3515
SEC_D_D	.3558	-.3097	-.0261	-.0541	-.0553	.1328
T_ZOO	.2999	-.0149	-.5814*	.0315	.3186	-.5514
TDS	-.7629**	-.2959	-.2033	.0312	.1268	-.3046
TH	.2484	.2095	-.5221	-.0869	.7145**	-.5162
TPHYT	-.2218	-.4390	-.0948	.3460	-.4434	-.0098
WATT	.8499**	.3574	.2161	-.4721	-.1407	.4353

- - Correlation Coefficients - -

	DO	ECOND	EH_MV	FCO2	GPPMG	HCO3_ALK
AIR_T	-.1186	-.3938	.1382	-.9793*	.1552	-.0149
AV_DEPT	-.4173	-.0935	.3469	-.8411	.3896	-.0389
BODS	-.4770	-.5125	.4594	.3434	.5206	-.5626
CHLORIDE	.1663	.7693**	.0999	.1263	.2155	.1908
CO3ALK	.3765	.3269	-.5810*	-.2768	-.4237	.6715*
COD	-.4698	-.6590*	.4374	.0653	.4869	-.5950*
DO	1.0000	.3367	-.5140	.3587	.0211	.4435
ECOND	.3367	1.0000	-.1215	.7872	-.0754	.3521
EH_MV	-.5140	-.1215	1.0000	-.7793	.6934*	-.8581**
FCO2	.3587	.7872	-.7793	1.0000	.7273	.9613*
GPPMG	.0211	-.0754	.6934*	.7273	1.0000	-.5715
HCO3_ALK	.4435	.3521	-.8581**	.9613*	-.5715	1.0000
NH3	.2029	.3072	-.7324**	-.7273	-.7596**	.8650**
NPPMG	.2980	.6965*	.1333	-.8794	.3610	-.0800
PH	.5146	.1460	-.9887**	.9054	-.7028*	.8985**
PO4	-.5236	-.1180	.6794*	-.9909**	.6124*	-.5061
RH2	-.5030	-.0924	.9953**	-.7824	.6838*	-.8148**
SATO2_PR	.9045**	.1366	-.3734	-.4062	.1575	.3577
SEC_D_D	.4866	-.1860	.0000	-.7273	.3189	-.0400
T_ZOO	.0233	.0495	-.2625	-.9610*	-.5119	.3445
TDS	.0557	.4308	-.0752	.7848	-.3113	.0566
TH	.1725	.0837	-.6918*	-.9799*	-.6660*	.7988**
TPHYT	.1004	.1026	-.1974	.1003	-.1259	.0189
WATT	-.2359	-.7858**	.2497	-.9402	.2276	-.2933

* - Signif. LE .05 ** - Signif. LE .01 (2-tailed)

" . " is printed if a coefficient cannot be computed

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- - Correlation Coefficients - -

	AIR_T	AV_DEPT	BODS	CHLORIDE	CO3ALK	COD
AIR_T	1.0000	.5270	-.0970	-.1150	.1641	.0803
AV_DEPT	.5270	1.0000	.2062	.0827	.1961	.1641
BODS	-.0970	.2062	1.0000	-.1965	-.6371*	.9440**
CHLORIDE	-.1150	.0827	-.1965	1.0000	-.1288	-.3052
CO3ALK	.1641	.1961	-.6371*	-.1288	1.0000	-.6315*
COD	.0803	.1641	.9440**	-.3052	-.6315*	1.0000
DO	-.1186	-.4173	-.4770	.1663	.3765	-.4698
ECOND	-.3938	-.0935	-.5125	.7693**	.3269	-.6590*
EH_MV	.1382	.3469	.4594	.0999	-.5810*	.4374
FCO2	-.9793*	-.8411	.3434	.1263	-.2768	.0653
GPPMG	.1552	.3896	.5206	.2155	-.4237	.4869
HCO3_ALK	-.0149	-.0389	-.5626	.1908	.6715*	-.5950*
NH3	-.2022	-.1624	-.5059	.0871	.5054	-.6059*
NPPMG	-.2394	-.0057	.0065	.7209**	-.0470	-.1546
PH	-.1317	-.3044	-.4936	-.1166	.6489*	-.4845
PO4	.4077	.6790*	.3328	.0311	-.1236	.4017
RH2	.1487	.3602	.4144	.1330	-.5675	.3918
SATO2_PR	.3032	-.1962	-.4402	.1208	.3586	-.3515
SEC_D_D	.3558	-.3097	-.0261	-.0541	-.0553	.1328
T_ZOO	.2999	-.0149	-.5814*	.0315	.3186	-.5514
TDS	-.7629**	-.2959	-.2033	.0312	.1268	-.3046
TH	.2484	.2095	-.5221	-.0869	.7145**	-.5162
TPHYT	-.2218	-.4390	-.0948	.3460	-.4434	-.0098
WATT	.8499**	.3574	.2161	-.4721	-.1407	.4353

- - Correlation Coefficients - -

	DO	ECOND	EH_MV	FCO2	GPPMG	HCO3_ALK
AIR_T	-.1186	-.3938	.1382	-.9793*	.1552	-.0149
AV_DEPT	-.4173	-.0935	.3469	-.8411	.3896	-.0389
BODS	-.4770	-.5125	.4594	.3434	.5206	-.5626
CHLORIDE	.1663	.7693**	.0999	.1263	.2155	.1908
CO3ALK	.3765	.3269	-.5810*	-.2768	-.4237	.6715*
COD	-.4698	-.6590*	.4374	.0653	.4869	-.5950*
DO	1.0000	.3367	-.5140	.3587	.0211	.4435
ECOND	.3367	1.0000	-.1215	.7872	-.0754	.3521
EH_MV	-.5140	-.1215	1.0000	-.7793	.6934*	-.8581**
FCO2	.3587	.7872	-.7793	1.0000	.7273	.9613*
GPPMG	.0211	-.0754	.6934*	.7273	1.0000	-.5715
HCO3_ALK	.4435	.3521	-.8581**	.9613*	-.5715	1.0000
NH3	.2029	.3072	-.7324**	-.7273	-.7596**	.8650**
NPPMG	.2980	.6965*	.1333	-.8794	.3610	-.0800
PH	.5146	.1460	-.9887**	.9054	-.7028*	.8985**
PO4	-.5236	-.1180	.6794*	-.9909**	.6124*	-.5061
RH2	-.5030	-.0924	.9953**	-.7824	.6838*	-.8148**
SATO2_PR	.9045**	.1366	-.3734	-.4062	.1575	.3577
SEC_D_D	.4866	-.1860	.0000	-.7273	.3189	-.0400
T_ZOO	.0233	.0495	-.2625	-.9610*	-.5119	.3445
TDS	.0557	.4308	-.0752	.7848	-.3113	.0566
TH	.1725	.0837	-.6918*	-.9799*	-.6660*	.7988**
TPHYT	.1004	.1026	-.1974	.1003	-.1259	.0189
WATT	-.2359	-.7858**	.2497	-.9402	.2276	-.2933

* - Signif. LE .05 ** - Signif. LE .01 (2-tailed)

" . " is printed if a coefficient cannot be computed

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- - Correlation Coefficients - -

	NH3	NPPMG	PH	PO4	RH2	SATO2_PR
AIR_T	-.2022	-.2394	-.1317	.4077	.1487	.3032
AV_DEPT	-.1624	-.0057	-.3044	.6790*	.3602	-.1962
BODS	-.5059	.0065	-.4936	.3328	.4144	-.4402
CHLORIDE	.0871	.7209**	-.1166	.0311	.1330	.1208
CO3ALK	.5054	-.0470	.6489*	-.1236	-.5675	.3586
COD	-.6059*	-.1546	-.4845	.4017	.3918	-.3515
DO	.2029	.2980	.5146	-.5236	-.5030	.9045**
ECOND	.3072	.6965*	.1460	-.1180	-.0924	.1366
EH_MV	-.7324**	.1333	-.9887**	.6794*	.9953**	-.3734
FCO2	-.7273	-.8794	.9054	-.9909**	-.7824	-.4062
GPPMG	-.7596**	.3610	-.7028*	.6124*	.6838*	.1575
HCO3_ALK	.8650**	-.0800	.8985**	-.5061	-.8148**	.3577
NH3	1.0000	-.1913	.7927**	-.6698*	-.6845*	.0430
NPPMG	-.1913	1.0000	-.1774	.0354	.1105	.1938
PH	.7927**	-.1774	1.0000	-.6773*	-.9756**	.3749
PO4	-.6698*	.0354	-.6773*	1.0000	.6722*	-.2942
RH2	-.6845*	.1105	-.9756**	.6722*	1.0000	-.3585
SATO2_PR	.0430	.1938	.3749	-.2942	-.3585	1.0000
SEC_D_D	-.2874	-.0552	.0000	.0000	.0000	.6737*
T_ZOO	.4012	-.2510	.2852	-.3003	-.2475	.0847
TDS	.2899	.0394	.1178	-.3134	-.0600	-.2855
TH	.7953**	-.2778	.7453**	-.4131	-.6564*	.1889
TPHYT	-.0462	.1621	.0816	-.1962	-.1955	.0170
WATT	-.3963	-.5246	-.2595	.3856	.2456	.1537

- - Correlation Coefficients - -

	SEC_D_D	T_ZOO	TDS	TH	TPHYT	WATT
AIR_T	.3558	.2999	-.7629**	.2484	-.2218	.8499**
AV_DEPT	-.3097	-.0149	-.2959	.2095	-.4390	.3574
BODS	-.0261	-.5814*	-.2033	-.5221	-.0948	.2161
CHLORIDE	-.0541	.0315	.0312	-.0869	.3460	-.4721
CO3ALK	-.0553	.3186	.1268	.7145**	-.4434	-.1407
COD	.1328	-.5514	-.3046	-.5162	-.0098	.4353
DO	.4866	.0233	.0557	.1725	.1004	-.2359
ECOND	-.1860	.0495	.4308	.0837	.1026	-.7858**
EH_MV	.0000	-.2625	-.0752	-.6918*	-.1974	.2497
FCO2	-.7273	-.9610*	.7848	-.9799*	.1003	-.9402
GPPMG	.3189	-.5119	-.3113	-.6660*	-.1259	.2276
HCO3_ALK	-.0400	.3445	.0566	.7988**	.0189	-.2933
NH3	-.2874	.4012	.2899	.7953**	-.0462	-.3963
NPPMG	-.0552	-.2510	.0394	-.2778	.1621	-.5246
PH	.0000	.2852	.1178	.7453**	.0816	-.2595
PO4	.0000	-.3003	-.3134	-.4131	-.1962	.3856
RH2	.0000	-.2475	-.0600	-.6564*	-.1955	.2456
SATO2_PR	.6737*	.0847	-.2855	.1889	.0170	.1537
SEC_D_D	1.0000	.0075	-.5254	-.2959	-.0672	.3817
T_ZOO	.0075	1.0000	-.1539	.4298	-.1256	.0695
TDS	-.5254	-.1539	1.0000	.0974	.0103	-.6787*
TH	-.2959	.4298	.0974	1.0000	-.1912	.0221
TPHYT	-.0672	-.1256	.0103	-.1912	1.0000	-.1466
WATT	.3817	.0695	-.6787*	.0221	-.1466	1.0000

* - Signif. LE .05 ** - Signif. LE .01 (2-tailed)

" . " is printed if a coefficient cannot be computed