

**“STUDIES ON THE PLANKTON DYNAMICS IN THE
FISH NURSERY PONDS OF CHHATTISGARH”**

M.F.Sc. (Aquaculture) THESIS

by

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**DEPARTMENT OF FISHERIES
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INDIRA GANDHI KRISHI VISHWAVIDYALAYA
RAIPUR (C.G.)**

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FISH NURSERY PONDS OF CHHATTISGARH”**

THESIS

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ADITYA KUMAR

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REQUIREMENTS FOR THE
DEGREE OF**

**Master of Fisheries Science
(AQUACULTURE)**

Roll No. 13959

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CERTIFICATE - I

This is to certify that the thesis entitled "**STUDIES ON THE PLANKTON DYNAMICS IN THE FISH NURSERY PONDS OF CHHATTISGRH**" submitted in partial fulfillment of the requirements for the degree of "**Master of Fisheries Science (Aquaculture)**" of the Indira Gandhi Krishi Vishwavidyalaya, Raipur, is a record of the bonafide research work carried out by **ADITYA KUMAR** under my guidance and supervision. The subject of the thesis has been approved by Student's Advisory Committee and the Director of Instructions.

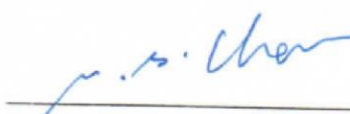
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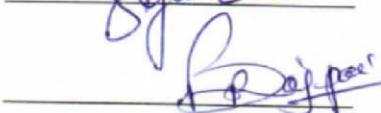
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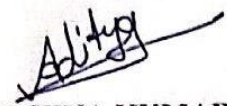
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ADITYA KUMAR

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Introduction

Chapter – I

INTRODUCTION

The word ‘plankton’ originated from the Greek word ‘planktos’ which means ‘drifting’. Plankton is a microscopic organism that formulates the base of food chains and food webs in all aquatic ecosystems. They are mostly small, many of them are minute, and their structure can only be seen clearly with the aid of a binocular or compound microscope. Although they belong to different taxa, they have one thing in common, i.e. owing to the lack of strong locomotory organs (like fish fins), they are weak in locomotion and can only drift about in water at mercy of waves and currents, being incapable of moving anywhere as fish do (Zheng Zhong *et al.*, 1984). Phytoplankton productivity, biomass and species composition change seasonally in response to variations in light, environment and nutrient availability and differences in grazing pressure imposed by higher trophic levels such as zooplankton and fish.

The scientific management of fisheries in a water body requires a thorough understanding of its trophic structure, their population characteristics and their nature of nutrient cycling with a view to achieving optimum fish productivity. Consequently, the fish yield of almost all natural aquatic system is directly or indirectly depends on plankton abundance. Plankton forms the natural food for many farmed fish species in their larval and adult stages.

Phytoplankton are being fed by zooplankton and facilitate the conversion of plant material into animal tissue and in turn constitute the basic food for higher animals including fishes, particularly their larvae. Zooplankton are the major mode of energy transfer between phytoplankton and fish (Howick and Wilhm, 1984). The importance

of zooplankton cannot be underestimated on account of their heterotrophic nature which helps in the subsequent transfer of the bound energy at the primary level thus forming a basic link in the food chain for higher aquatic animals, particularly the fish.

Total standing crop of flora and fauna is affected by the physico – chemical nature of the aquatic ecosystem and the nature of imported material from the surroundings. The aquatic system needs equilibrium between aquatic organism and their surrounding environment. Any change in this equilibrium such as deteriorations in water quality, changes in species community can result in stress to fish. The ponds and reservoir are constantly influenced by anthropogenic pressure and have stressed ecological conditions. Changes in the physico-chemical properties of water, therefore, alter both the composition and abundance of phytoplankton and zooplankton and thus affect the consumers of successive trophic levels. The examination of the quality and quantity of the aquatic organisms present in inland waters is of great use in understanding the biological productivity, nature of pollution, ecosystem imbalances etc.

Study of food in fishes has revealed that most of the fishes at adult and juvenile stages feed on plankton. Food composition of the fish can be ascertained by the gut analysis of fish which shows the degree of preference for different food items in a particular fish and the breeding intensity of the fish. Type of plankton a fish prefers as its feed can be known through a gut analysis. knowledge of food of a particular fish can be helpful for prediction of its production based on availability of natural live food, location of shoal at a particular place, prediction of migration on knowing decrease in preferred food, assessment of energy transfer from one trophic level to other, formulation of right food and suitable feeding strategy for maximum production from

aquaculture system. Thus during the study of plankton, a link in the food chain is a prerequisite to understand the capacity of the water body to support the fisheries and the need for introduction of additional selected species of commercially important fishes. Therefore, a study is planned to assess the dynamics of plankton in nursery ponds of Chhattisgarh with the following objectives;

1. To study the plankton available in nursery ponds.
2. To study the diurnal fluctuation of plankton in nursery ponds.
3. To study the physico-chemical parameters of nursery ponds.

Review of literature

CHAPTER-II

REVIEW OF LITERATURE

Review of literature is essential to understand the problems and to provide necessary guidelines as well as the feedback for the fulfillment of the objectives of study. Various people have worked on plankton in the ponds, lakes, and reservoir with their relation to the fish in aquatic system. A brief account of relevant work done in Chhattisgarh, India and abroad are follows:-

Khan and Siddiqui (1969) studied seasonal changes in the limnology of a perennial fish pond at Aligarh. They found five groups of phytoplankton community abundance namely Myxophyceae, Chlorophyceae, Bacillariophyceae, Phytoflagellates and Diophyceae. Chlorophyll concentrations were found to vary from 3.2 to 21.8 mg./liter. Zooplankton were mainly represented by rotifers, cladocera and copepods.

Sasmal *et al.* (2005) worked on diurnal variations in a tropical freshwater pond. The diurnal variations in water chemistry and plankton in rearing pond were quite apparent in that large fluctuations were noted in dissolved oxygen, pH, carbonate and bicarbonate concentrations. The pond water was oversaturated with oxygen during day time (9.4ppm) and the same was depleted at night (1.9ppm); pH increased in daytime and decreased at night. Among zooplankton, *Daphnia* and *Cyclops* showed diurnal movement but *Cypris* and *Diaptomus* did not show any apparent diurnal movement.

Gheorghe and Costache (2009) recorded the dynamics of the plankton for the second summer in carp polyculture with phytoplankton consumer species in six experimental ponds at the experimental centre at Cazaci – Marata. The plankton dynamics in six rearing ponds for the polyculture of carp (*Cyprinus carpio*) with silver carp (*H. molitrix*), grass carp (*C. idella*) and bighead carp (*A. nobilis*) was studied for a

period of 120 days. At the end of the experiment it was found the evolution of both phytoplankton and zooplankton was in a close correlation with both the variation of physical-chemical factors as well as with the inorganic, organic fertilization variation in these ponds.

Ssanyu and Schagerl (2010) studied the phytoplankton productivity in newly dug fish ponds within Lake Victoria wetlands (Uganda). The ponds with less dissolved oxygen were found with higher level of phosphorus and high temperature. Walukuba ponds recorded higher level of inorganic nitrogen in particular $\text{NH}_4\text{-N}$ than the Gaba ponds. There were 37 and 31 taxa in Gaba and Walukuba ponds

respectively, distributed among six taxonomic groups as follows: 17% Cyanobacteria, 18% Bacillariophyceae, 16% Euglenophyta and 52% Chlorophytes in Gaba ponds and 13% Cyanobacteria, 19% Bacillariophyceae, 19% Euglenophyta, 6% Chrysophyceae and 39% Chlorophytes were found in Walukuba ponds.

Gupta and Bhuiyan (2007) conducted studies in nine different ponds of rural area of Barak Valley, Assam. The concentrations of chemical parameters there were related to major phytoplankton taxa present in the ponds are Chlorophyceae, Cyanophyceae, Bacillariophyceae and Euglenophyceae.

Kyewalyanga and Mwandya (2004) worked on the influence of environmental variables on planktonic and phytobenthic communities in earthen ponds at Makoba, Zanzibar. The study was conducted between July 2002 and June 2003. Among the zooplankton, rotifer abundance peaked during the rainy period while protozoa and copepods were most abundant during the dry period. However, no seasonal effects were seen on the phyto benthos. The most abundant genera were *Pseudonitzschia* sp.,

Schizothrix sp., *Microcoleus* sp. and *Oscillatoria* sp. in general and algal mats were available throughout the year.

Padmavathi and Prasad (2007) studied algal bloom disasters in carp culture ponds in west Godavari district of Andhra Pradesh, India; the results indicated that the fish yield was lower with concomitant fish mortalities in a pond. The high stocking density of fish, large quantities of organic manures, inorganic nitrogen deficiency in upper layer of water, low N/P ratios and persistence of low dissolved oxygen lead to the formation of blue-green algal blooms. The water pH in all ponds was on the alkaline at which dense algal blooms observed was 9.2 – 9.4. *Oscillatoria* was observed at relative high total alkalinity while *Anabaena* at low alkalinity. The microcystis bloom was followed *Anabaena* and *Oscillatoria* blooms.

Ponce *et al.* (2010) studied the effect of chemical and organic fertilization on phytoplankton and fish production in carp (Cyprinidae) polyculture system in Hidalgo State, Mexico. Their study reports the effects of sheep manure (6.33 ± 1.95 kg/ha/day), pig liquid manure (8.27 ± 1.24 kg/ha/day) and chemical fertilizer (10.06 ± 0.67 (kg/ha/day), on the phytoplankton, primary productivity and aquaculture production in the cultivation of carp in semi-rustic ponds. It was also found that concentrations of phytoplankton were significantly ($P < 0.05$) higher in ponds fertilized with sheep and pig manure 945,940 and 1,157,706 cells/ml, respectively than in ponds where chemical fertilizer was used (744,560 cells/ml).

Shiddamallayya and Pratima (2011) observed seasonal changes in phytoplankton community in papnash pond, Bidar in Karnataka. They found phytoplankton community such as Cyanophyceae, Chlorophyceae, Euglenophyceae and Bacillariophyceae were in relation to physico-chemical characteristics.

Mahboob (2011) studied the natural food of major, common and some Chinese carps as influenced by fertilization in composite culture practices. The investigation was carried out in 15 earthen fish ponds of dimension 20m x 10m x 2.5m (Length x Width x Depth), located at the fisheries seed hatchery, Faisalabad. All ponds were treated with agriculture lime (CaCO_3) at the rate of 250 kg/ha, broiler manure and artificial food on alternate days at the rate of 0.15 gm Nitrogen/100 gm of fish/day and filled with water 7 days prior to fertilization. A total of 26 phytoplankton species, 9 Rotatoria and 9 Crustacea were identified.

Chari (1982) studied on the ecology of a reservoir in Manipur. The temperature could not be found to be a critical factor for the seasonal periodicity of phytoplankton; high pH value was related to heavy blooms of plankton. Higher value of CO_2 during different months could be associated with a proportionately higher number of phytoplankton. The phytoplankton population mainly consists of

Chlorophyceae, Myxophyceae, Bacillariophyceae, Euglenaceae, Dinophyceae, Chrysophyta and Xanthophyceae and Zooplankton consisted mainly of Protozoa, Rotifer and Orthropoda could be members.

George (1962) studied on the occurrence of a permanent algal bloom in a fish tank at Delhi with special reference to factors responsible for its production. pH and dissolved oxygen showed irregular fluctuations. Their value generally coincided with the abundance of algae, it was carried out seasonally revealed that high temperature, high contents of bicarbonates, carbonates, chlorides, silicates and low redox potential have very little to do with the production of algal bloom. The chemical factors which seem to favor the growth of these algae are large quantities of organic matter present in water high alkalinity and large concentration of phosphates and nitrates. *M. aeruginosa*,

the common Blue green algae, forms a permanent bloom in the tank. It occurs with varying degree of concentration throughout the year.

Kumar *et al.* (2011) studied the seasonal variations in zooplankton diversity of railway pond, Sasaram, Bihar. A total 76 zooplankton species was recorded which belonged to Protozoa, Rotifera, Cladocera, Copepoda and Ostracoda. Out of 76 species, 9 species belonged to Protozoa, 37 species belongs to Rotifera, 15 species to Cladocera, 12 species to Copepoda and only 3 species to Ostracoda.

Kumar and Gajaria (1995) studied on the limnological investigation of fish seed farm in relation to rearing and management of indian major carps and planktonic periodicity in fish – gut and fish pond water. Phytoplankton and zooplankton periodicity and abundance were studied in 3 fish ponds viz; nursery rearing and stocking ponds at Bhadrana fish seed farm Bhadran, Gujarat. Simultaneously, abundance of different plankters in fish gut also investigated. In the aquatic environment, group wise abundance of phytoplankton population was in the order of Cynophyceae > Chlorophyceae > Bascillariophyceae > Euglenophyceae, where in gut region, the order was Chlorophyceae > Cynophyceae > Bacillariophyceae > Euglenophyceae and Rotifers. *Actinastrum* sp., *Tetraderon* sp., *Chlamydomonas* sp., *Navicula* sp. and *Scenedesmus* sp. were dominant in *Catla catla*. But rotifers and ciliate were found dominant in *Labeo rohita* and *Cirrhinus mrigala*. The types of plankton population increases in gut are not by random selected food materials, but by the types of food selection by the fishes. They concluded that the breeding activities in fishes may have a significant role on the presence of available planktons.

Sulochana *et al.* (2009) studied the fish ponds fertilized with different organic manures at the fish seed farm Raipur. The effect of three organic manures viz; raw

cattle dung (T1), vermicompost (T2) and poultry manure (T3) on various hydro biological and physico – chemical characteristics in ponds stocked with carp seed. In ponds treated with poultry manure the plankton population was the highest with phytoplankton at 4442.0 nos. /liter and zooplankton at 7295.0 nos./lit. The treatment with raw cattle dung showed the lowest plankton population with phytoplankton at 2539 nos. /liter.

Singh *et al* (2000) studied the effect of differential stocking and phased harvesting on the development of plankton and fish production in silted non drainable ponds. Six species of Indian and exotic carps were stocked in prepared ponds. The ponds were drained and dried for a day limed with 50 kg slaked and fertilized with raw cowdung initially with 1000 kg and in subsequent dose of 500 kg/month were also applied. Fishes were fed daily with mixture of mustered oil cake (50%) and rice bran (50%) at the rate of 0.5 kg /day for two months. The feeding rate was doubled after every two months. The development of plankton was greatly influenced by the growth of fish. Phytoplankton were dominated by chlamydomonas, pediatrum, scenedesmus, volvox, ankistodesmus, navicula, nitzschia and syndera, brachionus while keratela, asplanchna, moina, daphnia, cyclops and diptomus were the prominent constitute of zooplankton.

Leon *et al.* (2010) made studies in spring 2007, on 120 farm ponds in Andalusia (South of Spain). Pond use was diverse, but the most common use was irrigation of vast areas of land and livestock watering. The farm ponds have low salinity due to their use for irrigation and other farming uses. Zooplankton showed an unexpected richness in these previously unstudied water bodies which lie on private properties. A total of 103 taxa were identified (62 rotifera, 27 cladocera, 8 copepoda and 6 ostracoda).

Kywalyanga (2003) made assessment of types and abundance of live food for fish farming in Makoba earthen ponds, Zanzibar, Tanzania. Identification of dominant plankton in the water column as well as the composition of algal mats. The effect of nutrients on the composition and abundance of the organisms was also assessed. Protozoa were found to be the dominant zooplankton in the water column, followed by rotifers. The most abundant phytoplankton genera were *Prorocentrum* (13.4%), followed by *Coscinodiscus* (10.4%) and *Diplopsalopsis* (7.5%), while the benthic algal mats were dominated by cyanobacteria, mostly *Spirulina* (22%) and *Oscillatoria* (18.4%).

Maria *et al* (2001) studied the effect of temperature decrease on carp *Cyprinus carpio* culture in a temperate climate, zoo and phytoplankton dynamics and the chemical composition of pond water. The cumulative, unfavorable impact of temperature decrease on the pond increased numbers of small Cladocera forms, decreased Copepoda and Rotatoria. When early cooling occurred, increase in the number of Cyanophyta and Chlorophyta in all seasons.

Roy *et al.* (2010) studied zooplankton abundance qualitatively and quantitatively in carp brood fish culture systems. Plankton samples were collected from Gallamari fisheries extension & training centre farm, Batiaghata, Khulna, once a month. A total of 6 groups of zooplankton were found in the study ponds. The identified zooplanktons were under six orders namely copepoda, rotifera, cladocera, ostracoda, crustacean larvae and bryozoa. Number of zooplankton groups were recorded to be the highest in December. In the brood pond copepod was the dominant order. Among various order of zooplankton, the percentage of copepod, rotifer, cladocera, ostracoda, crustacean larvae and bryozoa in brood fish culture system were

55%, 8%, 25%, 9%, 2% and 1% respectively. Copepoda was dominant in May, June, July, August, October, November and December but cladocera was dominant in September only. Insect larvae were dominant in all month of study period. Bryozoa was found only in December. The relationship of physico-chemical parameters

(Temperature, Salinity, Transparency, Dissolved Oxygen and pH) and the zooplankton abundance of carp brood fish pond have been made. The physicochemical parameters and the zooplankton abundance showed some interrelationships. These relationships are helpful to the seasonal and spatial variation of zooplankton population.

Stolovich *et al.* (2003) studied the development of phytoplankton and zooplankton in ponds fertilized with gypsum phosphate in 1 rearing pond and 2 growing ponds. A gypsum phosphate (liquid manure) was used at 10 to 12 days intervals. The dominant species of phytoplankton were Scenedesmus, Quadricauda,

Chlamydomonas, Chlorella, Aphanizomenon flos aquae and Microcystis aeruginosa. The average Biomass of phytoplankton was 64.4 mg/liter in the rearing pond and 126.1 mg/liter in the 2 growing ponds. Cladocera, Copepoda and Rotatoria and their biomass averaged 25.6 mg/liter in the rearing pond and 4.7 mg/liter in the growing ponds.

Mishra *et al.* (2003) worked on the limnological aspects of fish ponds in Tarai Region of U.P. India. They selected 3 different ponds in which various physicochemical and biological parameters and their fluctuation throughout the year were observed. The temperature – 14.9-29.9°C, TDS – 198-267mg/liter, conductivity – 346-456 micro/cm, transparency – 17.5-22 cm, DO – 5.6-7.6 mg/liter, CO₂ – 0.02-2.2 mg/liter, total alkalinity – 84-108 mg/liter and pH – 7.0-7.8. They found a total of 17 species of plankton belonging to 17 genera were identified.

Faved *et al.* (1996) studied the impact of physico-chemistry of water on the planktonic productivity and fish yields of ponds fertilized with broiler droppings at the

fisheries research farms at Faisalabad in Pakistan. The polyculture fish ponds containing *Catla catla*, *Labeo rohita* and *Cirrhinus mrigala* were fertilized with broiler droppings 0.10, 0.13, 0.16, 0.19 and 0.22 gm. nitrogen/100 gm. of wet fish weight daily. Nitrates, Potassium, Sodium, Light penetration and water temperature contribute significantly and positively towards planktonic productivity of ponds. Phytoplankton and zooplankton productivities were highest with 0.19 and 0.16% N, respectively. Higher orthophosphate concentrations in water due to treatment resulted in significantly higher planktonic biomass production.

Banik (1995) studied the abundance of rotifer population of a nursery fish pond in relation to the environmental factors, physico-chemical parameters recorded during summer and monsoon were Temperature – 30-34°C, 22-26.3 °C, Dissolved organic matter 0.92-1.20, 3.83-4.33mg/liter, Dissolved oxygen 3.3-3.9, 5.8- 6.7 mg/liter Alkalinity 230.0-260.3, 130.0-160.0 mg/liter and Phosphate 0.01-0.02, 0.200.29 mg/liter respectively. Among the 19 species recorded, *Brachionus* sp. were most predominant forms. Maximum total rotifer population were recorded in monsoon months (June to August) followed by winter (November to February) thus exhibiting two maxima.

Sipauba-Tavares *et al.* (2010) recorded the dynamics of phytoplankton and zooplankton communities related to the dynamics of a fish farm in Brazil. Samples were collected every other day, within a period of twenty consecutive days, during the dry and rainy seasons. Two samples were collected upstream from the fish pond (Reservoir) the other four samples were collected in the fish farm area. The fertilization in the ponds was done by chemical fertilizer (25.6 kg of simple superphosphate and 48 kg of ammonium sulphate), and by organic fertilizer adding 100 kg of pig dung in natura at approximately 7 days intervals. Fish were fed a supplementary diet containing

15% crude protein at the rate of 3% average live weight. Rotifera and Chlorophyceae species were found in high densities at almost all sampling sites during both seasons under analysis. The higher phytoplankton species richness from site P3 to P6 was influenced by the management employed within the fish farm. The zooplankton community showed low values of density, species richness and equitability during the dry season. The continuous water flow and the addition of fertilizers (organic and inorganic) in the fish ponds had an influence on the plankton community, leading to a reduction in water quality and Cyanobacteria dominance. A total of 48 taxa for phytoplankton and 23 for zooplankton were considered in fish farm.

Materials and Methods

CHAPTER - III

MATERIALS AND METHODS

A brief description of the Materials used and method adopted during the course of investigation are presented below:

Chhattisgarh is divided into three different agro climatic zones viz. Chhattisgarh plains, Northern Hills and Bastar Plateau. Raipur is the capital of the state Chhattisgarh. It comes under agro climate plain zone of Chhattisgarh. Raipur is the biggest city of the region it is located at 21° 16' North latitude and 81°36' East longitude with an altitude of 289.6 m above mean sea level. Raipur has Mahanadi River boarding it on its eastern side.

3.1. Climate:

The climate of Raipur is hot and sub humid. The region receives 1200-1400 mm rainfall normally out of which about 85% is received during rainy season (June to September) and 8% during winter season (October to February). The average annual rainfall is 1326 mm (based on 80 years mean). The maximum temperature ranges between 17°C to 48°C during summer and from 7°C to 22°C during winter. May is the hottest and December is the coolest month of the year.

3.2. Area of sampling:

The fish nursery pond (Department of Fisheries, College of Agriculture Indira Gandhi Krishi Vishwavidyala Raipur, C.G.) were selected for study. The average depth

of the fish nursery ponds ranges between 1-1.5 meters. During the study period there were no aquatic plants was found in study and the ponds received direct sunlight. Spawn of Catla, Rohu, Mrigal were stocked in the nursery ponds. Liming and manuring was done before stocking, supplementary feed was used to feed the spawn.

3.3. Sampling period:

Sampling was done from 24/07/2011 to 12/08/2011. Daily sampling was done in the early morning between 6 am to 7 am.

3.4. Collection of plankton samples:

The plankton samples were collected randomly from nurseries from surface water of each pond using plankton net by filtering 20 litres of water for each sample.

The net was made of standard bolting silk cloth no.22 having 75 meshes/linear cm. The net was of cone shape. The diameter of top metal ring was 36 cm with graduated testube. The samples collected were placed in small plastic container with label as to date of collection time, details of location and sample number etc.

3.5. Preservation of plankton samples:

All the plankton samples were preserved by Lugol solution to ascertain sedimentation and better staining. 1 or 2 drops Lugol's solution was added in 25 ml of collected samples. For further investigation, plankton was observed both in fresh and preserved samples. The concentration of plankton in the water was determined by the drop method. On an average of 3 counts were made for each sample and mean.

3.6. Identification plankton samples:

All Samples were studied under the S-R (Sedgwick Rafter) under microscopic to identify different species of plankton. Plankton were identified qualitatively following standard taxonomic keys (*Fritsc, 1935; Smith, 1964; Philipose, 1967 and Gonzalves, 1981,*). Leica ATC 2000 microscope was used for the study.

3.7. Counting of plankton:

For plankton counting, the S-R (Sedgwick-Rafter) cell was used which is 50 mm long, 20 mm wide and 1mm deep. Before filling the S-R cell with sample, the cover glass was diagonally placed across the cell and then sample was transferred with a large bore pipette so that no air bubbles in the cell cover were formed. After the plankton settled on the bottom of the S-R cell counting and enumerated was done with the help of LABOMED TCM – 400 microscope.

3.8. Physico-chemical analysis of water:

- I. **Temperature:** Water temperature was measured by using centigrade mercury thermometer by dipping directly into the water for about one minute on the spot till the mercury column is stabilized. ESICO Water and soil analysis kit Model No. 1160.
- II. **Transparency:** Transparency was measured with a Secchi disc.
- III. **pH:** pH of water sample was measured by pH strip or pH meter.
- IV. **Dissolved Oxygen:** Water samples were collected in BOD bottles (300 ml) with all necessary precautions. Modified Winkler's method will be followed for dissolved

oxygen estimation (APHA, 1998). The result will be expressed in terms of mg/l. ESICO Water and soil analysis kit Model No. 1160.

V. **Electrical Conductivity:** Electrical Conductivity of the water samples will be measured by Conductivity meter. ESICO Water and soil analysis kit Model No. 1160.

VI. **Ammonia:** Ammonia-nitrogen was estimated by Nessler's reagent spectrophotometric method (APHA, 1998). Standard curve was prepared with ammonium solution (NH_4Cl) and then colour absorbance was measured at 425 nm. The results were expressed in ppm.

VII. **Nitrate:** Nitrate-nitrogen was estimated by Phenol disulphonic acid spectrophotometric method (APHA, 1998). Standard curve was prepared with nitrate solution (KNO_3) and then colour absorbance was measured at 410 nm. The results were expressed in ppm.

VIII. **Orthophosphate:** Orthophosphate was measured by Ammonium chloride and Stannous chloride spectrophotometric method (APHA, 1998). Stock solution of phosphate was used for standard curve by dissolving dibasic potassium phosphate (KH_2PO_4). The colour absorbance was measured at 690 nm and results were expressed in terms of ppm.

Results and Discussion

CHAPTER – IV

RESULTS AND DISCUSSIONS

The present study deals with studies on the plankton dynamics in the fish nursery ponds of Chhattisgarh. Data collected on the basis of daily variation in the plankton dynamics are compared with the water quality, and briefly discussed.

4.1. Plankton abundance and diversity

4.1.1. Phytoplankton

Based on the morpho-taxonomic identification of phytoplankton in selected nursery ponds of I.G.K.V. Fish farm Raipur, Chhattisgarh, thirty three algal genera are enlisted. Seventeen genera belong to Chlorophyceae, nine to Cyanophyceae; six belong to class Bacillariophyceae and one belonging to class Euglenophyceae.

Chlorophyceae is represented by six orders Chlorococcales, Zygnematales, Volvocales, Oedogoniales, Ulothrichales and Chaetophorales. The order Chlorococcales is represented by Five families viz: - Oocystaceae (*Oocystis* and *Chlorella*), Hydrodictyaceae (*Pediastrum* and *Tetraedron*), Scenedesmaceae (*Scendesmus*), Selenastraceae (*Selenastrum* and *Ankistrodesmus*) and Batryococcaceae (*Botryococcus*).

Order Zygnematales is represented by three families viz:-Zygnemataceae (*Mougeotia* and *Spirogyra*), Desmidiaceae (*Closterium* and *Cosmarium*) Mesotaeniceae (*Mesotonium*).

The order Volvocales is represented by only one family viz: - Chlamydomonadaceae (*Chlamydomonas*).

The order Oedogoniales and Ulothrichales are represented by one family each viz:- Oedogoniaceae (Oedogonium), Ulothrichaceae (*Ulothrix*) respectively.

The order Chaetophorales is also represented by one family Chaetophoraceae (*Chaetophora*).

Class Cyanophyceae is represented by two orders Chroococcales and Nostocales. The order Chroococcales is represented by two families Chroococcaceae (*Aphanocapsa* and *Microcystis*) and Merismopediaceae (*Coelospharium*). The order Nostocales is represented by two families viz:-Oscillatoriaceae (*Phormidium*, *Spirulina* and *Oscillatoria*) and Nostocaceae (*Nostoc*, *Cylendrospermum* and *Anabaena*).

Class Bacillariophyceae is represented by three orders viz. Pennales, Centrales and Chaetophorales. The order Pennales is represented by three families viz-Fragilariaceae (*Fragilaria* and *Synedra*), Naviculaceae (*Pinnularia* and *Navicula*) and Nitzschiaceae (*Nitzschia*). The order Centrales and Chaetophorales are represented by only one family of each viz:-Coscinodiscaceae (*Melosira*) and Chaetophoraceae (*Protococcus*).

Class Euglenophyceae is represented by a single family Euglenaceae (*Euglena*) under the order of Euglenales.

4.1.2. Zooplankton

Seven genera of zooplankton were recorded in the present study. Among zooplankton three belongs to class Branchiopoda, one belong to class Maxillopoda, two belongs to class Monogononta and one belong to class Eurotatoria.

The class Branchiopoda is represented by two orders viz:- Cladocera and Anostraca. The order Cladocera is represented by two families Daphniidae (*Daphnia*) and Moinidae (*Moina*). The order Anostraca is represented by one single family

Chiropidae (*Eubbranchipus*).

Class Maxillopoda is represented by one order and one family viz:-

Cyclopoida, Cyclopidae (*Cyclops*).

Class Monogonota is represented by one order Ploimida. The order Ploimida is represented by one family Brachionidae (*Brachionus* and *Keratella*).

Class Eurotatoria is represented by one order Flosculariaceae, The order Flosculariaceae is represented by one single family Trochosphaeridae (*Filinia*).

Phytoplankton encountered in all the selected nursery ponds during the study includes algal and animal fractions. They were; *Pediastrum sp.*, *Oocystis sp.*,

Tetraedron sp., *Selanostriumv sp.*, *Botryococcus sp.*, *Scendesmus sp.*,

Ankistrodesmus sp., *Chlorella sp.*, *Mesotonium sp.*, *Mougeotia sp.*, *Closterium sp.*,

Cosmarium sp., *Spirogyra sp.*, *Chlamydomonas sp.*, *Oedogonium sp.*, *Ulothrix sp.*,

Chaetophora sp., *Aphanocapsa sp.*, *Microcystis sp.*, *Coelospherium sp.*,

Cylenndrospermum sp., *Oscillatoria sp.*, *Nostoc sp.*, *Phormedium sp.*, *Anabaena sp.*,

Spirulena sp., *Euglena sp.*, *Synedra sp.*, *Pinnularia sp.*, *Nitzschia sp.*, *Navicula sp.*,

Melosira sp., and *Protococcus sp.* The Zooplankton communities also consist of animal

fraction mainly represented by the members of Rotifers, Cladocera, Crustacean and

Copepodes viz:-*Daphnia sp.*, *Moina sp.*, *Eubbranchipus sp.*, *Cyclops sp.*, *Brachionus sp.*,

Keratella sp. and *Filinia sp.*

The taxonomic position of various Phytoplankton and Zooplankton in selected nursery ponds of I.G.K.V. Fish farm Raipur Chhattisgarh are shown in (Table 4.1) and photographs of plankton observed in selected nursery ponds of I.G.K.V. Fish Farm Raipur, Chhattisgarh are shown in Plate 4.1.

Out of total 40 genera observed under the phytoplankton and zooplankton, 33 genera were observed under the phytoplankton of which the Chlorophyceae constitute the largest group in terms of phytoplankton population diversity followed by Bacillariophyceae, Cyanophyceae and Euglenophyceae. The Chlorophyceae constitute (52%) of the total phytoplankton genera recorded followed by Cyanophyceae (27%), Bacillariophyceae (18%), and Euglenophyceae (3%).

Among the zooplankton communities, members of class Branchiopoda dominated (43%) followed by Monogononta (29%), Eurotatoria (14%) and Maxillopoda (14%).

4.2. Plankton dynamics

Plankton dynamics in nursery ponds were interpreted through assessment of dominance and diurnal fluctuation. The dominance among phytoplankton and zooplankton were determined from the pooled mean data on the frequency of occurrence of individual genera per ml of water sample, collected daily from all the nursery ponds during 20 days of production cycle of fry (Table 4.2.1 to 4.2.7). On the other hand, diurnal fluctuation of plankton was assessed from the standard deviation values of individual genera per ml of water sample, collected six times (6 am, 10 am, 2 pm, 6 pm, 10 pm and 2 am.) from the nursery ponds on the 10th day (Table 4.2.9 to 4.2.15).

4.2.1. Phytoplankton dynamics

Among Chlorophyceae, *Oocystis* sp. was found to be most dominant in N.P.-1 (5 units/ml), N.P.-2 (4 units/ml), N.P.-3 (5 units/ml), N.P.-6 (14 units/ml) and N.P.-7 (14 units/ml) while *Chlamydomonas* sp. is dominated in N.P.-4 (15 units/ml) and *Tetraedron* sp. dominant N.P.-5 (12 units/ml both).

Maximum diurnal fluctuation was exhibited by *Oocystis* sp. in N.P.-1 (± 1.90 units/ml), N.P.-6 (± 4.71 units/ml) and N.P.-7 (± 4.71 units/ml). Similarly, *Tetraedron* sp. showed highest diurnal fluctuation in N.P.-2 (± 3.33 units/ml), *Spirogyra* sp. in N.P.-3 (± 1.87 units/ml), *Chlamydomonas* sp. in N.P.-4 (± 6.91 units/ml) and *Mougeotia* sp. in N.P.-5 (± 3.71 units/ml).

Graphical analysis of diurnal fluctuation in chlorophycean population revealed maximum population in the surface waters during daytime, which was due to the availability of sunlight (Philipose, 1967). On the other hand, the algal community sank to deeper waters during night time.

The Chlorophyceae comprises one of the major groups of algae when considering the abundance of genera and species, and the frequency of occurrence. Philipose (1967) reported that Chlorophyceae members grow well in alkaline water rich in nitrate and phosphate.

4.2.1.2. Cyanophyceae

Among Cyanophyceae, *Oscillatoria* sp. was most dominant in N.P.-2 (6 units/ml), N.P.-3 (10 units/ml), N.P.-4 (16 units/ml both), N.P.-5 (8 units/ml both), N.P.-6 (41 units/ml) and N.P.-7 (41 units/ml) while both *Oscillatoria* sp. and *Aphanocapsa* sp. dominated in N.P.-1 (6 units/ml both).

Maximum diurnal fluctuation was exhibited by *Microcystis* sp. in N.P.-1 (± 7.0 units/ml) and N.P.-2 (± 3.40 units/ml). Similarly, *Oscillatoria* sp. showed highest diurnal fluctuation in N.P.-4 (± 5.90 units/ml), N.P.-5 (± 3.6 units/ml), and N.P.-6 (± 14.10 units/ml) while *Anabaena* sp. in N.P.-7 (± 2.31 units/ml). In N.P.-3, and *Oscillatoria* sp. showed maximum diurnal fluctuation (± 4.38 units/ml).

Graphical analysis of diurnal fluctuation in cyanophycean population revealed maximum population in the surface waters during daytime, which was due to the availability of sunlight (Philipose, 1967; Stewart and Pearson, 1970). On the other hand, the blue green algal community sank to deeper waters during night time. Similar trend was also observed for chlorophycean population. Therefore, a synchronous diurnal fluctuation exists among green algae and blue green algae.

Cyanophyceae are often referred to as cyanobacteria, blue green algae or blue-green bacteria. Stewart and Pearson (1970) opined that in light, blue-green algae grow more rapidly under micro-aerophilic conditions than under fully aerobic conditions. Development of blue-green algae may depend on the ability of the ponds to maintain low concentrations of dissolved oxygen for long periods (Ganf, 1974). Prescott (1984) and Zafar (1964) have also observed that high nutrients favour the luxuriant growth of Cyanophyceae.

4.2.1.3. Bacillariophyceae

Among Bacillariophyceae, *Nitzschia* sp. was found to be most dominant in N.P.-1 (21 units/ml), N.P.-2 (6 units/ml), N.P.-4 both *Protococcus* sp. and *Navicula* sp. was dominant (1 units/ml), N.P.-5 *Nitzschia* sp. (4 units/ml) while *Synedra* sp. dominated in N.P.-3 (11 units/ml), N.P. 6 *Melosira* sp. (1 units/ml). Both *Melosira* sp. and *Synedra* sp. dominated in N.P.-7 (1 units/ml each).

Maximum diurnal fluctuation was exhibited by *Navicula* sp. in N.P.-1 (± 1.67 units/ml) and N.P.-2 (± 2.48 units/ml). Similarly, *Synedra* sp. showed highest diurnal fluctuation in N.P.-3 (± 5.56 units/ml), *Nitzschia* sp. in N.P.-5 (± 1.29 units/ml) and N.P.-7 (± 0.98 units/ml) while *Melosira* sp. in N.P.-6 (± 0.96 units/ml). In N.P.-4, both *Navicula* sp. and *Melosira* sp. showed maximum diurnal fluctuation (± 0.5 units/ml).

both).

Graphical analysis of diurnal fluctuation in bacillariophycean population revealed maximum population in the surface waters during daytime, which was due to the availability of sunlight (Lund, 1965; Philipose, 1967). On the other hand, the diatom community sank to deeper waters during night time. Similar trend was also observed for chlorophycean and cyanophycean population. Therefore, a synchronous diurnal fluctuation exists among green algae, blue green algae and diatoms.

Bacillariophyta are commonly referred to as diatoms. Diatoms are able to grow in conditions of weak light and low temperature which are less suitable for other algae (Lund, 1965). Zafar (1964) opined that calcium rich water bodies have high number of diatoms. Patrick (1948) has observed that high pH favoured the high abundance of diatoms.

4.2.1.4. Euglenophyceae

Among Euglenophyceae, only *Euglena* sp. was found in all the nursery ponds viz. N.P.-1 (6 units/ml), N.P.-2 (1 units/ml), N.P.-3 (1 units/ml), N.P.-4 (5 units/ml), N.P.-5 (4 units/ml), N.P.-6 (18 units/ml) and N.P.-7 (18 units/ml).

Population of *Euglena* sp. fluctuated diurnally by ± 4.2 units/ml (N.P.-1), ± 0.54 units/ml (N.P.-2), ± 0.51 units/ml (N.P.-3), ± 3.94 units/ml (N.P.-4), ± 1.9 units/ml (N.P.-5), ± 5.7 units/ml (N.P.-6) and ± 5.77 units/ml (N.P.-7).

Graphical analysis of diurnal fluctuation in euglenophycean population revealed maximum population in the surface waters during daytime, which was due to the availability of higher temperature (Seeneyya, 1971). On the other hand, the diatom community sank to deeper waters during night time. Similar trend was also observed for chlorophycean, cyanophycean and bacillariophycean population. Therefore, a

synchronous diurnal fluctuation exists among green algae, blue green algae, diatoms and euglenoids.

The class Euglenophyceae as a whole is facultatively heterotrophic and is generally abundant in water very rich in organic matter (Hutchinson, 1975). Seeneyya

(1971) stated that temperature above 25°C is favourable for the growth of Euglenophyceae. Hegade and Bharati (1984) observed that high pH favoured the growth of Euglenophyceae.

4.2.2. Zooplankton dynamics

4.2.2.1. Branchiopoda

Among Branchiopoda, *Eubrachipus* sp. was found to be most dominant in N.P.-2 (3 units/ml), N.P.-3 (4 units/ml), N.P.-4 *Moina* sp. (4 units/ml), N.P.-5 both *Daphnia* sp. and *Moina* sp. (1.67 units/ml), N.P.-6 (6 units/ml) and N.P.-7 (3 units/ml) while both *Eubrachipus* sp. and *Moina* sp. dominated in N.P.-1 (4 units/ml both) and N.P.-5 (4 units/ml both).

Maximum diurnal fluctuation was exhibited by *Eubrachipus* sp. in N.P.-1 (± 3.06 units/ml), N.P.-2 (± 2.1 units/ml), N.P.-3 (± 1.75 units/ml), N.P.-6 (± 2.9 units/ml) and N.P.-7 (± 2.92 units/ml). Similarly, *Moina* sp. showed highest diurnal fluctuation in N.P.-4 (± 2.58 units/ml) and *Moina* sp. in N.P.-5 (± 0.98 units/ml).

Graphical analysis of diurnal fluctuation in branchiopoda population revealed maximum abundance in the early morning, minimum during afternoon and almost constant after the sunset. This can be attributed to the combined effect of sunlight and temperature (Murugan, 1998).

Branchiopods are a crucial group among zooplankton and form the most useful and nutritive group of crustaceans for higher members of fishes in the food chain. They are highly sensitive against even low concentrations of pollutants. The food source of this group is smaller zooplankton, bacterioplankton and algae

(Murugan, 1998).

4.2.2.2. Maxillopoda

Among Maxillopoda, only *Cyclops* sp. was found in all the nursery ponds viz. N.P.-1 (1 units/ml), N.P.-2 (7 units/ml), N.P.-3 (1 units/ml), N.P.-4 (1 units/ml), N.P.-

5 (13 units/ml), N.P.-6 (8 units/ml) and N.P.-7 (8 units/ml).

Population of *Cyclops* sp. fluctuated diurnally by ± 1 unit/ml (N.P.-1), ± 4 units/ml (N.P.-2), ± 4.38 units/ml (N.P.-5), ± 2.89 units/ml (N.P.-6) and ± 2.88 units/ml (N.P.-7). No diurnal fluctuation of Maxillopoda population was observed in N.P.-3 and N.P.-4.

Graphical analysis of diurnal fluctuation in maxillopoda population revealed maximum abundance in the early morning, minimum during afternoon and almost constant after the sunset. This can be attributed to the combined effect of sunlight and temperature (Murugan, 1998). Therefore, a synchronous trend exists between branchiopods and maxillopods.

The Maxillopods also form important food organisms for fish. They are much hardier and strongly motile than all other zooplankton with their tougher exoskeleton and longer and stronger appendages. They have long developmental time and a complex life history. They are almost wholly carnivorous on the smaller zooplankton for their food needs (Kalff, 2002).

4.2.2.3. Monogononta

Among Monogononta, *Keratella* sp. was most dominant in N.P.-2 (1 unit/ml) and N.P.-6 (3 units/ml) while *Brachionus* sp. dominated in N.P.-3 (2 units/ml), N.P.-4 (1 unit/ml) and N.P.-7 (2 units/ml). Both *Brachionus* sp. and *Keratella* sp. dominated in N.P.-1 (1 unit/ml both) and N.P.-5 (5 unit/ml both).

Maximum diurnal fluctuation was exhibited by *Keratella* sp. in N.P.-6 (± 1.60 units/ml). Similarly, *Brachionus* sp. showed highest diurnal fluctuation in N.P.-5 (± 2.06 units/ml). Population fluctuate of *Brachionus* sp. in both N.P.-3 and N.P.-4 (± 1.16 , ± 1.09), *Keratella* sp. fluctuate in N.P.-7 (± 1.60) and No diurnal fluctuation of

Monogononta population was observed in N.P.-1 and N.P.-2.

Graphical analysis of diurnal fluctuation in monogononta population revealed maximum abundance in the early morning, minimum during afternoon and almost constant after the sunset. This can be attributed to the combined effect of sunlight and temperature (Murugan, 1998; Dhanapathi, 2000). Therefore, a synchronous trend exists between branchiopods, maxillopods and monogonta.

Monogononts are the most important soft-bodied metazoans (invertebrates) among the plankton and very palatable by a number of fish species including IMCs. They have short reproductive stages they increase in abundance rapidly under favourable environmental conditions (Dhanapathi, 2000).

4.2.2.4. Eurotatoria

Among Eurotatoria, only *Filinia* sp. was found in all the nursery ponds except viz. N.P.-1 (2 unit/ml), N.P.-2 (4 units/ml), N.P.-3 (2 unit/ml), N.P.-4 (2 units/ml), N.P.-5 (1 unit/ml), N.P.-6 (1 unit/ml) and N.P.-7 (1 units/ml).

Population of *Filinia* sp. fluctuated diurnally by ± 1.71 units/ml (N.P.-1), ± 1.4 units/ml (N.P.-2), ± 2.09 , (N.P.-3) ± 1.2 units/ml and (N.P.-4) ± 1.03 units/ml. No diurnal fluctuation of Eurotatoria population was observed in N.P.-5, N.P.-6 and N.P.-7.

Graphical analysis of diurnal fluctuation in eurotatorian population revealed maximum abundance in the early morning, minimum during afternoon and almost constant after the sunset. This can be attributed to the combined effect of sunlight and temperature (Dhanapathi, 2000). Therefore, a synchronous trend exists between branchiopods, maxillopods, monogonta and eurotatoria.

4.3. Physico-chemical parameters

The ecological studies in fresh water involve a choice between two types of approaches, one connected with knowledge of the dynamics of aquatic species in a given area and the other relating to knowledge of water body and its physical and chemical characteristics. In order to define a particular freshwater body, it is important to analyze accurately as many physical and chemical characteristics of water as possible before preceding the biological studies. The measurements of these characteristics provide valuable information about the aquatic environment.

Plankton requires a favorable light, moisture, nutrient, pH and temperature as well as absence of toxic substances for their growth (Boyd, 1979). Aquatic ecosystem is governed by interaction of number of physical, chemical and biological factor and so the water quality of the seven selected nursery ponds was done. Study of water quality parameters gives an idea of the distribution of phytoplankton and zooplankton with respect to physico-chemical parameters in the nursery ponds. Water quality in seven nursery ponds is given in (Table 4.3.1 to 4.3.8)

4.3.1. Temperature

Water temperature in nursery ponds varied between 24.2 °C - 32.2 °C. Water temperature is one of the most important factor in an aquatic environment (Ruttner, 1963) and no other single factor has so much profound influence directly and or indirectly (Welch, 1952). Temperature is the degree of hotness, which depends on the intensity and duration of sunshine. It influences the physico- chemical and biological characters of any water body. Temperature is one of the most outstanding and biologically significant phenomena of aquatic environment; it has the relationship on zooplankton variation. Several researchers have proposed the temperature as a vital factor responsible for the growth of algae (Ramakrishnaiah and Sarkar, 1982; Verma and DattaMunshi, 1987; Bohra and Kumar, 1999). The minimum temperatures at which

photosynthesis occur depends upon the algal species. The rainfall and air temperature has the direct influences on the variation of water temperature (Michael,

1968). Critical temperature for many diatoms is about 15°C (Rodhe, 1948). Diatoms can tolerate a temperature range of 0°C to 35°C (Patrick, 1971). Munawar (1974) Observed that both low and high temperature favored the diatoms growth. Rai and Kumar (1980) and Nandan and Patel (1985) also reported that diatoms may survive even at high temperatures. Hot climate of this region also supported the development of diatoms. Warm temperature in Chhattisgarh would have influenced the production of phytoplankton (Sukumaran and Das, 2002). Many (Whitford and Schumacher, 1968) correlated the abundance of blue green algae with hot summer months which supports the present study (Welch, 1952 and George, 1962) believed that planktonic species of tropical waters are probably the forms which require relatively higher temperature. It was observed that euglenoids were more at high temperature i.e.; in summer than in winter and monsoon as also observed by (Hutchinson, 1967).

Temperature in water is inversely related to oxygen (Chattopadhyay, 1995, Creco, 1986).

4.3.2 Transparency

The transparency in the selected nurseries ponds ranged between 26-34 cm. Transparency of water depends upon the suspended materials present in water. Reid and Wood (1976) reported that the transparency of water depends on several factors e.g. silt, plankton density, suspended organic matter, latitude, season, angle and intensity of light. Therefore, is a good index of phytoplankton population (Khatavkar and Trivedy, 1993). Transparency provides a rough estimate of plankton levels in fish ponds. Higher transparency indicated lower plankton population, this was also reported by Selot (1977) and Saran Adoni (1982). Water transparency acts as an index of water quality and nutrient content in pond water (Mohanty, 1999). Higher the transparency, lower the nutrient content (NACA, 1994). According to Pearsall

(1923), kaloo *et al.* (1955) Munawar (1970) and Kaulet *al.* (1978). Higher transparency affects the growth of Chlorophyceae. According to Oglesby and Schaffer (1975) and Carlson (1977). Water transparency affects the growth of algae directly. The plankton maxima coincided with decreases in water depth. Transparency was also low in monsoon

due to high silt load resulting in more allochthonous nutrients increasing phytoplankton population (Mohnty 1999).

4.3.3. Dissolved Oxygen

The range of dissolved oxygen in all nursery ponds was between 5.2 mg/l to 6.9 mg/l. The dissolved oxygen in water depends upon several physico- chemical and biological factors. Kumar (2006) reported the dissolved oxygen range of 5.6- 13.18 mg/l. from a sewage fed tank of Raipur, Telibandha. Low level of dissolved oxygen in nursery ponds may be due to high organic load, which leads to oxygen depletion.

Substantiate quality of oxidizable substances in fish ponds (Excrement's of zooplankton and fishes application of organic fertilizers) may be of considerable benefit to Cyanobacteria indirectly because it lowers the concentration of dissolved oxygen (Sevrin –Reyssac and Pletikotic, 1990). Lower catabolic activity of the aquatic organisms probably accelerates dissolved oxygen further in the water (Chourasia and Adoni, 1985; and Sukumaran and Das; 2002). It is well known facts that with an increase in atmospheric temperature, water temperature also rise and dissolved oxygen decreases. Phytoplankton regulates dissolved oxygen by photosynthetic activities. Phytoplankton densities are also low in some nursery ponds which may be due to high weed infestation causing lower dissolved oxygen content in the water body.

4.3.4 pH

All nursery ponds were found to be alkaline (7.2 to 8.4 units). pH is a measure of hydrogen ion concentration present in water. Water pH is mainly influenced by the concentration of free CO₂ carbonate and bicarbonate ions (Chattopadhyay, 1995). pH depends on the density of organisms produced and utilizing carbon dioxide and on the buffering capacity of the water (Lokare and Rathinraj, 1997). According to Reynolds *et al* (1968), pH is considered to be the most important factor particularly in the case of

the green algae. Alikunhi (1957) reported that high pH (7.5 to 8.5) doubled fish production as compared to waters having low pH (6.5 to 7.5) domestic effluents and surface run off also increased pH as reported by Mohanty (1999). McCombie (1953) suggested that significant growth of phytoplankton results into high pH while George (1962) opined that high pH promotes the growth of phytoplankton.

4.3.5 Electrical conductivity

In the present investigation, Electrical conductivity (E.C.) value ranged between 148 – 428 umhos/cm. Among the all nursery ponds, Electrical conductivity values showed positive correlation with zooplankton production, while negative correlation with dissolved oxygen. EC is found to be good indicators of the water quality (Abbassiet *al.*, 1996; Gaikwadet *al.*, 2008). The dilution of solid substances in turn reduces the EC value alkalinity and zooplankton production. All the nursery ponds in the present study are considerably rich in calcium, showing good population of Chlorococcales (Class Chlorophyceae) and Cyanophyceae Kaulet *al.* (1978) and Pundit (1980) reported that the fresh water bodies of Kashmir, rich in calcium and magnesium have thick population of plankton, especially cyanophyceae. Luxuriant growth of blue green algae in all the water bodies may be attributed to good availability of calcium concentration in water (Nandan and Patel, 1985). Desmids were found to be poor in selected nursery ponds in present study which are rich in calcium as also reported by Pearsall (1932), Vass and Sachlan (1949) and Hutchinson (1967). Hosani and Bharti (1980) have concluded antagonistic effect between bluegreen algae and desmids and in the present study observation of abundance of blue green algae again explain for the poor abundance of desmids. Pearsall (1921) also investigated that those lakes dominated by desmids' are pure soft waters containing a high ratio of sodium, potassium, magnesium and calcium hydroxides.

4.3.6. Nitrate

In present study, the dissolved nitrate in nursery ponds ranged from 0.41 mg/l to 0.47 mg/l. Nitrate is a measure of organic nitrogen. It plays an important role in the eutrophication of water along with phosphates. Biswas (2006) reported nitrate nitrogen to range between 0.24 to 0.86 mg/l in BudhaTalab, Raipur. Non polluted tropical waters are generally deficient in nitrates (Ganpati, 1940) but discharge of domestic wastes and sewage adds nitrogen in urban ponds (Kailtha, 2008). Such Nitrate –nitrogen can readily be absorbed by autotrophs i.e. algae and bacteria.

High records of Nitrate –nitrogen was reported in Ramna Lake (0.25-6.00 ppm.) by Islam and Saha (1975) and in different water bodies in West Bengal, India (0.90-6.25 ppm.) by Mazumder *et al.* (1997). Rodhe (1948) observed that nitrates are essential for growth of Chlorophyta and Diatoms. Presence of nitrates seems an important source of nitrogen to promote the growth and rapid reproduction of *Microcystis aeruginosa* (Philipose, 1959).

4.3.7. Orthophosphate

In present study, the dissolved orthophosphate in nursery ponds ranged between 0.65 – 0.68 mg/l. Almost all of the phosphorus (P) present in water is in the form of phosphate (PO_4) and in surface water mainly present as bound to living or dead particulate matter and in the soil is found as insoluble $\text{Ca}_3(\text{PO}_4)_2$ and adsorbed phosphates on colloids except under highly acid conditions. It is an essential plant nutrient as it is often in limited supply and stimulates plant (algae) growth and its role for increasing the aquatic productivity is well recognized. Soil phosphorus (unit- mg of P_2O_5 per 100gm of soil) level below 3 might be considered indicative of poor production, between 3 and 6 of average production and ponds having available phosphorus above 6 are productive (Banerjea, 1967). According to Stone and

Thomforde (2004) the phosphate level of 0.06 mg/l is desirable for fish culture. The release of orthophosphate usually takes place when the concentration of nitrate is low, but when the concentration of nitrogen becomes highest the concentration of phosphates begins to decline (Anderson, 1982). Total Orthophosphate was also found higher in urban ponds (0.37 mg/l) than in periurban ponds (0.21mg/l) as reported by Kailtha (2008). Detergents and municipal sewage are rich in phosphorus and they may also contribute the same into ponds (Kanungo, 1986 and Dillon, *et al.*, 1991.). However, Sharma (1980) reported low Orthophosphate level of 0.083mg/l. in urban lake, FatehSagar. Hutchinson (1957) reported high phosphate in certain American lakes due to sewage contamination. Biswas (2006) reported total orthophosphate ranging from 0.25 to 0.76 mg/l in BudhaTalab, Raipur. Total Orthophosphate in Telibandha pond, Raipur ranged from 0.19 to 0.94 mg/l (Kumar,2006) and in village ponds in Raipur ranged from 0.29 to 0.48 mg/l (Ghosh, 2006). However, low orthophosphate could be due to the presence of iron in the ferric state (Einsele, 1983 and Mortimer, 1941). Lower value of total orthophosphate in inland waterbodies have been also reported by Sharma and Pant (1979), Hosmani and Bharti (1980).

Smith (1983) suggested that low phosphorus concentration favours phytoplankton. However it is established by Martin (1968) that the phosphate requirement of phytoplankton is met from the excretion of phosphorus by zooplankton. Luxuriant growth of blue green algae may be attributed with good availability of calcium and low contents of nitrates and phosphates (Munawar, 1970; Mittal and Sengar, 1991 and Nandan, 1993). Similar observation were made in the present study. Hammer (1964) stated that accumulation of orthophosphates by blue green algae helped in their bloom formation and again liberates phosphates back into water on their decomposition.

Pearsall and Lind (1942), Zafar(1964), Munawar (1970) and Sedamark andAngadi (2003) also recorded high density of Bacillariophyceae in the

Total phosphate and nitrate rich waters.

4.3.8. Ammonia

In present study, the dissolved nitrate in nursery ponds ranged from 0.11 mg/l to 0.14 mg/l. Ammonia is a nitrogen waste released by aquatic animals into the production pond environment. It is a primary byproduct of protein metabolism. Ammonia is excreted directly from the fish gill into the water. Ammonia concentrations are usually at their highest in the production season when biomass of the cultured species and the amount of protein fed are greatest. Ammonia is toxic to aquatic life and toxicity is affected by pond pH. Ammonia nitrogen ($\text{NH}_3\text{-N}$) has a more toxic form at high pH and a less toxic form at low pH, un ionized ammonia (NH_3) and ionized ammonia (NH_4^+), respectively. In addition, ammonia toxicity increases as temperature rises. Ammonia in the range $>0.1 \text{ mg L}^{-1}$ tends to cause gill damage, destroy mucous producing membranes, “sub- lethal” effects like reduced growth, poor feed conversion, and reduced disease resistance at concentrations that are lower than lethal concentrations, osmoregulatory imbalance, kidney failure. Fish suffering from ammonia poisoning generally appear sluggish or often at the surface gasping for air. The toxic levels for un-ionized ammonia for short-term exposure usually lie between 0.6 and 2.0 mg L^{-1} for pond fish, and sub lethal effects may occur at 0.1 to 0.3 mg L^{-1} (EIFAC, 1973; Robinette, 1976). During present study the ammonia range found 0.06 to 0.17 (ppm). According to Swann (1997) and OATA (2008) the levels below 0.02 ppm were considered safe. Stone and Thomforde (2004) stated the desirable range as Total $\text{NH}_3\text{-N}$: 0-2 mg/l and Un-ionized $\text{NH}_3\text{-N}$: 0 mg/l and acceptable range as Total $\text{NH}_3\text{-N}$: Less

than 4 mg/l and Un-ionized NH₃-N: Less than 0.4 mg/l. Bhatnagar and Singh (2010) recommended the level of ammonia (<0.2 mg/l) suitable for pond fishery.

Table 4.1: Taxonomic dominance of total Phytoplankton and Zooplankton observed in selected nursery ponds of I.G.K.V. Fish farm of Raipur, Chhattisgarh.

PHYTOPLANKTON			
S.No.	ORDER	FAMILY	GENERA
Class- Chlorophyceae			
1-	Chlorococcales	5	8
2-	Zygnematales	3	5
3-	Volvocales	1	1
4-	Oedogoniales	1	1
5-	Ulothrichales	1	1
6-	Chaetophorales	1	1
Class- Cyanophyceae			
1-	Chroococcales	2	3
2-	Nostocales	2	6
Class- Bacillariophyceae			
1-	Pennales	3	4
2-	Centrales	1	1
3-	Ceratophorales	1	1
Class- Euglenophyceae			
1-	Euglenales	1	1
ZOOPLANKTON			
S.No.	ORDER	FAMILY	GENUS
Class- Branchiopoda			
1-	Cladocera	2	2
2-	Anostraca	1	1
Class- Maxillopoda			
1-	Cyclopoida	1	1

Class- Monogononta			
1-	Ploimida	1	2
Class- Eurotatoria			
1-	Flosculariaceae	1	1

Plate 4.1: Biodiversity composition of phytoplankton and zooplankton classes (%) in seven nurseries ponds of I.G.K.V. Fish farm of Raipur, Chhattisgarh is given in figure.

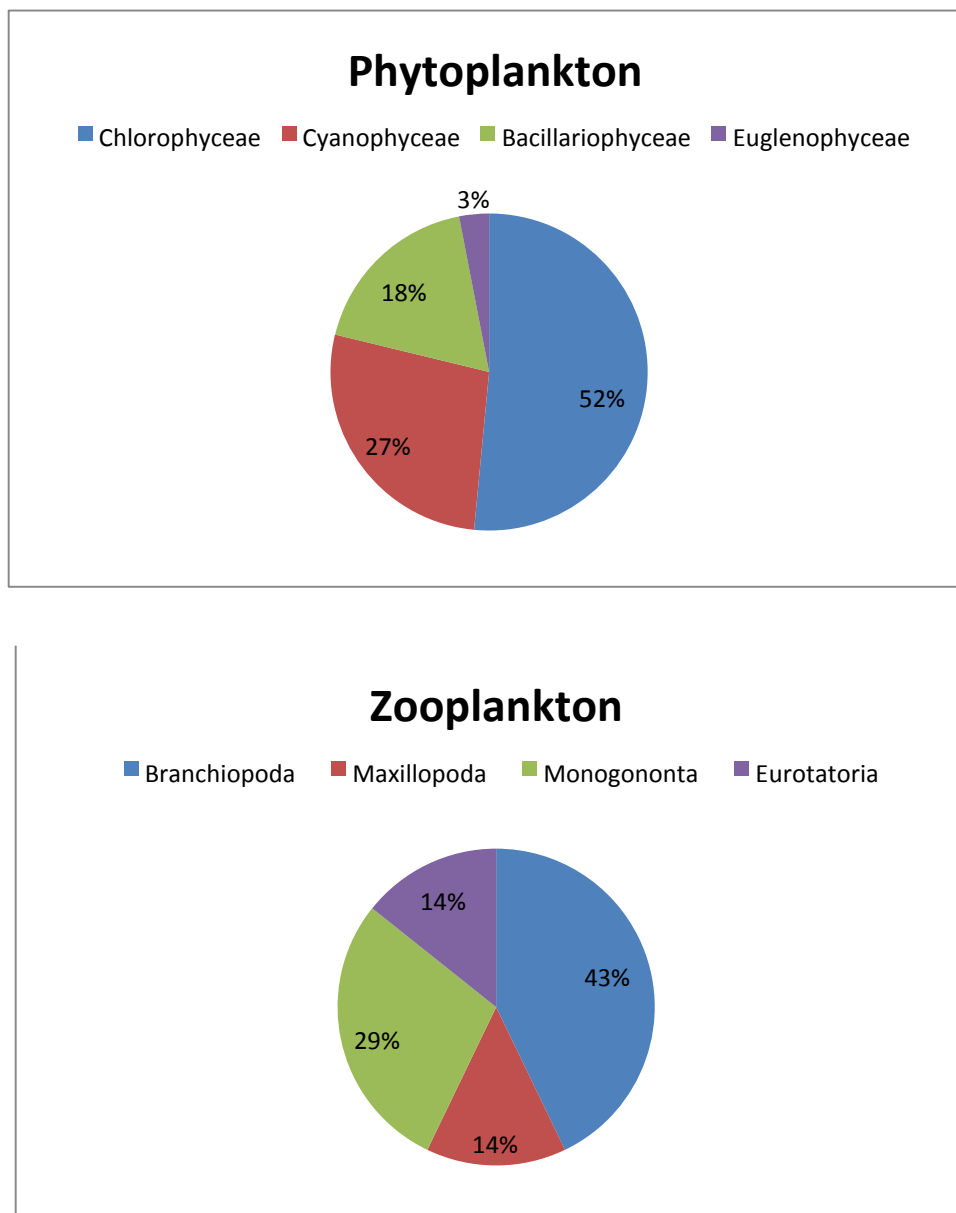


Table 4.3.1: Mean and STDEV of temperature in seven Nursery Ponds of I.G.K.V. Fish Farm Raipur Chhattisgarh Date from 24-07-2011 to 12-08-2011.

Date	Nursery Pond 1	Nursery Pond 2	Nursery Pond 3	Nursery Pond 4	Nursery Pond 5	Nursery Pond 6	Nursery Pond 7	Mean	STDEV
24/07/2011	26.7	26.9	25.5	26	25.9	26.4	25.7	26.15714	0.197432
25/07/2011	27.7	28.1	27.9	27.9	28.2	28	27.6	27.91429	0.079966
26/07/2011	29	29.1	28.6	29	28.7	28.6	28.5	28.78571	0.091101
27/07/2011	30	30.1	30.3	30	29.7	29.7	30	29.97143	0.080812
28/07/2011	29.7	30.1	31.4	30	30	29.8	29.6	30.08571	0.229314
29/07/2011	29	29.4	30	30	30	29.9	29.5	29.68571	0.14869
30/07/2011	30.1	30.2	30	30.3	30.6	30	30.7	30.27143	0.106266
31/07/2011	32	31.7	32.2	31.2	31.6	32.1	32	31.82857	0.132223
01/08/2011	28	30.7	31.3	31.5	32	31.5	28	30.42857	0.643545
02/08/2011	25.7	25.8	24.9	26	25.7	26.2	26.9	25.88571	0.228274
03/08/2011	26.8	26.5	27	26.9	26.4	26.2	26.6	26.62857	0.108484
04/08/2011	25	24.8	25	24.3	24.7	24.2	24.4	24.62857	0.124813
05/08/2011	26.2	25.9	26.1	25.9	26.7	26.4	27.8	26.42857	0.252336
06/08/2011	26.4	25.8	25.9	26	26.6	27	27.8	26.5	0.269921
07/08/2011	25.9	25.7	26	25.8	26.3	25.8	25.9	25.91429	0.073771
08/08/2011	25.6	25.7	25.7	25.6	25.7	26	26	25.75714	0.064944
09/08/2011	26.7	26.7	26.6	26.7	26.5	27	27	26.74286	0.071903
10/08/2011	26.1	26	26.7	26.5	26.9	26.3	27	26.5	0.146385
11/08/2011	26.4	26.2	26.5	25.9	26.3	26.8	27	26.44286	0.139484
12/08/2011	26.3	26.6	26.5	26.8	26.7	27.1	27	26.71429	0.105624

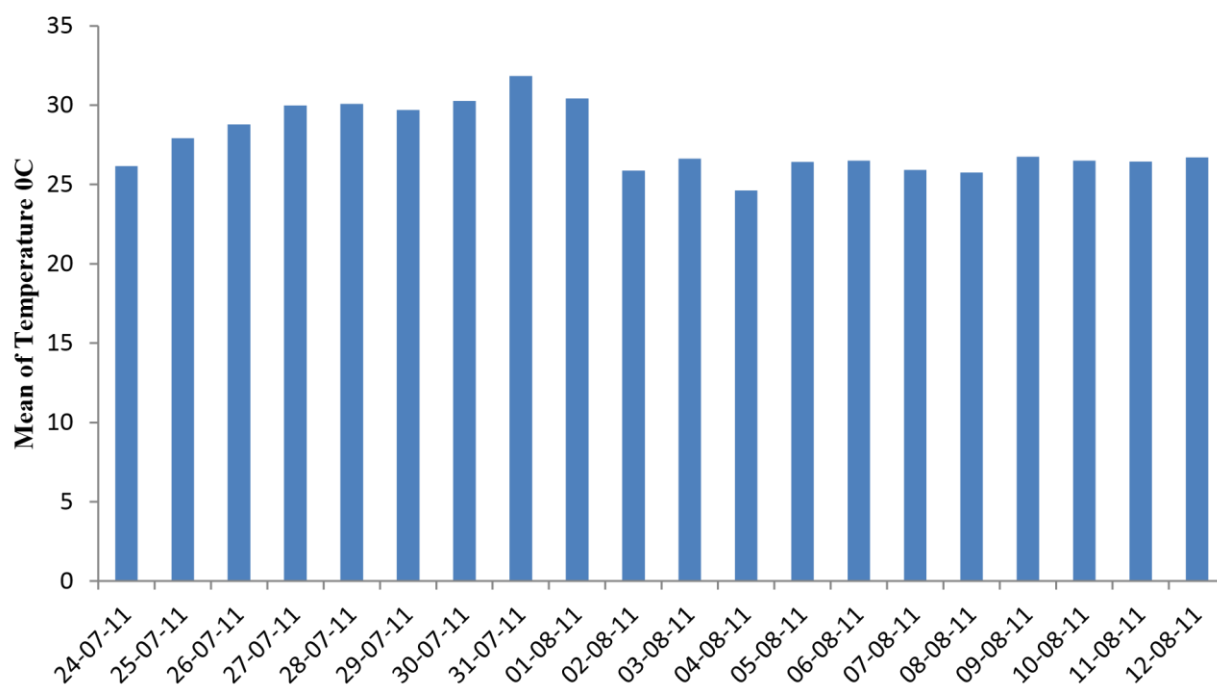


Plate 4.3.1: Daily variation water temperature (°C) at seven nursery ponds of I.G.K.V. Fish Farm Raipur Chhattisgarh during 24/07/2011 to 12/08/2011.

Table 4.3.2: Mean and STDEV of Transparency in seven Nursery Ponds of I.G.K.V. Fish Farm**Raipur Chhattisgarh Date from 24-07-2011 to 12-08-2011.**

Date	Nursery Pond 1	Nursery Pond 2	Nursery Pond 3	Nursery Pond 4	Nursery Pond 5	Nursery Pond 6	Nursery Pond 7	Mean	STDEV
24/07/2011	32	34	30	27	26	26	25	28.57143	1.306707
25/07/2011	30	33	30	28	27	26	26	28.57143	0.972408
26/07/2011	30	32	29	28	27	28	30	29.14286	0.63353
27/07/2011	32	30	27	26	27	29	32	29	0.92582
28/07/2011	30	32	29	30	27	30	26	29.14286	0.769309
29/07/2011	31	32	30	27	29	31	30	30	0.617213
30/07/2011	32	30	27	29	29	31	30	29.71429	0.606092
31/07/2011	31	29	28	30	32	27	26	29	0.816497
01/08/2011	32	30	29	31	27	26	29	29.14286	0.79966
02/08/2011	32	33	29	34	26	27	28	29.85714	1.183791
03/08/2011	30	31	29	32	29	27	30	29.71429	0.606092
04/08/2011	29	33	32	28	29	29	26	29.42857	0.895947
05/08/2011	32	31	29	27	27	29	26	28.71429	0.837066
06/08/2011	32	31	30	27	30	28	26	29.14286	0.8289
07/08/2011	32	31	30	29	29	28	27	29.42857	0.649437
08/08/2011	30	31	29	28	27	28	26	28.42857	0.649437
09/08/2011	29	31	30	28	27	29	26	28.57143	0.649437
10/08/2011	30	32	33	30	29	28	30	30.28571	0.644179
11/08/2011	30	32	31	27	28	30	28	29.42857	0.685119
12/08/2011	29	30	29	32	31	30	29	30	0.436436

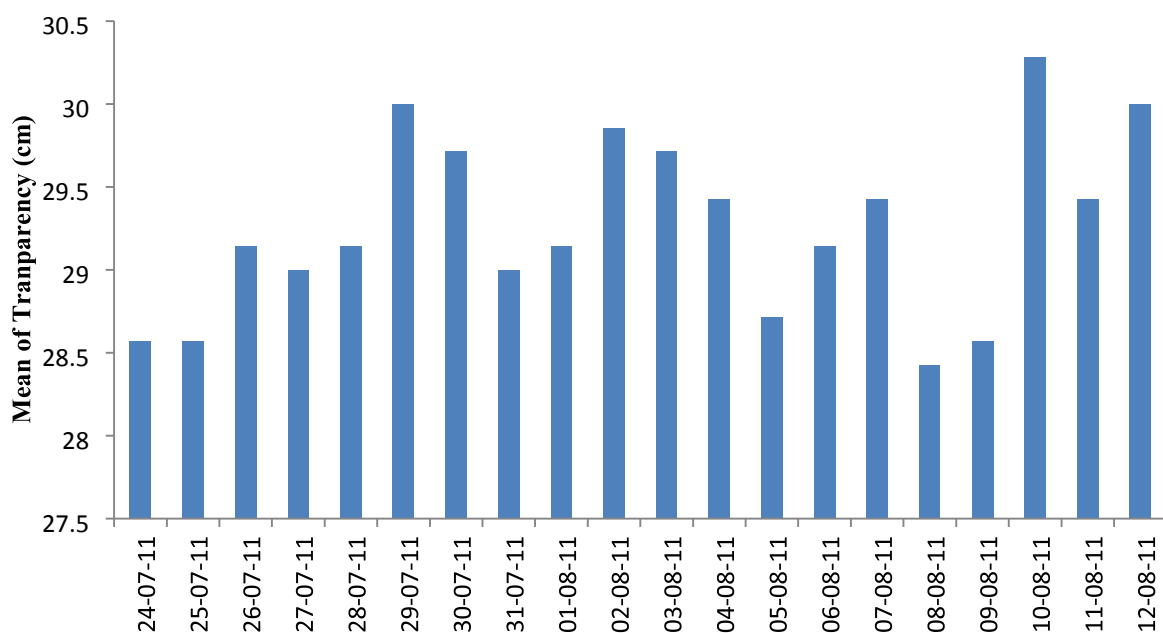


Plate 4.3.2: Daily variation of Transparency (Secchi disk reading in cm) at seven nursery ponds of I.G.K.V. Fish farm Raipur Chhattisgarh during 24/07/2011 to 12/08/2011.

Table 4.3.3: Mean and STDEV of Dissolved Oxygen in seven Nursery Ponds of I.G.K.V. Fish Farm Raipur Chhattisgarh Date from 24-07-2011 to 12-08-2011.

Date	Nursery Pond 1	Nursery Pond 2	Nursery Pond 3	Nursery Pond 4	Nursery Pond 5	Nursery Pond 6	Nursery Pond 7	Mean	STDEV
24/07/2011	5.4	5.5	5.8	6	6.2	5.8	6	5.814286	0.107855
25/07/2011	5.9	5.8	6.2	6.1	6.2	6	6.2	6.057143	0.061168
26/07/2011	6	6.2	5.9	6	5.9	6.2	6.2	6.057143	0.052812
27/07/2011	6.3	6.2	5.9	6.2	5.9	6	5.8	6.042857	0.071903
28/07/2011	6	6.3	5.9	6.3	6	6.2	5.9	6.085714	0.067006
29/07/2011	5.9	5.7	6	5.9	6.2	6.3	6	6	0.075593
30/07/2011	6.1	6	5.9	5.9	6.2	5.8	6	5.985714	0.050843
31/07/2011	5.8	5.7	6	6.1	5.9	6	6.2	5.957143	0.064944
01/08/2011	5.9	5.6	5.9	6.1	6	6.2	5.9	5.942857	0.071903
02/08/2011	6	5.8	5.9	6	6.1	6.2	6	6	0.048795
03/08/2011	6.2	6.7	6.3	5.9	6	6.8	6.3	6.314286	0.126168
04/08/2011	6.5	6.9	6.4	5.2	5.3	6.6	6.5	6.2	0.252605
05/08/2011	6	5.9	5.8	6.1	6.2	5.9	6	5.985714	0.050843
06/08/2011	5.8	5.9	5.7	5.6	5.9	5.7	5.8	5.771429	0.042056
07/08/2011	6	5.9	6.1	5.8	5.7	6	6	5.928571	0.052164
08/08/2011	5.7	5.9	6	6.2	6.1	5.8	5.9	5.942857	0.064944
09/08/2011	5.9	5.7	6	5.4	5.9	6.1	6.3	5.9	0.109109

10/08/2011	6.2	5.9	5.8	6.3	6	6.1	5.9	6.028571	0.068014
11/08/2011	6	5.9	6.2	6.3	6.1	5.9	5.8	6.028571	0.068014
12/08/2011	6.3	6	5.9	5.8	6.2	5.9	5.9	6	0.069007

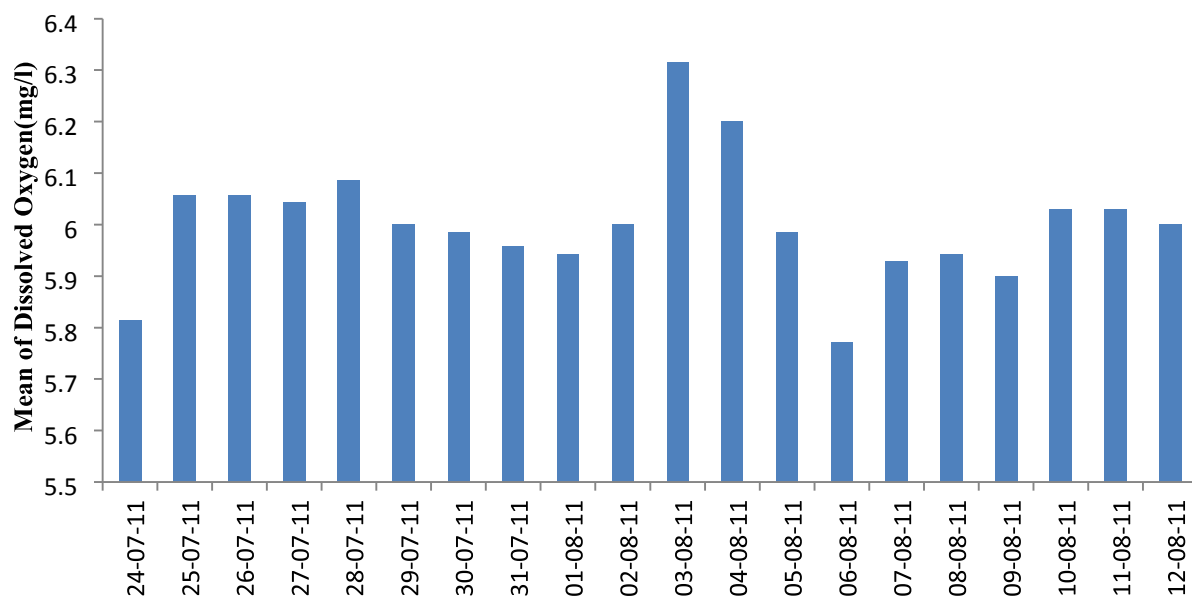


Plate 4.3.3: Daily variation in Dissolved Oxygen (Mean of seven nursery ponds) of I.G.K.V. Fish farm Raipur Chhattisgarh during 24/07/2011 to 12/08/2011.

Table 4.3.4: Mean and STDEV of pH in seven Nursery Ponds of I.G.K.V. Fish Farm Raipur Chhattisgarh Date from 24-07-2011 to 12-08-2011.

Date/ pH	Nursery Pond 1	Nursery Pond 2	Nursery Pond 3	Nursery Pond 4	Nursery Pond 5	Nursery Pond 6	Nursery Pond 7	Mean	STDEV
24/07/2011	7.7	7.9	8.1	7.8	8.2	7.7	7.6	7.857143	0.084112
25/07/2011	7.6	7.5	7.2	8.3	7	8.4	7.1	7.585714	0.213172
26/07/2011	7.7	7.5	6.9	7.3	7.2	7.4	6.3	7.185714	0.175158
27/07/2011	7.5	7.1	6.9	7.2	7.8	8	7.5	7.428571	0.147542
28/07/2011	7.7	7.9	7.6	8.3	7.5	8.1	7.9	7.857143	0.106586
29/07/2011	7.8	7.7	8	7.9	7.5	8.2	7.6	7.814286	0.091101
30/07/2011	7.8	7.4	7.9	8.4	7.6	8.1	7.2	7.771429	0.155402
31/07/2011	7.2	7.6	7.5	8.4	7.8	8.1	7	7.657143	0.18498
01/08/2011	7.2	7.6	7.5	8.4	7.8	8.1	7	7.657143	0.18498
02/08/2011	7.4	7.1	6.8	7.3	7.7	8.1	7.5	7.414286	0.158006
03/08/2011	7.5	7.4	7.9	8.3	7.3	8.7	7.7	7.828571	0.193605
04/08/2011	7.5	7.3	7.1	7.4	7.3	7.5	6.5	7.228571	0.132223
05/08/2011	7.7	7.7	7.3	8.5	7.1	8.7	7.7	7.814286	0.221927
06/08/2011	7.9	7.6	7.3	8.5	7.5	8.6	7.4	7.828571	0.19966

07/08/2011	7.9	7.6	7.8	8.3	7.7	8.5	7.6	7.914286	0.133503
08/08/2011	8	7.9	7.8	8.8	8.3	9.5	8.7	8.428571	0.230645
09/08/2011	7.9	7.8	7.8	8.9	8.2	9.4	8.6	8.371429	0.233722
10/08/2011	7.7	7.4	7.6	8.1	7.3	8.3	7.4	7.685714	0.143806
11/08/2011	7.6	7.7	7.4	8	7.3	8.4	7.6	7.714286	0.142141
12/08/2011	7.7	7.6	7.7	8.3	8.4	9	8.3	8.142857	0.191308

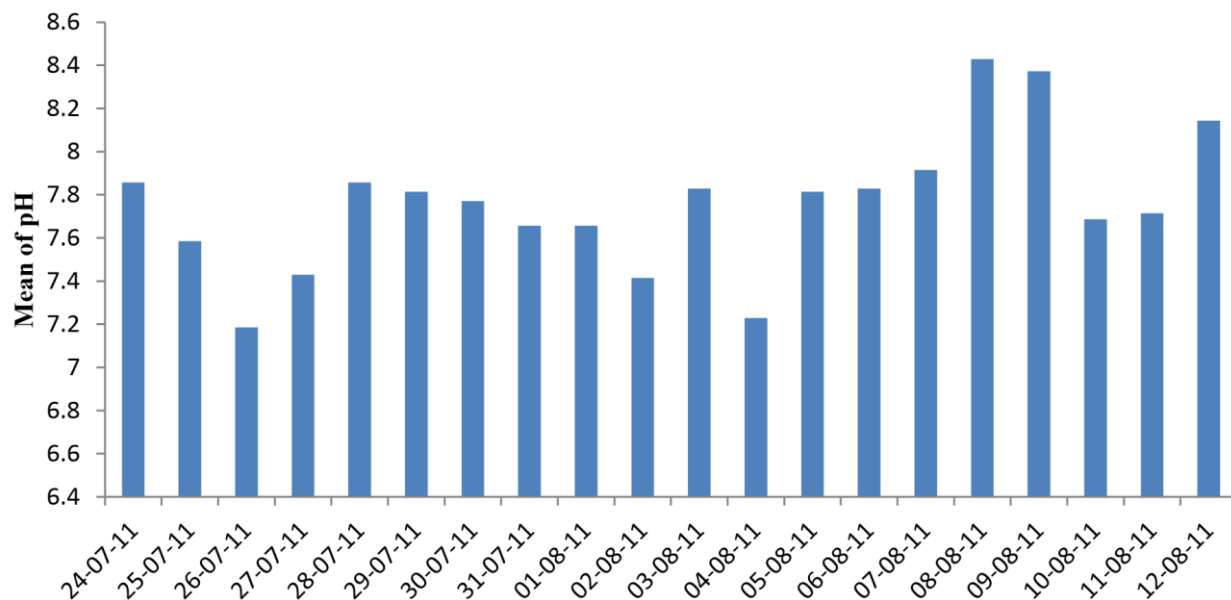


Plate 4.3.4: Daily variation in pH (Mean of seven nursey) of I.G.K.V. Fish farm Raipur Chhattisgarh during 24/07/2011 to 12/08/2011.

Table 4.3.5: Mean and STDEV of Electric conductivity in seven Nursery Ponds of I.G.K.V.

Fish Farm Raipur Chhattisgarh Date from 24-07-2011 to 12-08-2011.

Date	Nursery Pond 1	Nursery Pond 2	Nursery Pond 3	Nursery Pond 4	Nursery Pond 5	Nursery Pond 6	Nursery Pond 7	Mean	STDEV
24/07/2011	320	395	385	257	320	212	360	321.2857	25.38814
25/07/2011	313	398	376	227	348	229	365	322.2857	26.26397
26/07/2011	353	412	428	258	343	230	352	339.4286	27.63353
27/07/2011	360	428	439	280	312	272	389	354.2857	25.78548
28/07/2011	113	136	186	133	128	139	190	146.4286	11.19706
29/07/2011	330	401	358	253	380	223	332	325.2857	24.6651
30/07/2011	304	390	321	221	384	252	356	318.2857	24.37477
31/07/2011	349	408	326	255	313	225	390	323.7143	25.22443
01/08/2011	120	180	143	153	232	160	155	163.2857	13.33758
02/08/2011	398	474	467	260	390	240	239	352.5714	39.47384
03/08/2011	357	390	220	323	329	193	212	289.1429	29.87548
04/08/2011	346	405	436	243	316	218	369	333.2857	30.4222
05/08/2011	329	403	394	237	321	220	353	322.4286	26.8965

06/08/2011	319	401	386	239	363	227	360	327.8571	26.34246
07/08/2011	418	328	360	223	348	211	326	316.2857	28.14987
08/08/2011	283	320	313	188	324	165	384	282.4286	29.72001
09/08/2011	291	340	327	201	301	148	346	279.1429	28.61354
10/08/2011	396	320	344	229	338	199	312	305.4286	25.90078
11/08/2011	301	413	384	239	330	228	343	319.7143	26.1677
12/08/2011	276	323	334	223	312	156	339	280.4286	25.77823

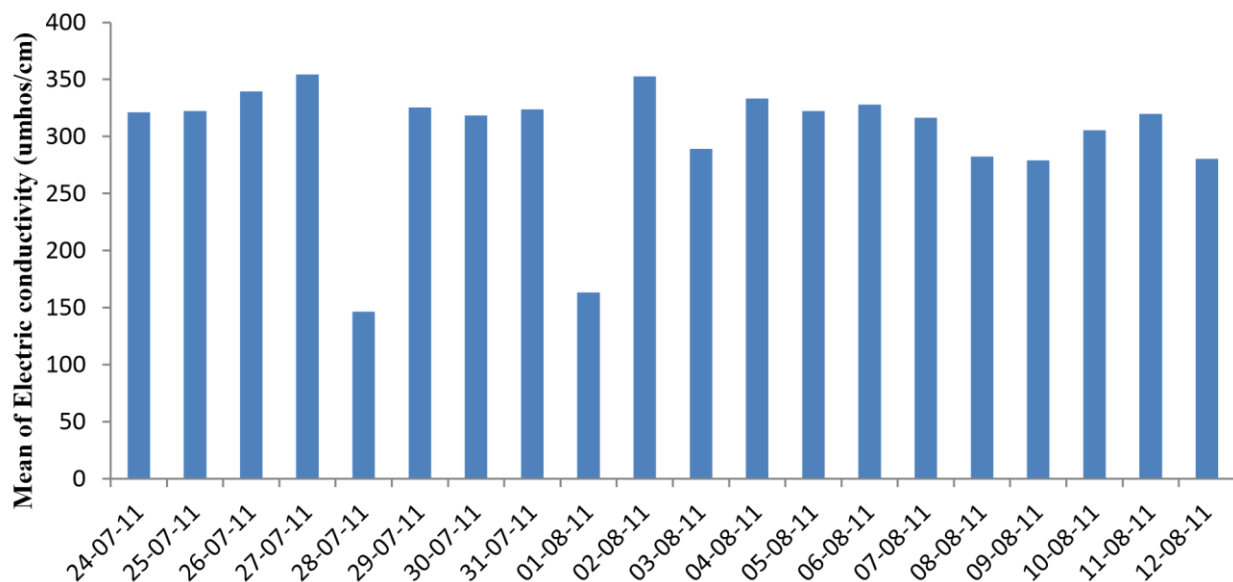


Plate 4.3.5: Daily variation of Electric conductivity (mean of seven nursery) ponds of I.G.K.V. Raipur Chhattisgarh, during 24/07/2011 to 12/08/2011.

Table 4.3.6:**Mean and STDEV of Nitrate (mg/l) in seven Nursery Ponds of I.G.K.V. Fish Farm****Raipur Chhattisgarh Date from 24-07-2011 to 12-08-2011.**

Date/ Nitrate	Nursery Pond 1	Nursery Pond 2	Nursery Pond 3	Nursery Pond 4	Nursery Pond 5	Nursery Pond 6	Nursery Pond 7	Mean	STDEV
24/07/2011	0.43	0.52	0.48	0.25	0.55	0.27	0.77	0.467143	0.177456
25/07/2011	0.27	0.32	0.45	0.28	0.57	0.28	0.69	0.408571	0.166876
26/07/2011	0.32	0.44	0.47	0.27	0.56	0.32	0.72	0.442857	0.15882
27/07/2011	0.29	0.45	0.49	0.3	0.53	0.3	0.75	0.444286	0.167517
28/07/2011	0.27	0.47	0.45	0.29	0.57	0.3	0.74	0.444286	0.172668
29/07/2011	0.28	0.39	0.44	0.28	0.54	0.31	0.78	0.431429	0.180594
30/07/2011	0.26	0.44	0.46	0.31	0.55	0.3	0.75	0.438571	0.171991
31/07/2011	0.25	0.42	0.47	0.28	0.53	0.31	0.76	0.431429	0.177898
01/08/2011	0.29	0.48	0.49	0.3	0.57	0.32	0.78	0.461429	0.177898
02/08/2011	0.33	0.46	0.48	0.29	0.59	0.33	0.7	0.454286	0.151312
03/08/2011	0.37	0.42	0.49	0.28	0.58	0.31	0.72	0.452857	0.156601
04/08/2011	0.36	0.49	0.45	0.3	0.57	0.32	0.74	0.461429	0.156357
05/08/2011	0.32	0.42	0.48	0.27	0.59	0.29	0.75	0.445714	0.176149
06/08/2011	0.27	0.46	0.46	0.25	0.54	0.28	0.77	0.432857	0.187057
07/08/2011	0.32	0.45	0.42	0.26	0.56	0.28	0.76	0.435714	0.17775
08/08/2011	0.35	0.42	0.47	0.27	0.57	0.3	0.78	0.451429	0.17771
09/08/2011	0.36	0.46	0.46	0.28	0.55	0.29	0.75	0.45	0.164722
10/08/2011	0.32	0.43	0.46	0.27	0.56	0.29	0.79	0.445714	0.183925
11/08/2011	0.35	0.44	0.49	0.28	0.57	0.3	0.7	0.447143	0.152721
12/08/2011	0.36	0.43	0.48	0.29	0.54	0.29	0.72	0.444286	0.153499

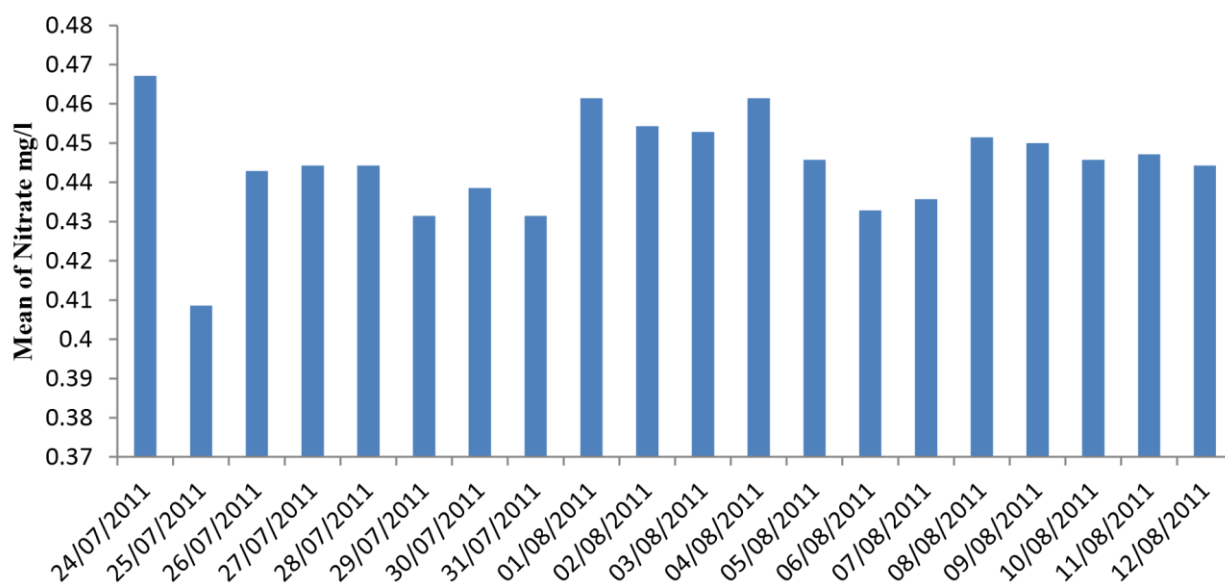
**Plate 4.3.6: Daily variation of Nitrate (mg/l) at seven nursery ponds of I.G.K.V. Fish farm Raipur Chhattisgarh during 24/07/2011 to 12/08/2011.**

Table 4.3.7:

Mean and STDEV of Total Ortho-phosphate (mg/l) in seven Nursery Ponds of I.G.K.V. Fish Farm Raipur Chhattisgarh Date from 24-07-2011 to 12-08-2011.

Date/ Orthophosphate	Nursery Pond 1	Nursery Pond 2	Nursery Pond 3	Nursery Pond 4	Nursery Pond 5	Nursery Pond 6	Nursery Pond 7	Mean	STDEV
24/07/2011	0.68	0.77	0.59	0.52	0.7	0.61	0.69	0.651429	0.083152
25/07/2011	0.73	0.75	0.64	0.56	0.72	0.59	0.7	0.67	0.073937
26/07/2011	0.65	0.68	0.65	0.57	0.73	0.57	0.72	0.652857	25.45662
27/07/2011	0.65	0.7	0.68	0.51	0.76	0.54	0.76	0.657143	0.099115
28/07/2011	0.67	0.73	0.68	0.54	0.74	0.58	0.67	0.658571	0.073808
29/07/2011	0.64	0.72	0.62	0.56	0.74	0.54	0.78	0.657143	0.091963
30/07/2011	0.67	0.74	0.63	0.53	0.78	0.55	0.73	0.661429	0.096338
31/07/2011	0.68	0.69	0.62	0.57	0.78	0.57	0.77	0.668571	0.086685
01/08/2011	0.67	0.71	0.67	0.56	0.77	0.54	0.74	0.665714	0.086959
02/08/2011	0.66	0.73	0.66	0.51	0.79	0.52	0.76	0.661429	0.11097
03/08/2011	0.65	0.69	0.63	0.53	0.75	0.53	0.79	0.652857	0.100285
04/08/2011	0.64	0.67	0.67	0.53	0.74	0.56	0.78	0.655714	0.089602
05/08/2011	0.64	0.72	0.65	0.58	0.72	0.57	0.75	0.661429	0.071047
06/08/2011	0.68	0.74	0.68	0.58	0.76	0.55	0.73	0.674286	0.0808
07/08/2011	0.69	0.78	0.65	0.55	0.75	0.54	0.72	0.668571	0.094062
08/08/2011	0.67	0.76	0.66	0.57	0.73	0.54	0.76	0.67	0.088318
09/08/2011	0.63	0.75	0.68	0.58	0.73	0.52	0.78	0.667143	0.095169
10/08/2011	0.64	0.75	0.67	0.59	0.74	0.59	0.79	0.681429	0.080089
11/08/2011	0.65	0.79	0.64	0.53	0.79	0.55	0.75	0.671429	0.108386

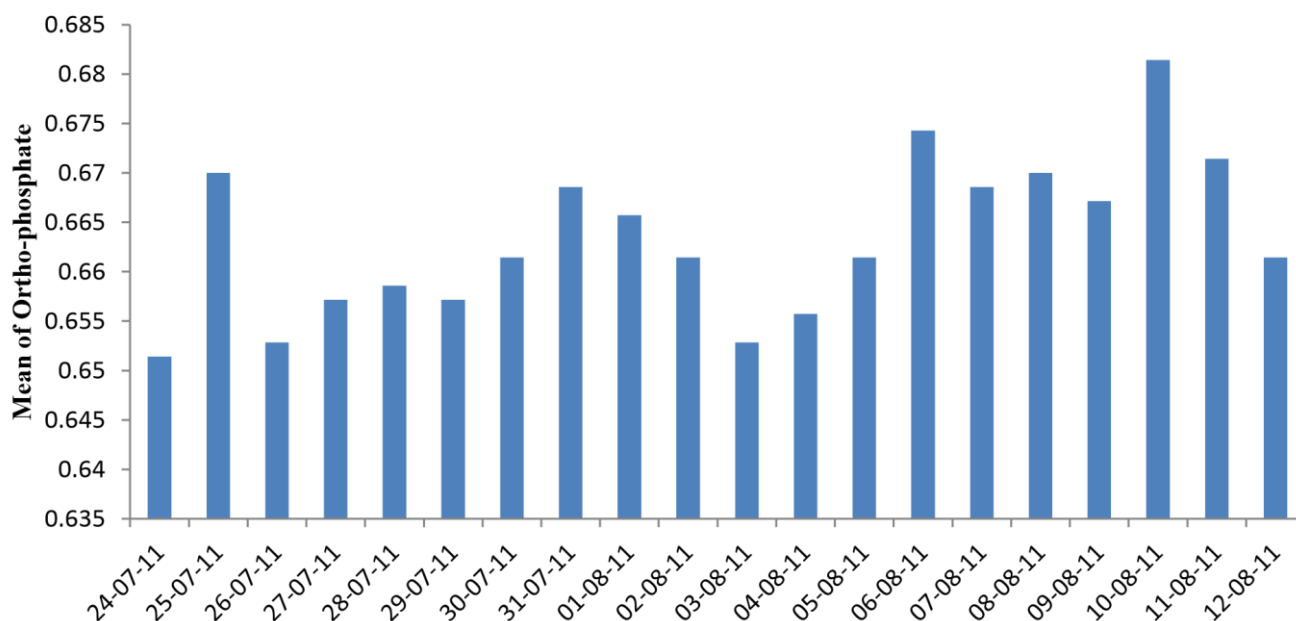


Plate 4.3.7: Daily variation in Ortho-Phosphate (Mean of seven nursery ponds) of I.G.K.V. Fish farm Raipur Chhattisgarh during 24/07/2011 to 12/08/2011.

Table 4.3.8:

12/08/2011	0.63	0.76	0.63	0.5	0.76	0.58	0.77	0.661429	0.10479
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Mean and STDEV of Ammonia (ppm) in seven Nursery Ponds of I.G.K.V. Fish

Farm Raipur Chhattisgarh Date from 24-07-2011 to 12-08-2011.

Date/ Ammonia	Nursery Pond 1	Nursery Pond 2	Nursery Pond 3	Nursery Pond 4	Nursery Pond 5	Nursery Pond 6	Nursery Pond 7	Mean	STDEV
24/07/2011	0.17	0.8	0.18	0.06	0.12	0.09	0.14	0.222857	0.257987
25/07/2011	0.16	0.1	0.12	0.08	0.17	0.1	0.17	0.128571	0.037607
26/07/2011	0.12	0.11	0.17	0.09	0.16	0.08	0.18	0.13	0.04
27/07/2011	0.13	0.09	0.16	0.07	0.1	0.06	0.15	0.108571	0.038914
28/07/2011	0.18	0.11	0.12	0.09	0.12	0.09	0.13	0.12	0.030551
29/07/2011	0.15	0.12	0.13	0.08	0.18	0.06	0.16	0.125714	0.04315
30/07/2011	0.15	0.09	0.11	0.1	0.13	0.09	0.17	0.12	0.031091
31/07/2011	0.11	0.1	0.15	0.09	0.18	0.1	0.18	0.13	0.039158
01/08/2011	0.16	0.13	0.14	0.06	0.16	0.07	0.16	0.125714	0.04315
02/08/2011	0.12	0.11	0.17	0.09	0.17	0.08	0.12	0.122857	0.035456
03/08/2011	0.14	0.12	0.14	0.11	0.18	0.06	0.13	0.125714	0.03645
04/08/2011	0.13	0.12	0.19	0.08	0.19	0.09	0.18	0.14	0.046904
05/08/2011	0.11	0.08	0.15	0.09	0.17	0.06	0.17	0.118571	0.044881
06/08/2011	0.15	0.09	0.18	0.06	0.17	0.1	0.16	0.13	0.046188
07/08/2011	0.16	0.11	0.13	0.08	0.16	0.09	0.18	0.13	0.038297
08/08/2011	0.11	0.12	0.17	0.09	0.12	0.08	0.17	0.122857	0.035456
09/08/2011	0.12	0.11	0.16	0.08	0.18	0.06	0.19	0.128571	0.049809
10/08/2011	0.13	0.13	0.18	0.07	0.17	0.1	0.17	0.135714	0.040766
11/08/2011	0.14	0.11	0.19	0.1	0.16	0.09	0.18	0.138571	0.039761
12/08/2011	0.15	0.11	0.18	0.08	0.19	0.08	0.19	0.14	0.049666

Table 4.3.9:

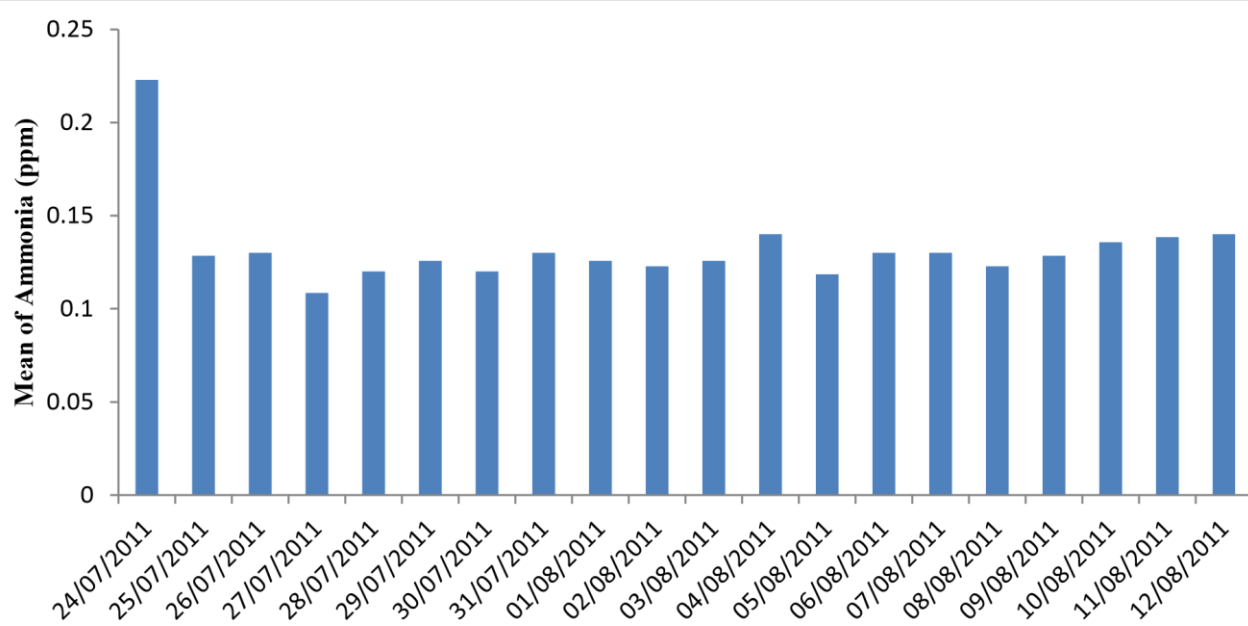


Plate 4.3.8: Daily variation of Ammonia (ppm) at seven nursery ponds of I.G.K.V. Fish farm Raipur Chhattisgarh during 24/07/2011 to 12/08/2011.

Table no. 4.2.1. Plankton abundance (units/ml) in nursery ponds no. 1 during date on 24/07/2011 to 12/08/2011.

Plankton/ Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Mean
CHLOROPHYCEAE																					
<i>Oocystis</i>	5	1	23	5	3	1	0	5	4	5	17	4	5	15	6	6	4	0	1	6	6
<i>Pediastrum</i>	4	3	3	7	0	9	8	19	11	5	0	5	4	0	0	0	0	0	1	0	4
<i>Tetradon</i>	3	1	6	7	0	4	2	6	3	3	0	1	2	3	5	3	0	6	1	4	3
<i>Selanosterium</i>	6	1	4	3	1	1	1	0	0	3	0	0	0	0	0	0	0	0	1	0	1
<i>Botryococcus</i>	4	1	2	1	0	0	2	0	0	3	1	0	0	0	0	0	0	0	1	0	1
<i>Scendesmus</i>	8	4	1	1	1	0	0	0	0	1	0	5	0	0	0	0	0	0	1	0	1
<i>Ankistrodesmus</i>	5	2	1	1	0	0	1	1	1	0	0	0	4	0	0	0	0	0	1	5	1
<i>Chlorella</i>	11	3	2	2	3	1	1	1	8	1	0	3	0	1	6	4	0	0	1	5	3
<i>Cosmarium</i>	5	1	1	2	1	5	2	4	5	1	3	2	4	3	2	0	0	0	1	0	2
<i>Spirogyra</i>	10	5	2	1	5	1	1	0	0	1	1	0	0	0	0	0	4	0	1	3	2
<i>Mesotonium</i>	5	2	1	1	1	1	5	1	0	1	1	0	0	1	2	0	10	0	0	0	1
<i>Mougeotia</i>	6	6	4	3	1	5	1	4	0	1	0	0	0	1	5	8	0	8	0	0	2
<i>Closterium</i>	4	4	7	3	1	1	1	0	0	1	0	0	9	6	0	0	4	3	0	0	2
<i>Chlamydomonas</i>	6	2	5	1	1	0	0	1	0	1	0	0	0	1	0	0	4	0	1	0	1
<i>Oedogonium</i>	7	1	6	1	0	1	1	0	1	1	0	0	0	2	0	0	1	0	3	0	1
<i>Ulothrix</i>	7	3	2	2	1	1	1	0	0	1	0	0	3	0	0	2	0	0	1	0	1
<i>Chaetophora</i>	4	2	3	1	1	1	1	1	1	1	0	0	0	1	0	1	7	0	0	0	1
CYANOPHYCEAE																					
<i>Aphanocapsa</i>	10	5	17	4	4	4	9	6	3	7	15	0	1	3	6	6	0	4	1	1	5
<i>Cylendrospermum</i>	7	12	2	3	0	3	1	1	0	0	1	1	1	0	4	0	0	0	8	8	3
<i>Oscillatoria</i>	10	10	15	1	1	1	2	5	5	6	0	0	0	13	1	11	0	4	10	3	5

<i>Nostoc</i>	4	3	4	2	1	1	0	0	0	1	0	2	0	3	0	0	9	0	0	0	1
<i>Anabaena</i>	6	2	3	1	2	1	0	0	0	6	0	4	1	0	3	3	4	4	1	4	2
<i>Microcystis</i>	8	4	8	1	8	1	4	1	0	16	5	5	0	4	4	0	0	0	2	0	3
<i>Coelospharium</i>	6	4	1	2	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1
<i>Spirulina</i>	12	2	1	1	1	1	0	1	1	1	0	1	2	10	3	0	0	3	0	0	2
<i>Phormidium</i>	7	2	3	1	1	0	0	1	1	1	0	1	3	0	0	0	6	0	0	0	1
EUGLENOPHYCEAE																					
<i>Euglena</i>	6	5	6	1	1	0	1	4	2	9	3	6	0	1	0	6	4	4	0	0	3
BACILLARIOPHYCEAE																					
<i>Synedra</i>	4	3	1	2	3	5	3	0	1	0	0	0	2	21	9	8	10	0	44	16	7
<i>Pinnularia</i>	3	2	1	1	1	1	0	0	1	1	0	0	0	1	0	5	0	0	0	0	1
<i>Nitzschia</i>	4	3	5	1	1	1	32	30	8	27	21	13	0	0	9	0	4	18	0	1	9
<i>Navicula</i>	4	1	2	2	1	3	0	0	0	3	3	2	1	0	3	0	0	0	0	1	1
<i>Melosira</i>	3	4	3	2	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1
<i>Protococcus</i>	4	4	2	1	0	1	1	1	2	1	0	0	15	3	0	0	0	0	0	3	2
BRANCHIOPODA																					
<i>Daphnia</i>	6	1	1	0	2	0	0	0	0	0	0	0	0	3	4	0	0	5	1	5	1
<i>Moina</i>	6	1	2	1	1	2	0	4	2	0	0	0	3	2	5	7	3	2	1	3	2
<i>Eubbranchipus</i>	4	2	1	1	3	3	1	0	1	5	0	0	0	1	4	4	0	0	3	2	2
MAXILLOPODA																					
<i>Cyclops</i>	4	1	1	1	0	0	2	0	0	1	7	3	3	0	0	5	0	0	1	4	2
MONOGONONTA																					
<i>Brachionus</i>	5	2	2	1	0	0	1	0	0	0	1	1	0	0	0	2	0	1	1	1	1
<i>Keratella</i>	6	1	3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	1
EUROTATORIA																					
<i>Filinia</i>	7	2	1	1	0	1	0	0	1	2	2	3	0	5	0	1	3	2	0	0	1

Table no. 4.2.2. Plankton abundance (units/ml) in nursery ponds no. 2 during date on 24/07/2011 to 12/08/2011.

Plankton/ Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Mean
CHLOROPHYCEAE																					
<i>Oocystis</i>	6	17	0	3	3	0	13	1	0	0	9	4	3	10	0	0	4	0	5	2	4
<i>Pediastrum</i>	0	1	0	1	0	8	3	1	0	0	0	0	0	3	0	1	0	0	0	1	1
<i>Tetradon</i>	0	1	0	3	4	4	4	5	4	7	10	6	5	0	3	6	2	0	0	0	3
<i>Selanostrium</i>	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Botryococcus</i>	0	2	0	2	0	1	0	0	0	1	0	1	1	0	0	1	0	1	0	0	0
<i>Scendesmus</i>	0	2	0	1	0	1	1	0	0	1	0	1	1	0	1	1	0	4	1	0	1
<i>Ankistrodesmus</i>	0	3	0	0	2	2	0	0	1	1	0	6	1	0	1	1	0	0	2	1	1
<i>Chlorella</i>	0	3	0	0	1	0	1	0	1	0	0	0	0	0	1	1	0	1	0	1	0
<i>Cosmarium</i>	0	4	0	2	1	1	4	3	5	6	6	0	0	1	4	1	1	3	0	0	2

[illegible]

<i>Daphnia</i>	6	1	0	1	0	0	5	0	0	0	0	0	3	0	0	0	0	0	1	0	1
<i>Moina</i>	6	0	0	1	0	0	0	1	0	1	7	1	0	0	0	0	1	2	1	0	1
<i>Eubbranchipus</i>	4	0	2	2	4	1	0	3	2	4	9	3	4	7	0	4	3	5	0	2	3
MAXILLOPODA																					
<i>Cyclops</i>	5	3	2	4	2	0	1	0	0	8	11	5	5	6	1	4	4	5	0	2	3
MONOGONONTA																					
<i>Brachionus</i>	1	0	1	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0
<i>Keratella</i>	2	0	2	0	0	0	1	0	0	0	3	0	0	0	0	3	0	0	0	0	1
EUROTATORIA																					
<i>Filinia</i>	2	1	1	1	1	1	0	0	0	4	0	3	5	4	0	3	1	0	6	0	2

Table no.4.2.3. Plankton abundance (units/ml) in nursery ponds no. 3 during date on 24/07/2011 to 12/08/2011.

Plankton/ Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Mean
CHLOROPHYCEAE																					
<i>Oocystis</i>	13	15	13	0	0	2	18	4	2	0	0	7	5	0	2	5	7	0	0	7	5
<i>Pediastrum</i>	0	0	0	0	0	3	0	0	1	5	0	0	0	0	0	0	0	0	1	0	0
<i>Tetradon</i>	0	1	11	2	3	4	3	4	4	5	8	1	0	6	0	4	0	9	1	10	4
<i>Selanosterium</i>	1	1	2	0	0	0	0	0	1	0	1	0	1	0	0	0	1	0	1	0	0

<i>Botryococcus</i>	1	1	0	0	1	0	0	0	1	0	1	0	1	0	1	10	1	0	1	1	1
<i>Scendesmus</i>	1	0	0	1	1	0	1	1	1	0	1	1	0	0	1	0	1	4	1	1	1
<i>Ankistrodesmus</i>	1	1	1	1	1	1	1	1	1	1	1	0	0	1	7	1	0	0	1	1	1
<i>Chlorella</i>	1	1	1	1	1	1	1	1	0	1	1	0	1	1	0	1	1	1	0	0	1
<i>Cosmarium</i>	1	0	0	1	1	0	1	1	5	1	5	5	0	1	16	6	4	4	4	1	3
<i>Spirogyra</i>	2	1	1	1	1	1	1	7	2	4	3	1	1	1	12	4	0	0	21	0	3
<i>Mesotonium</i>	0	0	4	1	1	1	1	1	0	0	0	1	2	1	0	0	1	0	0	1	1
<i>Mougeotia</i>	1	0	10	4	1	2	4	3	1	0	0	1	5	1	6	4	1	1	0	4	2
<i>Closterium</i>	1	0	0	1	1	0	0	1	2	3	1	1	9	6	3	10	1	11	1	0	3
<i>Chlamydomonas</i>	0	1	5	1	1	0	5	1	0	1	1	1	0	0	0	1	1	0	0	0	1
<i>Oedogonium</i>	0	1	5	0	1	0	6	1	0	0	1	1	0	5	1	1	1	8	1	1	1
<i>Ulothrix</i>	0	0	0	1	1	1	1	0	0	1	1	5	7	1	1	1	5	5	1	0	1
<i>Chaetophora</i>	0	0	0	0	1	1	1	1	0	0	1	1	0	0	1	0	0	0	1	1	0
CYANOPHYCEAE																					
<i>Aphanocapsa</i>	8	8	22	0	4	3	0	5	7	6	2	6	0	0	1	5	8	5	1	0	4
<i>Cylindrospermum</i>	2	1	0	0	0	0	1	0	0	1	0	0	0	0	1	3	0	0	1	1	0
<i>Oscillatoria</i>	0	0	14	2	1	4	11	4	7	12	7	6	1	7	8	11	0	0	16	5	6
<i>Nostoc</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	6	0	0
<i>Anabaena</i>	4	3	2	1	0	1	5	0	0	6	6	8	1	9	10	5	0	12	11	0	4
<i>Microcystis</i>	3	3	10	0	5	4	0	0	0	11	7	7	0	5	4	6	19	18	5	1	5
<i>Coelosphaerium</i>	0	0	0	0	0	1	1	1	1	0	0	0	1	0	0	0	4	0	0	0	0
<i>Spirulina</i>	0	0	0	0	0	1	4	1	1	4	0	0	0	5	0	0	2	0	0	0	1
<i>Phormidium</i>	0	1	1	1	1	1	1	1	1	0	0	0	1	0	1	0	0	1	1	1	0
EUGLENOPHYCEAE																					
<i>Euglena</i>	2	2	8	1	1	0	8	1	1	1	5	6	5	0	1	0	0	10	1	1	2
BACILLARIOPHYCEAE																					
<i>Synedra</i>	0	0	0	2	4	3	2	3	8	14	0	0	3	1	6	4	16	11	2	0	4
<i>Pinnularia</i>	1	0	1	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0
<i>Nitzschia</i>	0	0	1	2	3	0	0	1	0	4	6	7	1	19	4	8	10	4	0	0	3
<i>Navicula</i>	1	1	0	0	0	0	1	6	3	5	7	0	4	5	4	13	9	0	1	0	3

Melosira	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Protococcus	1	1	1	1	0	0	7	0	1	4	0	1	0	1	6	0	0	0	1	0	1
BRANCHIOPODA																					
Daphnia	0	0	1	0	0	0	0	1	0	0	0	1	3	4	3	2	0	0	0	2	1
Moina	0	0	0	0	0	0	0	0	0	0	0	5	0	2	3	0	6	2	2	0	1
Eubbranchipus	0	0	0	0	0	0	0	0	6	6	5	0	5	0	4	6	5	6	8	0	2
MAXILLOPODA																					
Cyclops	0	1	0	0	0	2	0	0	0	0	0	0	8	5	6	5	0	16	14	10	3
MONOGONONTA																					
Brachionus	0	2	3	3	2	6	5	7	0	0	5	5	3	0	0	0	3	3	0	2	2
Keratella	0	0	0	0	0	1	0	0	0	0	0	0	0	3	0	0	1	0	0	0	0
EUROTATORIA																					
Filinia	0	1	0	0	0	0	1	0	0	0	0	0	0	9	4	4	3	0	0	0	1

during date on 24/07/2011 to 12/08/2011.

Table no.4.2.4. Plankton abundance (units/ml) in nursery ponds no. 4

[illegible]

<i>Anabaena</i>	1	4	4	2	5	2	4	8	8	4	6	0	0	13	4	2	12	5	4	0	4
<i>Microcystis</i>	1	0	4	10	2	0	3	0	0	0	0	1	1	0	0	11	0	0	0	1	2
<i>Coelosphaerium</i>	1	1	0	0	0	1	0	0	0	0	0	1	1	0	0	0	4	0	0	1	0
<i>Spirulena</i>	1	0	0	0	1	1	0	0	10	0	10	1	13	0	1	0	6	10	1	1	3
<i>Phormidium</i>	1	1	1	0	1	1	1	1	0	1	0	1	1	6	1	0	0	5	1	0	1
EUGLENOPHYCEAE																					
<i>Euglena</i>	1	1	4	0	1	0	5	13	9	7	9	1	1	10	6	1	5	0	1	1	4
BACILLARIOPHYCEAE																					
<i>Synedra</i>	1	1	8	0	23	4	7	10	0	0	5	5	1	0	0	0	1	11	1	1	4
<i>Pinnularia</i>	1	3	0	1	0	1	0	0	2	0	0	1	1	0	0	0	0	0	1	0	0
<i>Nitzschia</i>	1	1	0	1	1	0	3	3	4	0	35	37	4	10	4	2	9	6	1	1	6
<i>Navicula</i>	0	1	5	1	2	0	4	5	3	1	0	0	2	10	8	2	0	4	2	1	2
<i>Melosira</i>	1	1	0	3	0	0	0	0	3	1	0	1	0	2	0	0	0	0	1	1	1
<i>Protococcus</i>	0	1	2	0	0	6	1	0	3	1	0	1	0	7	0	0	1	0	1	1	1
BRANCHIOPODA																					
<i>Daphnia</i>	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0
<i>Moina</i>	0	0	0	0	0	2	2	0	0	5	0	0	0	0	0	0	0	0	0	0	0
<i>Eubranchipus</i>	0	0	0	0	3	0	5	8	0	0	0	0	14	4	0	2	6	7	3	0	2
MAXILLOPODA																					
<i>Cyclops</i>	2	0	25	0	19	0	5	4	8	0	0	0	3	0	8	5	4	20	8	4	6
MONOGONONTA																					
<i>Brachionus</i>	2	0	2	0	0	0	0	0	0	0	5	0	7	0	0	0	0	0	4	3	1
<i>Keratella</i>	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0
EUROTATORIA																					
<i>Filinia</i>	0	0	2	0	0	0	3	0	0	2	3	0	0	12	0	0	8	5	0	0	2

during date on 24/07/2011 to 12/08/2011.

Table no. 4.2.5 Plankton abundance (units/ml) in nursery ponds no. 5

Plankton/ Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Mean
CHLOROPHYCEAE																					
<i>Oocystis</i>	7	0	10	0	0	0	0	5	6	2	0	4	0	8	6	7	12	13	4	0	4
<i>Pediastrum</i>	0	0	3	0	0	0	4	0	0	0	1	0	1	0	0	4	0	0	6	1	1
<i>Tetradon</i>	1	1	0	6	0	0	0	0	10	13	7	5	5	3	5	13	2	0	0	2	4
<i>Selanosterium</i>	1	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	2	0
<i>Botryococcus</i>	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	0	0	1	1	1	1
<i>Scendesmus</i>	1	1	0	0	3	1	2	1	0	0	1	8	1	0	1	1	1	1	3	1	1
<i>Ankistrodesmus</i>	1	1	1	1	1	0	0	3	4	1	9	7	1	1	0	1	1	0	0	1	2
<i>Chlorella</i>	1	0	1	1	1	1	0	0	0	0	8	4	1	0	1	0	1	1	0	1	1
<i>Cosmarium</i>	2	1	1	0	1	0	0	2	0	0	0	0	1	13	1	1	4	2	1	4	2
<i>Spirogyra</i>	0	1	2	1	0	1	4	0	6	1	1	3	1	0	5	0	5	2	1	6	2
<i>Mesotonium</i>	0	1	1	1	1	0	1	0	0	1	7	7	0	0	0	3	1	1	1	0	1
<i>Mougeotia</i>	0	0	1	1	1	1	1	3	17	12	0	8	1	17	1	0	1	1	1	0	3
<i>Closterium</i>	1	0	3	0	1	0	1	5	5	0	0	0	0	0	1	0	1	1	1	0	1
<i>Chlamydomonas</i>	0	1	2	0	1	4	1	1	0	1	1	5	3	0	0	2	1	5	1	5	1
<i>Oedogonium</i>	0	1	0	0	1	0	1	1	1	5	1	0	13	1	0	0	8	0	1	2	2
<i>Ulothrix</i>	1	1	0	1	1	1	1	1	1	0	12	1	9	1	1	1	0	0	1	0	2
<i>Chaetophora</i>	0	1	1	1	1	1	1	1	1	0	1	1	0	1	1	0	1	1	1	0	1
CYANOPHYCEAE																					
<i>Aphanocapsa</i>	4	5	12	2	0	8	4	5	2	7	0	4	0	0	0	3	1	3	0	3	3
<i>Cylendrospermum</i>	2	0	0	0	0	0	1	0	0	1	0	0	6	0	1	0	1	0	1	0	1

<i>Oscillatoria</i>	1	1	7	4	1	4	12	28	27	10	18	7	10	6	5	6	34	3	48	4	11
<i>Nostoc</i>	2	0	0	0	1	0	1	0	0	0	0	1	1	0	0	1	0	13	0	0	1
<i>Anabaena</i>	0	0	13	0	0	1	2	5	6	0	12	6	9	11	3	13	1	0	3	0	4
<i>Microcystis</i>	0	1	10	1	3	1	0	5	0	9	8	0	6	9	5	6	29	0	3	1	5
<i>Coelospharium</i>	0	2	0	1	0	1	0	0	1	0	0	1	0	0	0	0	0	1	0	1	0
<i>Spirulena</i>	0	0	0	1	1	1	0	1	1	1	1	10	10	5	6	1	0	1	1	0	2
<i>Phormidium</i>	0	1	3	1	1	1	5	1	1	0	1	4	0	3	3	1	0	1	2	1	1
EUGLENOPHYCEAE																					
<i>Euglena</i>	0	1	0	1	1	5	0	1	4	5	4	1	12	1	0	1	1	1	2	5	2
BACILLARIOPHYCEAE																					
<i>Synedra</i>	0	1	0	12	0	8	3	5	0	0	18	1	1	1	1	0	5	2	3	0	3
<i>Pinnularia</i>	1	1	1	0	0	0	0	0	1	1		1	0	1	1	1	0	0	0	0	0
<i>Nitzschia</i>	0	1	1	0	0	0	1	2	5	5	15	24	10	3	1	3	10	1	2	1	4
<i>Navicula</i>	0	1	1	4	2	0	2	1	0	0	12	18	4	3	9	4	5	0	1	1	3
<i>Melosira</i>	1	1	1	0	1	1	0	1	0	1	0	0	0	0	0	1	0	0	0	1	0
<i>Protococcus</i>	1	1	4	0	0	4	2	0	6	1	0	8	1	1	2	1	1	5	0	1	2
BRANCHIOPODA																					
<i>Daphnia</i>	0	0	15	4	0	0	0	0	0	1	0	0	0	3	0	5	2	2	0	0	2
<i>Moina</i>	0	0	2	0	0	0	0	2	6	0	0	0	0	6	3	0	4	0	0	0	1
<i>Eubbranchipus</i>	0	17	12	10	3	0	0	0	0	0	0	0	0	6	8	4	4	4	5	6	4
MAXILLOPODA																					
<i>Cyclops</i>	6	88	57	40	0	46	0	0	0	14	57	7	7	15	9	8	1	0	23	3	19
MONOGONONTA																					
<i>Brachionus</i>	0	0	3	2	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	1	1
<i>Keratella</i>	0	0	4	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	1
EUROTATORIA																					
<i>Filinia</i>	0	0	0	0	4	0	3	0	0	0	0	0	6	0	0	0	0	0	0	0	1

during date on 24/07/2011 to 12/08/2011.

Table no.4.2.6. Plankton abundance (units/ml) in nursery ponds no. 6

Plankton/ Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Mean
CHLOROPHYCEAE																					
<i>Oocystis</i>	0	25	0	13	0	11	0	2	6	17	5	0	6	0	6	11	1	0	0	0	5
<i>Pediastrum</i>	4	1	0	0	1	0	0	0	8	8	11	15	0	0	0	0	0	0	1	3	2
<i>Tetradon</i>	1	0	1	1	1	1	1	0	3	6	4	15	0	20	9	6	1	6	10	0	4
<i>Selanostrium</i>	1	0	3	1	1	1	1	1	0	0	0	0	1	0	0	0	2	0	0	0	0
<i>Botryococcus</i>	2	1	0	1	1	2	5	1	0	0	0	0	2	1	0	1	1	0	0	4	1
<i>Scendesmus</i>	1	1	0	0	5	1	1	3	1	1	1	1	1	1	2	1	1	5	1	2	2
<i>Ankistrodesmus</i>	2	1	3	3	1	0	1	3	0	2	1	1	3	1	5	1	1	2	1	4	2
<i>Chlorella</i>	0	0	0	0	0	1	1	1	0	0	1	1	0	3	0	1	0	0	2	3	1
<i>Cosmarium</i>	0	0	0	1	2	1	1	1	7	7	14	1	12	5	0	1	1	0	0	3	3
<i>Spirogyra</i>	1	0	1	0	0	1	1	1	0	0	0	1	7	17	0	1	1	1	1	2	2
<i>Mesotonium</i>	1	2	3	5	0	1	1	0	1	0	0	1	0	0	3	6	6	1	1	0	1
<i>Mougeotia</i>	1	2	3	0	1	3	18	5	2	0	1	1	5	5	0	7	10	1	2	0	3
<i>Closterium</i>	1	0	0	1	1	0	7	0	1	1	1	1	0	0	0	14	0	0	0	0	1
<i>Chlamydomonas</i>	1	0	1	0	1	1	0	3	12	10	1	5	5	0	0	19	0	2	0	0	3
<i>Oedogonium</i>	0	0	1	0	1	1	0	0	0	0	1	10	0	0	0	5	0	2	0	0	1
<i>Ulothrix</i>	0	0	0	0	1	1	1	0	0	0	0	0	0	1	1	8	6	9	6	0	2

<i>Chaetophora</i>	0	1	1	0	1	0	0	0	1	1	0	0	0	2	1	0	0	0	0	0	0
CYANOPHYCEAE																					
<i>Aphanocapsa</i>	8	5	2	23	8	19	3	1	1	8	1	4	3	12	2	0	0	0	10	11	6
<i>Cylendrospermum</i>	4	0	0	0	2	0	0	1	1	0	2	0	0	0	1	6	1	1	0	0	1
<i>Oscillatoria</i>	0	2	4	0	0	63	20	34	1	49	39	19	10	11	11	12	1	30	6	0	15
<i>Nostoc</i>	0	0	1	1	1	1	0	0	1	0	0	0	0	0	0	0	1	0	0	3	0
<i>Anabaena</i>	1	1	3	0	1	0	2	5	5	10	4	35	0	9	7	12	1	2	0	2	5
<i>Microcystis</i>	1	1	0	1	1	5	8	0	1	0	5	9	1	8	9	7	0	24	3	2	4
<i>Coelosphaerium</i>	1	5	1	1	1	1	0	0	1	1	0	0	1	13	5	0	1	0	0	1	2
<i>Spirulena</i>	1	1	1	1	1	1	0	1	1	1	0	15	2	0	0	0	1	0	0	1	1
<i>Phormidium</i>	1	1	1	2	1	19	1	2	1	1	6	0	2	0	0	0	1	0	2	0	2
EUGLENOPHYCEAE																					
<i>Euglena</i>	1	2	2	0	4	1	2	2	3	21	13	13	0	5	8	1	1	1	0	0	4
BACILLARIOPHYCEAE																					
<i>Synedra</i>	4	6	4	32	9	13	1	11	7	1	0	9	0	0	0	1	1	11	2	1	6
<i>Pinnularia</i>	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	1	1	0	0	0	0
<i>Nitzschia</i>	1	0	0	0	0	1	5	0	5	0	1	0	13	1	4	1	10	1	0	1	2
<i>Navicula</i>	1	4	1	1	0	5	1	1	0	0	0	11	7	11	5	1	0	1	1	0	3
<i>Melosira</i>	1	0	1	0	1	3	2	1	2	1	1	4	0	0	7	0	0	5	1	0	1
<i>Protococcus</i>	1	0	3	1	5	0	4	1	0	2	1	8	0	0	0	5	0	0	4	0	2
BRANCHIOPODA																					
<i>Daphnia</i>	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0
<i>Moina</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0	0	1
<i>Eubbranchipus</i>	0	10	12	6	3	8	0	0	0	8	0	0	5	7	8	0	10	0	11	26	6
MAXILLOPODA																					
<i>Cyclops</i>	3	9	9	48	0	6	0	0	0	10	24	54	0	8	8	8	0	0	16	2	10
MONOGONONTA																					
<i>Brachionus</i>	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0
<i>Keratella</i>	0	0	0	0	0	0	0	2	4	3	0	0	12	0	0	0	7	8	0	0	2

during date on 24/07/2011 to 12/08/2011.

EUROTATORIA																							
<i>Filinia</i>	0	0	1	0	0	2	5	0	0	0	0	4	0	0	0	0	0	0	4	3	1		

Table no.4.2.7. Plankton abundance (units/ml) in nursery ponds no. 7 during date on
2

Plankton/ Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Mean
CHLOROPHYCEAE																					
<i>Oocystis</i>	21	7	2	2	0	12	5	21	25	17	0	13	0	26	5	12	3	4	0	3	9
<i>Pediastrum</i>	5	2	0	4	0	0	0	5	5	12	15	15	0	7	0	0	0	0	0	1	3
<i>Tetradon</i>	0	0	1	0	1	6	4	8	0	4	0	12	7	12	0	7	0	5	1	2	3
<i>Selanosterium</i>	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0
<i>Botryococcus</i>	1	1	0	0	1	0	5	0	1	0	0	0	0	0	1	0	1	0	1	0	1
<i>Scendesmus</i>	1	0	3	0	0	2	0	0	6	0	1	7	0	0	2	0	0	7	1	0	1
<i>Ankistrodesmus</i>	1	1	1	0	1	0	0	1	0	0	1	0	1	0	0	5	0	0	1	1	1
<i>Chlorella</i>	0	0	0	1	1	0	0	1	0	0	0	0	1	1	0	0	0	0	1	1	0
<i>Cosmarium</i>	0	1	0	1	1	0	0	6	11	0	1	0	1	9	0	0	5	0	0	1	2
<i>Spirogyra</i>	1	0	0	1	1	1	1	0	0	0	1	0	0	0	7	0	0	0	1	0	1
<i>Mesotonium</i>	1	1	2	1	7	1	1	0	3	0	1	2	1	0	0	5	0	0	6	1	2
<i>Mougeotia</i>	2	2	3	0	8	11	6	0	0	1	0	0	5	7	8	0	0	0	0	1	3
<i>Closterium</i>	1	0	2	1	0	0	0	0	2	0	1	5	5	0	6	0	0	0	0	2	1
<i>Chlamydomonas</i>	1	0	0	0	0	0	4	1	0	1	1	0	0	0	0	0	0	1	0	0	0
<i>Oedogonium</i>	0	1	1	0	0	0	0	1	0	5	1	0	0	12	0	1	0	1	7	1	1
<i>Ulothrix</i>	0	0	0	1	1	0	0	2	1	0	13	0	9	0	12	1	1	1	0	0	2
<i>Chaetophora</i>	1	0	0	2	8	0	0	0	1	0	0	0	0	0	0	0	1	1	0	1	1
CYANOPHYCEAE																					
<i>Aphanocapsa</i>	5	7	3	4	3	12	3	17	13	1	0	1	1	1	6	1	1	5	3	1	4
<i>Cylendrospermum</i>	3	0	2	0	0	0	0	0	0	1	0	1	7	1	0	2	0	1	0	1	1
<i>Oscillatoria</i>	0	11	4	0	0	0	6	32	25	13	0	7	11	5	8	12	7	0	4	1	7
<i>Nostoc</i>	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0
<i>Anabaena</i>	6	0	2	1	1	2	5	13	9	16	11	5	0	6	14	0	0	21	4	10	6
<i>Microcystis</i>	0	0	3	0	4	0	4	0	0	6	0	0	7	13	0	8	9	6	0	2	3
<i>Coelosphaerium</i>	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	11	0	3	0	0	1

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<i>Spirulena</i>	0	0	0	1	0	0	0	0	0	0	0	1	0	0	7	8	0	0	1	0	1
<i>Phormidium</i>	1	0	4	0	2	1	0	2	0	0	1	7	1	0	0	2	0	0	4	0	1
EUGLENOPHYCEAE																					
<i>Euglena</i>	1	0	3	2	2	5	5	0	0	20	0	4	0	10	11	5	6	0	0	1	4
BACILLARIOPHYCEAE																					
<i>Synedra</i>	1	9	7	0	9	14	0	12	7	0	17	0	1	0	0	6	0	0	0	1	4
<i>Pinnularia</i>	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
<i>Nitzschia</i>	1	0	0	1	0	0	5	7	6	6	8	12	6	6	10	7	0	1	7	1	4
<i>Navicula</i>	1	3	1	1	2	12	0	0	6	0	8	0	5	7	0	0	0	1	0	1	2
<i>Melosira</i>	1	0	0	1	0	0	0	0	0	0	0	0	0	0	22	0	0	1	0	1	1
<i>Protococcus</i>	1	0	4	1	0	0	0	0	0	0	0	0	10	8	0	0	0	1	4	6	2
BRANCHIOPODA																					
<i>Daphnia</i>	0	0	1	0	1	3	0	5	0	0	0	0	3	4	1	1	2	0	0	0	1
<i>Moina</i>	4	0	2	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
<i>Eubbranchipus</i>	0	5	1	4	2	0	3	7	0	8	0	0	5	0	8	6	5	5	7	2	3
MAXILLOPODA																					
<i>Cyclops</i>	0	13	2	4	0	12	0	0	0	12	0	0	7	18	7	0	0	0	11	7	5
MONOGONONTA																					
<i>Brachionus</i>	0	6	0	0	4	0	6	3	3	0	0	3	0	0	7	7	0	0	0	5	2
<i>Keratella</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1	0	0
EUROTATORIA																					
<i>Filinia</i>	0	1	0	0	0	0	5	0	0	0	0	0	5	15	0	3	4	4	5	2	2

Table no 4.2.9 Plankton diurnal fluctuation pattern in nursery pond no. 1 on date 02-082011.

CHLOROPHYCEAE	6:00 a.m.	10:00 a.m.	2:00 p.m.	6:00 p.m.	Mean	STDEV
<i>Oocystis</i>	3	8	3	6	5	2.44949
<i>Pediastrum</i>	4	7	4	6	5.25	1.5
<i>Tetradon</i>	1	3	1	5	2.5	1.914854
<i>Selanosterium</i>	1	0	0	0	2.5	0.5
<i>Botryococcus</i>	0	1	0	0	2.5	0.5
<i>Scendesmus</i>	0	1	0	1	0.5	0.57735
<i>Ankistrodesmus</i>	0	0	0	1	0.25	0.5
<i>Chlorella</i>	1	0	1	1	0.75	0.5
<i>Cosmarium</i>	1	1	1	1	1	0
<i>Spirogyra</i>	1	1	0	1	0.75	0.5
<i>Mesotonium</i>	1	1	0	1	0.75	0.57735
<i>Mougeotia</i>	1	1	0	0	0.5	0.5
<i>Closterium</i>	1	1	0	1	0.75	0.5
<i>Chlamydomonas</i>	1	1	0	1	0.75	0.57735
<i>Oedogonium</i>	1	0	0	1	0.5	0.57735
<i>Ulothrix</i>	1	0	0	1	0.5	0.5
<i>Chaetophora</i>	1	1	0	1	0.75	0.433013
CYANOPHYCEAE						
<i>Aphanocapsa</i>	6	10	3	8	6.75	2.986079
<i>Cylindrospermum</i>	0	1	0	0	0.25	0.5
<i>Oscillatoria</i>	7	9	3	6	6.25	2.5
<i>Nostoc</i>	1	0	0	1	0.5	0.57735
<i>Anabaena</i>	5	7	4	6	5.5	1.290994
<i>Microcystis</i>	14	21	16	12	15.75	3.86221
<i>Coelospharium</i>	0	1	0	0	0.25	0.5
<i>Spirulina</i>	0	1	0	1	0.5	0.57735
<i>Phormidium</i>	1	1	0	1	0.75	0.5
EUGLENOPHYCEAE						
<i>Euglena</i>	9	12	6	8	8.75	2.5
BACILLARIOPHYCEAE						
<i>Synedra</i>	0	0	0	1	0.25	0.5
<i>Pinnularia</i>	1	0	0	1	0.5	0.57735
<i>Nitzschia</i>	29	41	13	26	27.25	11.5
<i>Navicula</i>	3	4	2	1	2.5	1.290994
<i>Melosira</i>	1	0	0	1	0.5	0.57735
<i>Protococcus</i>	1	1	0	1	0.75	0.5
BRANCHIOPODA						
<i>Daphnia</i>	0	0	0	0	0	0

<i>Moina</i>	0	0	0	0	0	0
<i>Eubbranchipus</i>	10	6	1	3	5	3.91578
MAXILLOPODA						
<i>Cyclops</i>	0	0	0	2	0.5	1
MONOGONONTA						
<i>Brachionus</i>	0	0	0	0	0	0
<i>Keratella</i>	0	0	0	0	0	0
EUROTATORIA						
<i>Filinia</i>	4	2	0	1	1.75	1.707825

Table no 4.2.10 Plankton diurnal fluctuation pattern in nursery pond no. 2 on date 02-082011.

CHLOROPHYCEAE	6:00 a.m.	10:00 a.m.	2:00 p.m.	6:00 p.m.	Mean	STDEV
<i>Oocystis</i>	0	0	0	0	0	0
<i>Pediastrum</i>	0	0	0	0	0	0
<i>Tetradon</i>	8	11	4	6	7.25	2.986079
<i>Selanosterium</i>	0	0	0	0	0	0
<i>Botryococcus</i>	1	1	0	0	0.5	0.57735
<i>Scendesmus</i>	1	0	0	1	0.5	0.57735
<i>Ankistrodesmus</i>	1	1	0	0	0.5	0.57735
<i>Chlorella</i>	1	0	0	0	0.25	0.5
<i>Cosmarium</i>	6	8	3	7	6	2.160247
<i>Spirogyra</i>	0	0	0	0	0	0
<i>Mesotonium</i>	0	0	0	0	0	0
<i>Mougeotia</i>	0	0	0	0	0	0
<i>Closterium</i>	4	8	3	6	5.25	2.217356
<i>Chlamydomonas</i>	6	10	7	9	8	1.825742
<i>Oedogonium</i>	0	0	0	0	0	0
<i>Ulothrix</i>	0	0	0	0	0	0
<i>Chaetophora</i>	0	0	0	0	0	0
CYANOPHYCEAE						
<i>Aphanocapsa</i>	0	0	0	0	0	0
<i>Cylendrospermum</i>	0	0	0	0	0	0
<i>Oscillatoria</i>	9	11	5	7	8	2.581989
<i>Nostoc</i>	0	0	0	0	0	0
<i>Anabaena</i>	2	3	1	2	2	0.816497
<i>Microcystis</i>	9	14	6	8	9.25	3.40343
<i>Coelospharium</i>	0	0	0	0	0	0
<i>Spirulina</i>	0	0	0	0	0	0
<i>Phormidium</i>	0	0	0	0	0	0

EUGLENOPHYCEAE						
<i>Euglena</i>	1	1	0	0	0.5	0.5774
BACILLARIOPHYCEAE						
<i>Synedra</i>	0	0	0	0	0	0
<i>Pinnularia</i>	0	0	0	0	0	0
<i>Nitzschia</i>	6	8	4	7	6.25	1.707825
<i>Navicula</i>	6	10	3	7	6.5	2.886751
<i>Melosira</i>	0	0	0	0	0	0
<i>Protococcus</i>	0	0	0	0	0	0
BRANCHIOPODA						
<i>Daphnia</i>	0	0	0	0	0	0
<i>Moina</i>	1	0	0	1	0.5	0.57735
<i>Eubbranchipus</i>	7	3	1	4	3.75	2.5
MAXILLOPODA						
<i>Cyclops</i>	14	6	2	8	7.5	5
MONOGONONTA						
<i>Brachionus</i>	0	0	0	0	0	0
<i>Keratella</i>	0	0	0	0	0	0
EUROTATORIA						
<i>Filinia</i>	8	3	2	4	4.25	2.629956

Table no 4.2.11 Plankton diurnal fluctuation pattern in nursery pond no. 3 on date 02-082011.

CHLOROPHYCEAE	6:00 a.m.	10:00 a.m.	2:00 p.m.	6:00 p.m.	Mean	STDEV
<i>Oocystis</i>	0	0	0	0	0	0
<i>Pediastrum</i>	4	6	3	5	4.5	1.290994
<i>Tetradon</i>	5	6	2	5	4.5	1.732051
<i>Selanostrium</i>	0	0	0	0	0	0
<i>Botryococcus</i>	0	0	0	0	0	0
<i>Scendesmus</i>	0	0	0	0	0	0
<i>Ankistrodesmus</i>	1	1	1	1	1	0
<i>Chlorella</i>	1	1	0	1	0.75	0.5
<i>Cosmarium</i>	1	1	0	0	0.5	0.57735
<i>Spirogyra</i>	5	6	2	1	3.5	2.380476
<i>Mesotonium</i>	0	0	0	0	0	0
<i>Mougeotia</i>	0	0	0	0	0	0
<i>Closterium</i>	3	5	3	2	3.25	1.258306
<i>Chlamydomonas</i>	1	1	0	0	0.5	0.57735
<i>Oedogonium</i>	0	0	0	0	0	0
<i>Ulothrix</i>	1	1	0	0	0.5	0.57735

<i>Chaetophora</i>	0	0	0	0	0	0
CYANOPHYCEAE						
<i>Aphanocapsa</i>	5	9	3	8	6.25	2.753785
<i>Cylindrospermum</i>	1	1	0	0	0.5	0.57735
<i>Oscillatoria</i>	11	15	9	14	12.25	2.753785
<i>Nostoc</i>	0	0	0	0	0	0
<i>Anabaena</i>	4	8	3	7	5.5	2.380476
<i>Microcystis</i>	11	13	8	12	11	2.160247
<i>Coelospharium</i>	1	0	0	0	0.25	0.5
<i>Spirulina</i>	4	6	2	4	4	1.632993
<i>Phormidium</i>	0	0	0	0	0	0
EUGLENOPHYCEAE						
<i>Euglena</i>	1	1	0	0	0.5	0.57735
BACILLARIOPHYCEAE						
<i>Synedra</i>	11	20	9	16	14	4.966555
<i>Pinnularia</i>	0	0	0	0	0	0
<i>Nitzschia</i>	3	5	2	4	3.5	1.290994
<i>Navicula</i>	3	8	2	6	4.75	2.753785
<i>Melosira</i>	0	0	0	0	0	0
<i>Protococcus</i>	2	5	3	4	3.5	1.290994
BRANCHIOPODA						
<i>Daphnia</i>	0	0	0	0	0	0
<i>Moina</i>	0	0	0	0	0	0
<i>Eubbranchipus</i>	7	5	4	6	5.5	1.290994
MAXILLOPODA						
<i>Cyclops</i>	0	0	0	0	0	0
MONOGONONTA						
<i>Brachionus</i>	0	0	0	0	0	0
<i>Keratella</i>	0	0	0	0	0	0
EUROTATORIA						
<i>Filinia</i>	0	0	0	0	0	0

Table no. 4.2.12 Plankton diurnal fluctuation pattern in nursery pond no. 4 on date 02-082011.

CHLOROPHYCEAE	6:00 a.m.	10:00 a.m.	2:00 p.m.	6:00 p.m.	Mean	STDEV
<i>Oocystis</i>	0	0	0	0	0	0
<i>Pediastrum</i>	0	1	1	1	0.75	0.5
<i>Tetraderon</i>	0	1	0	0	0.25	0.5
<i>Selanosterium</i>	1	1	1	1	1	0
<i>Botryococcus</i>	0	1	0	1	0.5	0.57735

<i>Scendesmus</i>	1	0	0	1	0.5	0.57735
<i>Ankistrodesmus</i>	1	1	0	0	0.5	0.57735
<i>Chlorella</i>	11	18	10	16	13.75	3.86221
<i>Cosmarium</i>	0	0	0	0	0	0
<i>Spirogyra</i>	0	0	0	0	0	0
<i>Mesotonium</i>	11	19	12	16	14.5	3.696846
<i>Mougeotia</i>	0	0	0	0	0	0
<i>Closterium</i>	0	0	0	0	0	0
<i>Chlamydomonas</i>	20	26	11	19	19	6.164414
<i>Oedogonium</i>	0	0	0	0	0	0
<i>Ulothrix</i>	0	0	0	0	0	0
<i>Chaetophora</i>	0	0	0	0	0	0
CYANOPHYCEAE						
<i>Aphanocapsa</i>	4	6	2	3	3.75	1.707825
<i>Cylendrospermum</i>	0	0	0	0	0	0
<i>Oscillatoria</i>	12	27	13	19	17.75	6.898067
<i>Nostoc</i>	0	0	0	0	0	0
<i>Anabaena</i>	3	5	2	4	3.5	1.290994
<i>Microcystis</i>	0	0	0	0	0	0
<i>Coelospharium</i>	0	0	0	0	0	0
<i>Spirulina</i>	0	0	0	0	0	0
<i>Phormidium</i>	1	1	0	0	0.5	0.57735
EUGLENOPHYCEAE						
<i>Euglena</i>	8	10	3	7	7	2.94392
BACILLARIOPHYCEAE						
<i>Synedra</i>	0	0	0	0	0	0
<i>Pinnularia</i>	0	0	0	0	0	0
<i>Nitzschia</i>	0	0	0	0	0	0
<i>Navicula</i>	1	1	1	1	1	0
<i>Melosira</i>	1	0	1	1	0.75	0.5
<i>Protococcus</i>	1	0	1	1	0.75	0.5
BRANCHIOPODA						
<i>Daphnia</i>	0	0	0	0	0	0
<i>Moina</i>	9	3	2	6	5	3.162278
<i>Eubbranchipus</i>	0	0	0	0	0	0
MAXILLOPODA						
<i>Cyclops</i>	0	0	0	0	0	0
MONOGONONTA						
<i>Brachionus</i>	0	0	0	0	0	0
<i>Keratella</i>	0	0	0	0	0	0
EUROTATORIA						
<i>Filinia</i>	4	2	1	2	2.25	1.258306

Table no. 4.2.13 Plankton diurnal fluctuation pattern in nursery pond no. 5 on date 02-082011.

CHLOROPHYCEAE	6:00 a.m.	10:00 a.m.	2:00 p.m.	6:00 p.m.	Mean	STDEV
<i>Oocystis</i>	2	3	1	2	2	0.816497
<i>Pediastrum</i>	0	0	0	0	0	0
<i>Tetraderron</i>	11	17	10	14	13	3.162278
<i>Selanosterium</i>	0	0	0	0	0	0
<i>Botryococcus</i>	1	1	1	1	1	0
<i>Scendesmus</i>	0	0	0	0	0	0
<i>Ankistrodesmus</i>	1	1	1	1	1	0
<i>Chlorella</i>	0	0	0	0	0	0
<i>Cosmarium</i>	0	0	0	0	0	0
<i>Spirogyra</i>	0	1	0	1	0.5	0.57735
<i>Mesotonium</i>	1	1	1	1	1	0
<i>Mougeotia</i>	11	16	8	12	11.75	3.304038
<i>Closterium</i>	0	0	0	0	0	0
<i>Chlamydomonas</i>	1	1	0	1	0.75	0.5
<i>Oedogonium</i>	4	6	3	5	4.5	1.290994
<i>Ulothrix</i>	0	0	0	0	0	0
<i>Chaetophora</i>	0	0	0	0	0	0
CYANOPHYCEAE						
<i>Aphanocapsa</i>	6	9	5	7	6.75	1.707825
<i>Cylindrospermum</i>	1	1	1	1	1	0
<i>Oscillatoria</i>	11	13	7	9	10	2.581989
<i>Nostoc</i>	0	0	0	0	0	0
<i>Anabaena</i>	0	1	0	0	0.25	0.5
<i>Microcystis</i>	8	12	6	9	8.75	2.5
<i>Coelosphaerium</i>	0	0	0	0	0	0
<i>Spirulina</i>	1	1	1	1	1	0
<i>Phormidium</i>	0	0	0	0	0	0
EUGLENOPHYCEAE						
<i>Euglena</i>	4	7	2	5	4.5	2.081666
BACILLARIOPHYCEAE						
<i>Synedra</i>	0	0	0	0	0	0
<i>Pinnularia</i>	1	0	0	1	0.5	0.57735
<i>Nitzschia</i>	4	6	3	5	4.5	1.290994
<i>Navicula</i>	0	0	0	0	0	0
<i>Melosira</i>	1	2	0	1	1	0.816497
<i>Protococcus</i>	1	1	0	1	0.75	0.5

BRANCHIOPODA						
<i>Daphnia</i>	2	1	0	1	1	0.816497
<i>Moina</i>	0	0	0	0	0	0
<i>Eubbranchipus</i>	0	0	0	0	0	0
MAXILLOPODA						
<i>Cyclops</i>	20	13	7	15	13.75	5.377422
MONOGONONTA						
<i>Brachionus</i>	9	5	3	6	5.75	2.5
<i>Keratella</i>	0	0	0	0	0	0
EUROTATORIA						
<i>Filinia</i>	0	0	0	0	0	0

Table no. 4.2.14 Plankton diurnal fluctuation pattern in nursery pond no. 6 on date 02-082011.

CHLOROPHYCEAE	6:00 a.m.	10:00 a.m.	2:00 p.m.	6:00 p.m.	Mean	STDEV
<i>Oocystis</i>	16	21	10	19	16.5	4.795832
<i>Pediastrum</i>	7	11	4	9	7.75	2.986079
<i>Tetraderon</i>	3	7	5	7	5.5	1.914854
<i>Selanosterium</i>	0	0	0	0	0	0
<i>Botryococcus</i>	0	0	0	0	0	0
<i>Scendesmus</i>	2	1	0	0	0.75	0.957427
<i>Ankistrodesmus</i>	3	3	1	2	2.25	0.957427
<i>Chlorella</i>	0	0	0	0	0	0
<i>Cosmarium</i>	7	10	4	8	7.25	2.5
<i>Spirogyra</i>	0	0	0	0	0	0
<i>Mesotonium</i>	0	0	0	0	0	0
<i>Mougeotia</i>	0	0	0	0	0	0
<i>Closterium</i>	1	1	0	0	0.5	0.57735
<i>Chlamydomonas</i>	10	12	7	9	9.5	2.081666
<i>Oedogonium</i>	0	0	0	0	0	0
<i>Ulothrix</i>	0	0	0	0	0	0
<i>Chaetophora</i>	1	1	0	0	0.5	0.57735
CYANOPHYCEAE						
<i>Aphanocapsa</i>	8	10	5	8	7.75	2.061553
<i>Cylendrospermum</i>	0	0	0	0	0	0
<i>Oscillatoria</i>	47	60	35	52	48.5	10.47219
<i>Nostoc</i>	0	0	0	0	0	0
<i>Anabaena</i>	10	12	7	9	9.5	2.081666
<i>Microcystis</i>	0	0	0	0	0	0
<i>Coelospharium</i>	2	1	0	0	0.75	0.957427

<i>Spirulena</i>	2	1	0	0	0.75	0.957427
<i>Phormidium</i>	1	2	0	1	1	0.816497
EUGLENOPHYCEAE						
<i>Euglena</i>	22	27	14	19	20.5	5.446712
BACILLARIOPHYCEAE						
<i>Synedra</i>	1	1	1	1	1	0
<i>Pinnularia</i>	0	0	0	0	0	0
<i>Nitzschia</i>	0	0	0	0	0	0
<i>Navicula</i>	0	0	0	0	0	0
<i>Melosira</i>	2	1	0	0	0.75	0.957427
<i>Protococcus</i>	2	2	0	2	1.5	1
BRANCHIOPODA						
<i>Daphnia</i>	0	0	0	0	0	0
<i>Moina</i>	0	0	0	0	0	0
<i>Eubbranchipus</i>	10	7	4	9	7.5	2.645751
MAXILLOPODA						
<i>Cyclops</i>	10	13	6	9	9.5	2.886751
MONOGONONTA						
<i>Brachionus</i>	0	0	0	0	0	0
<i>Keratella</i>	5	3	1	2	2.75	1.707825
EUROTATORIA						
<i>Filinia</i>	0	0	0	0	0	0

Table no. 4.2.15 Plankton diurnal fluctuation pattern in nursery pond no. 7 on date 02-082011.

CHLOROPHYCEAE	6:00 a.m.	10:00 a.m.	2:00 p.m.	6:00 p.m.	Mean	STDEV
<i>Oocystis</i>	18	21	10	17	16.5	4.654747
<i>Pediastrum</i>	11	15	9	14	12.25	2.753785
<i>Tetraderon</i>	4	5	3	5	4.25	0.957427
<i>Selanosterium</i>	0	0	0	0	0	0
<i>Botryococcus</i>	0	0	0	0	0	0
<i>Scendesmus</i>	0	0	0	0	0	0
<i>Ankistrodesmus</i>	0	0	0	0	0	0
<i>Chlorella</i>	0	0	0	0	0	0
<i>Cosmarium</i>	0	0	0	0	0	0
<i>Spirogyra</i>	0	0	0	0	0	0
<i>Mesotonium</i>	0	0	0	0	0	0
<i>Mougeotia</i>	1	1	0	0	0.5	0.57735
<i>Closterium</i>	0	1	0	0	0.25	0.5
<i>Chlamydomonas</i>	1	1	0	1	0.75	0.5

<i>Oedogonium</i>	6	8	3	4	5.25	2.217356
<i>Ulothrix</i>	0	0	0	0	0	0
<i>Chaetophora</i>	0	0	0	0	0	0
CYANOPHYCEAE						
<i>Aphanocapsa</i>	1	1	0	0	0.5	0.57735
<i>Cylindrospermum</i>	0	1	0	1	0.5	0.57735
<i>Oscillatoria</i>	12	16	8	15	12.75	3.593976
<i>Nostoc</i>	0	0	0	0	0	0
<i>Anabaena</i>	17	21	11	16	16.25	4.112988
<i>Microcystis</i>	6	8	4	7	6.25	1.707825
<i>Coelospharium</i>	0	0	0	0	0	0
<i>Spirulena</i>	0	0	0	0	0	0
<i>Phormidium</i>	0	0	0	0	0	0
EUGLENOPHYCEAE						
<i>Euglena</i>	21	27	13	19	20	5.773503
BACILLARIOPHYCEAE						
<i>Synedra</i>	0	0	0	0	0	0
<i>Pinnularia</i>	0	0	0	0	0	0
<i>Nitzschia</i>	6	8	3	5	5.5	2.081666
<i>Navicula</i>	0	0	0	0	0	0
<i>Melosira</i>	0	0	0	0	0	0
<i>Protococcus</i>	0	0	0	0	0	0
BRANCHIOPODA						
<i>Daphnia</i>	0	0	0	0	0	0
<i>Moina</i>	0	0	0	0	0	0
<i>Eubbranchipus</i>	11	9	5	8	8.25	2.5
MAXILLOPODA						
<i>Cyclops</i>	15	11	7	13	11.5	3.41565
MONOGONONTA						
<i>Brachionus</i>	0	0	0	0	0	0
<i>Keratella</i>	0	0	0	0	0	0
EUROTATORIA						
<i>Filinia</i>	0	0	0	0	0	0

Table 4.3.9: List of Phytoplanktons and Zooplanktons in 7 nurseries ponds of I.G.K.V. Fish farm Raipur, Chhattisgarh and their taxonomic position

Phytoplankton Group	Family	Genera with its identifying Characters
Division- Chlorophyta		
Class- Chlorophyceae		
Order- Chlorococcales	Oocystaceae	<i>Oocystis</i> Cells usually free floating solitary or enclosed within the expanded mother cell membrane to form temporary colonies; cells spherical, ovoid, ellipsoid, fusiform or cylindrical with rounded or pointed ends; cell wall smooth or with conspicuous nodular thickening at the poles, rarely granular, chloroplast one or more parietal, disc- shaped, laminate, irregularly setellate or reticulate and with or without pyrenoids , reproduction by formation of autospores.
		<i>Chlorella</i> Cells small, spherical to broadly elliposed, solitary or aggregated in small colonies of irregular shape; free living or symbiotic; chloroplast usually single, parietal, cup-shaped or laminate, rarely reticulate and usually with a pyrenoid not always clear.
	Hydrodictyaceae	<i>Pediastrum</i> Nonmotile, multinucleated cells that can form a flat colony one cell thick. Individual cells form together with at least 4 cells up to 128 cells in concentric rings making a flat plate that resembles a snowflake. Cells can be cone like or polyhedral with protrusions.

		<i>Tetraedron</i> Cells solitary, free floating, flat, isodiametric or twisted, triangular, quadrate or polyangular; angles simple, with or without spines; cell wall smooth granular or verrucose; chloroplasts one to many, parietal or disciform and with or without pyrenoids.
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	Scendesmaceae	<i>Scenedesmus</i> Colony generally a flat (rarely curved), cells acicular, ellipsoid, avoid or cylindrical, arranged in one or two rows and in lateral contact; cell wall smooth or granulate, with or without lateral ridges, lateral teeth or spines; chloroplast single and parietal and often filling the cell, and with a single pyrenoids.
	Selennastraceae	<i>Selenastrum</i> Free floating colonies made up of 4-8-16 cells usually without an outer mucilaginous envelope; sometimes, several such groups joined together to form larger colonies containing as many as 100 or more cells; cells semi-lunar, acicular or spirally twisted, joined to each other by their convex sides.
		<i>Ankistrodesmus</i> Unicells or colonies of loosely bound unicells. Fiber-shaped cells are either straight, bent, or spiral. Needle like, sometimes curving. Unicellular but can be found in clusters or twining around one another.

	Batryococcaceae	<i>Botryococcus</i> Free floating colonies of irregularly spherical or indefinite shape with the cells arranged densely and more or less radially within a gelatinous tough membrane which is sometimes folded or wrinkled; colonies usually with cells in several net like aggregates that or connected by broad or delicate strands of tough mucilage.
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Order- Zygnematales	Zygnemataceae	<i>Mougeotia</i> Filaments unbranched with cylindrical cells; vegetative cells uninucleate 5-20 times longer than broad with plan and walls; each vegetative cell consisting of one axial, flat plate like chloroplast with several pyrenoids arranged in row, reproduction by fragmentation.
		<i>Spirogyra</i> The spiral chloroplast is the defining characteristic of this species. It grows to form slimy filamentous masses of algae. It is capable of reproducing both sexually and asexually. A filament may fragment into smaller pieces, each one capable of forming new cells.

	Desmidiaceae	<i>Closterium</i> Unicellular lunate desmids with two large chloroplasts, one per semicell. Lack an isthmus (found in many desmid genera). Near each cell terminus is a transparent spherical or elongate vacuole containing from one to many granules that may act as gravity sensors. Some species "walk" by tumbling end over end across substrates
	Mesotaeniceae	<i>Cosmarium</i> Single-celled placoderm. The cells are deeply divided in the middle which holds the nucleus. The two semicells are rounded when views from the front and flattened, oval, or elliptic when viewed from the side. The older half of the cell wall secretes mucilage. <i>Mesotonium</i> Plant like body may be unicellular, colloidal or filamentous. Usually green due to the dominance of pigments like chlorophyll A Or B. The chloroplast may be discoid, cupshaped, spiral or ribbon shaped in different species.
Order- Volvocales	Chlamydomonadaceae	<i>Chlamydomonas</i> Cells spherical or hemispherical, oval or ovoid, ellipsoidal or cylindrical or spindle-shaped, motile; cell wall smooth, thin or thick, with or without an anterior papilla, sometimes longitudinally striated; protoplast with the same shape as the cell.

Order- Oedogoniales	Oedogoniaceae	<i>Oedogonium</i> Filamentous unbranched , attached when young, but frequently free floating when older; vegetative cells usually cylindrical, sometimes capitellate or dolioform, rarely hexagonal or with the sides nodulose or unulate cell wall usually smooth.
Order-Ulothricales	Ulothrichaceae	<i>Ulothrix</i> Attached unbranched trichomes. Cylindrical to barrel-shaped cells contain one parietal "wrap-around", "napkin-ring" chloroplast and one or more pyrenoids. Cell walls either thin or thick with H-shaped pieces and lamellate. Cross-walls are flat, providing maximal contact between adjacent cells.
Order Chaetophorales	Chaetophoraceae	<i>Chaetophora</i> Branching green trichomes with one parietal "wrap-around", "napkin-ring" chloroplast per cell. Cross-walls are flat, providing maximal contact between adjacent cells. Motile stages produced from peripheral cells, zoospores quadriflagellate and gametes biflagellate and isogamous.
Division- Cyanophyta		
Class- Cyanophyceae		

Order- Chroococcales	Chroococcaceae	<i>Aphanocapsa</i> A globular, ovate, or sometimes amorphous mass, gelatinous and free –floating, in which spherical, cells are usually widely and evenly distributed through a yellowish or hyaline, homogenous colonial mucilage;
		<i>Microcystis</i> Cells spherical or elongated, many in spherical, ellipsoidal or irregularly overlapping or net like colony, free swimming, often with attached daughter colonies, cells in homogenous colourless.
	Merismopediaceae	<i>Coelosphaerium</i> Spherical to oval colonies of cells held in a single outer layer of the mucilage. Usually colorless or black in the presence of gas vesicles.
	Oscillatoriaceae	<i>Oscillatoria</i> Trichomes (usually no sheath except under some stress), slight if at all ' <i>eingeschnurt</i> ' ('incut' at cross walls between cells). Rigid and straight trichomes, or flexible and bending. Variable cell length and width (at least 2 - 20 µm) and length/width ratio (at least 0.1 - 10).
Order- Nostocales		

		<i>Phormidium</i> Trichome lacking heterocysts, not tapered, and having a sheath extending beyond the end of the trichomes.
		<i>Spirulina</i> Helical trichome with variable coils from tight to loose. Variable cell length and width (at least 2 - 20 µm) and length/width ratio (at least 0.1 - 10). Difficult to see crosswalls with standard light microscopy, but can be demonstrated with electron microscopy.
	Nostocaceae	<i>Nostoc</i> Spherical colonies of twisted trichomes enveloped within a firm gelatinous matrix that can be yellow, brown or black. Colonies can reach large sizes (up to 30 cm in diameter). Macroscopically they would be seen as colonies. <i>Cylindrospermum</i> Thallus mucilaginous, mostly dull blue green; trichome uniformly broad, short, without sheath, but in common mostly very delicate and often imperceptible, mucilage of thin

		consistency; cells cylindrical, constricted at the cross- wall.
		Anabaena Trichomes with spherical cells and intercalary heterocysts (frequency varies inversely with available dissolved nitrogen mainly as nitrate, nitrite or ammonium ions). Occasionally a "watery" sheath forms, although in this key it is classified as having no visible sheath. Staining is needed to see the thin sheaths when present.
Division- Bacillariophyta		
Class- Bacillariophyceae		
Order- Pennales	Fragilariaceae	Fragilaria Cells are oblong and swollen in the center in girdle view where they are linked together to form a ribbon like colony. Valves are linear and elliptical with rounding at the edges. There is often a space between each cell on each side of the swollen center where cell is connected. Most common in girdle view.
		Synedra The frustules are usually narrow and many times longer than broad; they may solitary

		and free floating colonies, in radiate free floating colonies, or epiphytic and in radiating or fan shaped colonies that are either sessile or attached to the host by a gelatinous salk.
	Naviculaceae	<i>Navicula</i> Cells are solitary and are elliptical to lanceolate in shape with rounded, flat, or capititate ends. Striations vary and may or may not be visible under light microscope. The central area may be thickened but without a banded stauros shape. Most species are found in valve view, but can be found in girdle view. Each cell contains two plastids that are pushed against the girdle of the frustule.

		<i>Pinnularia</i> Unicellular diatom, bilaterally symmetric, with relatively pronounced "costae" (thickened silica rows) between striations bearing two or three rows of punctae. A relatively large pennate diatom.

	Nitzschiaceae	<i>Nitzschia</i> The cells are usually elongated and in valve view its outline can vary widely. The valves can be straight to sigmoid and can lie in either valve or girdle view. In valve view the center can be slightly swollen with rounded edges at each pole. The keeled margin on one valve faces the margin of the other cell with no keel and the keel appears to cross the cell diagonally. Striations occur along the valve face of the cell.
Order- Centrales	Coscinoidiscaceae	<i>Melosira</i> Cylindrical cells with length greater than width. The valves can be either flat or convex. Convex forms can have a small ring of teeth along with a gelatinous cushion in the center of the valve face that help individual cells form chains. <i>Melosira</i> appears circular in valve view. There is annular constriction (sulcus) at the girdles of half-cells.
Order- Cheatophorales	Cheatophoraceae	<i>Protococcus</i> A thin green covering on the moist, shaded side of trees, rocks, and soil. The spherical cells, either solitary or clumped together, have heavy cell walls that protect the cells against excessive water loss. Each cell contains a large dense chloroplast, either lobed or plate-shaped. Reproduction is by vegetative cell division only.
Division- Euglenophyta		
Class- Euglenophyceae		

Order- Euglenales	Euglenaceae	<i>Euglena</i> Free swimming unicell with one emerging flagellum. Cells are spindle-shaped, cylindrical in cross-section, although most species can change cell shape by contraction, a process called metaboly.
Zooplankton - Group		
Class - Branchiopoda		
Order- Cladocera	Daphnidae	<i>Daphnia</i> Head moderate in size and prolonged into a head spine; eyes moderate in size small oculus present; carapace broad interiorly but tapers at posterior. Dorsal edge of carapace almost straight in young specimens while ventral curved. Shell spinules present only on posterior half of ventral edge of carapace and continue on both sides of prominent shell spine.
	Moinidae	<i>Moina</i> Body ovate, valves serrated, head large; antennules long slender and curved post abdomen extended into blunt process on which abdominal setae are borne, pre-anal part semi elliptical with numerous spinules along convex edge and many fine hair,

Order -Anostraca	Chiroptidae	<i>Eubranchipus</i> Usually small; with short body (number of segments varies), reduced, unsegmented antennule, leaf-like thoracic legs with epipodal gills; maxillae small, 2nd maxillae often absent; without abdominal appendages except caudal furca; characteristic nauplius larva with numerous segments and further appendages added at each molt; carapace (when present) forms bivalved shell; compound eyes in combination with simple eyes usually present.
Class - Maxillopoda		
Order – Cyclopoida	Cyclopidae	<i>Cyclops</i> Body slender, cephalothorax oval, much broader than abdomen, Antennules 17-segmented, last two segments together longer than previous three, last segment with smooth hyaline membrane.
Class - Monogonota		
Order- Ploimida	Brachionidae	<i>Brachionus</i> Lorica barrel-shaped, anterior dorsal margin with six well-developed spines, median longest, curved outward, and laterals slightly divergent. Postero-laterally two stout and parallel lateral spines usually present but their length varies. The ventro-posterior portion of the lorica forms a typical tubular sheath surrounding the foot opening.

		<i>Keratella</i> Antero-dorsal margin with 6 spines, medians longest intermediates shorts, mental edge bifurcate, posterior spines unequal in size, width of lorica at bases of posterior spines smaller than width at occipital margin.
Class - Euratatoria		
Order- Flosculariaceae	Trochosphaeridae	<i>Filinia</i> Lorica thin, flexible, barrel shaped, spines long seta form extensions of cuticle, movable, two long antero-lateral spines and one long posterior spine may be terminal or lateral in position.

Daily basis metrological data of Chhattisgarh (24/07/2011 to 12/08/2011).

Date	Max temp (°c)	Min temp (°c)	Rainfall (mm)	Relative humidity (%)		Vapour pressure (mm)		Wind velocity (km/ph)	Evapo ration (mm)	Sunshine (hours)	Total rainfall (mm)
				I	II	I	II				
24/07/2011	26.8	24.0	000.0	87	68	20.6	21.5	03.9	03.4	00.3	624.1
25/07/2011	30.8	25.8	000.0	89	63	23.2	21.9	00.03	03.4	00.8	624.1
26/07/2011	32.4	25.5	000.0	84	58	22.5	21.3	00.2	04.2	05.6	624.1
27/07/2011	32.7	25.9	000.0	87	62	24.2	22.8	03.2	04.5	07.9	624.1
28/07/2011	33.5	26.5	000.0	91	62	25.2	24.6	04.4	04.9	09.1	624.1
29/07/2011	34.6	26.2	000.0	89	76	24.9	24.6	03.7	05.4	08.0	624.1
30/07/2011	34.6	25.5	016.4	92	73	23.8	26.6	04.6	04.4	05.7	640.5
31/07/2011	32.6	26.8	000.0	89	64	25.2	24.9	03.0	04.0	08.2	640.5
01/08/2011	34.0	27.0	000.0	87	70	24.2	24.6	01.4	05.8	09.9	640.5
02/08/2011	33.0	26.6	000.0	90	73	24.5	25.8	01.5	04.7	07.2	640.5
03/08/2011	32.0	25.0	053.2	92	82	23.8	25.2	01.5	04.4	03.8	693.7
04/08/2011	30.3	24.4	005.0	100	93	22.9	23.6	06.2	04.4	02.1	698.7
05/08/2011	28.8	25.4	000.4	93	85	23.2	24.1	08.1	02.0	01.0	699.1
06/08/2011	25.0	25.5	006.2	93	90	22.7	24.8	07.3	03.0	00.2	705.3
07/08/2011	28.6	25.5	001.0	89	74	22.9	23.1	09.3	02.4	00.1	706.3
08/08/2011	30.0	24.5	016.2	95	78	22.5	23.2	06.0	03.0	02.6	722.5
09/08/2011	29.6	25.0	000.0	90	82	22.0	23.8	05.6	03.8	00.1	722.5
10/08/2011	29.0	23.9	030.0	100	84	22.9	23.1	05.5	03.6	01.0	752.5
11/08/2011	28.0	24.5	009.6	100	85	23.8	24.1	00.7	01.9	00.0	762.1
12/08/2011	28.3	24.0	030.0	98	82	23.2	22.8	01.4	03.1	00.0	792.1

Source: Department of Agricultural Meteorology I.G.K.V. Raipur, Chhattisgarh.
Station: Labhandi Raipur.

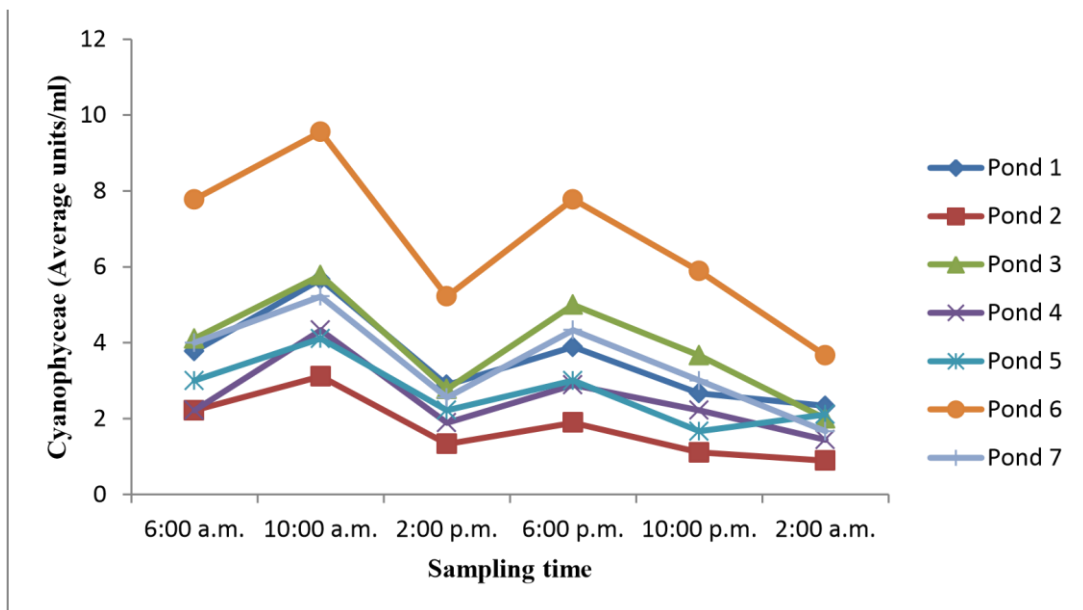
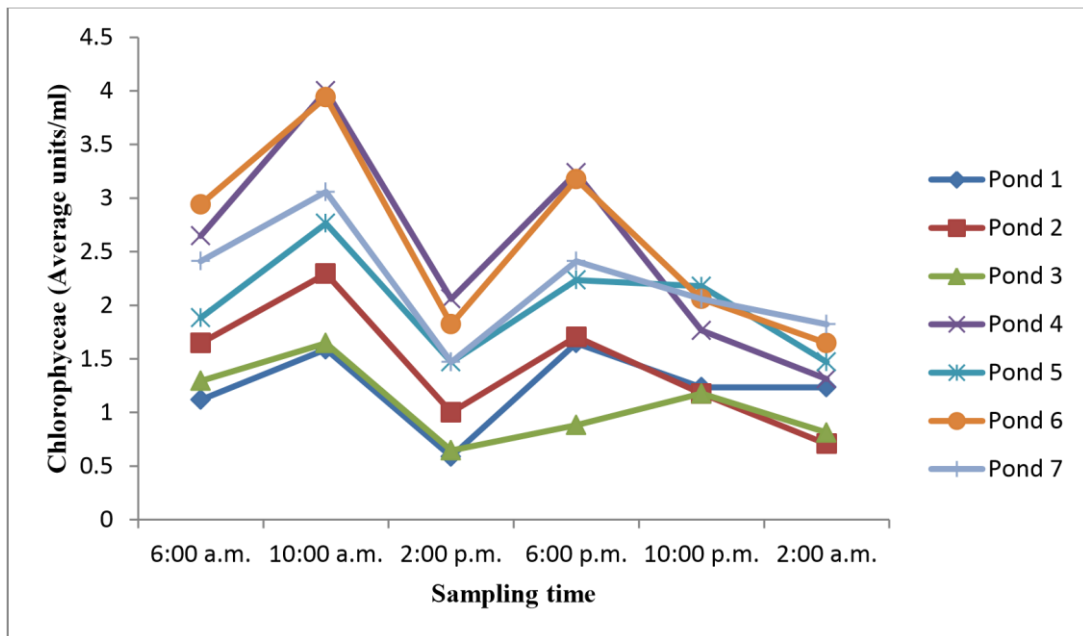


Plate 4.3.1: Diurnal fluctuation of plankton population (group wise) in the nursery ponds

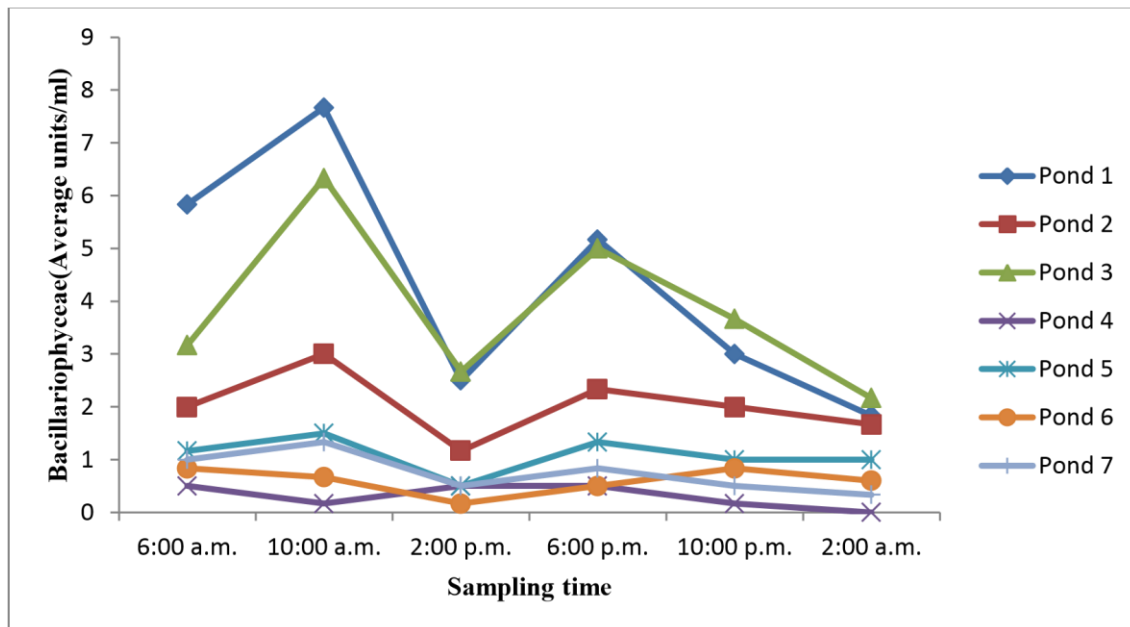
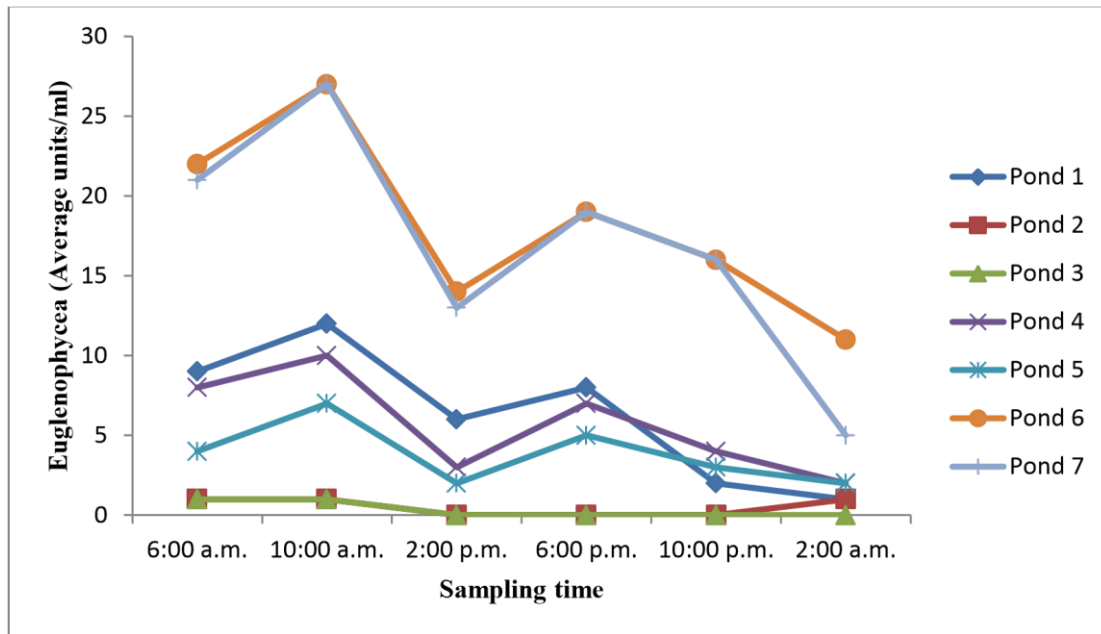


Plate 4.3.1 (contd.): Diurnal fluctuation of plankton population (group wise) in the nursery ponds

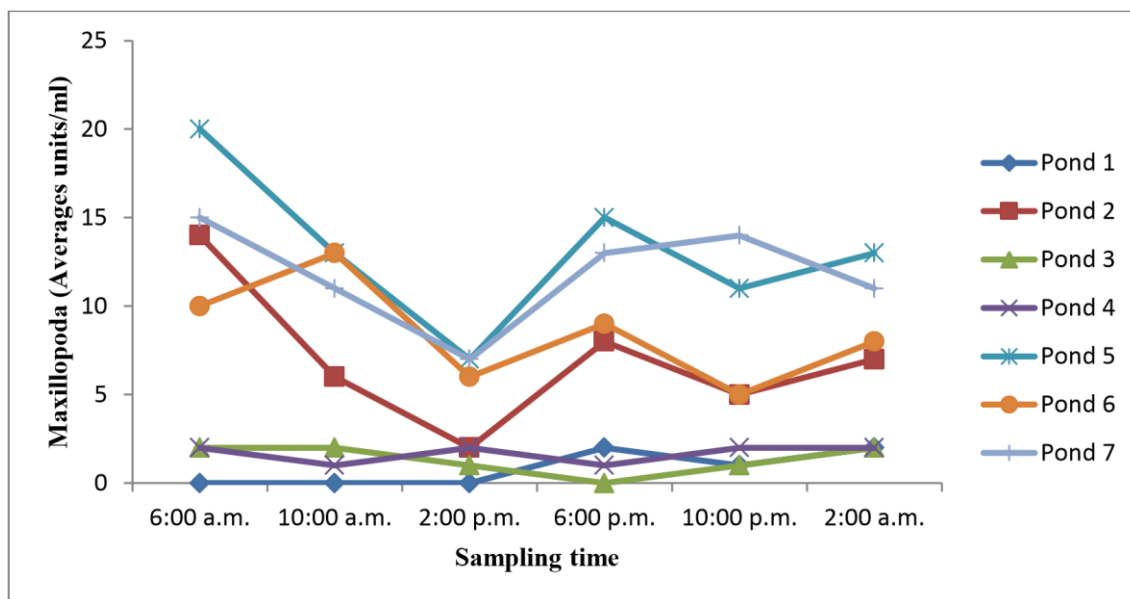
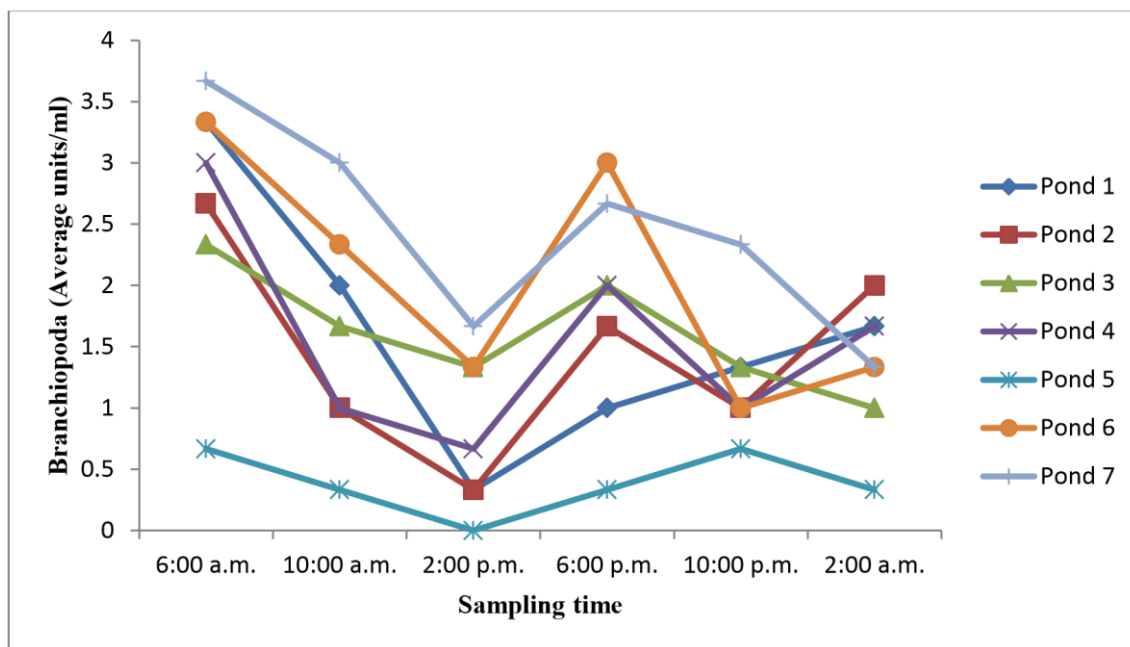


Plate 4.3.1 (contd.): Diurnal fluctuation of plankton population (group wise) in the nursery ponds

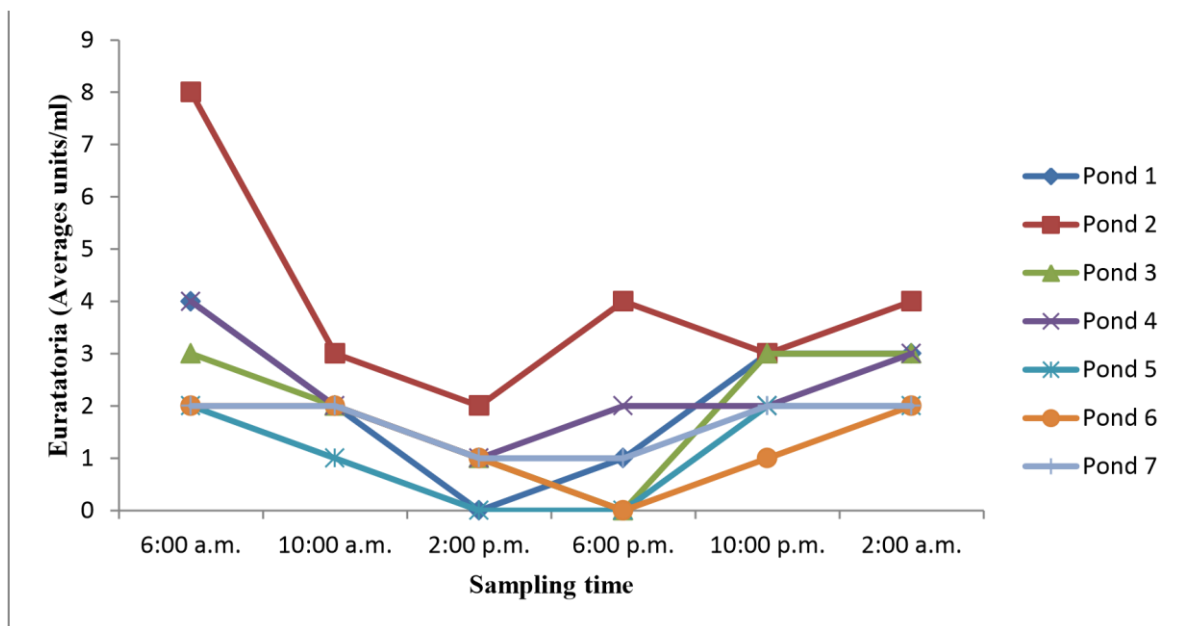
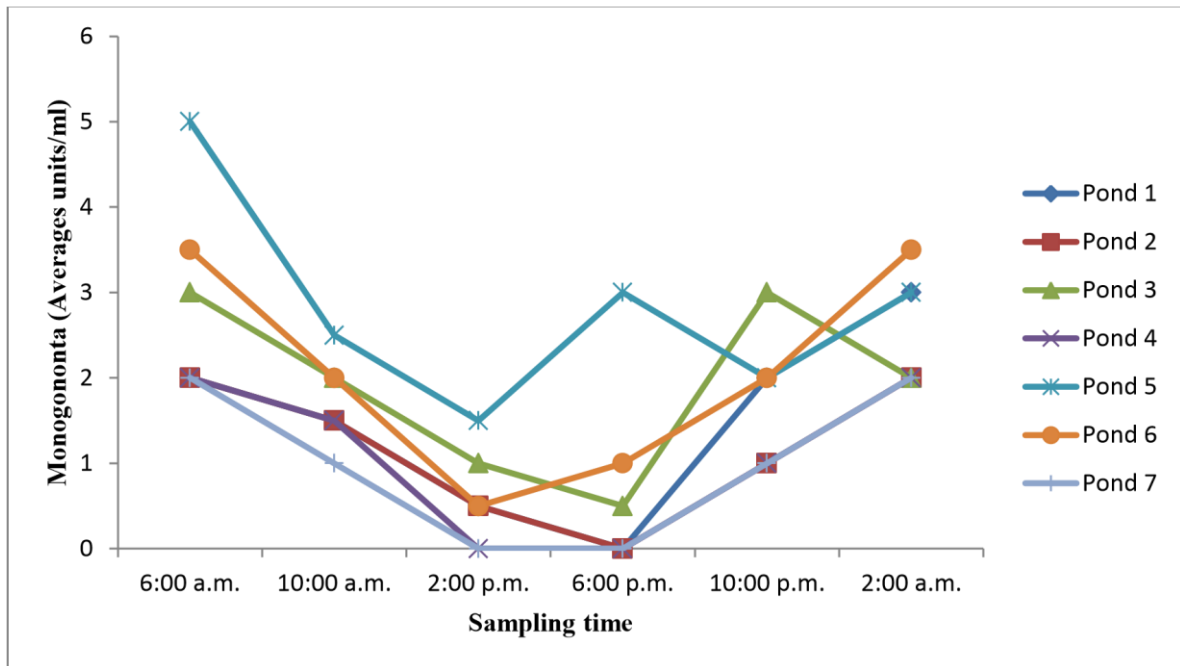


Plate 4.3.1 (contd.): Diurnal fluctuation of plankton population (group wise) in the nursery ponds



Plate 5a: Chlorophyceae observed in selected nursery ponds of I.G.K.V.
Fish Farm Raipur. Chhattisgarh.



Peridinium sp.



Radiococcus sp.



Scenedesmus sp.



Scenedesmus sp.

Scenedesmus sp. *Scenedesmus* sp.

Plate 5b: Chlorophyceae observed in selected nursery ponds of



Tetraderon sp. *Selanosterium* sp.

I.G.K.V. Fish Farm Raipur. Chhattisgarh.



Ankistrodesmus sp. *Ankistrodesmus* sp.

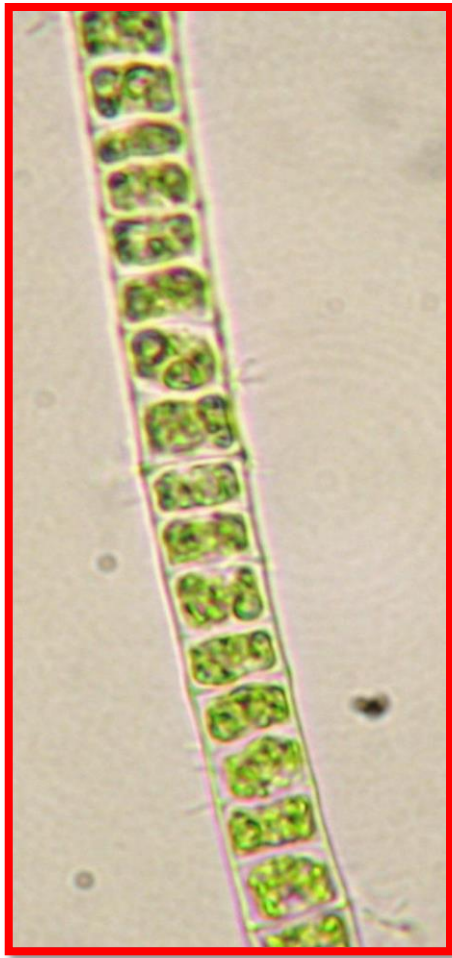


Plate 5d: Chlorophyceae observed in selected nursery ponds of I.G.K.V. Fish Farm Raipur, Chhattisgarh.



Closterium sp.



Closterium sp.



Ulothrix sp. *Spirogyra* sp.



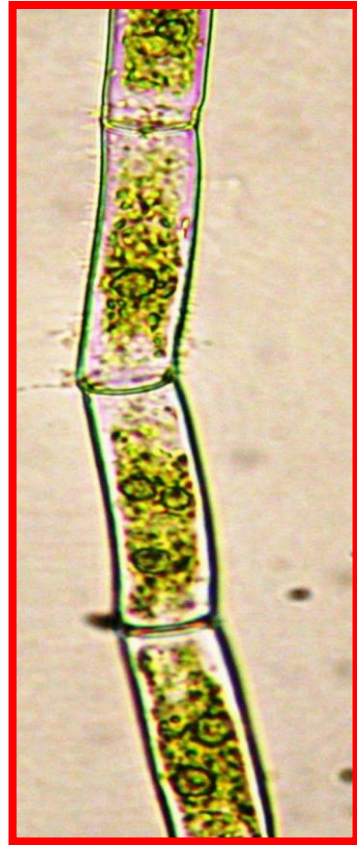
Chaetophora sp.



Chaetophora sp.



Mougeotia sp.



Mougeotia sp.

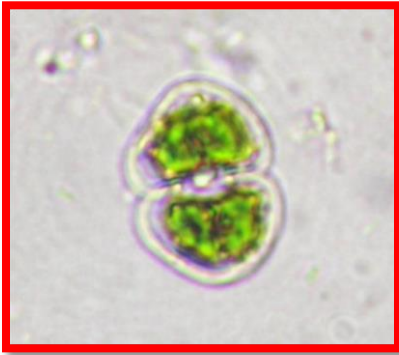


Cosmarium sp.



Cosmarium sp.

Plate 5g: Chlorophyceae observed in selected nursery ponds of I.G.K.V. Fish Farm Raipur, Chhattisgarh.



Cosmarium sp.



Mesotonium sp



Oedogonium sp.



Oedogonium sp.

Plate 5f: Chlorophyceae observed in selected nursery ponds of
I.G.K.V. Fish Farm Raipur. Chhattisgarh.



Chlorella sp. *Oedogonium* sp.



Oedogonium sp. *Chlamydomonas* sp

Plate 5g: Chlorophyceae observed in selected nursery ponds of
I.G.K.V. Fish Farm Raipur. Chhattisgarh.

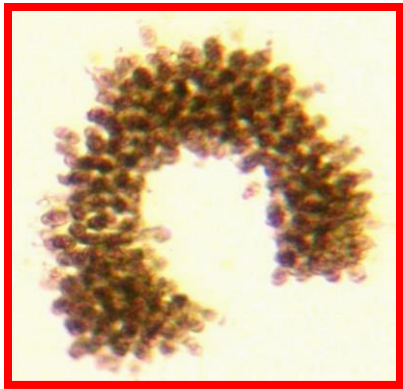


Euglena sp

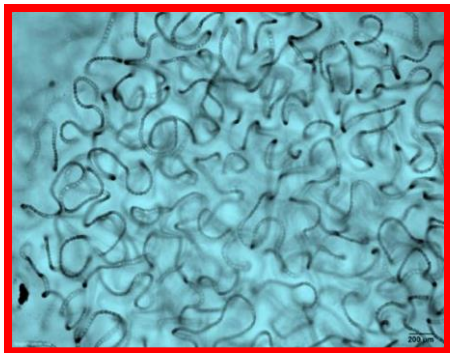
Plate 7: Euglenophyceae observed in selected nursery ponds of
I.G.K.V. Fish Farm Raipur. Chhattisgarh

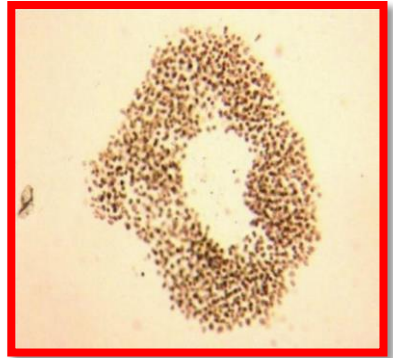
Nostoc sp.

Anabaena sp.



Microcystis sp.



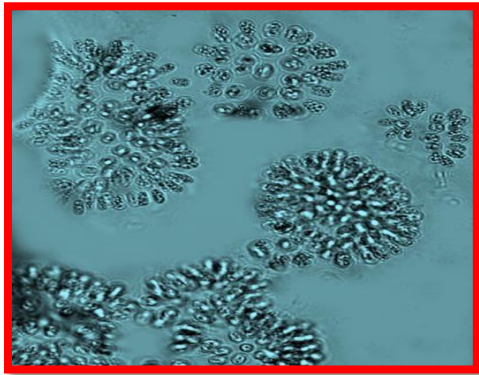


Microcystis sp.

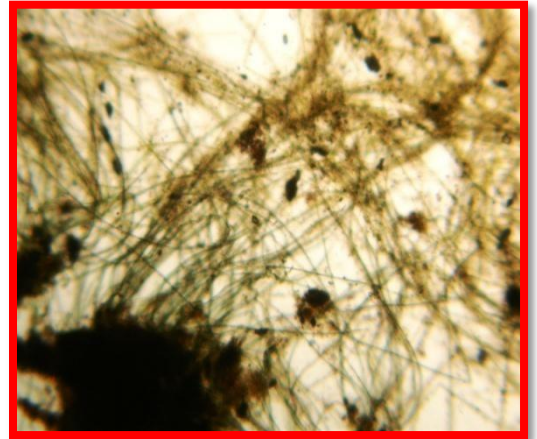


Cylindrospermum sp Aphanocapsa sp.

Plate 6a: Cyanophyceae observed in selected nursery ponds of
I.G.K.V. Fish Farm Raipur. Chhattisgarh.



Coelosphaerium sp



Phormidium sp.



Oscillatoria sp.

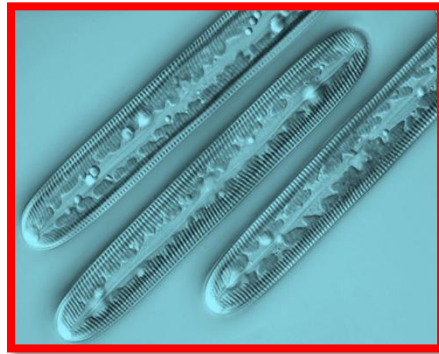
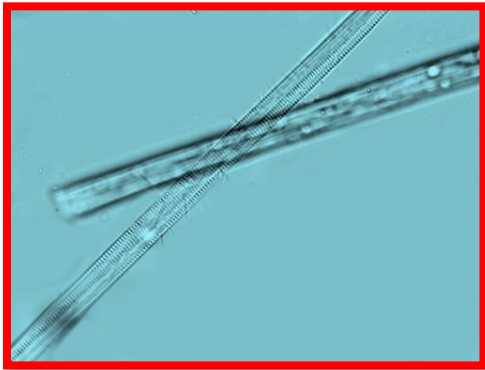


Oscillatoria sp.

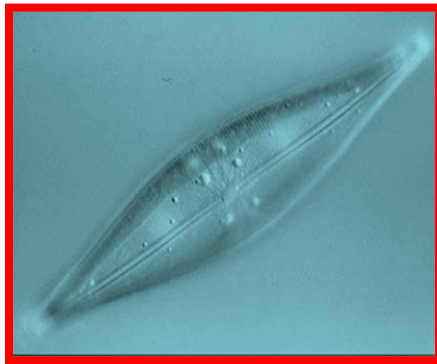
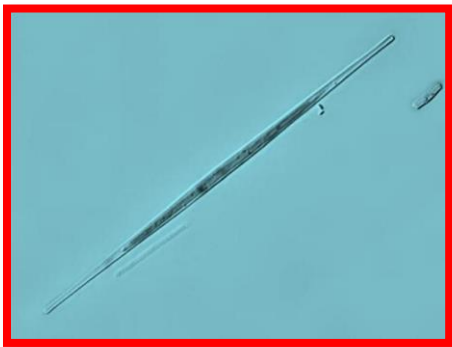


Spirulina sp.

Plate 6b: Cyanophyceae observed in selected nursery ponds of
I.G.K.V. Fish Farm Raipur. Chhattisgarh.

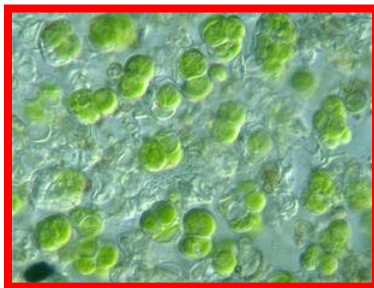


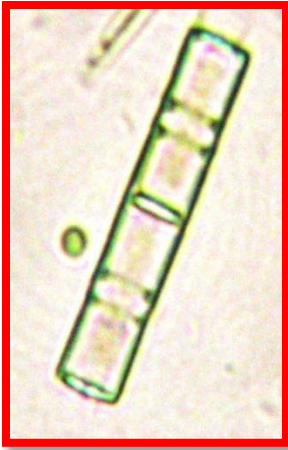
Synedra sp. *Pinnularia* sp



Nitzschia sp

Navicula sp





Melosira sp. *Protococcus* sp

Plate 8a: Bacillariophyceae observed in selected nursery ponds of
I.G.K.V. Fish Farm Raipur. Chhattisgarh



Daphnia sp



Eubranchipus sp



Moina sp

Plate 9: Branchiopoda observed in selected nursery ponds of I.G.K.V. Fish Farm Raipur. Chhattisgarh



Cyclops sp

Plate 10: Maxillopoda observed in selected nursery ponds of

I.G.K.V. Fish Farm Raipur. Chhattisgarh



Brachionus sp Keratella sp

Plate 11: Monogononta observed in selected nursery ponds of
I.G.K.V. Fish Farm Raipur. Chhattisgarh



Filinia sp

Plate 12: Eurotatoria observed in selected nursery ponds
of I.G.K.V. Fish Farm Raipur. Chhattisgarh



© 2010 Google
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Imagery Date: Oct 14, 2009

21°13'53.40" N 81°42'58.71" E elev 953 ft

Eye alt 2145 ft

Plate : 3.1 Satellite images of selected nursery ponds of I.G.K.V.
Fish Farm Raipur, Chhattisgarh.





Plate : 3.2 View of nursery pond and plankton sampling

*Summary, Conclusion and
suggestions for Future Research
Work*

CHAPTER - V

SUMMARY, CONCLUSION AND SUGGESTIONS FOR FUTURE RESEARCH WORK

5.1. Summary

An investigation was carried out on the plankton dynamics and water quality parameters in seven nursery ponds of I.G.K.V. Fish Farm, Raipur, Chhattisgarh during July 2011 to August 2011. Water and plankton samples were collected daily for 20 days. Diurnal fluctuation of plankton was assessed from the plankton samples collected four times (6:00 am, 10:00 am, 2:00 pm 6:00 pm, 10:00 p.m. and 2:00 a.m.) from the nursery ponds on the 10th day.

A total of thirty three algal genera were enlisted among which seventeen genera belonged to Chlorophyceae, nine to Cyanophyceae, six to Bacillariophyceae and one belonged to Euglenophyceae. Chlorophyceae constituted the largest group in terms of phytoplankton population diversity followed by Bacillariophyceae, Cyanophyceae and Euglenophyceae.

A total of seven genera of zooplankton were recorded in the present study. Among zooplankton, three belonged to Branchiopoda, one belonged to Maxillopoda, two belonged to Monogononta and one belonged to Eurotatoria. Among the zooplankton communities, members of class Branchiopoda dominated followed by Monogononta, Eurotatoria and Maxillopoda.

Among Chlorophyceae, *Oocystis* sp. was found to be most dominant in N.P.-1 (5 units/ml), N.P.-2 (4 units/ml), N.P.-3 (5 units/ml), N.P.-6 (14 units/ml) and N.P.-7

(14 units/ml) while *Chlamydomonas* sp. is dominated in N.P.-4 (15 units/ml) and *Tetraedron* sp. dominant N.P.-5 (12 units/ml both). Maximum diurnal fluctuation was exhibited by *Oocystis* sp. in N.P.-1 (± 1.90 units/ml), N.P.-6 (± 4.71 units/ml) and N.P.-7 (± 4.71 units/ml). Similarly, *Tetraedron* sp. showed highest diurnal fluctuation in N.P.-2 (± 3.33 units/ml), *Spirogyra* sp. in N.P.-3 (± 1.87 units/ml), *Chlamydomonas* sp. in N.P.-4 (± 6.91 units/ml) and *Mougeotia* sp. in N.P.-5 (± 3.71 units/ml).

Among Cyanophyceae, *Oscillatoria* sp. was most dominant in N.P.-2 (6 units/ml), N.P.-3 (10 units/ml), N.P.-4 (16 units/ml both), N.P.-5 (8 units/ml both), N.P.-6 (41 units/ml) and N.P.-7 (41 units/ml) while both *Oscillatoria* sp. and *Aphanocapsa* sp. dominated in N.P.-1 (6 units/ml both). Maximum diurnal fluctuation was exhibited by *Microcystis* sp. in N.P.-1 (± 7.0 units/ml) and N.P.-2 (± 3.40 units/ml). Similarly, *Oscillatoria* sp. showed highest diurnal fluctuation in N.P.-4 (± 5.90 units/ml), N.P.-5 (± 3.6 units/ml), N.P.-6 (± 14.10 units/ml) while *Anabaena* sp. in N.P.-7 (± 2.31 units/ml). In N.P.-3, and *Oscillatoria* sp. showed maximum diurnal fluctuation (± 4.38 units/ml).

Among Bacillariophyceae, *Nitzschia* sp. was found to be most dominant in N.P.-1 (21 units/ml), N.P.-2 (6 units/ml), N.P.-4 both *Protococcus* sp. and *Navicula* sp. was dominant (1 units/ml), N.P.-5 *Nitzschia* sp. (4 units/ml) while *Synedra* sp. dominated in N.P.-3 (11 units/ml), N.P. 6 *Melosira* sp. (1 units/ml). Both *Melosira* sp. and *Synedra* sp. dominated in N.P.-7 (1 units/ml each). Maximum diurnal fluctuation was exhibited by *Navicula* sp. in N.P.-1 (± 1.67 units/ml) and N.P.-2 (± 2.48 units/ml). Similarly, *Synedra* sp. showed highest diurnal fluctuation in N.P.-3 (± 5.56 units/ml), *Nitzschia* sp. in N.P.-5 (± 1.29 units/ml) and N.P.-7 (± 0.98 units/ml) while *Melosira* sp.

in N.P.-6 (± 0.96 units/ml). In N.P.-4, both *Navicula* sp. and *Melosiras* sp. showed maximum diurnal fluctuation (± 0.5 units/ml both).

Among Euglenophyceae, only *Euglena* sp. was found in all the nursery ponds viz. N.P.-1 (6 units/ml), N.P.-2 (1 units/ml), N.P.-3 (1 units/ml), N.P.-4 (5 units/ml), N.P.-5 (4 units/ml), N.P.-6 (18 units/ml) and N.P.-7 (18 units/ml). Population of

Euglena sp. fluctuated diurnally by ± 4.2 units/ml (N.P.-1), ± 0.54 units/ml (N.P.-2), ± 0.51 units/ml (N.P.-3), ± 3.94 units/ml (N.P.-4), ± 1.9 units/ml (N.P.-5), ± 5.7 units/ml (N.P.-6) and ± 5.77 units/ml (N.P.-7).

Among Branchiopoda, *Eubbranchipus* sp. was found to be most dominant in N.P.-2 (3 units/ml), N.P.-3 (4 units/ml), N.P.-4 *Moina* sp. (4 units/ml), N.P.-5 both *Daphnia* sp. and *Moina* sp. (1.67 units/ml), N.P.-6 (6 units/ml) and N.P.-7 (3 units/ml) while both *Eubbranchipus* sp. and *Moina* sp. dominated in N.P.-1 (4 units/ml both) and N.P.-5 (4 units/ml both). Maximum diurnal fluctuation was exhibited by *Eubbranchipus* sp. in N.P.-1 (± 3.06 units/ml), N.P.-2 (± 2.1 units/ml), N.P.-3 (± 1.75 units/ml), N.P.-6 (± 2.9 units/ml) and N.P.-7 (± 2.92 units/ml). Similarly, *Moina* sp. showed highest diurnal fluctuation in N.P.-4 (± 2.58 units/ml) and *Moina* sp. in N.P.-5 (± 0.98 units/ml).

Among Maxillopoda, only *Cyclops* sp. was found in all the nursery ponds viz. N.P.-1 (1 units/ml), N.P.-2 (7 units/ml), N.P.-3 (1 units/ml), N.P.-4 (1 units/ml), N.P.-5 (13 units/ml), N.P.-6 (8 units/ml) and N.P.-7 (8 units/ml). Population of *Cyclops* sp. fluctuated diurnally by ± 1 unit/ml (N.P.-1), ± 4 units/ml (N.P.-2), ± 4.38 units/ml (N.P.-5), ± 2.89 units/ml (N.P.-6) and ± 2.88 units/ml (N.P.-7). No diurnal fluctuation of Maxillopoda population was observed in N.P.-3 and N.P.-4.

Among Monogononta, *Keratella* sp. was most dominant in N.P.-2 (1 unit/ml) and N.P.-6 (3 units/ml) while *Brachionus* sp. dominated in N.P.-3 (2 units/ml), N.P.-4

(1 unit/ml) and N.P.-7 (2 units/ml). Both *Brachionus* sp. and *Keratella* sp. dominated in N.P.-1 (1 unit/ml both) and N.P.-5 (5 unit/ml both). Maximum diurnal fluctuation was exhibited by *Keratella* sp. in N.P.-6 (± 1.60 units/ml). Similarly, *Brachionus* sp. showed highest diurnal fluctuation in N.P.-5 (± 2.06 units/ml). Population fluctuate of *Brachionus* sp. in both N.P.-3 and N.P.-4 (± 1.16 , ± 1.09), *Keratella* sp. fluctuate in N.P.-7 (± 1.60) and No diurnal fluctuation of Monogononta population was observed in N.P.-1 and N.P.-2.

Among Eurotatoria, only *Filinia* sp. was found in all the nursery ponds except viz. N.P.-1 (2 unit/ml), N.P.-2 (4 units/ml), N.P.-3 (2 unit/ml), N.P.-4 (2 units/ml), N.P.-5 (1 unit/ml), N.P.-6 (1 unit/ml) and N.P.-7 (1 units/ml). Population of *Filinia* sp. fluctuated diurnally by ± 1.71 units/ml (N.P.-1), ± 1.4 units/ml (N.P.-2), ± 2.09 , (N.P.-3) ± 1.2 units/ml and (N.P.-4) ± 1.03 units/ml. No diurnal fluctuation of Eurotatoria population was observed in N.P.-5, N.P.-6 and N.P.-7.

Water temperature in nursery ponds varied between 24.2°C – 32.2°C . The transparency reading varied significantly in the selected nurseries ponds over the season and it ranged from 26cm to 34 cm. Electrical conductivity (EC) value ranged between 148 – 428 umhos/cm. The range of dissolved oxygen in all nursery ponds was between 5.2 – 6.9 mg/l. The dissolved ammonia, nitrate and orthophosphate ranged between 0.11 – 0.14 mg/l, 0.41 – 0.47 mg/l and 0.65 – 0.68 mg/l respectively.

5.2. Conclusion

1. The study of plankton dynamics and water quality parameters in the nursery ponds of departmental fish farm, I.G.K.V., Raipur (C.G.) revealed that these ponds are conducive for the growth of fish spawn in terms of water quality and availability of natural fish food organisms.

2. Both phytoplankton and zooplankton shows diurnal fluctuation as well as variation on daily basis.
3. In managed ponds, the physico-chemical parameters do not fluctuate widely.

5.3. Suggestions for future research work

1. Sampling of benthic organisms will help to deduce a complete food chain.
2. Identification of plankton up to species level will further add to the diversity studies because each genera look to have several number of species.
3. Role of decomposers and microbes in pond ecosystem.

Abstract

“STUDIES ON THE PLANKTON DYNAMICS IN THE FISH NURSERY PONDS OF CHHATTISGARH”

By,

Aditya Kumar

ABSTRACT

An investigation was carried out on the plankton dynamics and water quality parameters in seven nursery ponds of I.G.K.V. Fish Farm, Raipur, Chhattisgarh during July 2011 to August 2011. Water and plankton samples were collected daily for 20 days. Diurnal fluctuation of plankton was assessed from the plankton samples collected six times (6:00 am, 10:00 a.m., 2:00 p.m. 6:00 p.m., 10:00 p.m. and 2:00 a.m.) from the nursery ponds on the 10th day.

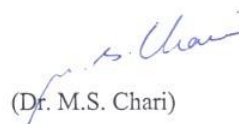
A total of thirty three algal genera were enlisted among which seventeen genera belonged to Chlorophyceae, nine to Cyanophyceae, six to Bacillariophyceae and one belonged to Euglenophyceae. Chlorophyceae constituted the largest group in terms of phytoplankton. Among Chlorophyceae, *Oocystis* sp. and *Tetraedron* sp. was found to be most dominant. Maximum diurnal fluctuation was exhibited by *Oocystis* sp., *Tetraedron* sp., *Spirogyra* sp., *Chlamydomonas* sp. and *Mougeotia* sp. Among Cyanophyceae, *Oscillatoria* sp. and *Aphanocapsa* sp. was dominant. *Microcystis* sp., *Oscillatoria* sp., *Anabaena* sp. and *Aphanocapsa* sp. showed highest diurnal fluctuation. Among Bacillariophyceae, *Nitzschia* sp. and *Synedra* sp. dominated. Maximum diurnal fluctuation was exhibited by *Navicula* sp., *Nitzschia* sp., *Melosira* sp., *Protococcus* sp. and *Synedra* sp. Among Euglenophyceae, only *Euglena* sp. was found.

A total of seven genera of zooplankton were recorded in the present study. Among zooplankton, three belonged to Branchiopoda, one belonged to Maxillopoda, two belonged to Monogononta and one belonged to Eurotatoria. Among the zooplankton communities, members of class Branchiopoda dominated. Among Branchiopoda, *Eubbranchipus* sp. and *Moina* sp. was found to be most dominant. Maximum diurnal fluctuation was exhibited by *Eubbranchipus* sp., *Moina* sp. and *Daphnia* sp. Among Maxillopoda, only *Cyclops* sp. was found which showed diurnal fluctuation. Among Monogononta, *Keratella* sp. and *Brachionus* sp. dominated. No diurnal fluctuation of

Monogononta population was observed in most of the ponds. Among Eurotatoria, only *Filinia* sp. was found which showed diurnal fluctuation.

Water temperature in nursery ponds varied between 24.2 °C – 32.2 °C. The transparency reading varied significantly in the selected nurseries ponds over the season and it ranged from 26 cm to 34 cm. Electrical conductivity (EC) value ranged between 148 – 428 umhos/cm. The range of dissolved oxygen in all nursery ponds was between 5.2 – 6.9 mg/l. The dissolved ammonia, nitrate and orthophosphate ranged between 0.11 – 0.14 mg/l, 0.41 – 0.47 mg/l and 0.65 – 0.68 mg/l respectively.

The study revealed that these ponds are conducive for the growth of fish spawn in terms of water quality and availability of natural fish food organisms.



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Date.....

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Appendix

APPENDIX

Abbreviations	Description
%	Per cent
&	And
/g	Per gram
/ha	Per hectare
/kg	Per kilogram
/l	Per liter
°C	Degree Celsius
cm	Centimeter
EC	Electrical Conductivity
<i>et al.</i>	And other
Fig.	Figure
g	Gram
ha	Hectare
hr	Hour
i.e.	That is
Kg	Kilogram
km	Kilometer
m	Meter
mg	Milligram
mg C	Milligram Carbon
ml	Milliliter
N.P.	Nursery Pond
ppm	Parts per million
ppt	Parts per thousand
sqkm	Square kilometer
<i>viz.</i>	Namely