

**STUDIES ON THE RELATIONSHIPS BETWEEN WATER
QUALITY PARAMETERS AND ZOOPLANKTONS, BENTHOS
AND SOME SELECTED FISH OF GULSHAN LAKE, DHAKA.**

A THESIS SUBMITTED TO THE DEPARTMENT OF ZOOLOGY,
UNIVERSITY OF DHAKA FOR DOCTOR OF PHILOSOPHY



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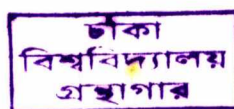
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FEBRUARY, 2004

DEPARTMENT OF ZOOLOGY
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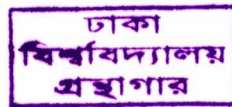
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ঢাকা
বিশ্ববিদ্যালয়
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Declaration

I am submitting my declaration to the University of Dhaka in fulfillment for the Ph.D. degree. I performed this research work under the supervision of Dr. Gulshan Ara Latifa, and Dr. Miah Muhammad Abdul Quddus, Professor, Department of Zoology, University of Dhaka.

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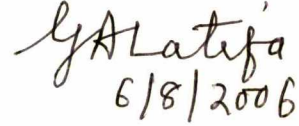
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CERTIFICATE

It is certified that the thesis submitted by Mrs. Geeta Sharma Acharya is the result of her own findings and investigations. The thesis has not been submitted elsewhere for any degree or prizes.



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Research Co-supervisor


6/8/2006

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ABSTRACT

The study was conducted to establish relationship between water quality parameters and zooplanktons, benthos and some selected fish for the period of August 1999 to January 2002 in the Gulshan Lake, Dhaka. Samples were collected from the three stations selecting in relation to the pollutant sources of the Gulshan Lake. The physico-chemical parameters such as air temperature, water temperature, transparency, dissolved oxygen (DO), free carbondioxide (CO₂), p^H, alkalinity, hardness, ammonia and nitrite were measured. The concentration of DO ranged from 3.06 mg/l to 7.24 mg/l, which was more or less fair for aquatic organisms except during December to April, when lethal condition was exist. The average value of free CO₂ was 11.27±2.39 mg/l and concentration was high in summer that appeared to be erratic. The P^H values were alkaline in nature. Ammonia concentration ranged from 1.2 mg/l to 3.7 mg/l. The parameters showed strong seasonal variations and also showed spatial fluctuations among three sampling stations and different layers. The parameters also showed special fluctuations among the three sampling stations and different layers. Some of the parameters indicate that the water is polluted and this is much pronounced in station-2. The abundance of zooplankton varied from 1,225 indiv./l to 21,325 indiv./l with an average of 6,426 indiv./l. The zooplankton was more abundant during the months from February to May and lowest in August. The most dominant group was Rotifera comprising 48% of the total zooplankton population followed by Cladocerans (21%), Ostracods (13%) and Copepods (9%). The benthic fauna ranged from 503 to 1,158 indiv./m² with an average 702 indiv./m². The most dominant group of benthos was Mollusca comprising 41% of the total benthos population followed by Oligochaeta (31%), and Chironomids (23%). The abundance of zooplankton and benthos largely influenced by different physico-chemical parameters. Zooplankton showed significant negative correlation with dissolved oxygen and positive correlation with P^H, alkalinity, hardness and ammonia.

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Chapter -1

Introduction

Water is indispensable to the continuation of human and non-human life. The healthy functioning of human societies and natural ecosystems requires water that is plentiful and clean. Yet today, water supplies throughout the world are being threatened because of human and natural activities such as with acid rain. A recent statement in the Jewish journal Tikkun recognizes the problem: "Global water pollution needs to be halted and water quality restored" (Merchant 1991).

Of the world's freshwaters, it is the large lakes that have attracted the most attention of the scientists and tourist industries due to their huge volume and grandeur and often-spectacular settings. But, they occupy only a small proportion of the world's freshwater area. But it is the shallow pools (less than 5 meters deep) that are much more numerous and are ultimately much more important to both people and wildlife.

The shallow lakes, usually in the lowland, contain higher biodiversity. Millions of tropical people depend on shallow lakes for survival by using them in various ways, like taking fish for daily meals. Their complex ecological structures and high productivity support the bulk of the biodiversity associated with freshwaters. Pollution of a large water body is easily soluble. But the restoration of a shallow lake, whose ecological structure has been damaged by pollution, is more difficult. So, the different systems function in these two types of lakes. Deep lakes are dominated by phytoplankton where as large water plants (macrophyte) dominate the shallow lakes. So, shallow lakes have drawn attentions to the scientists in recent years.

Limnology is supremely an integrative environmental science. The functioning system of a lake demands knowledge of the catchments of the lakes, its geology, land-use, meteorology, hydrology and soil science. All these influence the amount of water flowing into a lake, its quality, especially the amount of phosphorus and nitrogen compounds that are key nutrients in determining the productivity of the lake. The greater the human use, by urban development or agriculture, the greater will be the degradation of water bodies through water withdraws and annual loads of nutrients, pollutants and sediments that reach the lake.

The husbandry of aquatic animals has been practiced for centuries throughout the world. The ancient Egyptians and Chinese cultured Tilapia and carp long before the

Christian era. The Japanese are the modern leaders in aquaculture technology and have long tradition of aquaculture husbandry. Fan Lee described Chinese techniques for fish culture 2500 years ago. At the early age of fish culture, people used to collect fry from natural water body and reared them in natural or artificial water body up to demandable size. Modern societies cannot now afford the time consuming practice of developing new production techniques through trial and error. Today, it is increasingly evident that if we wish to maintain aquatic foods in our diet, we must intervene in natural processes, manages dwindling resources carefully and utilize those not yet exploited (Allen, 1984).

Bangladesh, the largest delta in the world is formed by Ganges and Brahmaputra river basin. She is blessed with vast water resources in the form of river, lake, hoar and beels, ponds, estuaries, coastal belts, inundated fields and a part of Bay of Bengal. These water bodies play an important role in the development of the country. There is about 43,45,936 ha of inland waters and 1,66,07,000 ha of marine water in Bangladesh (DOF, 1996). Of the inland waters, 40,48,532 is open water out of which 1,14,162 ha is beel, 23,34,008 ha flood plain, 68,000 ha. Kaptai lake area and river, canal and estuarine regions are 10,31,563 ha. (DOF, 1996). Being a riverine country its principal occupation is agriculture. 88% people depend on agriculture (BBS, 1996). Bangladesh is concentrating more on utilizing its water resources to fight the serious protein deficiency and malnutrition of her people. So, aquaculture can be one of the most important activities that can play a vital role in the national economy of Bangladesh. Fisheries sector fulfills nearly four fifth of countries animal protein supply (Rahman, 1986). The water quality of these water bodies determines the quality of aquatic flora and fauna. It is important in relation to the cultivation to freshwater fishes. The proper utilization of these freshwater bodies can yield better productivity. It has been proved that a unit area of water has higher carrying capacity than a unit area of land.

All the water bodies of Bangladesh are highly productive due to the geophysical, and climatic condition of the country. There are so many beels and lakes in the country, which are full of organic debris, mud and aquatic vegetation along with a very low level of fish production. There is no management system to improve the biological

conditions of these water bodies, a little improvement of the habitat of which may ensure a high fish production.

Fish, a major food item is the cheapest source of animal protein in Bangladesh. Fish contributes about 6% of the total protein consumption and 80% of animal protein in Bangladesh (BBS, 1996). The per capita fish consumption was 33gm/day in 1963-64 (Rahman, 1986), whereas it reduced to 20.5gm/day during 1995-96 (BBS, 1996), a decrease of 12.5gm/day against requirement of 73gm/day food protein. So, the requirement of fulfilling the food protein demand is increasing day by day. Fish is becoming more popular due to its lesser degree of animal protein, high in essential minerals and low in saturated fats (Shang, 1981). The average fish production in Bangladesh is very low compared to neighboring countries against an average of 3200kg/ha/yr in China, 1390kg/ha/yr in India and 2250kg/ha/yr in Indonesia (Wohlfarth, 1987). The major reason for low production is both institutional and social. Although fish rearing in ponds is an age-old practice in Bangladesh, modern fish culture technologies were relatively unknown to farmers. That is probably one of the main reasons for low level of fish production (Alam, 1986). This tragic decline in fish availability is a direct reflection of upland environmental disruption. Aquatic life is said to be adversely affected by pollution (ESCAP, 1988). Adequate attention to environmental pollution problem was hitherto not paid which is now affecting its fisheries resources. Environmental pollution is mainly attributed to over-population, urbanization and industrialization. The other important causes are lack of knowledge about proper culture techniques inadequate fishery extension programs, lack of knowledge about the ecology and natural habit of major fish species (TFYP, 1985). According Edwards (1977), the industrial effluents are perhaps the most important source of contamination of river and estuaries. These water bodies may be improved to fish culture. These changes or improvements of the habitat are a necessity because there is hardly any possibility of getting land for the construction or new ponds for fish culture. So we have to ensure the most beneficial use of the existing resource.

For the improvement and proper management of the lake all information on the resources, physiography, chemical and biological characteristics is very much necessary. It is also necessary to analyze and interpret the comparative information on water quality of inland freshwater bodies such as lakes in order to provide qualitative

inputs to fish farming and better use of freshwater bodies. Apart from fish, which is a well-known group due to its economical value and conspicuousness, the other groups mostly belong to the invertebrate category that remain little known. Their diversity is high and they perform valuable and essential ecological functions in the energy flow and biogeochemical cycles.

As fish lives in water, investigation and understanding of the water quality becomes the basic task for scientific management of fish culture. The nutrient status of water and soil play the most important role in governing the production of fish (Banerjea, 1967). The types and numbers of organisms and seasonal abundance vary greatly in relation with water qualities. Fishes are more dependent on water temperature, pH, dissolved oxygen, free carbon dioxide, alkalinity and some salts for growth and development (Nikolsky, 1963). Any change in these parameters may affect the growth, development and maturity of fish (Nikolsky, 1963; Jhingran, 1985).

Different chemicals which are used in modern industry, agriculture forestry, and related fields, ultimately enter various water bodies. Poisonous substances of industrial sewer waters, pesticides, chemical fertilizers and agricultural drainage waters on reaching water bodies make fatal effect on fish fry and eggs, destroy spawning grounds and feeding areas, restrict migration of fish, reduce fish resistance to disease, and deteriorate the quality of fish productions. Polluted sewer water change the physical and chemical properties of water, alter the quality and quantity of food organism and disrupt biological balance of the process of self purification in water bodies linked with the life activity of single celled organism such as bacteria, algae and protozoa. The list of the substances which enter the water as a result of human activity and which affect the aquatic fauna including the fishes is very large (Beak, 1958; Ellis, 1973).

The fundamental nature of the adverse effect of various elements is that as they oxidize in water they rapidly deplete oxygen of water mass (Nikolsky, 1963). The uptake and accumulation of these trace elements in the fish from the water and sediments are influenced by various environmental factors such as temperature, salinity, pH, density of the trace elements, location of catch, type and age of fish etc. Some of the toxic compounds of fish are salts of copper, mercury, lead zinc,

aluminum and trivalent chromium. The study of toxic elements in the fishes is of a great significance in view of fish production, quality to determine health, safety and environment.

Zooplanktons assume a very important role in the ecology of a water body in the sense that they limit the population of fishes, as they constitute food of various species of fish. The information on the composition of species of plankton's and their seasonal trend is of great value to the fish cultivation in water bodies (Michael, 1968). Zooplanktons constitute important food item of omnivorous and carnivorous fishes. The fries of carps feed mostly on Zooplankton (Bardach, 1972) as they produce necessary protein for the growth of the fish. Zooplanktons contribute about 47.66% of food of *Catla catla* (Ali, 1981) 6.37% of *Labeo rohita*, 24.19% of *Oreochromis niloticus*, 82% of *Anabas testudineus* (Shafi, 1976). Zooplanktons also play a very important role in the food chain as they are in the second trophic level as primary consumers (Quassim, 1977). Zooplanktons are critical links between algae and fish. They have a direct relation to both fish production and water quality.

The primary productivity of different water bodies is essentially dependent on their physico-chemical condition (Rahman, 1982). The pH and dissolved oxygen content of water significantly influence the abundance of the zooplankton (Nayar, 1965). The abundance of zooplanktons varies according to seasons and the availability of nutrient nitrate oxygen (Munro, 1966). Greater numbers of species of zooplanktons are found in the deeper water than in the shallower water (Patalas, 1968). The population density of zooplanktons is found to be higher in ponds that are richer in organic matter (Das, 1980).

It has been reported that pH from 7.3 to 8.4 provides optimum condition for the growth of plankton and that lower pH values can adversely affect the plankton production and hence the growth of fish (Villadolid, 1954).

A pond with good water quality will produce more and healthy fish than a pond with poor water quality (Boyd, 1979). For the proper management of aquatic environment, the knowledge of benthic fauna is also essential, as it constitutes a part of the biological environment. The functional role of the benthic communities in the trophic

dynamics through the detritus food chain of the lake ecosystem is well known. The bottom fauna plays a significant role in recycling of materials in the ecosystem concerned and as food for fish. For the proper manipulation of the environment the knowledge of the benthic fauna is also essential, as it constitutes a part of the biological environment.

Every animal must have other organisms within its range to serve as food. The benthic macro-invertebrates live in the bottom sediments of a water body. The functional role of benthic communities in the trophic dynamics through the detritus food chain of the lake ecosystem is well known. The bottom fauna plays a significant role as food for fish (most of the bottom dwelling fishes) and recycling of materials in the ecosystem concerned and the overall biological productivity of the natural water is dependent of the abundance of benthic fauna.

Benthic macro-invertebrates constitute an important intermediate link between phytoplankton, zooplankton and the fish stock in the food chain. Assessment of monthly fluctuation in abundance of benthos may lead to the assessment of bio-nutrient status of productivity in an aquatic habitat. In order to assess the trophic base for fishes, knowledge of net production and assimilation by benthic species is necessary. Many benthic organisms are important not only as fish food but also in that they take part in the process of biological water purification.

Benthic organisms are the basic sources of other bio living in the media. It indicates the productivity of water bodies (Dewan, 1973). These organisms are also essential food items for cultivation of introduced fishes in the managed water bodies (Vyas, 1968). The distributions of seasonal variations of the benthic fauna are interesting. The abundance and distribution varies with depth in relation to physico-chemical factors (Ali, 1977). A good number of workers on the field of limnology and related perspectives have been done from home and abroad. But the system followed in a variety of pond management system (Dewan, 1973).

It is apparent from the foregoing discussion that is very much important to have a clear knowledge of the physico-chemical and biological conditions of a water body for its proper management.

Bangladesh is land of rivers. The country is equally endowed with the diverse of very rich and extensive inland and marine fishery resources, which mainly included rivers, lakes, haors, baors, ponds, estuaries, costal belt and seashore and all together offer tremendous opportunities for fisheries development.

There are about 43,85,937 ha of inland water and 1,66,07,000 ha of marine water in Bangladesh. Of the inland waters, 40, 48,532 ha is open water, 1,51,916 ha pond area, 5,488 ha baors, 1,80,000 ha is costal shrimp (DoF, 1996).

The biological resources of Bangladesh fisheries are also rich. There are a total of 260 species of freshwater finfish (Rahman, 1986), 63 species of prawns and shrimps, (25 species of edible tortoises and turtles and 17 species of crabs. In addition 470 species of fish have been reported from the Bay of Bengal, of which 65 species are commercially exploitable (Sarker, 1993). In addition to the rich fishery resources of indigenous origin, about 15 exotic culturable finfish species have been introduced in the country. So, there is a great opportunity for culturing commercially and biologically important fast growing and genetically improved freshwater fish species in these water bodies.

The importance of fish as a source of protein in the country needs no introduction. Most of the people in Bangladesh depend on fish as principal source of animal protein. Fisheries provide 23% per capita protein intake (82 kg/yr) of our people (BBS, 1996). Fish protein is 85-95% designated and contains essential dietary amino acids and polyunsaturated fatty acids. Nutritionists agree that fish is an excellent source of protein; fish flesh contains all the ten essential amino acids in desirable concentrations for human beings. Fish also contain minerals. It is an important source of iodine, a significant source of phosphorus, potassium, iron, copper and vitamins A and D. The fat content of fish is high but carbohydrate content is low and thus fish can make an especially valuable contribution to any diet. Fisheries sector not only supplements our daily demand of animal protein but also plays an important role in the economy of Bangladesh in terms of income, employment and foreign exchange earnings. Fisheries sector contributes about 3.5% to national GDP, about 10.4% to the

agriculture GDP and about 9.12% to foreign exchange earnings (DoF, 1994). A comprehensive scientific knowledge is a must to increase the production of fish.

The pond culture in Bangladesh is mostly done with carps. To meet the gap in fish production, government as well as private culturists have given great emphasis on fish culture in the inland closed water bodies, especially in the ponds. Pond is an important source of inland closed water fish production in Bangladesh. The total number of ponds in Bangladesh was 12,88,222 and the projected fish production in these ponds was 2.31 Lac mt. in 1993-94, which was 84% of the total inland closed water fish production, 27.93% of the total inland fish production and 21.25% of the total fish production in Bangladesh in 1993 (DOF, 1994). This statistics shows importance of ponds in fish production. Present level of production can easily be increased by 2.5 to 3.0 times from ponds and dighis using simple aquaculture techniques disseminated to the rural community through extension.

The growing demand for fish protein in Bangladesh has motivated active development of aquaculture. This is particularly noticeable in case of pond aquaculture. It is generally held that capture fishery has being overexploited and the resource is under tremendous pressure. In the face of growing population and concomitant fall in capture fisheries and drop in per capita fish consumption, the one option remains to boost up fish production through culture practice. It has been proved that a unit area of water has higher carrying capacity than a unit of land with whatever effort is put into it. Fisheries experts believe that it is possible to double or triple the current level of fish production by shifting from traditional extensive culture to semi-intensive or intensive culture.

The practice of aquaculture will probably be a right approach for meeting future demands for fish. Aquaculture has been emerged as one of the most promising industries in the world with considerable growth potential. It is well established that aquaculture would give higher production from per unit area as compared to agriculture or animal husbandry. To meet the growing demand of fishery products, primarily for human nutrition, aquaculture is emerging as a formidable animal industry.

Intensification of the culture practice is still required to enhance the production rate and important to produce a large quantity of quality food in shortest time possible. It can be said that adoption of intensive aquaculture with possible lead to fill up the growing gap between demand and supply. Of the estimated 4.27 million ha of inland waters, only 5.27% is being used for fish culture (Chowdhury, 1989). There are about 1.3 million ponds and dighis having an area of 1.47 lakh ha. The average production from these ponds is about 2,31,530 mt (DoF, 1994). As a result of this the production from per area of water body is still low compared to the neighboring countries.

C. catla (Ham.-Buch.) is one of the three major carps commonly available in rivers and their tributaries, lakes, beels, ponds, dighi and tanks of Bangladesh. It is locally known as 'katla' in Bangladesh. The original natural range of distribution of *C. catla* is a freshwater river throughout Pakistan, India, down the Krishna river, Bangladesh and Burma. This fish has also been reported from Nepal. *C. catla* is one of the most important food fishes of Bangladesh and is known to be the largest of the carps of this sub-continent.

Because of its excellent taste and high rate of growth, it is widely cultured to the impounded waters like ponds, tanks, dighi etc. in Bangladesh. But for successful culture of any fish, scientific knowledge of various aspects of biology of that fish and dynamics of its population are essential and it is especially so in capture fishery like *Catla catla*.

Catla catla is the fastest growing of the Indian major carps. In natural waters, *C. catla* attains a length of 295 mm (weight 354g) in the first year, 514 mm (weight 2,193g) in the second year, 716 mm (weight 6,501g) in the third year, 828 mm (10, 282g) in the fourth year and 917 mm (weight 14,665g) in the fifth year. *C. catla* attains first maturity in the second year of life. Alikunhi, 1957 mentioned that in ponds *C. catla* matures when 22 months old.

Labeo rohita is one of the most important protein suppliers. It is commonly known as 'Rohu' or 'Roi' is the second largest major carp found in freshwater of Bangladesh. *L. rohita* is widely distributed in Bangladesh, India and Burma (Bhuiyan 1974). *L. rohita* is easily cultured in the impounded water like ponds, tanks, dighies etc. in

Bangladesh. *L. rohita* attains maturity towards the end of the second year in ponds (Alkunhi, 1957). It has been observed at Cuttack, India that a certain percentage of both males and females reached sexual maturity in one year only. The average size of maturity was 292 mm/ 282g in one pond and 348 mm/ 500g in the other pond. One of the smallest ripe females *L. rohita* has been reported to measure 26 cm in length and 250g in weight in ponds at Cuttack. It is reported that *L. rohita* mature in Bangladesh at the age of 3-4 years.

Labeo calbasu is one of the most important protein suppliers of Bangladesh. Because of its excellent taste and high rate of growth, it is widely cultured in the impounded waters like ponds, tanks, dighi etc. in our country. The original natural ranges of distribution of *L. calbasu* are freshwater rivers through Pakistan, India, down the Krishna River, Bangladesh and Burma. It is known as 'Khalibaush' in Bangladesh.

Aims and objectives of the study:

The study of eutrophication of water systems such as lakes, estuaries, coastal water and enclosed water have received great amount of attention in the recent years. Deteriorating environmental conditions, due to human changes are extensive and accelerated and they have significant consequences on inland water ecosystems. The pollution and its impact on the environment, particularly on biodiversity, has become the central focus of present day's research.

Residents around the lake (Baridhara and Gulshan) have been concerned in recent years with the polluting environmental condition especially with the water quality and sediment build up in their lake. Fish population dynamics and water quality resources can be influenced by management at the bottom of the food web or from the top of the food web. Non management factors known to affect fish quality and quantity and water quality, it becomes necessary to determine the extent to which management and non-management factors influence fish quality and quantity, as well as water quality. So, lake management measures demand considerable ecological study to achieve the desired results. Based upon prior understanding of lakes in general and personal observations on plankton of this region, following predictions have been made.

These studies aims at identifying and analyzing the physical, chemical and biological information concerning the present state of Gulshan lake and also synthesizes and expand research on water quality.

The main objectives of the study are:

- To collect qualitative and quantitative information on plankton and observe the changes in plankton distribution
- To collect qualitative and quantitative information on benthos
- To find out relationships with different physico-chemical parameters, zooplankton and benthos
- To observe the feeding habit of three major carps
- To make a thorough documentation of the present condition of the lake for possible aquaculture so that future planning can be done for lake management.
- To expand existing knowledge in the region to include species composition and population dynamics of the plankton.

Chapter -2

Review of Literature

Many limnological studies have been carried out by many researches in the different parts of the world. But only few works have been done in Bangladesh. However, in recent time there has been growing awareness amongst the researchers in Bangladesh to study on hydrobiology and environment. This section reviews the available literature relevant to the present study.

Thieneman (1925) stated that a lake is poorly productive when it produces 1000 animals/m² or less than it whereas a concentration of 2000 animals/m² or more in a square meter is considered as highly productive.

Basu and Gupta (1939) studied the biological value of proteins of some of Bengal fish by nitrogen balance and growth methods.

Hynes (1950) reported that the diets of fish often varied, they also changed with locality, age, and season.

Welch (1952) found that the nature of the bottom deposit is an important feature in determining biological productivity of a lake and the benthos vary widely with different conditions of the bottom both of the same level and different depths. He also considered the temperature to be a controlling factor in the distribution of bottom fauna.

Villadolid *et al.* (1954) reported that the water with pH ranging from 7.3 to 8.4 provided optimum condition for the growth of plankton. They stated that the lower pH values were known to adversely affect the plankton production and subsequently growth of fish.

Alikuhni (1957) confirmed that in Madras state, India, water of pH 6.5 to 7.5 gave average yield than that of pH 7.5 to 8.5 in two ponds. The average pH values of both the ponds were 7.5 ± 0.16 and 7.4 ± 0.16 .

Hutchinson (1957) stated that temperature influences the solubility of different gases, especially oxygen and carbon dioxide in water.

Chakraborty *et. al.* (1959) studied on the quantitative occurrence of plankton and the physico-chemical condition of the river Jamuna at Allahabad.

Ward and Whipple (1959) published a book “the freshwater biology” for identification and description of almost all freshwater micro-organisms.

Bargstrom (1961) studied the new methods in appraising the role of fisheries in world nutrition.

Melanby (1963) studied the animals of freshwater in London.

George (1964) studied comparative plankton ecology of five fish tanks in Delhi.

Joyangodour (1964) made a bio-ecological study of Nuggikani Lake in Dharwan state in India.

Sreenivasan (1964) studied hydrobiology in Madras state.

Zafar (1964) studied on the ecology of algae in certain fishponds of Hyderabad.

George (1966) made comparative plankton ecology of five fish tanks in Delhi.

Krisnomorthi and Visweswara (1966) studied on the hydrobiology of the Gaudhi Sagar in India.

Munro (1966) reported 17 genera of zooplankton. He suggested that abundance of plankton was directly related to the availability of nitrite and nitrate nitrogen. The number of rotifers was highest in November and the abundance of Cladocera and Copepoda were observed in January and February.

Needham and Needham (1966) published a guide on freshwater biology in San Francisco.

Patalas and Patalas (1968) worked on the composition and seasonal changes in plankton in which they found a relationship between the plankton abundance and

electrolyte content of water. They also observed a greater number of species in deeper water than in shallow water.

Vyas and Kumar (1968) studied the phytoplankton and other algae in Indra Sagar tank in Udaipur.

Michael (1969) found the yearly variation in the total quantity of plankton highly affected growth and production. In a study on seasonal variation of the physico-chemical factors and plankton of freshwater pond in India, the amount of dissolved oxygen in the ponds was found to be dependent on various biological process taking place in the medium. The pH ranged between 7.5 and 8.4 that was consider suitable for fish culture.

Bhuiyan (1974) reported that the average dissolved oxygen contents of two ponds were $6.4 \pm 1.46\text{ppm}$ and $6.2 \pm 1.00\text{ppm}$ and found to be in the good productivity ranges.

Munawar (1970) worked on the limnology of a fresh water pond in Hydrabad.

Dhawan (1970) studied plankton and hydrobiological factors at Kandla in the Gulf of Kutch. He observed that temperature was the only factor following the same pattern variation during the period. The fluctuations in the phytoplankton count did not affect the total volume of plankton and the zooplankton content was mainly responsible for the variation in the plankton biomass.

Sreenivasan (1970) reported that the high bottom temperature was responsible for the speed of decomposition of organic matter.

Bardach et. al .(1972) reported that though some pollutants notably human and animal metabolites (sewage or animal wastes) may be turned to the culturist's advantage (as fertilizer) but water pollution caused by them may be detrimental or lethal to aquatic organisms or their consumers.

Dewan (1973) in a study on the ecology of lake from Mymensingh established an inverse relationship of dissolved oxygen with temperature and free CO_2 and direct

relationship with pH and total alkalinity. He observed the lowest values of water level and transparency during summer and the highest values during monsoon.

Patnaik (1973) studied the seasonal fluctuation of plankton in the Chilka Lake. He reported that the plankton biomass in different sectors showed a summer peak during April-June, a monsoon peak in July-August, a winter peak during October-December and a spring peak in February.

Khan and Siddiqui (1974) investigated seasonal changes in physical, chemical and biological characteristics in a perennial fishpond and recorded uniform distribution of temperature of all the depths. They noted wide seasonal fluctuations in transparency and turbidity. Transparency was found to be affected by turbidity and phytoplankton crop. Fluctuations in carbonate alkalinity along with pH values were mainly due to photosynthesis activity of phytoplankton and other aquatic plants. The loss of phytoplankton was found to be associated with high production of zooplankton and the factor causing the disappearance of phytoplankton from the environment was primarily zooplankton grazing.

Watson and Carpenter (1974) studied on the seasonal abundance of crustacean zooplankton and net plankton biomass of lake. They observed the zooplankton fluctuation throughout the seasons with maximum in the spring or summer months.

Das and Bhuiyan (1974) studied the limnoplankton of some inland water of Dacca city. Planktons were abundant in April, May and October and depleted in August and January-February. According their observation various physico-chemical factors influence the abundance of plankton population in a water body like water temperature, rainfall, sunshine hours, pH nutrient salts etc.

Islam and Saha (1975) studied the Ramna lake of Dhaka city. They found the lowest number of zooplankton and phytoplankton in March. The growth rate of planktons gradually increased up to the month of July but the rate of increase of zooplankton was less than that of the phytoplankton.

Mathew (1975) studied the limnology and lake productivity of Govindgarh.

Young (1975) observed the seasonal and diurnal changes in the water temperature of a temperate pond in England and a tropical pond in Kenya.

Nordlie (1976) studied the abundance of zooplankton. Rotifers were abundant in cold months while cladocerans showed the highest densities during the summer months. Copepods were variable throughout the year.

APHA (1976) made a standard method for the examination of water and wastewater in Washington.

Ali et al. (1977) investigated the population dynamics and biomass of oligochaete fauna of a fish pond and role of physico-chemical factors on their population. The maximum abundance of different species occurred at different times of the year. The highest peak of the population, taking all the species together was recorded in February with 1710 individuals/m² and the lowest peak in October was 22 individuals/m² maximum and minimum biomass was obtained to 10 gm/m² and 0.06 gm/m² February and October respectively.

Mollah and Haque (1978) studied monthly variation of plankton in relation to the physico-chemical characteristics of both soil and water (and of air) was found to have some effects on the periodicity of zooplankton.

Naser (1978) noticed the diurnal movement of zooplankton in freshwater pond of Bhagalpur. The zooplankton population was always abundant near the surface during daytime. Light was assumed to be the most important factor, responsible for diurnal movement of zooplankton. Besides light, dissolved oxygen and availability of food may also be responsible for vertical movements.

Oppenheimer et al., (1978) studied the limnology of three ponds in Dhaka.

Mollah et al. (1979) found a more or less direct relationship between pH and dissolved oxygen content and inverse relationship of free carbon dioxide and pH.

Ali et al., (1980) studied the ecology and seasonal abundance of zooplankton in a pond in Tongi, Dhaka. The pH fluctuated between 7.5 to 9.5 and dissolved oxygen varied from 12 to 22mg/l during the experimental period.

Das (1980) while investigating the growth of major carps in relation to physico-chemical and biological factors of three artificial ponds found higher population density of zooplanktons in ponds that were rich in organic matter.

Miah et. al. (1981) made a comparative study of the growth of major carps in relation to physico-chemical and biological factors in Dhaka.

Storms (1981) studied on the seasonal distributions of zooplankton in Quantico Creek and the adjacent Potomac River. The highest number of zooplankton (286,000/m³) was recorded in June and the lowest (186/m³) in February. Rotifers were numerous in April, cladocerans in December and June and copepods in February, August and October.

Rahman et. al. (1982) suggested that primary productivity of a pond depend upon the physico-chemical condition of water after conducting the limnological study of four ponds. Temperature and chemical properties showed vertical variations. Water temperature, dissolved oxygen and pH values were higher at the surface waters than at the bottom. Carbon dioxide, in contrast, was higher at the bottom waters than at the surface.

Ali and Islam (1983) studied the phytoplankton of a pond in Bangladesh Agriculture University Campus.

Habib et al (1983) in a study on some important physico-chemical characteristics in two ponds reported that the transparency of water body normally indicated its productivity and higher values of transparency might be associated with heavy growth of phytoplankton and heavy rainfall.

Khatri (1984) studied the seasonal variation in the ecosystem and observed that the transparency showed diverse relation with phytoplankton. PH has negative

relationship with free carbon dioxide and positive with bicarbonate. He further noted that phytoplankton and chlorophyll had positive relationship with zooplankton.

Alam et al. (1985) studied monthly abundance of zooplankton with some characters in a pond. The populations of zooplankton were found to be highly significant but vertical abundance was insignificant in their study. The growth and abundance of zooplankton were influenced by the combined effect of rainfall, water temperature, pH and transparency of water but the effect was not significant.

Banu et al. (1987) studied food and feeding habits of 367 young *Labeo rohita* (Ham.) caught from two different ponds at Tongi Fish Seed Multiplication Farm over a period of twelve months are presented. Food contents were analyzed through the use of occurrence method and points method. These two methods showed marked similarities when it came to listing the dominant food items. The seasonal analysis of food items showed with month to month fluctuations in percentage of major food items in total diet.

Alam et al (1987) made an observation on the zooplankton in newly constructed ponds and their relation to some meteorological and limnological factors in Bangladesh.

Chowdhury and Majumdar (1987) studied the limnology and the physico-chemical features on the Kaptai Lake in Bangladesh.

Mumtazuddin and Khaleque (1987) studied the effect of plankton biomass on the relative growth potential of carp.

Patra and Azadi (1987) made a quantitative and qualitative study of plankton in relation to physico-chemical factors of the Halda river water. Zooplankton growth cycle was noticeably less than the phytoplankton abundance almost throughout their study period.

Hossain et al. (1988) studied the qualitative and quantitative status of the plankton of Basukhali Salimpur Kola Barnal beel. Rotifera was the abundant group. Both

zooplankton and phytoplankton exhibited common peak in May. Zooplankton showed a second peak in September.

Ali *et al* (1989) reported on seasonal variations of physico-chemical and biological conditions of a pond in Dhaka. They observed considerable variations in water qualities in different seasons. They observed that temperature had an inverse relationship with the density of phytoplankton and direct relationship with the density of zooplankton.

Begum *et al.* (1989) studied the limnology of a mini pond to find out the seasonal variation and interrelationship between physico-chemical parameters and plankton.

Chowdhery *et al.* (1989) studied the occurrence and seasonal variation of zooplankton in a fishpond in relation to some physico-chemical factors. They recorded the monthly distribution of zooplankton and their major groups. Rotifers appeared the dominant group (52%) followed by protozoan (16%) and ostracods (12%).

Khan *et al* (1990) reported that the productivity of water bodies is related to pH. High seasonal pH condition in the water may pose some health hazards. Hardness of water is directly related to the biological productivity. Hardness above 500mg/l is unsuitable for domestic use because good quality water should possess the hardness of 170mg/l.

Yousuf (1990) studied phytoplankton dynamics in Dal Lake, Kashmir and stated that the algal plankton of lakes consist of adverse assemblage of nearly all the major taxonomic groups. Although different phytoplanktons have different environmental requirements, many of them co-exist in the same water body. However, dominant genera in these groupings changed not only from place to place but also seasonally, as a consequence of change in the environmental conditions within the water body.

Begum *et al.* (1992) investigated the occurrence and seasonal variation of rotifers in a semi-intensively managed pond in Dhaka city. The highest number of rotifers was recorded in April and the lowest in May. The lowest representation of zooplankton was related to high water temperature and low turbidity.

Begum *et al* (1994) reported the fluctuation in the physico-chemical parameters of semi-intensively managed fishpond. They compared the degree of variability of each physical or chemical parameters. The pH value of the pond was found to have the lowest variability while carbonate had the highest variability.

Khan (1994) studied the physical and chemical limnology of lake kaptai, Bangladesh, the largest man made lake of South East Asia.

Wan *et al.* (1994) observed that the basic pH promote degradation of Ops pesticides in water samples by stabilizing the more phenolic structures.

Banik (1995) studied the zooplankton abundance in a freshwater fish-farming pond in West Bengal in relation to some environmental factors. Winter supported the maximum abundance of zooplankton and was minimum in summer.

Abubacker *et al.* (1996) investigated the physico-chemical and biological aspects of water from Uyyakondan Canal of Cauvery River and indicated high levels of chlorides and calcium, which made the water unsuitable for human use. They recoded Diatoms, *Melosira granulata*, *M. sulcabam*, *Cyclotella meneghiniana*, *Pleurosigma angulatum* and were the dominant pollution-tolerant species.

Bais, *et al.* (1996) investigated the comparative relationships between chlorophyll 'a' and hydrospheric factors of the two freshwater lakes and also the trophic status of the two lakes. The low concentration of chl 'a' in one lake was due to presence of permanent turbidity.

Birasal (1996) studied the primary productivity of a man made lake in Karnataka. The study revealed that lake to be unproductive and oligotrophic in nature.

Chang and Entz (1996) suggested the weekly sampling of ground water during growing season to avoid missing of peak nitrate level.

Chaurasia, S. (1996) studied the seasonal fluctuation of the major zooplankton communities of a polluted water tank. She recorded bimodal pattern of fluctuation by total zooplankton and rotifers while copepods showed a single peak. She also

found the limited migration of different zooplanktonic groups with depth. Her study revealed higher population of rotifers and copepods in surface water and cladocerans in deeper water.

Gnana et al (1996) collected the data to study the distribution of organic matter in two freshwater lakes. According to their study NO_3 peak preceded the COD peak in winter season that clearly indicated that ambient dissolved oxygen levels were sufficient to oxidize both organic carbon and oxygen.

Hosmani et al. (1996) studied the Calcium Carbonate saturation index and its influence on phytoplankton in sixteen lakes. According to their study the rate of deposition was different in various lakes.

Kaur et al. (1996) studied abiotic and biotic components of a freshwater pond on monthly basis for six months. Physico-chemical analysis of the pond water revealed high values of alkalinity, hardness, chlorides and nitrates, showing that water of this pond was polluted. This was further confirmed by the presence of pollution indicator species in the pond.

Khan (1996) studied on community structure and ecology of macrobenthic invertebrate fauna of Lake Kaptai, Bangladesh on the basis of monthly sampling for full two years.

Majahan et al. (1996) selected three ponds to conduct productivity studies. Maximum gross primary productivity was recorded in the month of May and the lowest in the months of July, November and September.

Kumar (1996) studied the monthly and diurnal variations of physico-chemical factors of fish farming pond. The water temperature ranged between 20 and 39 °C with minimum and maximum value obtaining in January and June respectively. The range of pH (7.4-8.8), DO (3.0-9.5 ppm), bicarbonate alkalinity (150-280ppm) indicated the eutrophic nature of the pond. The data pertaining to simple correlation and coefficient showed that the temperature was significantly correlated with pH (0.920), but other parameters did not show any marked correlation.

Hossain et al (1997) studied the physico-chemical parameters of the Basukhali-Salimpur Kola-Barnal beel, a completely closed system flood plain. The turbidity values of the flood plain was almost translucent, conductivity values were found higher in comparison to some other aquatic ecosystem and dissolved oxygen maintains an inverse relationship with temperature.

Kabir et al. (1997) made a qualitative and quantitative study on the zooplankton from Noakhali North floodplain.

Bhuiyan and Nesa (1998) studied the seasonal variation on the occurrence of some zooplankton in a fishpond of Rajshahi University campus, Bangladesh.

Chapter -3

Materials and Methods

3.1 Study place and period :

The study was conducted in the Gulshan-Baridhara Lake that lies in the posh area of Dhaka city, a long, narrow perennial shallow water body stretching in north south direction. The lake is fed by a number of domestic sewer drainage from the surrounding areas. This lake is connected to Lakkha, a tributary of Buriganga River by a narrow canal near Rampura. This lake carries mainly sewerage water except in rainy season, which gets rain- water. The lake is situated between $23^{\circ}37'$ N to $23^{\circ}48'$ N latitude and between $90^{\circ}13'E$ to $90^{\circ}29'E$ longitude (I.W.T.A., Dhaka). The study was conducted in two and half consecutive years from August 1999 to January 2002.

3.2 Sampling designs :

The study lake was divided into three sampling stations in order to get the representative values of different water quality parameters and to document the spatial variation in relation to sewer discharge point. The selected stations have been shown in Fig-1. It was necessary to divide sample areas of the lake at various points between Nutunbaridhara Bridge and Gulshan-I Taltala. The description of the selected sampling sites are given below :

Station-1 (Nursery area of Baridhara Bridge) : It is located in the north of Baridhara Bridge. The station lies in the plant nursery area (Plate-1).

Station-2 (Gulshan Taltala) : It is located in the human settlement area. This station receives sewerage canal. Lake water is used for various purposes like washing, cleaning, bathing etc in this area. This site is polluted as domestic wastes mix up with the water of the lake during dry season (Plate-2).

Station-3 (Rampura Bridge area) : This site is located very near the open area and has the facilities for pumping out of water when necessary. The color of discharge water is blackish. (Plate -3)

Sampling : Sampling is the first effective effort and one of the most important parts of any biological oriented research work. The goal of sampling is to obtain a portion of the water-body that is truly representative. The most critical factors are points of sampling, frequency of sampling and maintenance of integrity of the sample for the analysis.

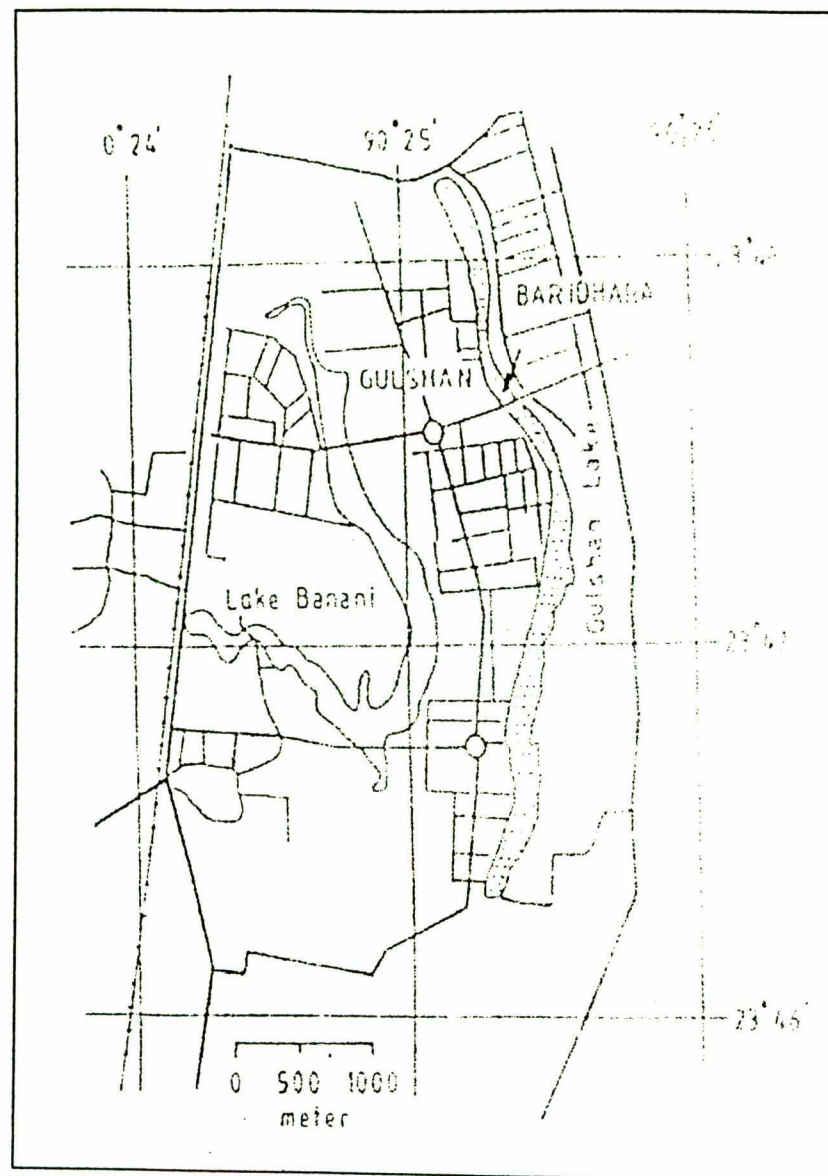


Fig. 1. Map of Gulshan Lake.

Types of samples : At each fixed station, chosen with respect to the information desired and in conformity to local conditions, three sampling depths were considered: the lake surface, compensation layer and the lake bottom. Samplings were done for this research work from August 1999 for the limnological study of a shallow lake in order to know the condition of the lake. The most important components of the aquatic ecosystem have been selected. These are – water, plankton, benthos and fish.

Sampling schedule and frequency : The study was based on fortnightly sampling at three different stations, generally during first and fifteenth of each month. All three stations were monitored on the same day within a three hours time in order to get a ‘snap-shot’ of the lake. Water samples for physico-chemical and benthos were collected from the selected marked areas between 9.00 to 12.00 hours on the sampling days. Zooplanktons were sampled fortnightly from three different layers –surface, compensation and bottom at 6 am, 12 noon and 6 pm.



Photograph-1. Side view of sampling station-1 of the studied Gulshan Lake



Photograph-2. Side view of sampling station-2 of the studied Gulshan Lake



Photograph-3. Side view of sampling station-3 of the studied Gulshan Lake

3.3 Methodology for water quality parameters :

Collection of water : The water samples from three depth i.e. surface, compensation and bottom were taken from three stations using a Kemmerer Water Sampler (Model 190-E-307) and preserved in plastic vials. The physical and chemical parameters of the studied lake were analyzed immediately after collection

Analytical methods : Water samples from three stations were for recording of temperature, turbidity, dissolved oxygen (DO), free carbondioxide (CO₂), hydrogen-ion concentration (pH), alkalinity, hardness, ammonia and nitrite. The apparatus used to analyze the chemical and physical parameters was the Universal Aquaculture Test Kit Model no-FF2 of Hach Company, U.S.A.

Temperature : The water temperature of three stations was recorded with a centigrade thermometer dipping into the water body at the time of sampling. The corresponding air temperature of the lake's bank was recorded at the same time.

Depth : The average depth of different stations was recorded in the field with the help of long bamboo pole. The bamboo pole was dipped in water till it reached to the bottom, then the length of the wet part of bamboo was measured with the help of measuring tape. The depth of each station was measured and means depth was calculated.

Transparency : Transparency or the level of light penetration was measured by lowering a "Secchi disc" into the water until it just disappeared and measuring the length of rope bearing Secchi disc by a measuring tape in cm. The disc was then ascended and the distance at which the disc just reappeared was observed. Then the mean of these two readings of secchi disc was noted as transparency in cm or meter.

$$\text{Transparency} = \frac{\text{Disc just disappeared} + \text{disc just appeared}}{2}$$

$$K = \frac{1.7}{D}$$

Where,

K = Transparency coefficient.

D = Secchi's disc reading

1.7 = Constant factor

Dissolved oxygen (DO) : The determination of DO is done with the HACH employ Winkler's method provided in HACH Kit. In the determination of dissolved oxygen samples are treated with Manganous-sulfate and alkaline iodide-azide reagents to form an orange-brown precipitate. Sulfuric acid is added, which reacts with the iodide to release iodine. The free iodine is then titrated with standard sodium thiosulfate solution. The concentration of DO is directly proportional to the amount of titrant used. The quantity of DO thus estimated was expressed in milligrams per liter of water (mg/l).

Free carbondioxide : Unit of free carbondioxide was determined in the sample by titration method by using a HACH Kit. Sample was titrated with standard sodium hydroxide to the phenolphthalein end point.

Hydrogen ion concentration (P^H) : The pH value was measured using a pH meter (HANNA, mode No. C-100). Sometimes HACH Water Quality Test Strips (5-in-1, Cat. 27552-50) was also used for the testing purpose. The testing strip was dipped in the sample for one second. The strip was removed from the water and kept for 30 seconds without shaking. Then the color of the strip pads was compared to the color chart given in the bottle.

Ammonia and Nitrite : Determination of ammonia and nitrite in sample water were done by the color comparator method. Sample taken into two tubes one in untreated and other treated with reagents and indicators. Color disc for each test was used to compare the color of untreated sample with the color of treated samples. Comparison was made by naked eye. Nessler reagent method was applied for obtaining the amount of total ammonia in the sample. This method is a sensitive single reagent test. Interference due to high water hardness was eliminated by adding Rochelle salt in the sample. Nitriver 3 nitrite reagent was used to determine the amount of Nitrite in the water.

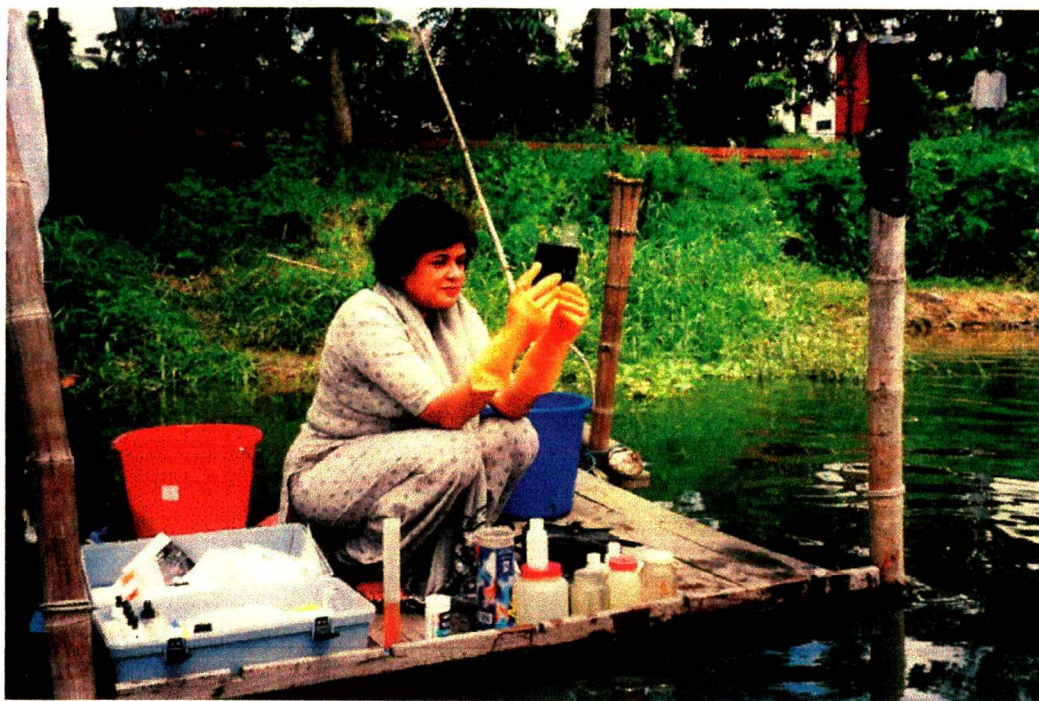
Hardness : The determination of hardness concentrations in water was also based on titration method. The water sample is buffered to a pH of 10.1 where the test functions best. An organic dye is added which reacts with calcium and magnesium ions to give a red-colored complex. The solution is then titrated with standard EDTA

to a blue end point. The amount of EDTA titrant is directly proportional to the concentration of total hardness (as CaCO_3).

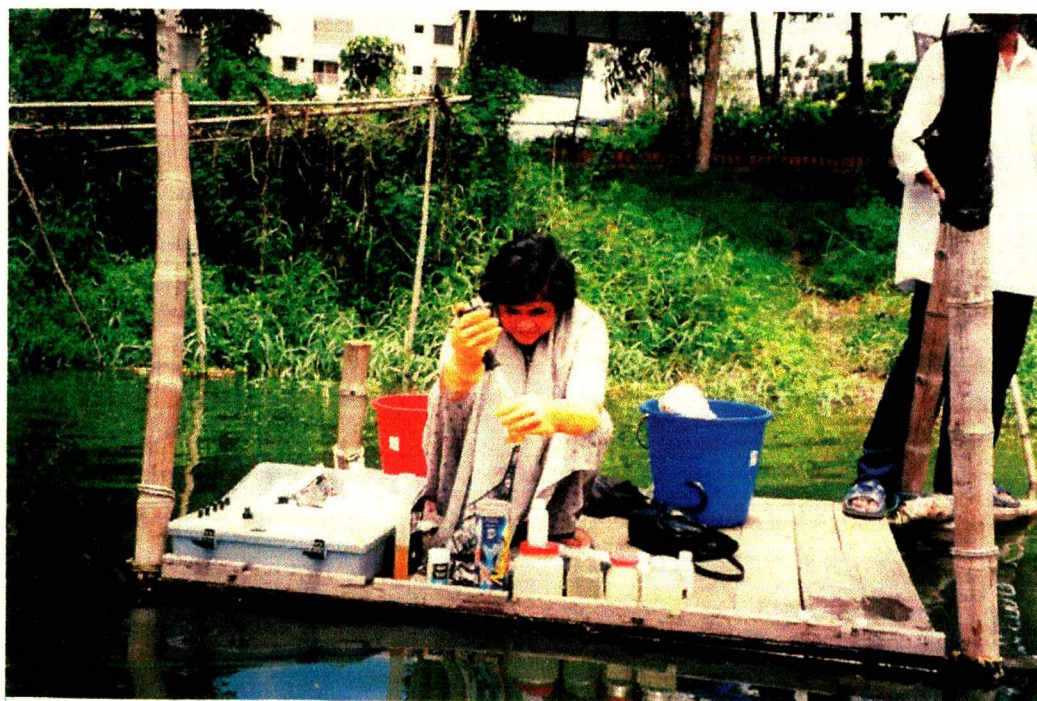
Alkalinity : Alkalinity was determined by the phenolphthalein method. The phenolphthalein alkalinity is determined by titration with sulfuric acid to a pH of 8.3 (phenolphthalein end point) and registers the total hydroxide and one half the carbonate present.



Photograph-4. Showing the researcher working with HACH KIT for determination of water quality parameters



Photograph-5. Showing the researcher working with HACH KIT for determination of water quality parameters



Photograph-6. Showing the researcher working with HACH KIT for determination of water quality parameters

3.4 Biological parameters :

3.4.1 Zooplankton :

Collection of samples : Samplings were done from different layers of three stations with a Kemmerer Water Sampler (Model 190-E-307) using an engine boat. Plankton was collected by filtering twenty liters of water taken from within 250-m² areas through a net of 63µm mesh size and finally concentrated to 50 ml.

Preservation of samples : Transeau's solution, prepared by mixing 60ml of distilled water with 30 ml absolute alcohol and 10ml formaldehyde was used to preserve collected samples in the plastic bottles. The compositions of preservatives were 60 ml distilled water, 30 ml absolute alcohol and 10 ml formaldehyde. Five ml of glycerine was added to above 100 ml solution to make 5%, which prevent the planktons from being brittle.

Mounting Fluid : 10% glycerine solution in distilled water was used as mounting fluid for the preparation of temporary slide for microscopic studies. Aqueous eosin or cotton blue and lactophenol were used as stain and as mounting fluid, which facilitated a clear view of the materials under microscope and better contrast for photography. Compositions of lactophenol were 20 ml phenol, 20 ml lactic acid, 40 ml glycerine and 20 ml distilled water.

Observation : The preserved samples collected in the plastic bottles were transported to the laboratory for analysis of plankton. The bottle containing the plankton were shaken gently for proper mixing, from which 1ml sub-sample was drawn with pipette into the Sedgwick Rafter Counting Cell (Known as S-R Cell). The counting cell was then covered with a glass slide and examined under a compound binocular microscope at a magnification of 10X.

Identification : The zooplanktons were identified by taxonomic keys, identifying characteristics and specific figures following Ward and Whipple (1959), Mellanby (1963), Needham and Needham (1966), Tonapi (1980) and Bhoutayn & Asmat (1992).

Enumeration of Plankton: After identification of plankton in each sample they were then enumerated for the study of abundance of planktons in the investigated area. A total of 20 out of 1000 sub cells of S-R cell were randomly examined for each sample and the organisms falling within the 20 sub cells were counted. The samples were examined for three times for each and then the average counts were taken for further calculation. The total numbers of planktons were estimated by following the formula given below:

$$N = \frac{A \times C \times X}{L \times Y}$$

Where,

N = Number of zooplankton per liter of original water.

C = Volume of the concentrated sample in ml.

L = Volume of the original water expressed in liter.

A = Average number of zooplankton observed in 20 sub cells of the S-R cell

X = Number of Total cells in the S-R cell.

Y = Number of counted sub cells of the S-R cells

3.4.2 Benthos :

The community of organisms living on the bottom of a water body is called the benthos form a very important collection of food items of fishes, especially bottom feeders.

Collection of samples : For the purpose of benthos sampling, soil samples from a number of points of each selected station were carried out by Ekmen Dredge covering an area of 225 cm² from an anchored boat. Then the samples were passed for washing through a series of standard brass sieves of mesh sizes 2mm, 1mm and 0.149mm. The benthic organisms remaining on the sieves were collected with care into plastic vials containing 5% formaline. The vials were labeled properly and taken to the laboratory for study. The preserved sample from each vial was poured on a clean petridish containing distilled water.

Identification of Benthos : For study the samples were kept for 48 hours in the laboratory to allow the animals to harden (Maitland and Heedspith, 1974). The

preserved animals were then transferred to a petridish and washed with tap water to remove the remaining washable detritus and mud. Then the benthic organisms were separated and counted into different major taxonomic group by using magnifying glass and calculated as number of individuals /m². The benthos was identified according to Ward and Whipple (1959), Needham and Needham (1966), Ali (1973), Issaque (1975) and Macan (1959).

3.4.3 Food and Feeding habit of Fish and their growth :

The present study was conducted on food and feeding habits of three species of major carp such as *Catla catla*, *Labeo rohita* and *L. calbasu*.

Sampling schedule and frequency : Monthly samples were collected between 1st to 3rd day of each month with the help of a 'seine net' and 'cast net' or hand net having mesh size 1-2.5 inches and 1-4 inches.

Time of sampling : Generally, the samples were collected at monthly basis from 9 AM. to 12 PM. and 3 PM to 6 PM. Sampling was done in early hours of the day to avoid the effect of any diurnal rhythm in feeding and different digestion of various food items.

Identification of fish specimens : Collected fish specimens were identified with local and scientific name following the work of Hamilton (1922), Rahman (1944), Monro (1955), Day (1958), Fischer (1974), Chawdhury (1981) and Shafi and Quddus (1982).

Growth rate of three major carps : The average growth rate of the selected 96 fish species were calculated in 12 months ranging from 176 mm to 410 mm, 147 mm to 458 mm and 135 mm to 365 mm in average total length for *C. catla*, *L. rohita*, *L. calbasu*, respectively and 310 g to 1000 g, 365 g to 1050 g and 192 g to 630 g for *C. catla*, *L. rohita*, *L. calbasu*, in weight respectively. For calculating the co-efficient of correlation (r) of length and weight, the method by Croxton *et al.* (1968) was followed.

Preservation of gut : The guts of the collected fishes were removed with the help a pair of scissor and forceps immediately after the measurement of total length. The collected guts were injected with Xylocaine to prevent the breakdown of the food

materials in the stomachs. Collected guts were then preserved in 10% Formaldehyde solution in plastic container. Each of the containers was then properly labeled with the necessary information such as date, total number of guts, species name, length group, time of sampling etc. Afterwards, the specimens were taken to the Fisheries Laboratory of the Department of Zoology, University of Dhaka for further analysis.

Analysis of gut contents : No single method is adequate for gut analysis (Azadi *et al.* 1994). Therefore, three methods *i.e.* occurrence, points (volume) and fullness methods were followed to get a detailed idea about food contents of the fish stomach.

Occurrence method : The number of stomachs in which each food item occurred expressed as a percentage of the total number of stomach with food. This method was suggested by Allen (1915), Frost, (1939, 1946 b, 1954), Frost & Went (1940), Hartely (1940, 1947, 1948) Hunt & Carbine (1931), Lagler (1956), Okedi (1971), Willoughby and Tweddle (1978). In the present study, this method was followed to find out the frequency of occurrence of major food items. Occurrence method has a disadvantage, too. It does not take into account the number and size of organisms present. The following point's method was used to overcome this disadvantage.

Points method : Points method is the best and most simple and easiest method Hynes (1950) reported all the methods used in studying food of fishes and concluded that the points method as the most satisfactory method because, it was quick and easy, it required no special apparatus for the measurement, it was not influenced by the frequent occurrence of a small organism in small numbers nor of heavy bodies. In this method, food items present in the stomach were identified as far as possible and placed in their various food items and then each food items was allotted points to the volume of it present in the stomach. In this way one large organism counted as much as several small ones. The largest volume found in a preliminary study was allotted 100 points. In allotting the points the size of the fish and fullness of the stomach were also taken into account.

Fullness method : This method was used to observe the intensity of feeding. The fullness of stomach was assessed by noting the state of distention of the stomachs and the amount of food contained in them (Frost, 1939; Frost & Went, 1940; Harkely,

1947). The stomachs were classified as full, three-fourths full, half-full, one, fourth full and empty etc. as suggested by pillay (1952). The points were allotted to the stomachs according to their fullness.

Observation Technique : The stomach of the individual fishes of each species was opened and the contents from the stomach were removed on to a petridish very carefully with the help of a very fine needle. Upon opening each stomach the following procedures were followed:

a) The occurrence of each and every food item in the individual stomach was recorded.

b) The volume of stomach contents as estimated by observation was recorded on absolute scale. The largest volume found in a preliminary study was allocated 100 points, and each of the stomach as examined was then rated in one of the following categories: 0, 3, 6, 12, 25, 50 and 100 points, according to the volume of food present. The categories were based on inspection and estimation, but a set of standard of all the point categories, was made from the extra stomach and was used in relation absolute volume to assigned point values. Stomachs with intermediate quantities of food were allotted to the point's category which they most nearly approached.

c) An index of fullness of the stomach was recorded irrespective of the size of the stomach and points were allocated to each of the stomach according to theft fullness in following way:

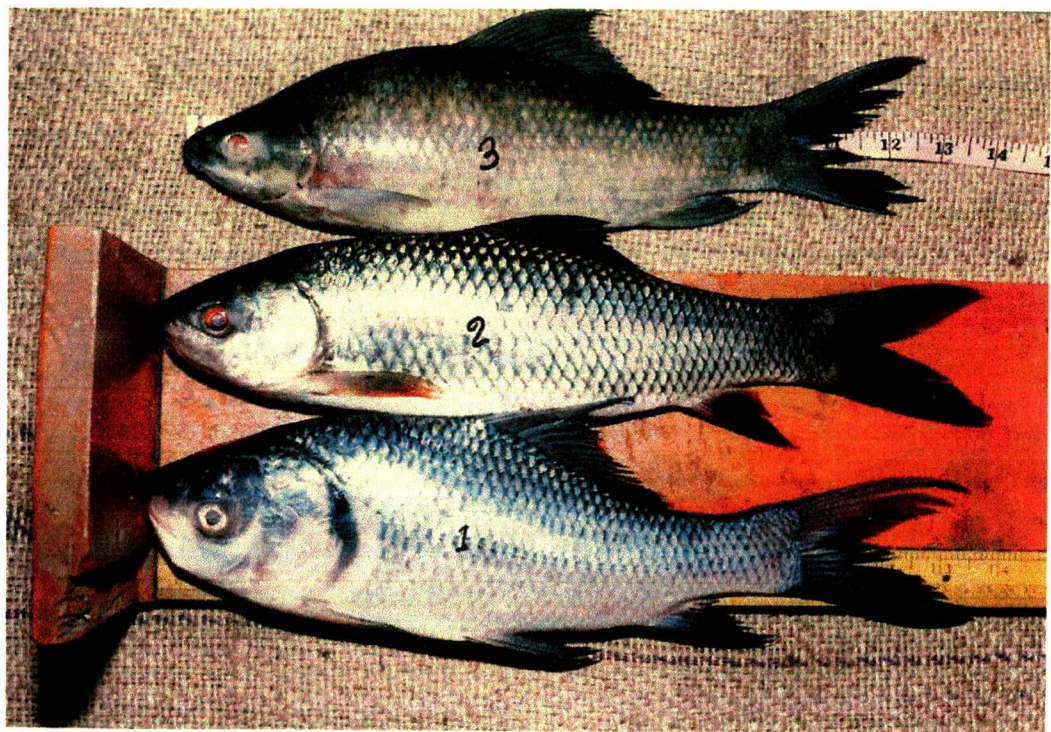
Points allotted	Fullness condition of the stomach
0	Empty
1	One fourth full
2	Half-full
3	Three-fourths full
4	Full

d) For identifying and counting the microscopic mod items I drop and 1 ml sample of the gut content was transferred by a pipette to a slide and a Sedgwick Rafter cell. A drop of lacto phenol solution was also added to the I drop and 1 ml gut sample for making the specimens transparent.

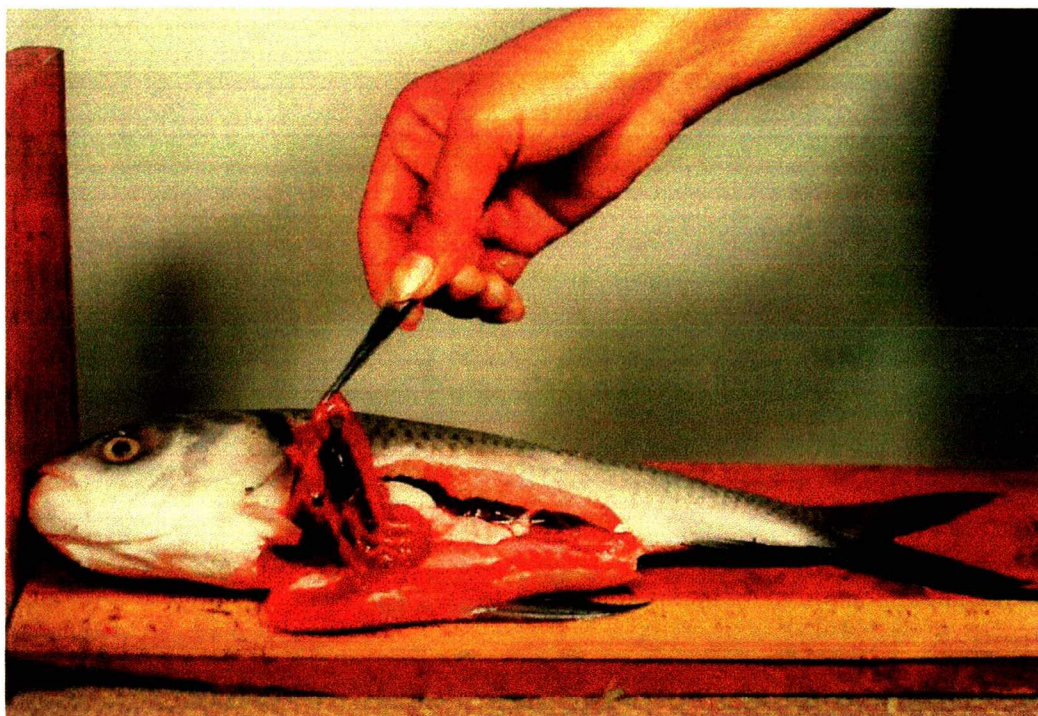
The cover glass was placed carefully over the chamber without forming an air bubble. Laying the cover glass diagonally across the chamber and slowly rotating the cover glass as the sample is introduced from the pipette can usually accomplish this.

After placing the slide and counting chamber beneath the compound microscope (magnification 5x, 10x) a random microscopic field was selected and identification and counting of finer items were done. This procedure was repeated 10 times. Each food item was identified as far as possible and organisms of each taxonomic group were then grouped together and points were assigned to the different categories of food by partitioning the total points allotted to the fish. Identifications of different food items was made Endmondson (1918), Needham & Needham (1962), Helen-Mellanby (1963) and Tonapi (1980).

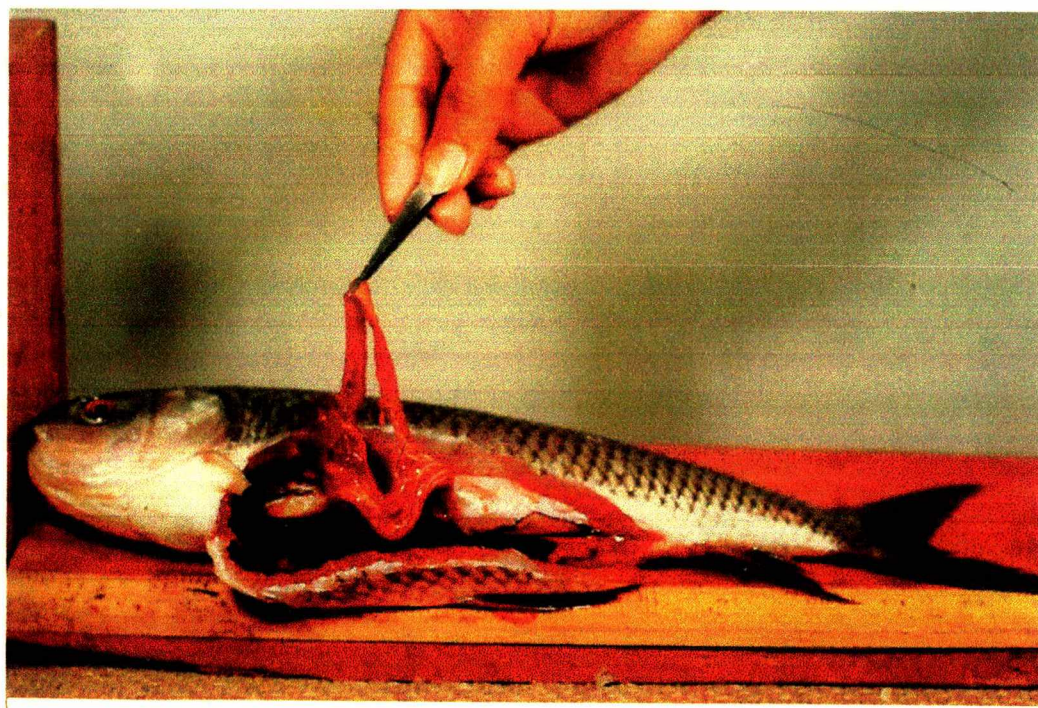
In total, stomach contents of 176 fish specimens were collected for the analysis, of which 54 were *C. catla*, 57 *L. rohita* and 65 *L. calbasu*. All the dietary items were then grouped into algae, plant parts, rotifer, crustacean, benthos, animal parts, semi-digested materials and mud & debris substance.



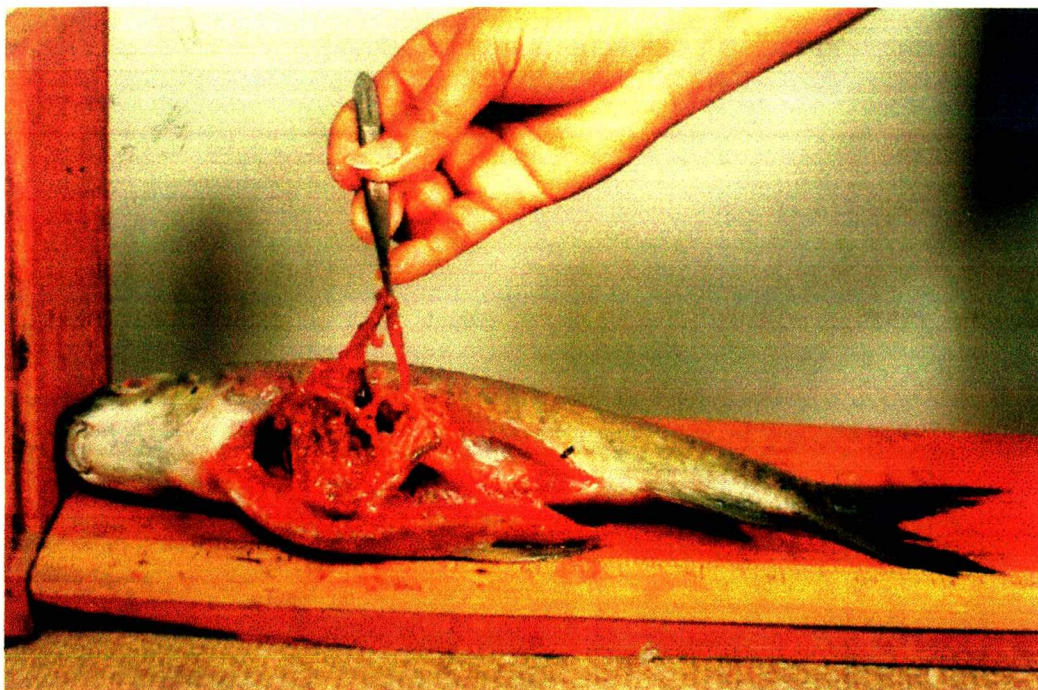
Photograph -7. Side view of three major carps- *C. catla*, *L. rohita* & *L. calbasu*.



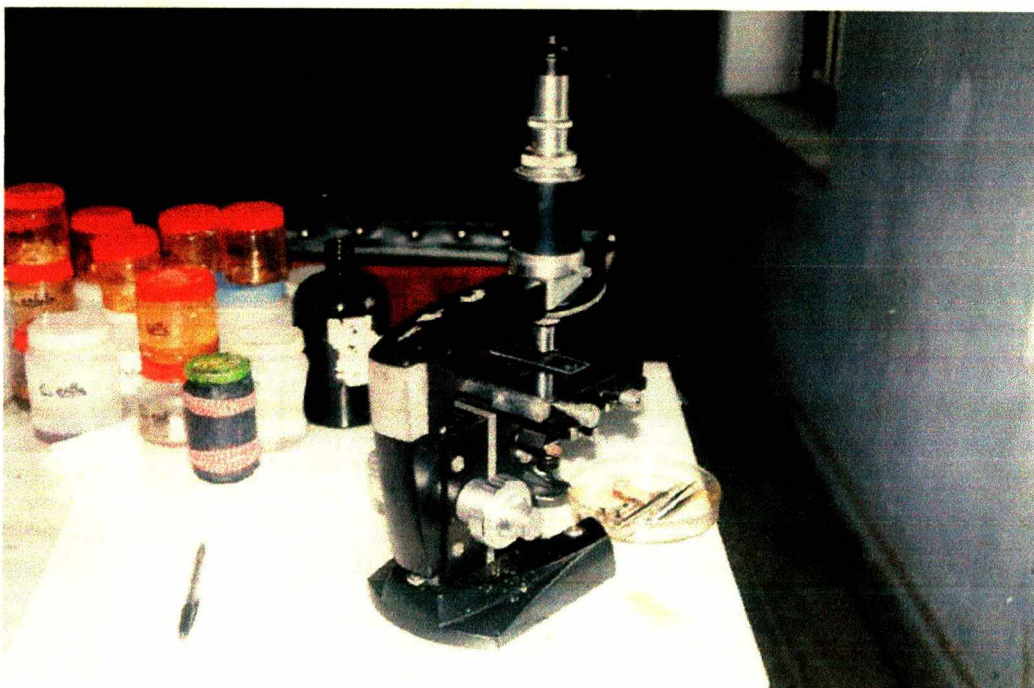
Photograph -8. Showing the open stomach of *C. catla*.



Photograph -9. Showing the open stomach of *L. rohita*.



Photograph -10. Showing the open stomach of *L. calbasu*.



Photograph -11. Showing the examination of food contents under microscope



Photograph -12. Showing the examination of food contents under microscope with Sedgwick-Rafter cell

Chapter -4

Results and Observation

In the present investigation the result of a comprehensive study on different physico-chemical parameters and biological characteristics of lake water were monitored from 3 selected studied areas of the Gulshan Lake fortnightly with a view to demonstrate the condition of the lake as well as to show the seasonal influence in the parameters. For the purposes of this study data of sampling points were analyzed. The influences of seasons in the variations of the measured parameters were also pronounced. Data of different physico-chemical and biological parameters collected from the samples have been processed and plotted in the tables and figures. Data have been collected during two and half years from August 1999 to January 2002, where August 1999 to July 2000 mentioned as year-1 (Y-1), August 2000 to July 2001 mentioned as year-2 (Y-2) and August 2001 to January 2002 mentioned as year-3 (Y-3). The detail results are presented below:

4.1 Physico-chemical parameters :

During the study period, air temperature, water temperature, transparency, P^H , dissolved oxygen, free carbon dioxide, alkalinity, hardness, ammonia and nitrite were measured and analyzed. It was observed that there was no significant variation of physico-chemical parameters between surface and bottom layers of the lake. The F values were 0.60, 0.85, 0.66, 0.81, 0.95, 0.93 and 0.79 in cases of DO, CO_2 , P^H , alkalinity, hardness, nitrite and ammonia respectively. The details of physico-chemical parameters of the studied lake have been presented in appendix-A.

4.1.1 Temperature :

The fluctuation of air & water temperature at different sampling stations was found marginal during the study period. The average range of air and water temperature varied from $19.33^{\circ}C - 35.0^{\circ}C$ and $18.67^{\circ}C - 35.67^{\circ}C$ respectively. It was

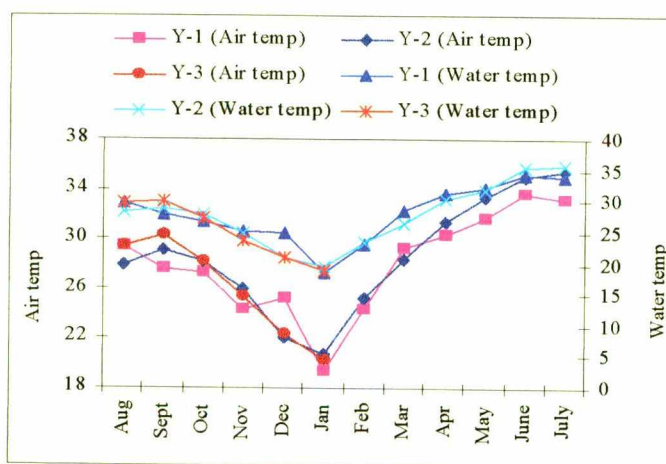


Fig.2. Monthly average variation of air and water temperature in the Gulshan Lake

recorded a steady increment of temperature till September and dropped again from mid September to January. The scenario was almost same in 1st, 2nd and 3rd year. The average value of standard deviation of air and water temperature was 27.81 ± 4.33 and 27.41 ± 4.85 respectively. (Fig.-2).

4.1.2. Transparency :

The sechidisc depth for transparency ranged from 18 cm to 63 cm. The maximum transparency was observed during August and minimum was during March (Fig.-3). It was observed probably due to high solar radiation and less plankton population. The mean value of standard deviation of transparency was 38.36 ± 10.58 . The details have been shown in appendix-A.

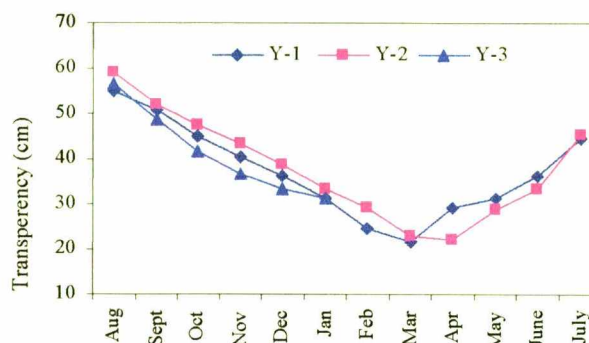


Fig.-3. Monthly average variation of transparency

4.1.3. Dissolved Oxygen (DO) :

The average dissolved oxygen content ranged from 3.06 mg/l to 7.24 mg/l. The lower values of dissolved oxygen were recorded during spring (December - April) and higher values were in rainy and summer months. The scenario was almost similar in all the sampling years expect in February of 1st year. The mean value of standard deviation was 4.95 ± 1.28 . (Fig-4). The details of DO fluctuations have been shown in appendix-A.

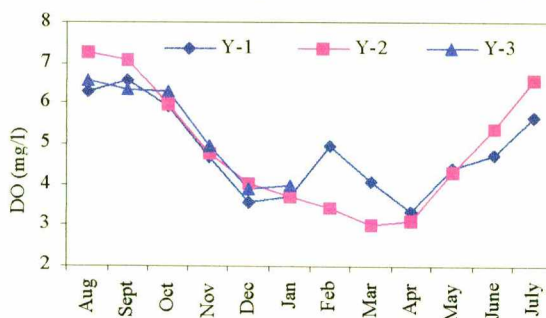


Fig. 4. Monthly average variation of dissolved oxygen in the Gulshan Lake

4.1.4 Free Carbondioxide :

Carbondioxide content in the water sample collected from different sampling stations varied greatly. Carbondioxide level found to fluctuate from average 7.00 mg/l to 15.74 mg/l at different sampling stations during the study period. The mean value of standard deviation was 11.27 ± 2.39 . Average monthly variations of free carbondioxide

have been shown in the Fig.-5 and details in appendix A. The free CO₂ content was lowest during winter. The summer time observation appears to be little erratic.

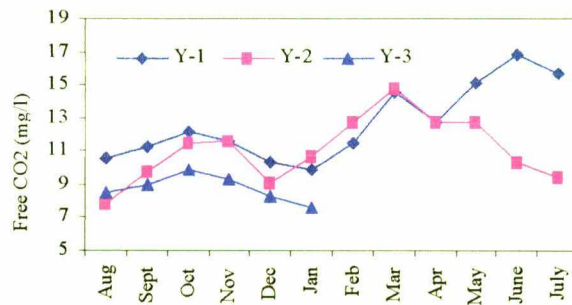


Fig. 5. Monthly average variation of free CO₂

4.1.5 Hydrogen ion concentration (P^H) :

The hydrogen ion concentration (P^H) in the water samples collected from three different sampling stations of the Gulshan Lake varied from 7.06 to 8.01 during the study period (Fig-6). The details of P^H value have been shown in appendix-A. The P^H values were more or less similar in all sampling year except in some cases. It was observed that the water was slightly alkaline (7.5-8.2) throughout the study period except in August 2001, when it was found to be neutral. The bottom layer was found more alkaline than mid and surface layers. The mean value of standard deviation was 7.57± 0.21.

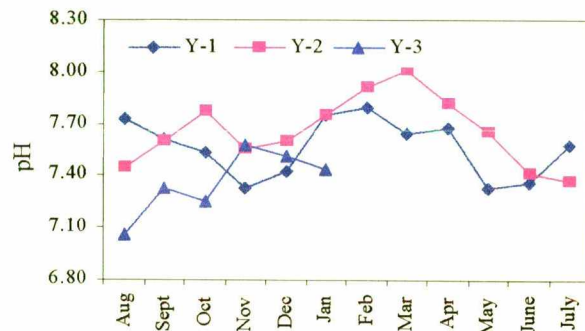


Fig. 6. Monthly variation of P^H in the Gulshan Lake

4.1.6 Alkalinity :

The monthly average fluctuations of alkalinity in the studied lake have been shown in Fig-7 and details in appendix-A. The alkalinity concentration ranged from 90.2 mg/l to 138.4 mg/l during

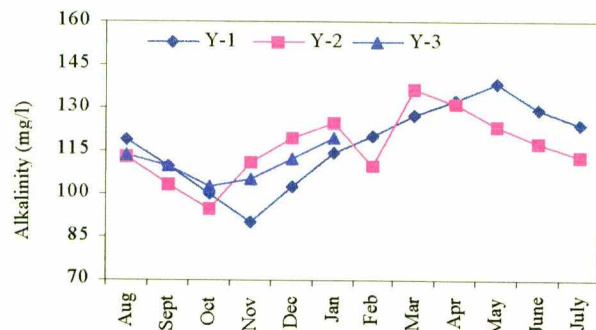


Fig-7. Monthly variation of alkalinity in the Gulshan Lake

the study period. The highest value was observed in May where as the lowest value was revealed in November. More or less similar scenario was observed in year 1, 2 and 3. The average value of standard deviation was 115.8 ± 12.7 .

4.1.7 Hardness :

Monthly fluctuations of hardness concentrations have been shown in the Fig-8 and details in appendix A. Hardness content in the water samples collected from 3 different study areas varied greatly. The average value of hardness ranged from 92.1 mg/l to 138.8

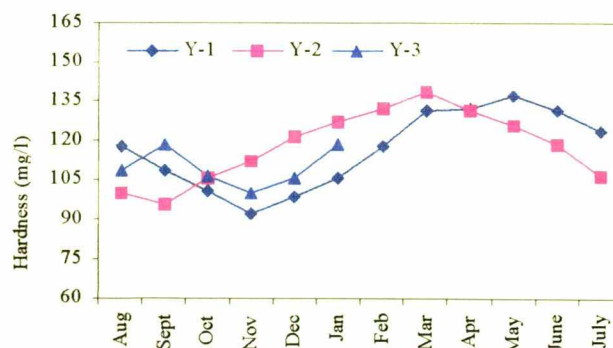


Fig-8. Monthly variation of hardness in the Gulshan Lake

mg/l respectively. It showed a low but gradual increase from December to April. More or less similar result was observed in all the sampling years.

4.1.8. Ammonia :

The monthly average ammonia concentration ranged from 1.2 mg/l to 3.7 mg/l shown in the Fig-9 and details in appendix A. The mean value of standard deviation was 2.3 ± 0.6 . Ammonia concentration increased from August to December and decreased from April to till July, but sudden increased in September in Year-1 and sudden fall in November in the same year was observed.

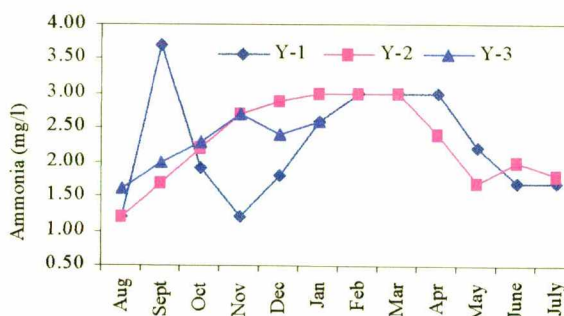


Fig-9. Monthly variation of ammonia in the Gulshan Lake

4.1.9. Nitrite :

Nitrite concentrations varied from 0.04 mg/l to 0.21 mg/l during the study period. The fortnightly fluctuations in different sampling stations of the Gulshan Lake are given in appendix A. Nitrite concentrations were more or less uniformly distributed in different layers of the lake. The average value of standard deviation was 0.11 ± 0.03 .

4.2 Zooplankton :

The present study quantitative observations were made at fortnightly intervals on the zooplankton community of three selected sites in the Gulshan Lake during study period from August 1999 to January 2002. It appeared that the range of zooplankton had fluctuated numerically during the course of the study. Abundance and diversity of zooplanktons in the three stations of Gulshan Lake of different times and different layers have been shown details in Appendix-A. From the accumulated data during the study period abundance of Zooplankton varied from 21,325 indiv/l in February 2000 to 1,225 indiv/l in July 2000 with an average of 6,426 indiv/l. In all the selected sites seasonal influence on the abundance and diversity of zooplankton were profound. In general the zooplanktons were more abundant during the months from February to May in all the stations and less abundant in August.

The major groups of zooplankton were recorded from the studied lake during the course of investigation and ranked on the basis of dominance by average number. The most dominant group was Rotifera comprising 48% of the total zooplankton population followed by Cladocerans (21%), Ostracods (13%) and copepods (9%) (Fig.-10). The pattern of dominance was more or less similar in the different layers of the water body (Fig. 11-13). The study has revealed that abundance of zooplankton was

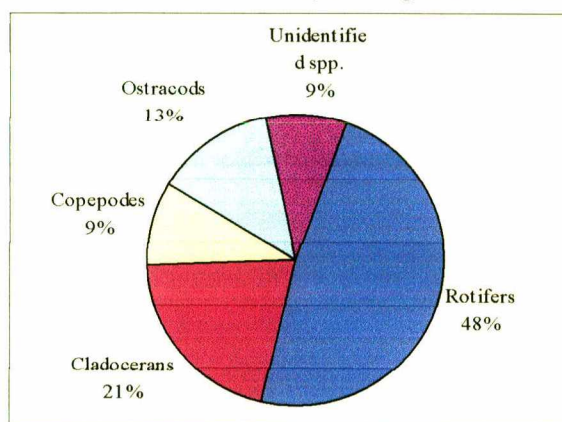


Fig.-10. Percentage composition of average zooplankton abundance

relatively higher in the bottom layer followed by surface layer (Fig. 14). The values of t were 0.71, 0.37 and 0.59 in cases of surface, middle and bottom layer, which indicated that abundance of zooplankton in different layers were almost similar. Zooplankton abundance varied in different stations of the studied lake. The highest abundance was recorded in station 3 (8144.77 indiv/l) followed by station 1 (7812.50 indiv/l) and station 2 (6184.08 indiv/l) (Fig. 15). It was observed that relatively higher zooplankton abundance was found in the morning (Fig. 16).

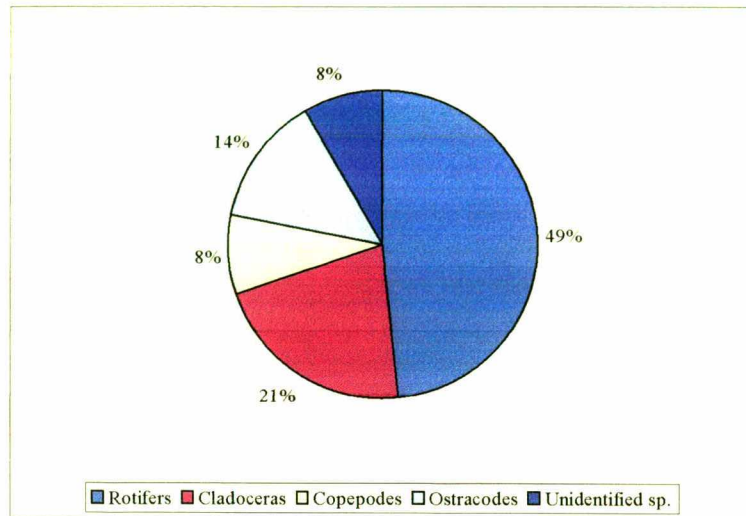


Fig.-11. Percentage composition of Zooplankton at surface layer of water

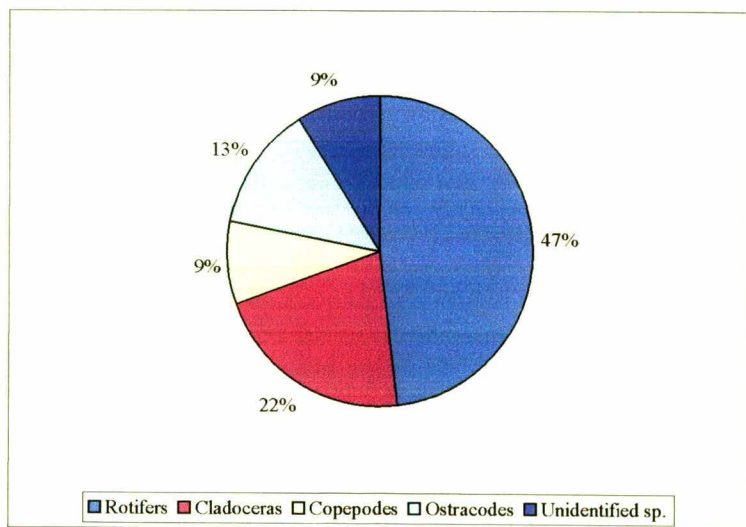


Fig.-12. Percentage composition of Zooplankton at middle layer of water

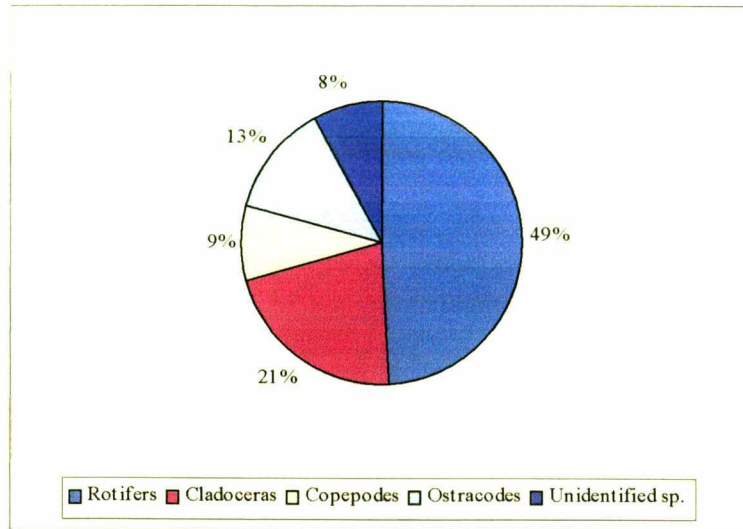


Fig.-13. Percentage composition of Zooplankton at bottom layer of water

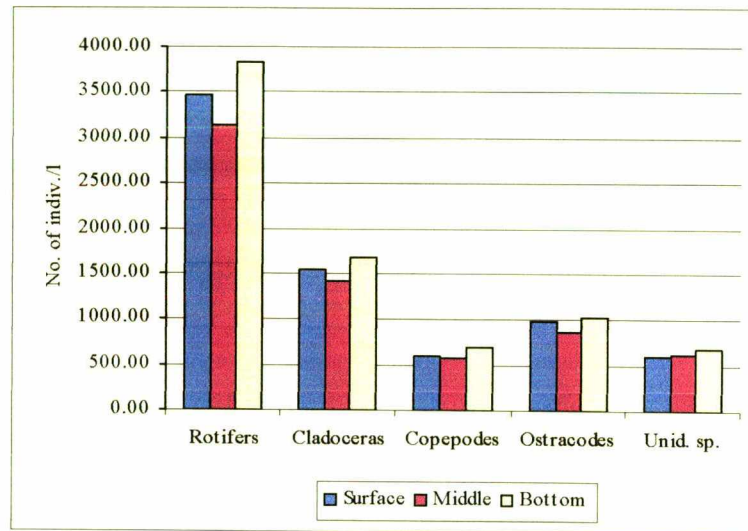


Fig.-14. Abundance of Zooplankton at different water layers

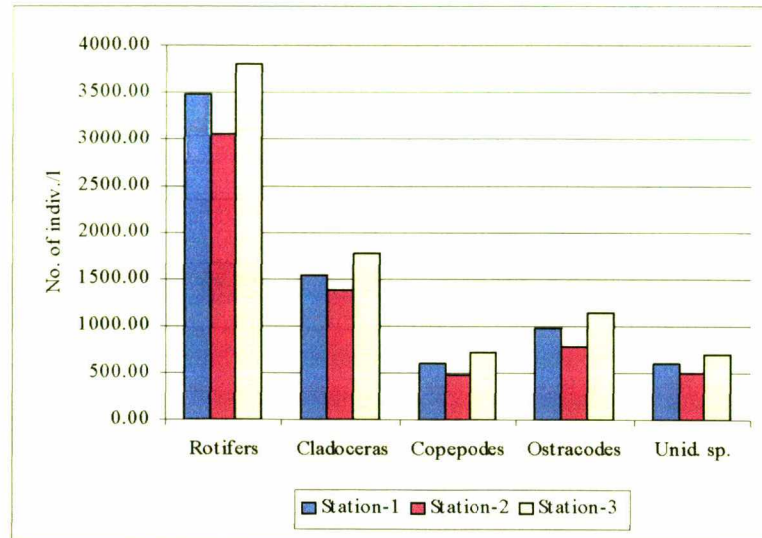


Fig.-15. Abundance of Zooplankton in three station of Gulshan Lake

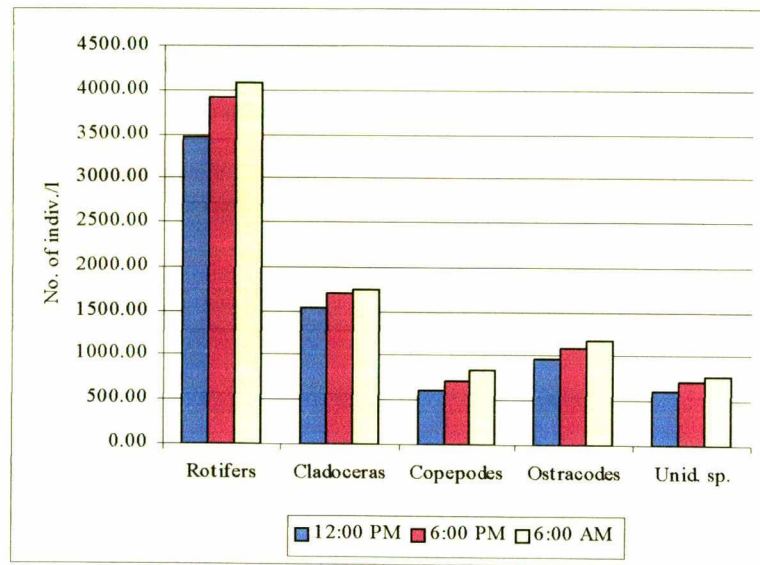


Fig.-16. Abundance of Zooplankton in variation of day time in the studied lake

During the study period, a total of 37 genera and 41 species of zooplankton were identified in the studied lake. Out of these, 14 genera and 27 species belongs to Rotifers. The monthly average abundance of different groups of zooplankton has been showed in figure 17.

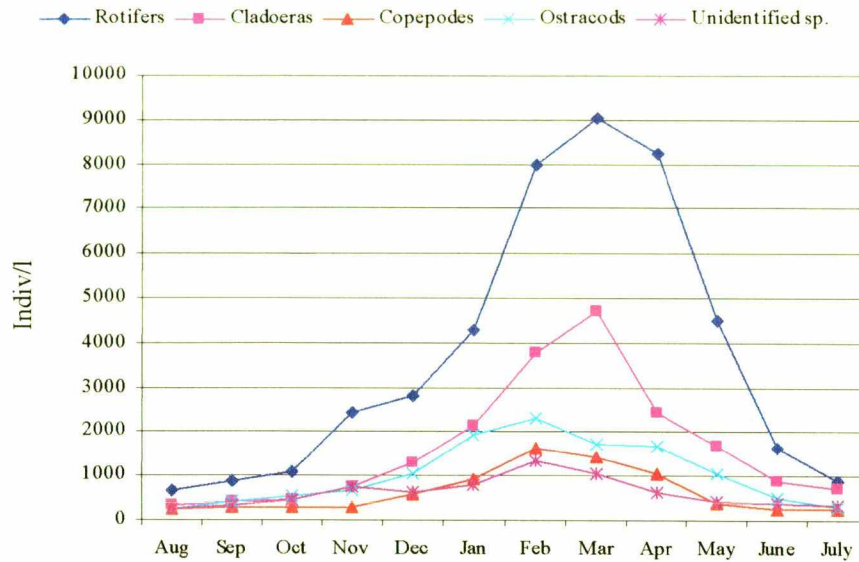


Fig.-17. Monthly average abundance of different groups of zooplankton

4.2.1 Rotifera:

The abundance of rotifers in the studied lake has been shown in Fig.-17. and details in appendix-B. The average value of rotifers abundance was 3440.69 indiv/l. The abundance of rotifers were increased from January to till March and then gradually decreased till June. The lowest abundance was observed in August. Similar pattern were observed in all the years. The abundance of major genera of rotifers is as below:

Brachionus spp was the most dominant rotifers. Seven *Brachionus* species were identified in the studied lake such as *B. angularis*, *B. calciflorus*, *B. caudatus*, *B. aculatus*, *B. plicatilis*, *B. quadridentatus* and *B. forficula* during the study period. *Filinia* was the second dominant rotifers genus. They were generally most abundant in March. Four species of *Filinia* were identified as *F. major*, *F. longiseta*, *F. terminalis* and *F. opaliensis*. Out of these, *F. longiseta* was the most abundant species. The third dominant rotifers genus was *Keratella* in position. Generally *Keratella* spp. were most abundant in the month of March. Four species were identified as *K. cochlearies*, *K. vulga*, *K. earline*, *K. tropica*. *K. cochlearies* was the

most abundant species. Among the rotifers *Asplanchna* was fourth dominant genus in position. In general this group of rotifers was most abundant in the month of March. Only one species of *A. priodonta* was identified during the study period. Among the rotifers *Polyarthra* was fifth dominant genus in position. In general this group of rotifers was most abundant in the month of September. In one species of *Polyarthra* was identified as *P. vulgaris*. Among the rotifers *Monostyle* was sixth dominant genus in position. In general this group of rotifers was most abundant in the month of April. In one species of *Monostyle* was identified as *M. hamata*. Among the rotifers *Trichocera* was seventh dominant genus in position. In general this group of rotifers was most abundant in the month of March. In two species of *Trichocera* was identified as *T. longiseta* and *T. rattus*. Beside, other rotifers such as *Cephalodella*, *Pedalia*, *Lecana*, *Lepadella*, *Epipheanes*, *Lindia* etc. were also identified from the samples of the pretest study. Most of these species were generally abundant from December to May.

4.2.2 Copepoda:

The monthly abundance of Copepods has been shown in Fig-17 and details in appendix B. Copepodes were the forth-abundant group of zooplanktons in all the studied areas. The average abundance of Copepods was 598.86 indiv/l. in the Gulshan Lake. The only *C. stermis* was identified among the collected samples. Besides, other Cyclopoids such as *Meocyclops*, *Thermocyclops*, *Eucyclops* and *Paracyclops* etc. were also identified during the present study.

4.2.3 Cladocera:

The abundance of Cladocera has been shown in the Fig.-17. Cladocera were recorded as second abundant group of zooplankton in all the studied areas. The average Cladocerans abundance was 1560 ± 1356 indiv./l. *Bosmina longirostris* was the most dominant identified genus in the studied lake during the study period. *Diaphanosoma brachyuren* was the other dominant genus. Besides, other cladocera such as *Bosminopsis dietersi*, *Moina branchiata*, *Daphnia spp.* and *Simocephalus spp.* etc. were also identified from the samples of the present study. Most of the species are generally not common.

4.2.4 Ostracoda:

The abundance of Ostracoda has been shown in Fig.-17 and details in appendix B. Ostracoda were identified as the third abundant group of zooplankton in all studied areas. The average abundance of Ostracoda was 960.50 indiv/l in the studied lake.

4.3 Benthos :

The benthic fauna ranged from 503 to 1,158 indiv/m² with an average mean data of 702 ± 152.41 indiv/m² during the study period in the studied lake. The abundance of benthos on an average was 672 ± 154.92 indiv/m² in station 1, 733 ± 154.02 indiv/m² in station 2 and 703 ± 152.76 indiv/m² in station 3 respectively.

The lowest abundance of benthos was observed in March and highest was in July. There were no significant variation of benthos abundance from August to February and sudden fall in March and then increasing their abundance till July. (Fig.18).

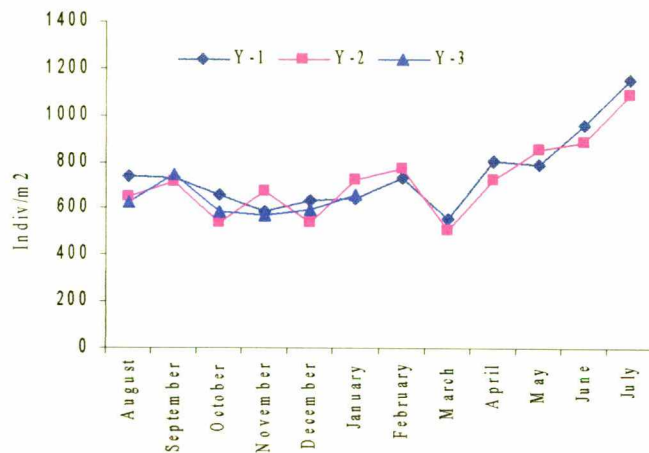


Fig.18. Average monthly abundance of benthos

Benthic fauna was sorted as major groups of Mollusca, Oligochaeta as well as Chironomidae and other organisms. Important organisms were systematically analyzed. The monthly average abundance of benthos and their percentage compositions are showed in figures 19 and 20.

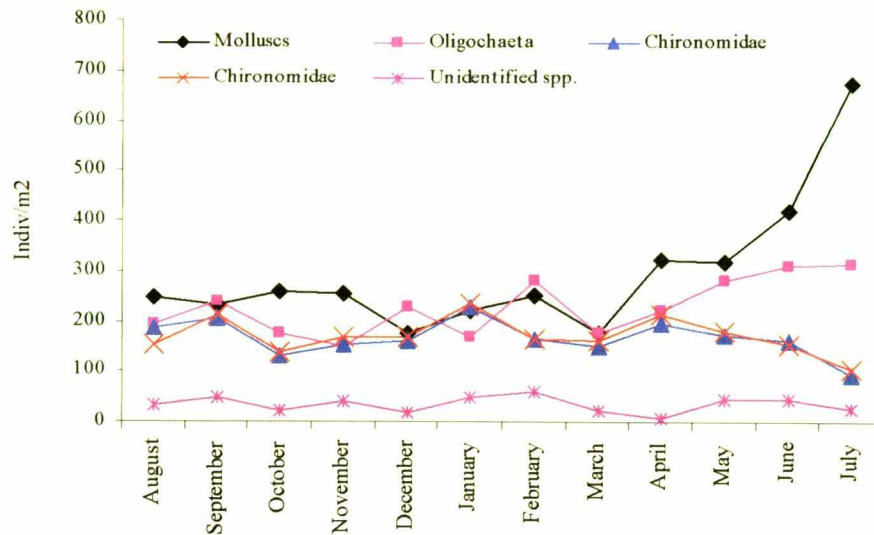


Fig.19. Monthly average abundance of different group of benthos

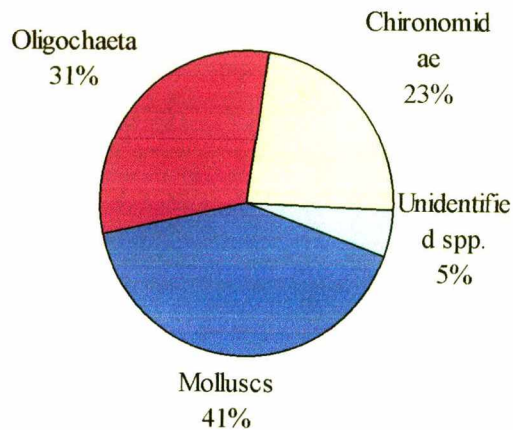


Fig.-20. Percentage composition of benthos abundance

4.3.1 Mollusca :

Mollusca were found as the most dominant group in the lake comprised of 41% of the total benthic fauna (Fig.20). The monthly average abundance of mollusca was 260 ± 108 indiv/m² in station 1, 279 ± 106 indiv/m² in station 2 and 272 ± 108 in station 3, respectively. The highest peak of Mollusca was (676 indiv/m²) in July and lowest

(136 indiv/m²) in March of station 1. However, the second highest peak was recorded in November (265 ind/m²). Important identified genus was *Bythinia*, *Viviparus*, *Pila* & *Lymnaea* spp.

4.3.2 Oligochaeta :

Oligochaeta was the second dominant group of the benthic organisms of the Gulshan Lake. They constituted 31 % of the total benthic fauna (Fig.20). The monthly average density was 216±65 indiv/m² in station 1, 232±66 indiv/m² in station 2 and 221±66 in station 3. The maximum number of Oligochaete was found in July (392 ind/m²) and minimum in November (125 ind/m²). Some important animals were *Nais*, *Dero*, *Tubifex*, *Limnodrilus*, spp.

4.3.3 Chironomid :

Chironomid was the third in position of dominancy, comprised of 23% of the total benthic fauna (Fig.-20). The monthly average abundance of mollusca was 163±35 indiv/m² in station 1, 178±34 indiv/m² in station 2 and 171±35 in station 3, respectively. Chironomids showed their highest peak in the month of July (172 ind/m²) and lowest (115 ind/m²) in December. Identified genuses were *Chironomus*, *Tanytus* & *Pelopia* spp.

4.3.4 Other animals :

The density of other benthic organisms was very low. The monthly average abundance was 34±18 indiv/m² in station 1, 44±20 indiv/m² in station 2 and 39±18 in station 3, respectively. Their maximum abundance was recorded in October (76 indiv/m²). Other animals included Culicinae and other insect larvae.

4.4 Food and Feeding habit of Fish and their growth :

The major food items found in the stomach of *Catla catla*, *Labeo rohita* and *L. calbasu* were (1) algae -blue green algae (*Microcystis*, *Oscillatoria*, *Spirulina*), Cyanophyceae (*Anabaena*, *Nostoc*), green algae (*Chlorella*, *Ulothrix*, *Oedogonium*, *Spirogyra*) (2) plant parts (aquatic plants, root, parts of leaves) (3) rotifers (*Rotaria*, *Lecane*, *Keratella*) (4) crustaceans (*Cyclops*, *Dapni* and *Cypris*) (5) benthos (6) animal parts (fish remains, fish scale, barbles) (7) semi digested materials and (8) mud and debris. The percentage composition of major food items found in the stomach

contents of *Catla catla*, *Labeo rohita* and *Labeo calbasu* in different months have been shown in tables 1 to 6.

Catla catla : Analysis the occurrence of each of the food items in the stomach of *C. catla* it was found that the algae, especially blue-green, algae, green algae and diatom, plant parts, rotifers and mud & debris were the most common. Crustacean benthos and animal parts were represented as occasional food items. Stomach contents by point's method clearly indicated that the fish consumed algae, plant parts, rotifers as basic food and Crustacea, benthos and animal parts as an incident food. According to fullness method, the average index fullness was observed that *C. catla* showed highest peak in September. None of the stomach was found empty. Co-efficient fish correlation of average index of fullness between *C. catla* and *L. rohita* were less correlated.

Labeo rohita : Frequency of occurrence of food items in the stomach showed that algae, plant parts, rotifers and mud & debris were the common food item. Crustaceans, benthos and animal parts were represented as occasional food items. Stomach contents by point's method clearly indicated that the fish consumed algae, plant parts, and rotifers as basic food and Crustacea, benthos and animal parts as an incident food. Co-efficient fish correlation of average index of fullness was less correlated.

Labeo calbasu : Analysis the occurrence of each of the food items in the stomach of *L. calbasu* it was found the algae, benthos, plant parts, mud & debris were the most common food items. Plant parts, rotifers, crustaceans and animal parts were represented as occasional food items. Percentage of various food items was in the stomach by point's method, it was found that algae, plant parts, mud and debris were dominant and can be considered as basic food. Rotifers, crustacean benthos, animal parts found incidentally in the stomach of *L. calbasu*. Co-efficient fish correlation of average index of fullness between *L. rohita* and *L. calbasu* were less correlated.

Table-1. Percentage composition of major food items found in the stomach contents of *Catla catla*, *Labeo rohita* and *Labeo calbasu* in September (1999) to average size of fish 180-360 (mm) by pointed method.

	Food items	<i>Catla catla</i>	<i>Labeo rohita</i>	<i>Labeo calbasu</i>
1	Algae	39.06	32.14	16.39
	a)Blue green algae	12.07	15.96	8.41
	b) green algae	15.06	7.05	-
	c) Diatoms	11.39	9.13	7.92
2	Plant parts	17.93	15.06	15.75
3	Rotifer	15.00	13.29	11.15
4	Crustacea	4.17	-	7.29
5	Benthos	-	-	5.27
6	Animal parts	-	8.61	-
7	Semi-digested materials	12.67	16.87	24.09
8	Mud and Debris	11.17	14.03	20.06

Table-2. Percentage composition of major food items found in the stomach contents of *Catla catla*, *Labeo rohita* and *Labeo calbasu* in January (2000) to average size of fish 180-360 (mm) by pointed method.

	Food items	<i>Catla catla</i>	<i>Labeo rohita</i>	<i>Labeo calbasu</i>
1	Algae	37.62	29.39	28.78
	a)Blue green algae	15.25	8.92	-
	b) green algae	14.08	8.30	10.07
	c) Diatoms	8.29	12.17	18.01
2	Plant parts	18.65	17.57	-
3	Rotifer	12.29	11.06	13.15
4	Crustacea	-	8.71	-
5	Benthos	-	3.05	18.01
6	Animal parts	-	-	-
7	Semi-digested materials	10.67	19.15	14.80
8	Mud and Debris	20.77	11.07	25.26

Table-3. Percentage composition of major food items found in the stomach contents of *Catla catla*, *Labeo rohita* and *Labeo calbasu* in May (2000) to average size of fish 180-360 (mm) by pointed method.

	Food items	<i>Catla catla</i>	<i>Labeo rohita</i>	<i>Labeo calbasu</i>
1	Algae	31.91	30.89	32.48
	a)Blue green algae	10.02	9.39	14.88
	b) green algae	14.15	11.29	17.60
	c) Diatoms	7.74	10.21	-
2	Plant parts	14.01	11.97	14.20
3	Rotifer	13.19	10.08	-
4	Crustacea	7.01	-	-
5	Benthos	-	10.57	10.79
6	Animal parts	5.97	-	-
7	Semi-digested materials	15.37	25.05	16.04
8	Mud and Debris	12.54	11.44	26.19

Table-4. Percentage composition of major food items found in the stomach contents of *Catla catla*, *Labeo rohita* and *Labeo calbasu* in October (2001) to average size of fish 180-360 (mm) by pointed method.

	Food items	<i>Catla catla</i>	<i>Labeo rohita</i>	<i>Labeo calbasu</i>
1	Algae	41.40	29.17	28.19
	a)Blue green algae	15.30	10.09	10.00
	b) green algae	12.08	13.19	12.08
	c) Diatoms	14.02	5.08	6.11
2	Plant parts	13.02	11.06	9.70
3	Rotifer	12.87	9.13	-
4	Crustacea	8.45	5.34	7.19
5	Benthos	3.11	5.01	13.09
6	Animal parts	-	6.08	3.20
7	Semi-digested materials	12.12	15.96	15.54
8	Mud and Debris	8.96	18.25	23.09

Table-5. Percentage composition of major food items found in the stomach contents of *Catla catla*, *Labeo rohita* and *Labeo calbasu* in February (2001) to average size of fish 180-360 (mm) by pointed method.

	Food items	<i>Catla catla</i>	<i>Labeo rohita</i>	<i>Labeo calbasu</i>
1	Algae	23.00	27.05	23.03
	a)Blue green algae	5.60	10.71	6.01
	b) green algae	7.03	8.29	10.52
	c) Diatoms	10.37	8.05	6.50
2	Plant parts	9.19	11.19	10.25
3	Rotifer	13.00	7.08	8.07
4	Crustacea	9.29	11.84	6.00
5	Benthos	10.90	10.14	13.71
6	Animal parts	8.36	5.06	6.52
7	Semi-digested materials	11.21	13.45	14.37
8	Mud and Debris	15.05	14.19	18.05

Table-6. Showing the percentage composition of major food items found in the stomach contents of *Catla catla*, *Labeo rohita* and *Labeo calbasu* in June (2001) to average size of fish 180-360 (mm) by pointed method.

	Food items	<i>Catla catla</i>	<i>Labeo rohita</i>	<i>Labeo calbasu</i>
1	Algae	38.06	34.40	37.08
	a)Blue green algae	13.03	12.80	8.67
	b) green algae	11.85	14.19	15.25
	c) Diatoms	13.18	7.41	13.16
2	Plant parts	8.18	7.10	-
3	Rotifer	6.09	-	-
4	Crustacea	6.83	11.08	8.03
5	Benthos	7.75	10.89	10.19
6	Animal parts	2.85	-	4.31
7	Semi-digested materials	14.88	17.20	18.38
8	Mud and Debris	15.36	19.33	22.01

4.5 Relationship between physico-chemical and biological parameters :

The abundance of zooplankton and benthos are largely influenced by different physico-chemical parameters of the studied lake. The relationship between physico-chemical parameters and biological parameters has been showed in the figures 21 to 27 and in appendix-D.

The zooplankton population was highly influenced by DO and significant negative correlation exists between them. The more concentration of zooplankton was found

between 4.5 mg/l and 6.8 mg/l. level of DO. Benthos was positively correlated with DO and highest concentration was found between 3.5 to 4.5 mg/l level of DO. (Fig.-21). There were positive correlation between free CO₂ and abundance of zooplankton and benthos. The concentration of zooplankton and benthos was found between 7.5 - 12 mg/l. and 7.5 - 13 mg/l level of CO₂ respectively (Fig-22). A significant positive correlation was observed between zooplankton and P^H in the studied lake and highest concentration of zooplankton was found between 7.3 and 7.7 P^H level. There was no significant relationship exist between benthos and the pH value. (Fig.-23). The abundance of zooplankton in the studied lake was significantly influenced by the concentration of alkalinity. A strong positive correlation was existed between them and higher concentration of zooplankton population was observed between 98 mg/l to 115 mg/l alkalinity level. Benthos was positively correlated with alkalinity. (Fig.-24). A significant positive correlation was observed between zooplankton and hardness. Higher concentration of zooplankton population was existed between 95 mg/l to 110 mg/l hardness level. Benthos was positively correlated with hardness. (Fig.-25). A positive correlation was observed between zooplankton and nitrite while benthos correlated negatively. Higher concentration of zooplankton and benthos were found between 0.05 mg/l to 0.13 mg/l and 0.07 mg/l to 0.15 mg/l nitrite level. (Fig.-26). The abundance of zooplankton was highly influenced by the ammonia concentration and there existed a strong positive correlation. Benthos showed negative correlation with ammonia. (Fig.-27).

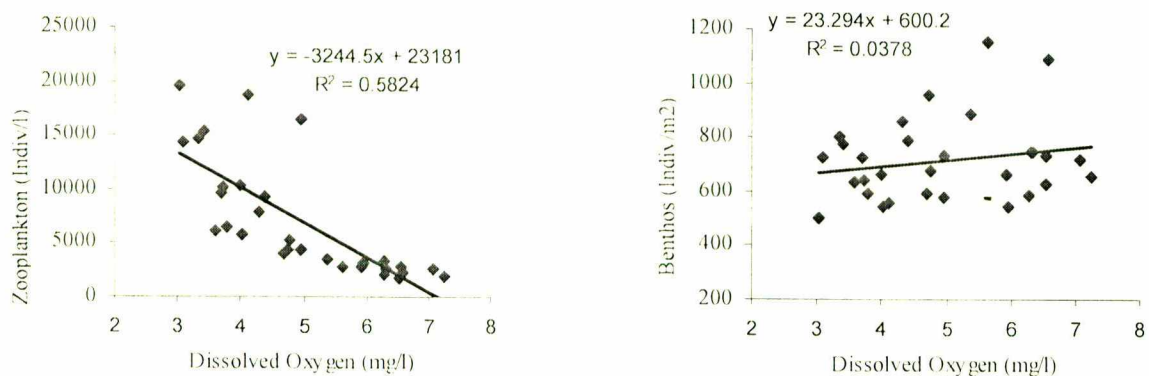


Fig.21. Effect of dissolved oxygen (mg/l) on zooplankton and benthos abundance in the studied lake

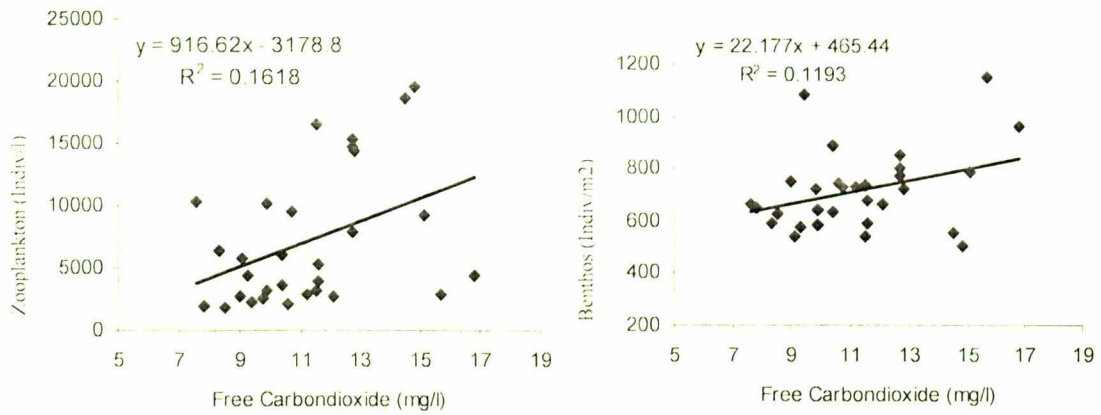


Fig.22. Effect of free carbon dioxide (mg/l) on zooplankton and benthos abundance in the studied lake

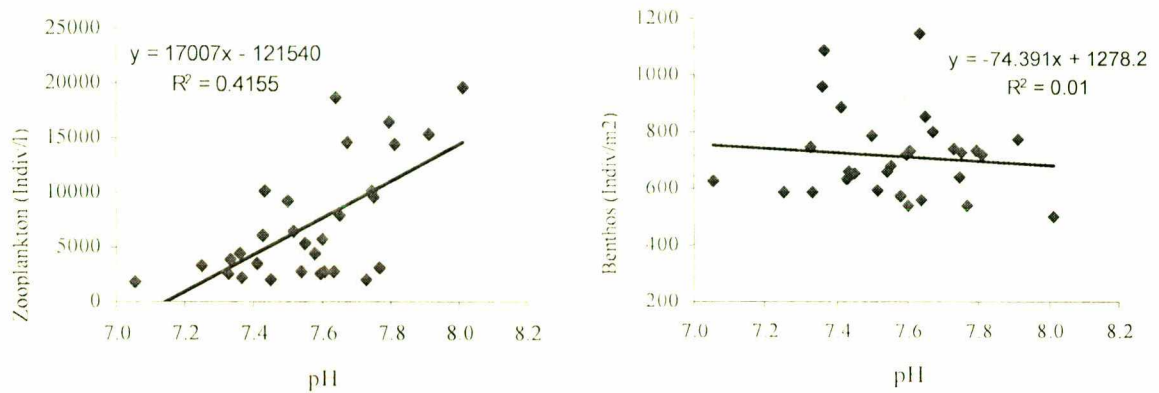


Fig.23. Effect of P^H on zooplankton and benthos abundance in the studied lake

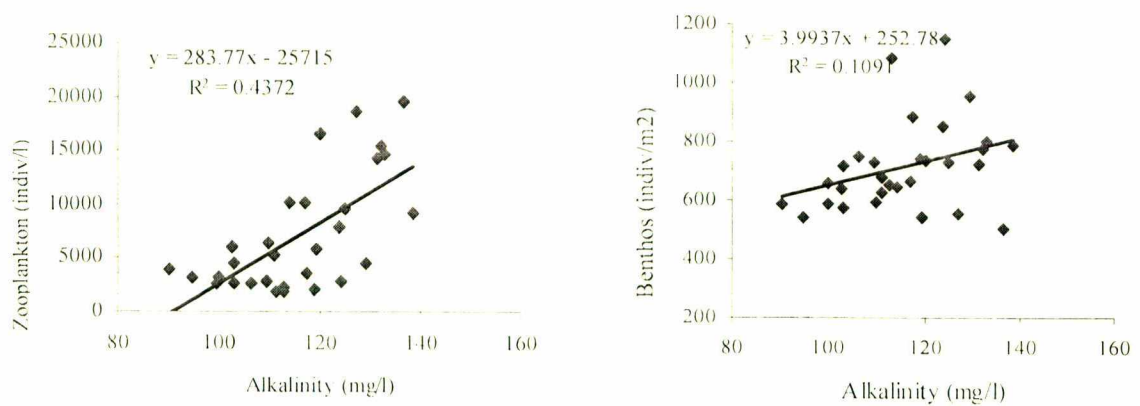


Fig.24. Effect of alkalinity on zooplankton and benthos abundance in the studied lake

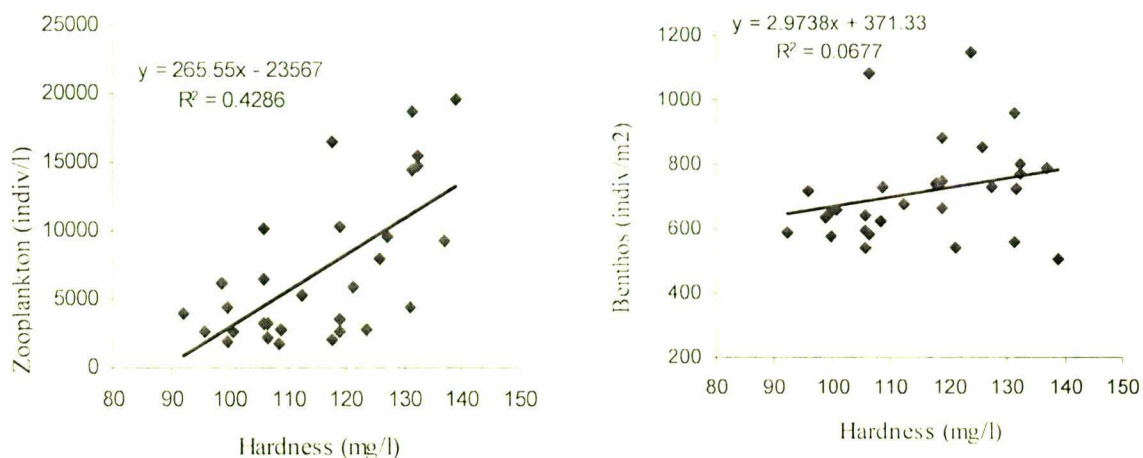


Fig.25. Effect of hardness on zooplankton and benthos abundance in the studied lake

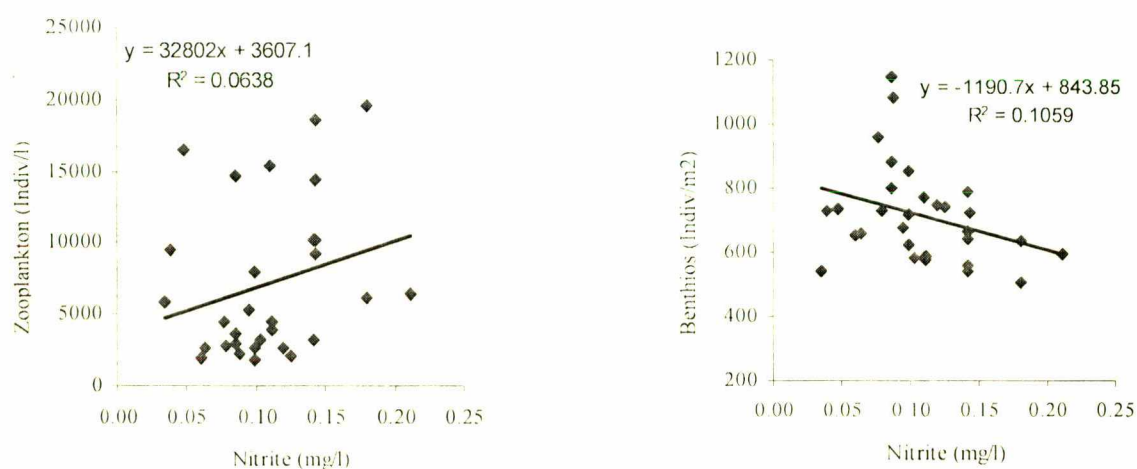


Fig.26. Effect of nitrite on zooplankton and benthos abundance in the studied lake

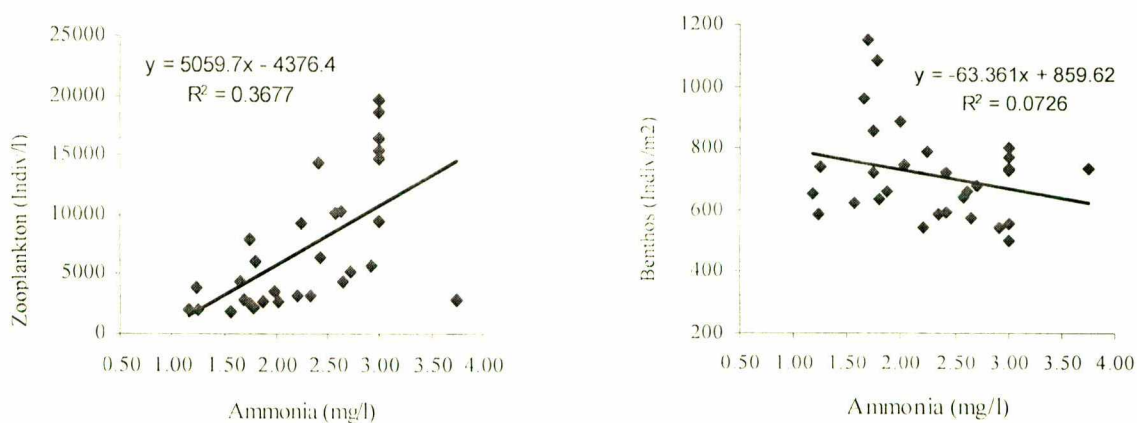
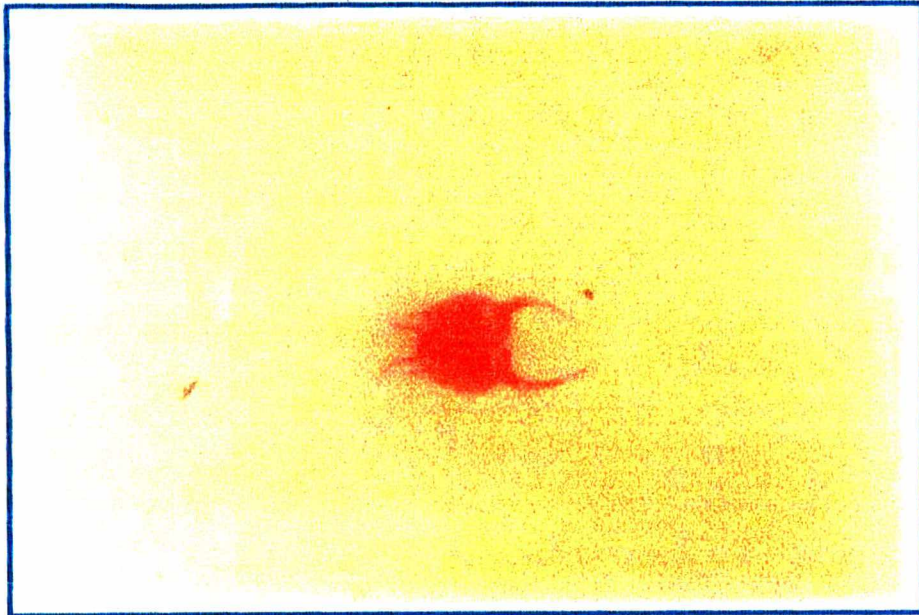
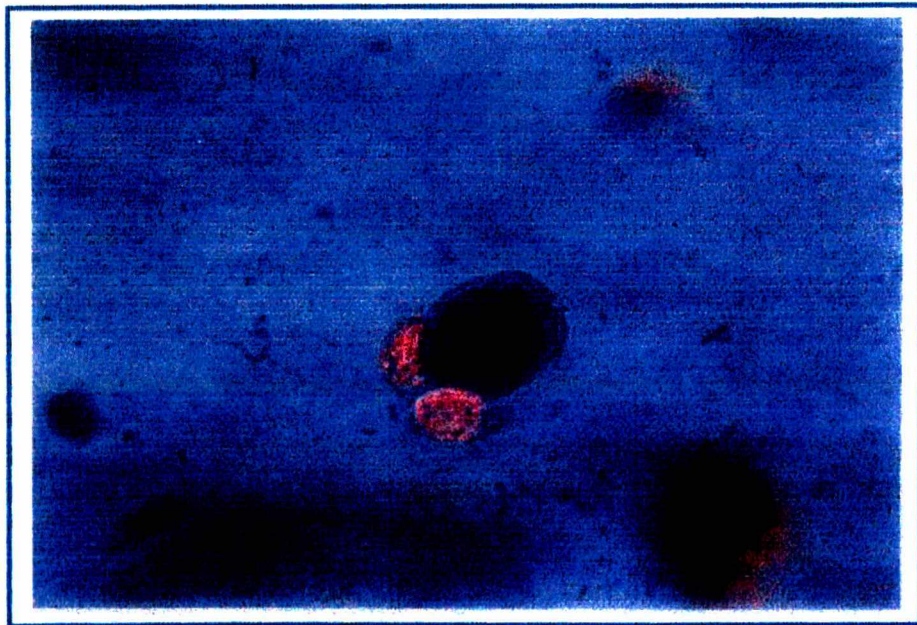


Fig.27. Effect of ammonia on zooplankton and benthos abundance in the studied lake

Rotifers



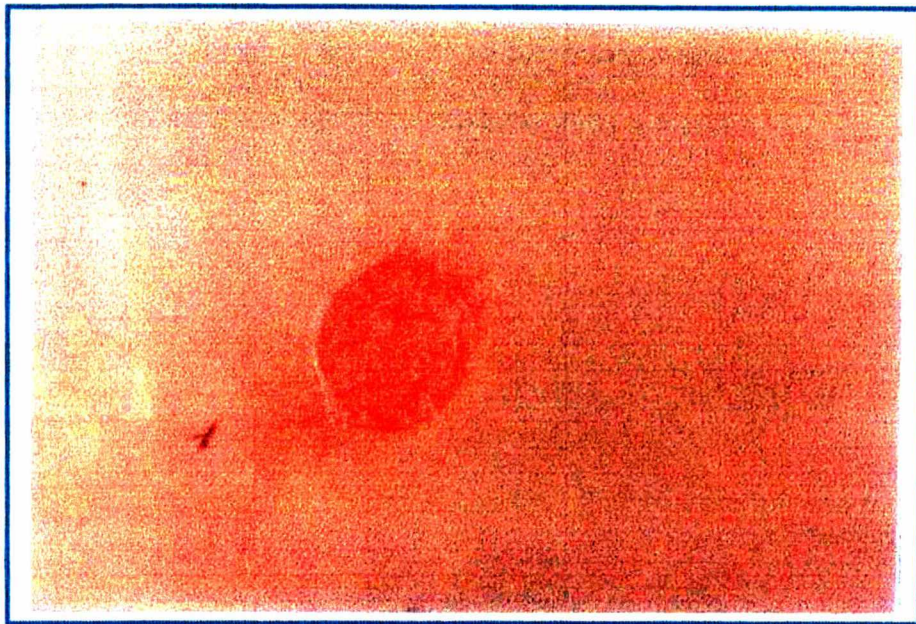
a



b

Plate 1. a. *Brachiorus falcatus* ($\times 40$)

b. *B. angularus* ($\times 40$)



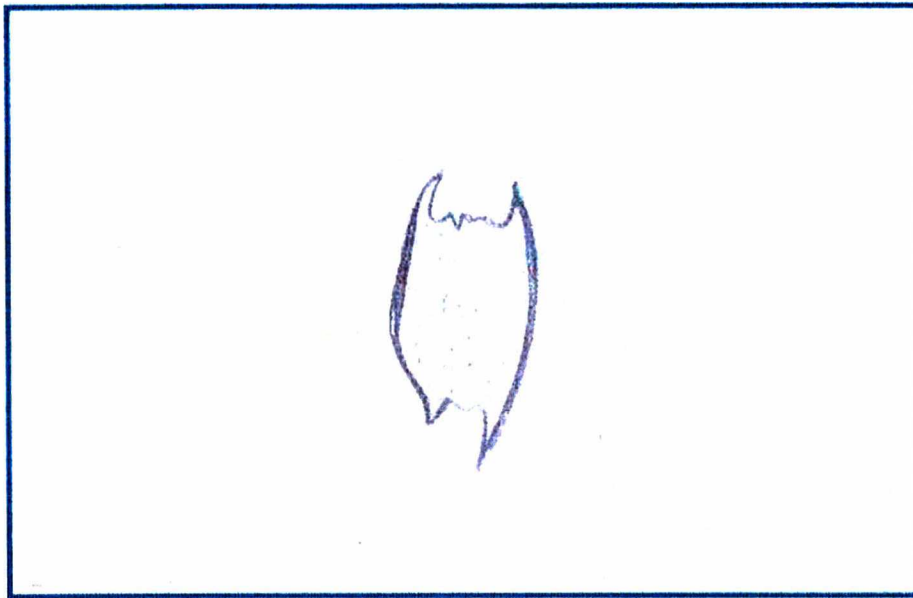
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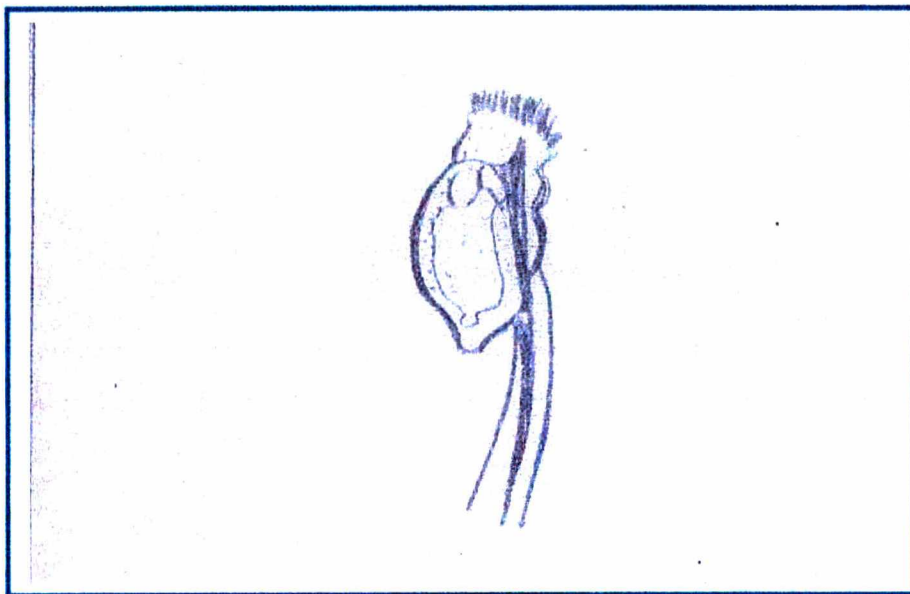
b

Plate 2. a. *B. plicatilis* (♂) (× 40)

b. *B. plicatilis* (♀) (× 40)

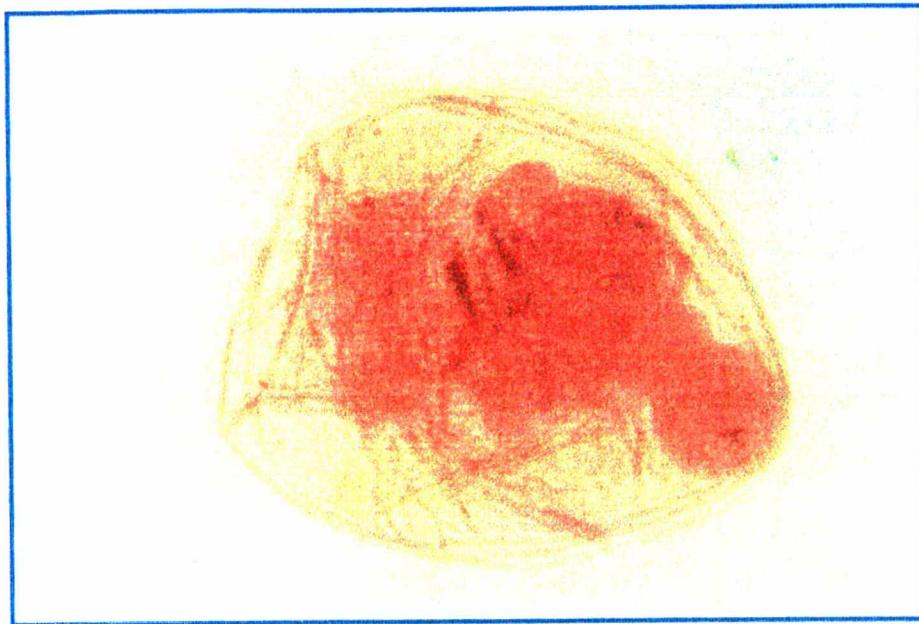


a

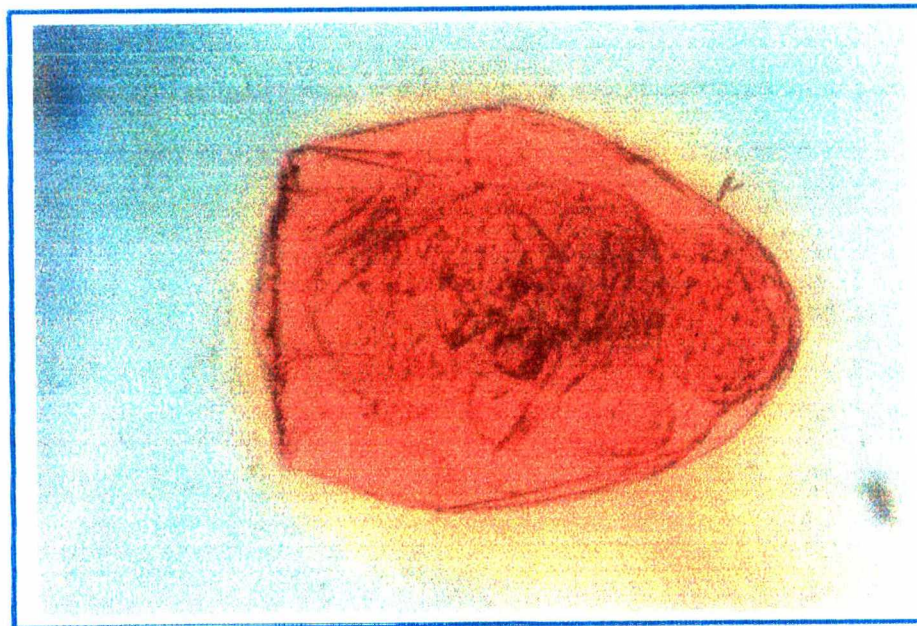


b

Plate 3. a. *B. diversicornis*
b. *Filina longiseta*



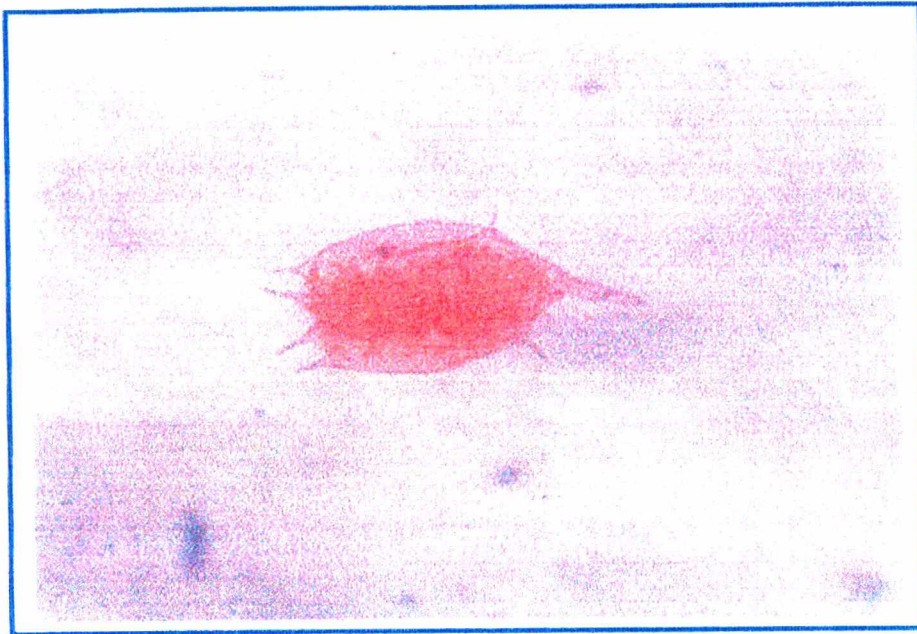
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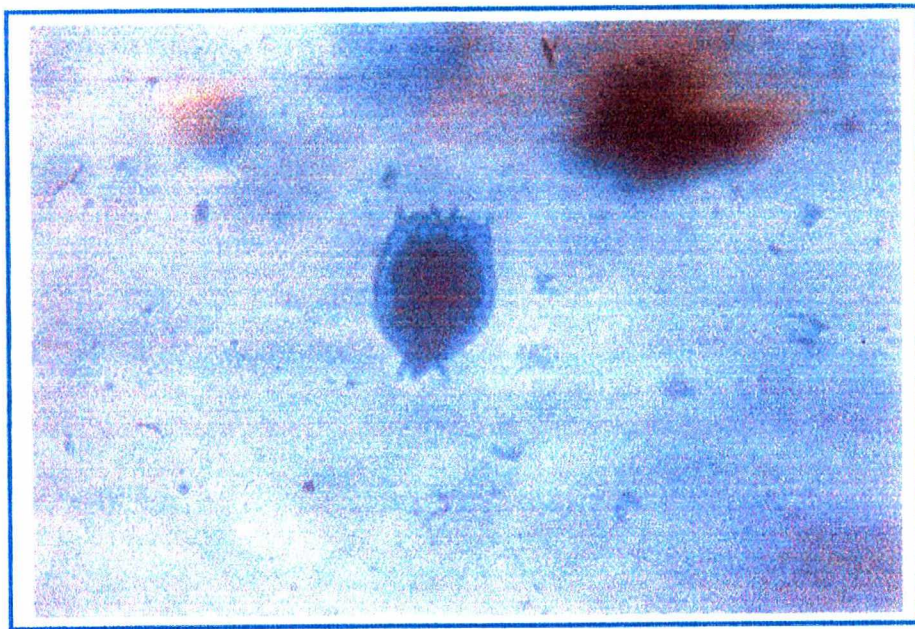
b

Plate 4. a. *Asplanchna* species. ($\times 60$)

b. *A. priodonta* ($\times 60$)



a

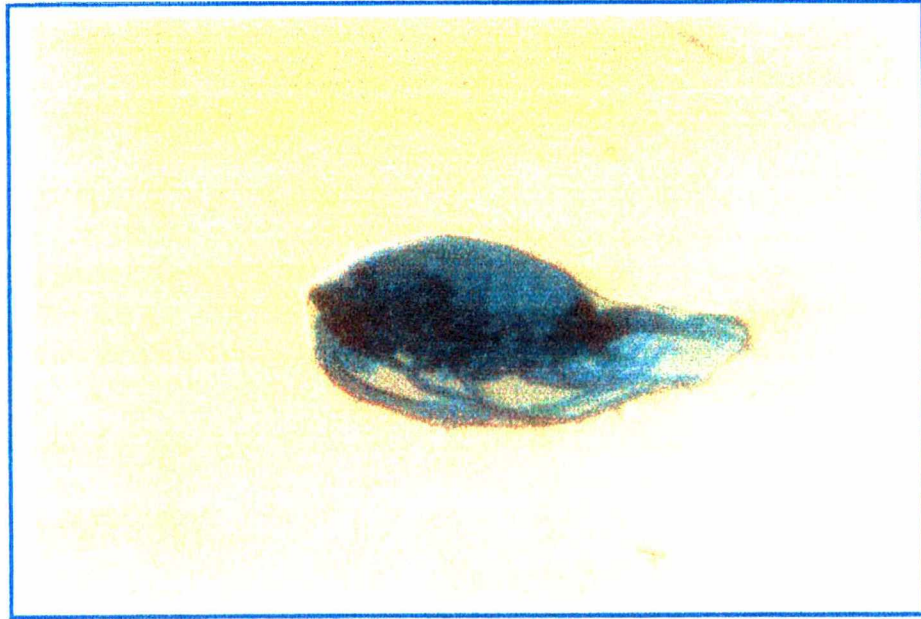


b

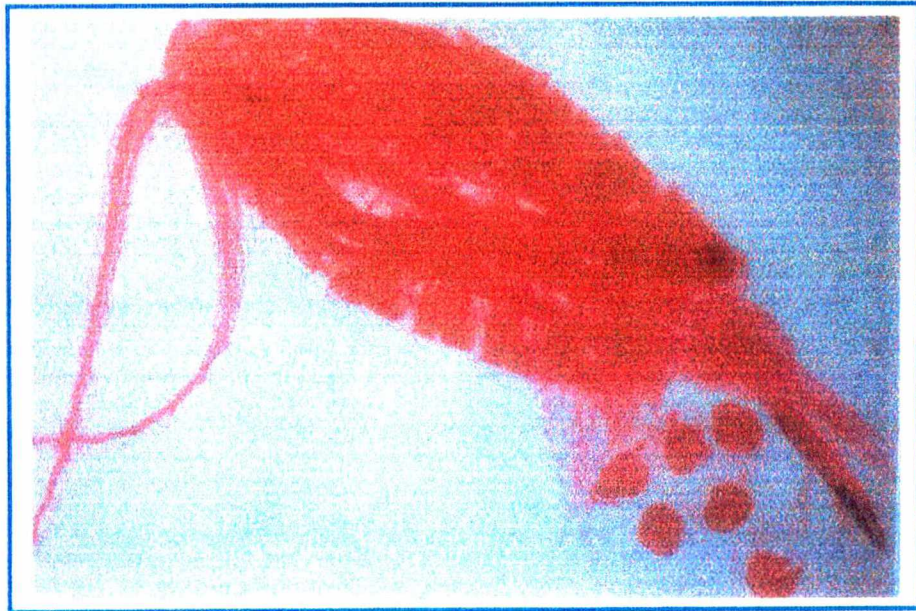
Plate 5. a. *Platyias* sp. ($\times 40$)

b. *Platyias* sp. ($\times 40$)

Copepods



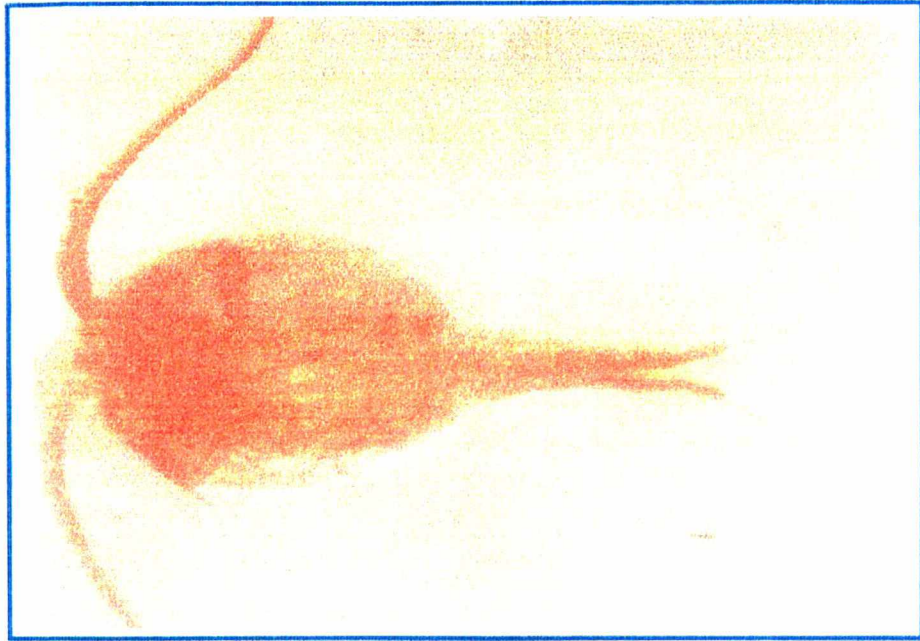
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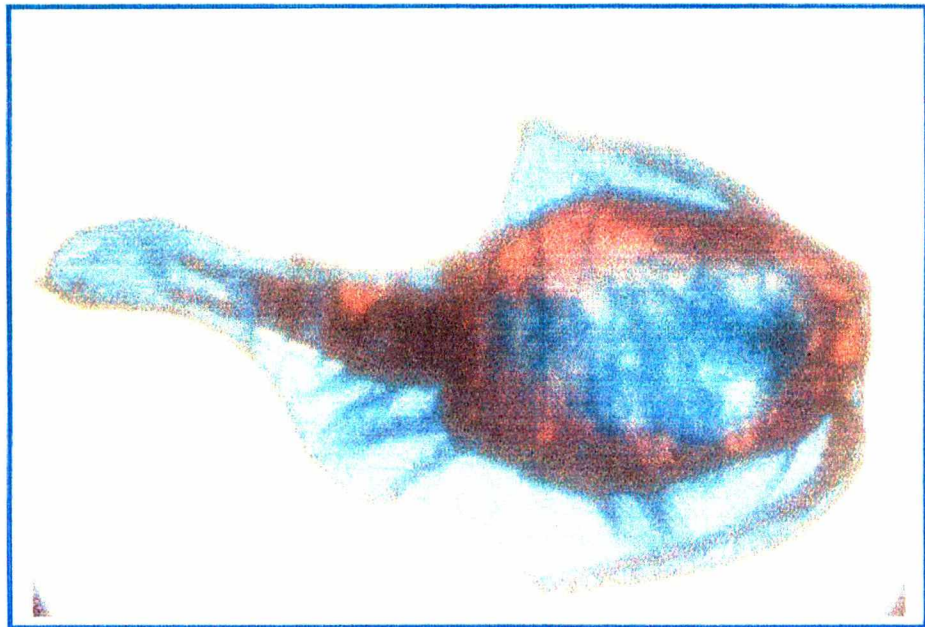
b

Plate 6. a. *Diatomus* sp. (♂) ($\times 40$)

b. *Diatomus* sp. (♀) ($\times 100$)



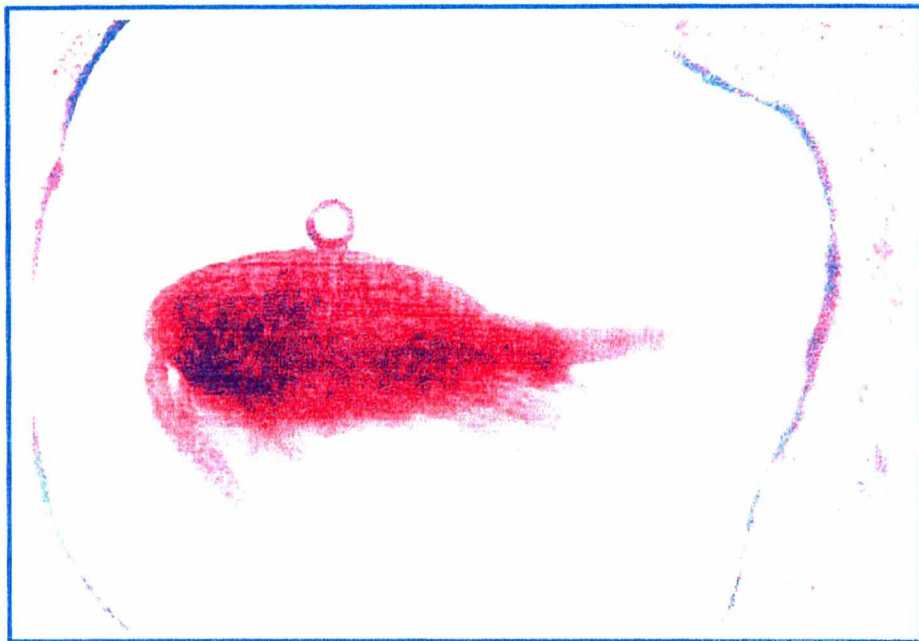
a



b

Plate 7. a. *Cyclops sp* ($\times 60$)

b. *Mesocyclops hyalinus* ($\times 60$)



a



b

Plate. 8. a. *Mesocyclops sp.* ($\times 60$)

b. *Mesocyclops leuckart* ($\times 60$)

Cladoeras



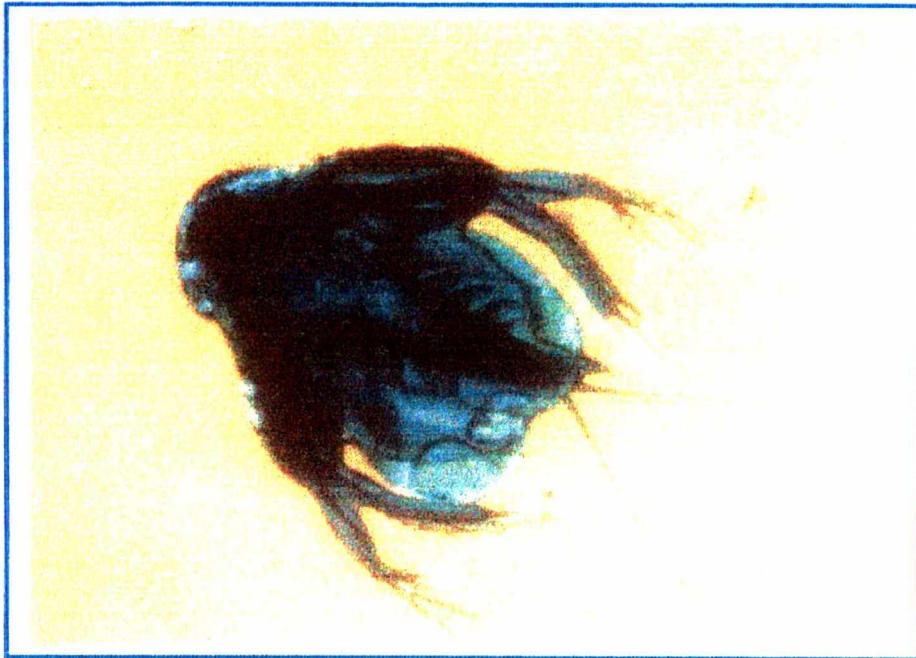
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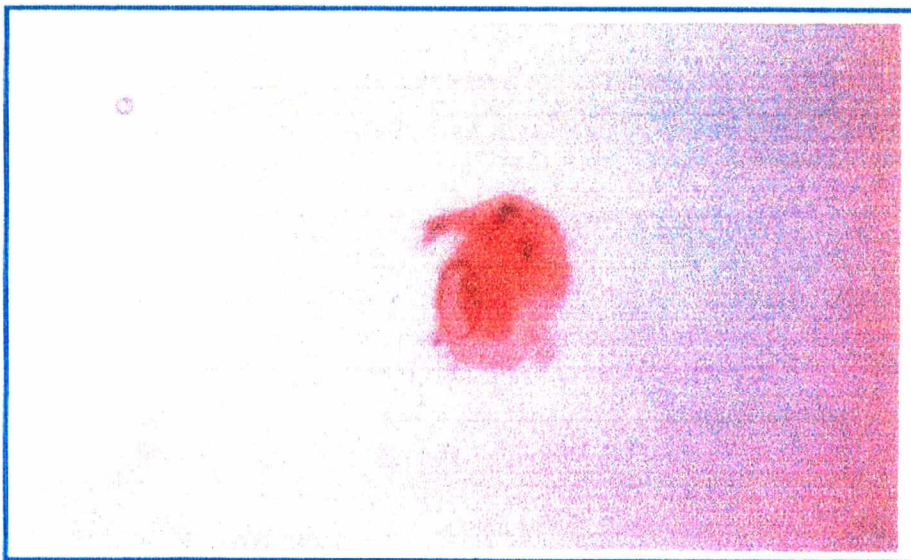
b

Plate 9. a. *Daphnia similis* . (× 100)

b. *Bosmina logirostris* . (× 100)



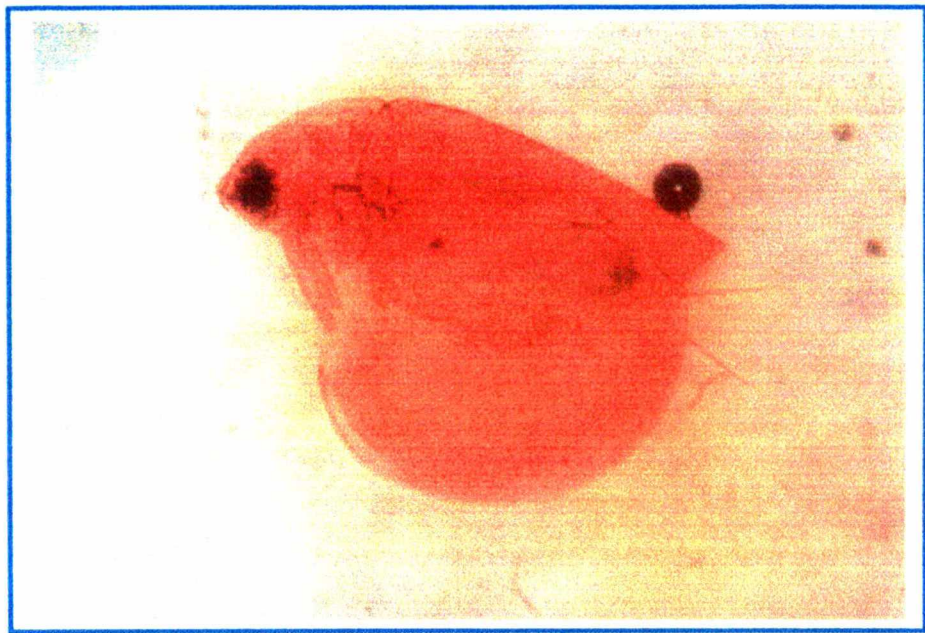
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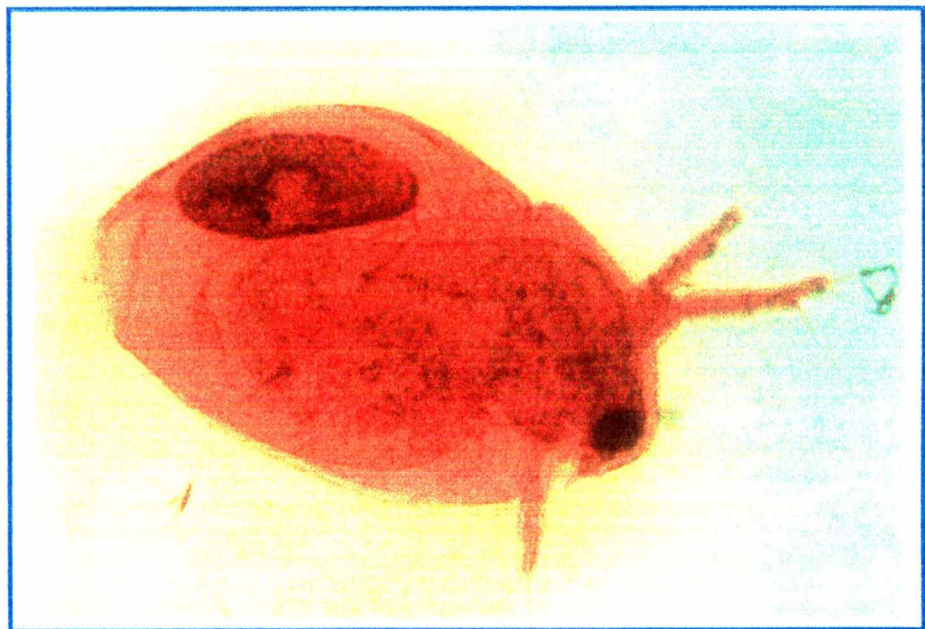
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Plate10. a. *Diaphansoma brachyurum* ($\times 60$)

b. *Bosmina* sp. ($\times 60$)



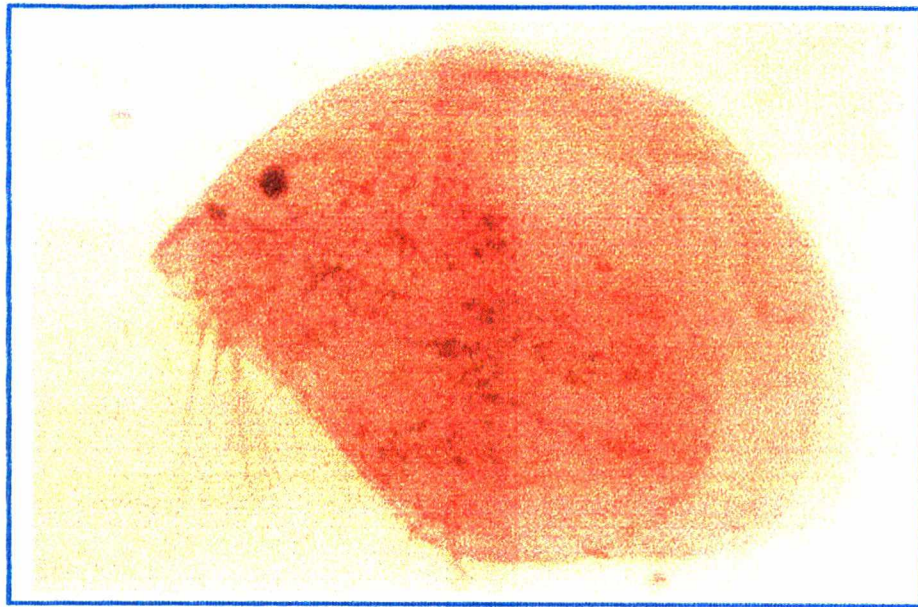
a



b

Plate 11. a. *Moina macropa* ($\times 60$)

b. *Moina brachita* ($\times 60$)



a

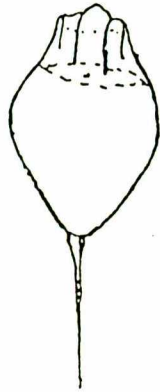


b

Plate 12. a. *Hydrous* sp. ($\times 60$)

b. *Macrothrix* sp. ($\times 60$)

Rotiferans



a



b



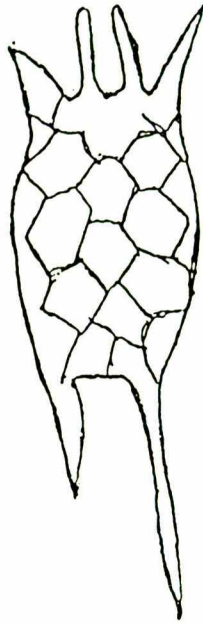
c



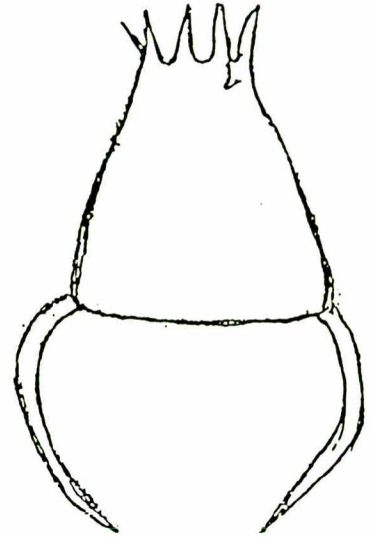
d

Plate 13. (a) *Trichocera multicrotinus* (b) *Trichocera similis*
(c) *Trichocera longiseta* (d) *Brachionus quadridentata*

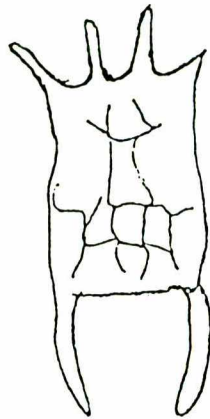
Rotiferans



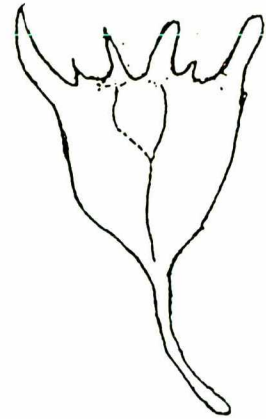
a



b



c



d

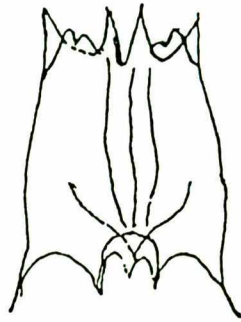
Plate 14. (a) *Keratella volga*

(c) *Keratella hiemalis*

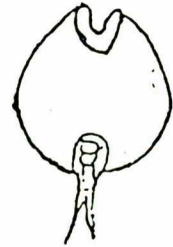
(b) *Keratella canadensis*

(d) *Keratella taurocephala*

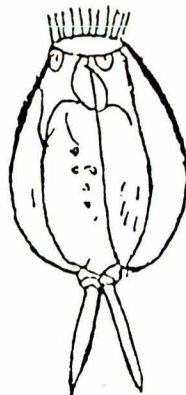
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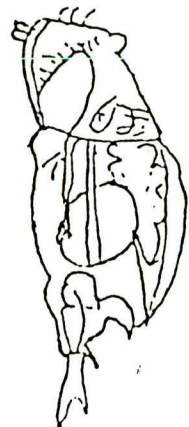
a



b



c



d

Plate 15. (a) *Platyias polyacanthus*

(b) *Lepadella ovalis*

(c) *Diplois daviesiae*

(d) *Cephalodella auriculata*

Rotiferans

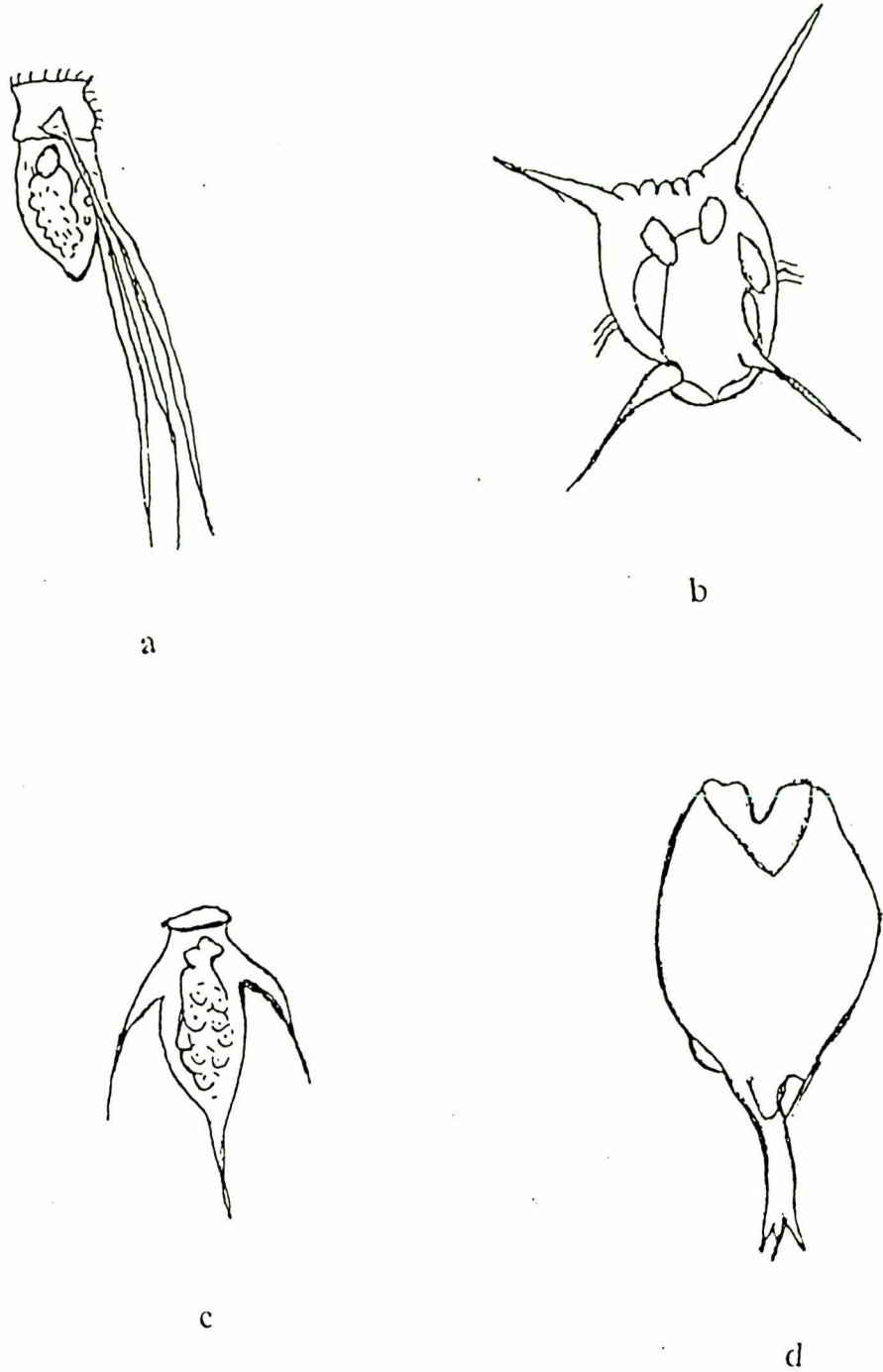


Plate 16. (a) *Filinia longiseta*

(b) *Filinia minuta*

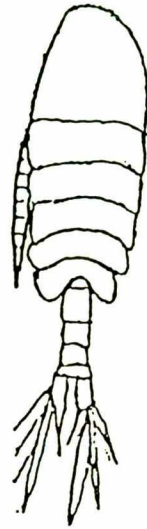
(c) *Filinia brachiata*

(d) *Monostyla bulla*

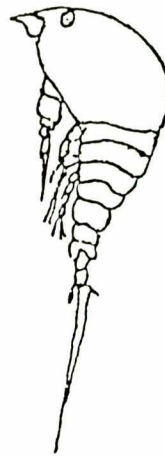
Copepods



a



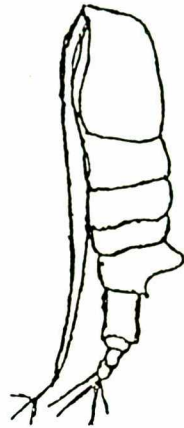
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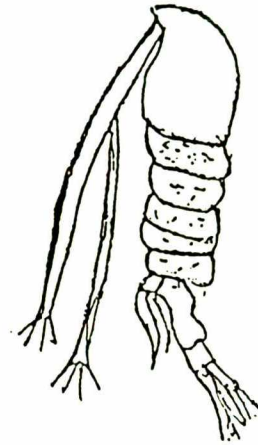
c

Plate 17. (a) *Parastenocaris satarretti* (b) *Osphranticum* sp.
(c) *Metis* sp.

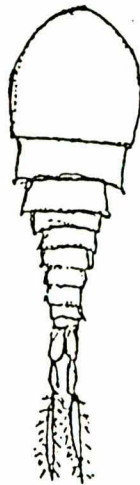
Copepods



a



b



c



d

Plate 18.

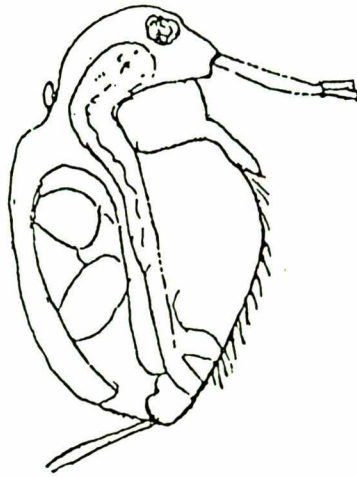
(a) *Diaptomus marshianus*

(b) *Heliodiaptomus* sp.

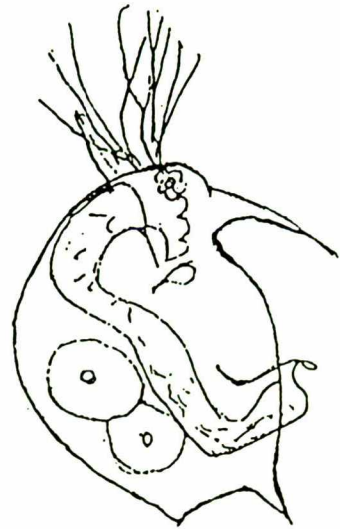
(c) *Cyclops magnus*

(d) *Heliocyclops* sp.

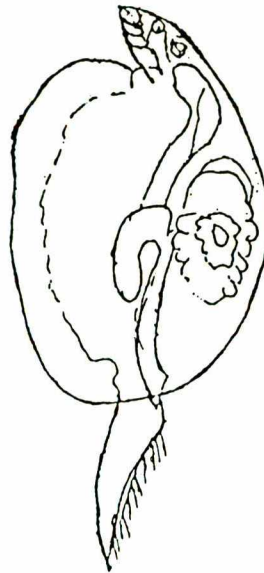
Cladocerans



a



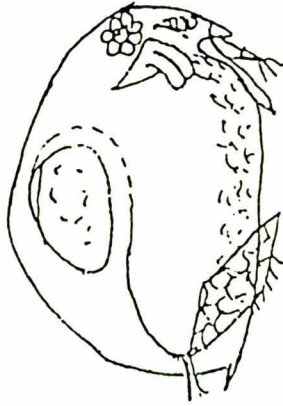
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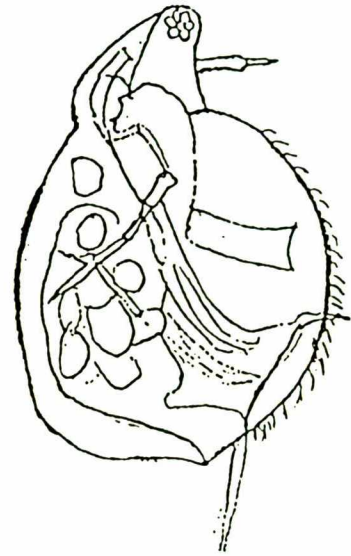
c

Plate 19. (a) *Lathonura rectirostris* (b) *Bosmina coregoni*
(c) *Euryalona* sp.

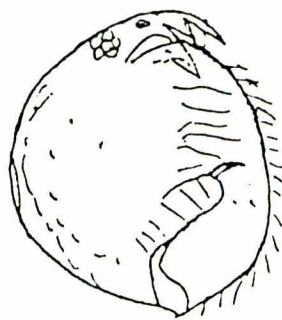
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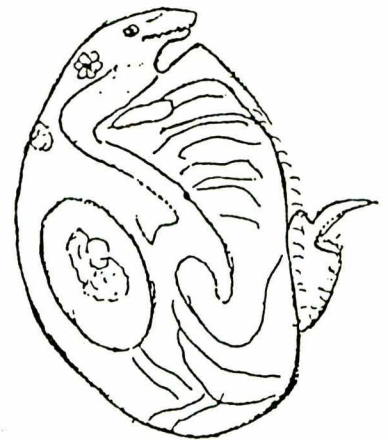
a



b



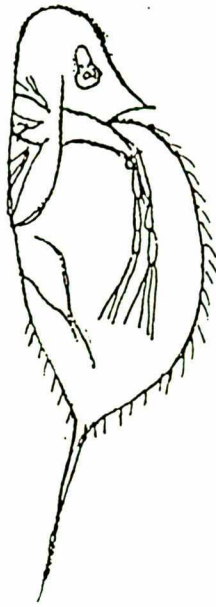
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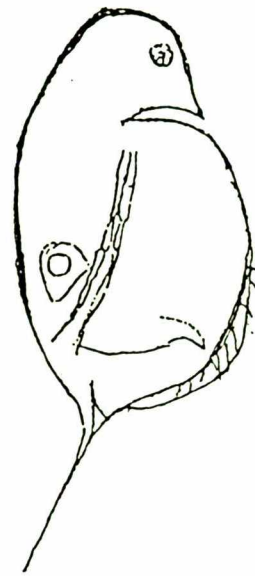
d

Plate 20. (a) *Moinodaphnia macleayii* (b) *Dudaya macrops*
(c) *Alona karua* (d) *Chydorus piger*

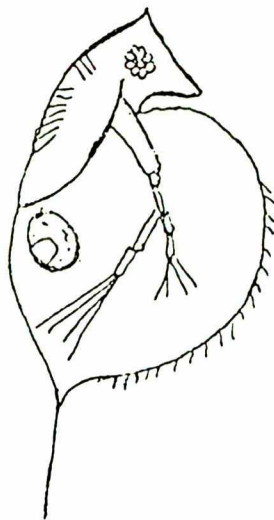
Cladocerans



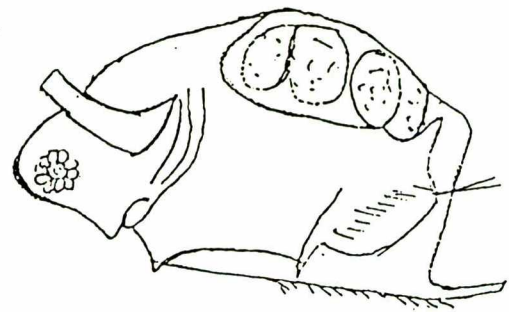
a



b



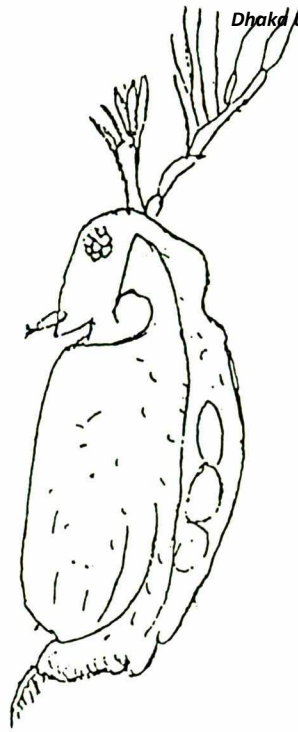
c



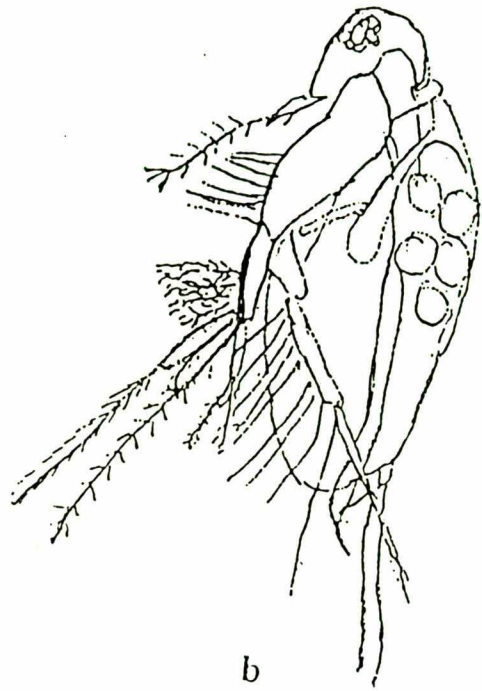
d

Plate 21. (a) *Daphnia thorata*
(c) *Daphnia ambigua*

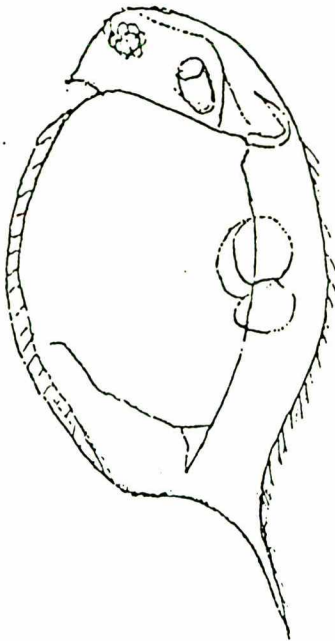
(b) *Daphnia catawba*
(d) *Scapholebris kingi*



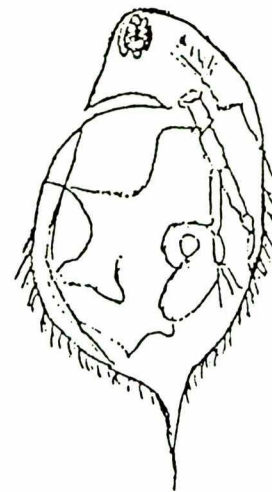
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b



c



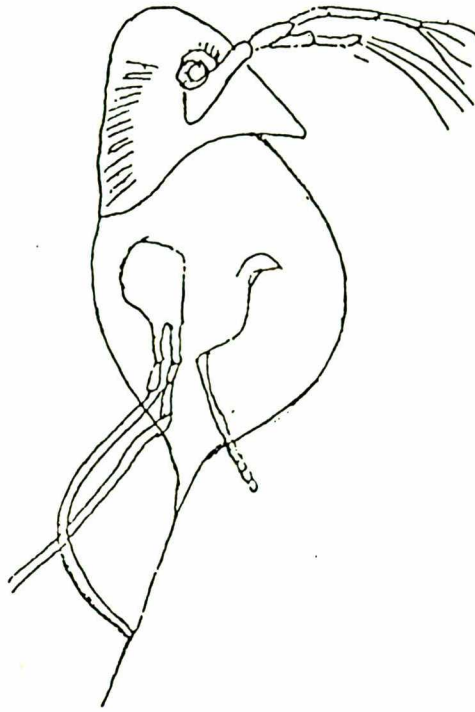
d

Plate 22. (a) *Syda crystalina*

(b) *Pseudosid bidentata*

(c) *Daphnia magna*

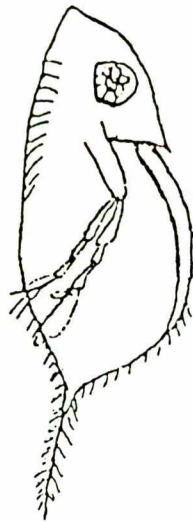
(d) *Daphnia rosea*



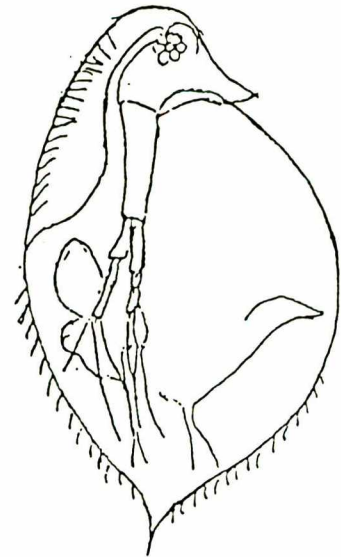
a



b



c



d

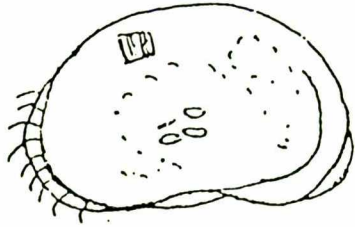
Plate 23. (a) *Daphnia longirimis*

(b) *Daphnia laevis*

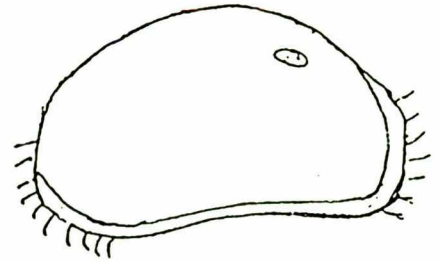
(c) *Daphnia galeata*

(d) *Daphnia pulex*

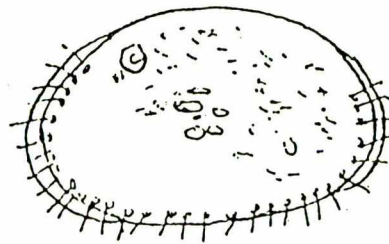
Ostracods



a

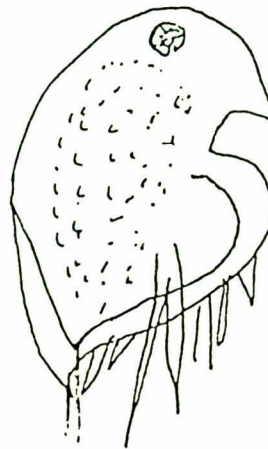


b

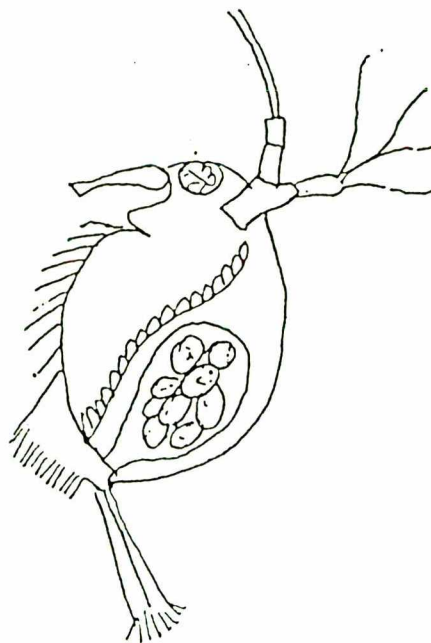


c

Plate 26. (a) *Cypria lacustris* (b) *Cyclocypria kinkaidia*
(c) *Physocypria posterotuberculata*



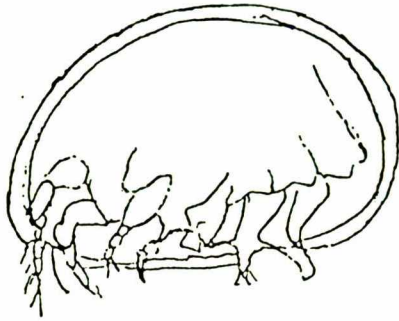
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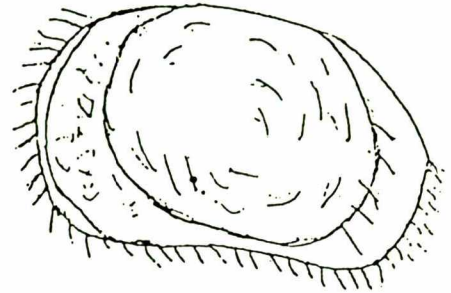
b

Plate 24. (a) *Macrothrix laticornis*

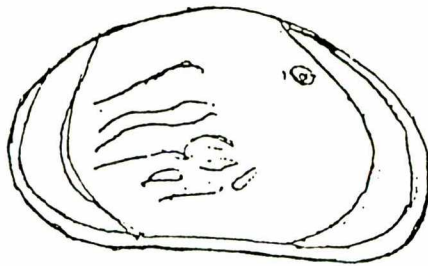
(b) *Macrothrix rosea*



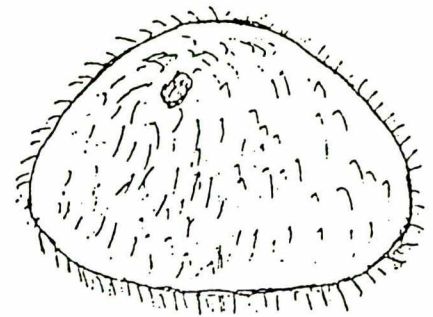
a



b



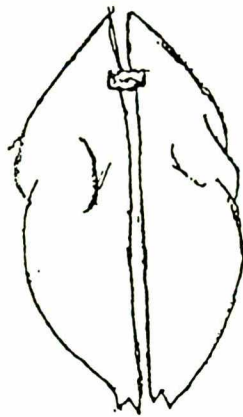
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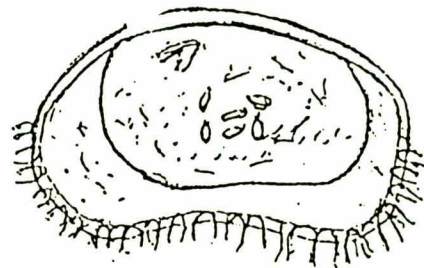
d

Plate 25(a) *Entocythere insignipes* (b) *Cypridopsis viduella*

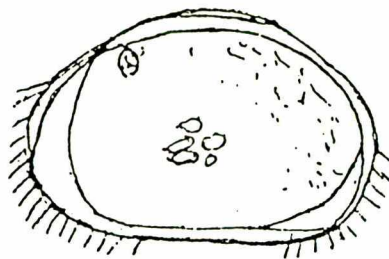
(c) *Cypricercus hirsutus* (d) *Cyprinotus americanus*



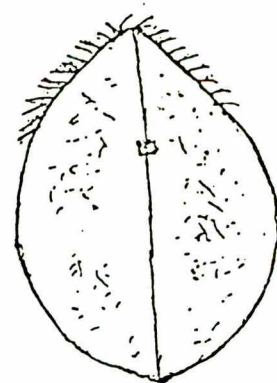
a



b



c



d

Plate 27. (a) *Ilyocypris bradyi*

(b) *Candocypris osborni*

(c) *Cyclocypris serena*

(d) *Cyclocypris globosa*

Chapter -5

Discussion

5.1 Physico-chemical parameters :

In recent years there has been a tremendous concern on the quality of freshwaters as influence by human activities. Water bodies in their natural state also undergo changes in their physico-chemical and biological characteristics. However, it is the human development activities that are proving detrimental to the freshwater bodies. Man's interference by the way of development activities in the catchment's area and disposal of effluent from housing settlements and industry shorten the span of the lakes which leads to eutrophication. The process of eutrophication results in a number of changes in the physico-chemical and biological alternations (Hasler, 1947). Many researchers in different rivers and lakes of Bangladesh have carried out extensive investigations along these lines. However, there have been very few studies on Gulshan Lake. This lake has been subjected to extension human pressure due to increase developmental activities and extension of urbanization in the area. So, water resources have become a victim of such activities. Present investigation was an attempt to monitor the water body fortnightly to have a clear picture of hydro-biological characteristics of the urban lake. The limnological conditions such, as the physical and chemical parameters of the study lake have been determined. The values of different parameters were calculated by the statistical analysis, which can be treated as the useful indicator for the assurance and abundance of zooplankton. Among the physico-chemical factors temperature, transparency, P^H , dissolve oxygen, free carbon dioxide, total hardness, total alkalinity, ammonia, and nitrite were considered in the present study.

The overall behavior and nature of an environment is largely governed by the interaction of the meteorological, physical, chemical and biological parameters. Again a factor is not always independent. There remains a close relationship between the factors. A little variation in one of the factors influences the other. The temperature, rainfall, totals hours of sunshine, P^H and transparency of water had significant combined effect upon the abundance and growth of various species of zooplankton and benthos (Ali, 1985). Similar type of interaction was observed in the present study.

Air temperature has seasonal trends in fluctuation during the study period. The air temperature was recorded low during winter and high during summer, spring and autumn. The air temperature gradually decreases from November to January. The

lowest air temperature was recorded in January in the two and half year's observation and then gradually increased from February to till June. The highest air temperature was recorded in July (35°C) in 1st year's observation and June (35°C) in the second year's observation.

Water temperature is one of the most outstanding and biologically significant phenomena of aquatic environment. The water temperature of all the studied water bodies usually declined from November and reached the minimum in January and there after increased steadily reaching the maximum during April to June in the lake. The range of water temperature was lower in winter and gradually increased towards summer. The pattern of fluctuation was almost similar in all the treatments. According to Khan et al (1990) the water temperature showed seasonal variations. In summer, the water was chemically the richest because of the mixing of surface and bottom water. Bottom water temperature is slightly lower or equal to surface water temperature. Rahman et al (1982) also recorded similar type of result. The highest water temperature during summer months were reported by Das and Bhuiyan (1974a), Islam et al (1975), Ismail et al (1994) and Patra and Azadi (1987) in Bangladesh. The low water temperature during the study period was found in winter months, which are supported by Das and Bhuiyan (1974a), Islam et al (1974), Oppenheimer et al (1978), Islam et al (1979), Ali et al. (1980), Ismail et al. (1994) and Chowdhury et al. (1989) in Bangladesh. Several authors in India also observed the low water temperatures during winter months notably George (1964), Verma (1969), Hussainy (1996) and in England by Young (1975).

The present observation reveals that the annual air temperature cycle maintained a close parallel relationship with annual cycle of water temperature. Similar results were reported by Zafor (1964), Munwar (1970), Chowdhury and Mazumder (1981) and Miah *et al* (1981). It implies that role of seasonal change was more prominent than the inputs applied in changing water temperature (Ahmed, 1993). According to Rahman (1982) water temperature is directly related to the air temperature but sometimes exception may occur. Differences between air and water temperature are lower during winter and higher in summer. The heavy rainfall followed the water and air temperature in comparison to the water temperature. On the other hand both the curves differ before and after monsoon period due to absence of cooling effect by

rainfall and the presence of windless and hot days that prevail in the ponds. Similar ideas were also studied by Geisler *et al.* (1975), Islam and Mendes (1976).

In the present study, the highest value of transparency was recorded in August, where as the lowest was in March. Similar result was observed by Singh and Ahmed (1990). But Singh *et. al* (1980) recorded the highest transparency in August but the lowest in January. The transparency of water was affected by the factors such as silting microscopic organisms, suspended organic matter, the angles and intensity of entering light. The lowest value was recorded in the month of March, which might be due to increase in concentration of plankton, suspended materials and silt load. Reid (1961) reported that the transparency of a water body affected by several factors such as concentration of phytoplankton, suspended organic matter, latitude, season, the angle of intensity of entering light which was also supported by Hutchinson (1957), Amarasinghe *et. al.*, (1983), Khan and Siddiqui (1974). Michael (1969) also made similar observations. The turbidity of water is generally due to suspended inorganic substances and planktonic organisms present in water.

The dissolved oxygen condition is one of the most important factors for the aquatic life. In station-1 the lowest dissolved oxygen was recorded 3.15 mg/l in March, station-2 was 2.60 mg/l in March and station-3 was 3.15 mg/l in March. In station-1 the highest dissolved oxygen was recorded 8.45 mg/l in August, station-2 was 8.15 mg/l in August and station-3 was 8.70 mg/l in August. George (1964), Vays and Kumar (1968) in India; Chowdhury and Mazumder (1981) and Khan et al. (1990) in Bangladesh observed minimum amount of oxygen during monsoon months. Islam and Mendes (1976) reported maximum dissolved oxygen in February and minimum in August. Islam et al. (1979) reported highest dissolved oxygen in summer months and lowest in monsoon. Ali et al. (1989) found high value during winter and low value in summer. Begum et al. (1989) recorded lowest dissolved oxygen in September. The fluctuation in the dissolved oxygen concentration is mainly influenced by the factors like organic matter, plankton and bottom vegetation. According to Chakrabarty et al. (1959), the dissolved oxygen values were low 3.12-3.8 mg/l. In the monsoon months July to September which is presumably due to the consumption of oxygen by the organic matter and retarded photosynthetic activities of plankton and bottom vegetation under turbid conditions. Dissolved oxygen is one of the primary factors in

natural water as a regulator of metabolic process of plants and animals. Low oxygen content of water has great influence on the abundance and diversity of plankton and benthic fauna. Banerjee (1967) considered 5.0 to 7.0 mg/l dissolved oxygen content of water to be fair or good in respect of productivity, which also followed by Cagauan (2001). Rahman (1992) reported dissolve oxygen at levels of 3 mg/l. or lower regarded as hazardous to lethal under stream and lake conditions; and that 5 mg/l. or more of dissolve oxygen is better for freshwater fishes. Fishes can survive at low level of dissolve oxygen (1 mg/l or less) for a few hours but not for long time.

The free CO₂ content of the lake showed seasonal changes which increased during summer and autumn and decreased during winter. Similar results were observed by Islam & Mendes (1976), Ismail et. al. (1994), Patra & Azadi (1987) and Vays & Kumar (1968). According to Sreenivasan (1966) free carbondioxide is absent in surface water during certain periods indicating its removal by phytoplankton for photosynthesis. Phenolphthalein alkalinity was present when free carbondioxide was absent but in very low concentration. Habib et al. (1983) observed free CO₂ higher in bottom than surface. The lowest free CO₂ was recorded in January (7.00 mg/l) in station-3, in August (7 mg/l) in station-2 and in January (7.40 mg/l) in station-1. The highest value of free CO₂ was recorded as 19.80 mg/l (bottom) in June in station-2. Hossain (1996) reported fish could tolerate 10 mg/l carbon dioxide. Lagler (1972) stated that the free carbon dioxide excess of 20 mg/l might be regarded harmful to fish. Cagauan (2001) reported carbon dioxide content below 10 mg/l is suitable for fish culture. Swarup and Singh (1979) reported the free carbon dioxide in water form carbonic acid resulting change in the P^H as the hydrogen ions are set free after dissociation. Inversion of CO₂ in the waters can increase total alkalinity due to increase in bicarbonates and carbonates. A higher concentration of these ions is considered to provide buffering action to the waters. However, pollution of water can increase the levels of total alkalinity in water. As the total alkalinity largely depends on the naturally occurring ions, biological activities may not be affected by. This is also shown by Khatavkar 1986, when studying two eutrophic polluted water bodies. Average alkalinity values were above 120 mg/l in the lake water.

Swingle (1967) observed the relationship of P^H of water to their availability of fish culture and satisfactory results were obtained from water P^H ranging from 7.05 to 8.0.

He also reported that the water having P^H values more than 9.5 were unproductive and above 11.00 marked the death point of fish. The low P^H value was recorded in high CO_2 , low DO and low water temperature condition. Verma (1969), Ruttner (1975), Vays and Kumar (1968), Mathew (1975), Islam and Saha (1975), Islam et al. (1979), Ali et al. (1985), Patra and Azadi (1987) reported low value in spring. The low P^H value may due to the entry of cloth washing waste.

The concentration of Ammonia at different sampling sites was 1.1 mg/l to 3.0 mg/l. it was very high during winter (Mid December- Early April). According to Reid (1961) Ammonia contain in polluted water bodies is usually above 1.0 mg/l. The concentration of Ammonia in all the water bodies in the present study remains quite above the oligotrophic limit of 0.1 mg/l reflecting the level of pollution in the lake.

5.2 Zooplankton :

Both qualitative and quantitative parameters of zooplankton were estimated during this study. Plankton is directly or indirectly subjected to the complex of influences which changes with seasons and some effects might be made, some of which result in the quantitative changes, *i.e.*, increases or decreases of size of the population. Such variation in population might be due to the variation in nutrients and other favorable conditions of water during plankton production (Welch, 1952).

The abundance of Zooplankton varied from 21,325 indiv/l in February 2000 to 1,225 indiv/l in July 2000 with an average of 6426 indiv/l. In all the selected sites seasonal influence on the abundance and diversity of zooplankton were profound. In general the zooplanktons were more abundant during the months from February to May in all the stations and less abundant in August. Storms (1981) recorded maximum number of zooplankton in June and minimum in February in Quantico Creek and the adjacent Potomac rivers. The maximum production was observed in the warmer weather, the results of which can be compared with the observations, shown by Green (1960). Similarly Das and Bhuiyan (1974) found the maximum production in warmer month and minimum in August and January to February in some inland water of Dhaka city. Watson and Carpenter (1974) showed peaks of zooplankton in the spring or summer months from the lakes Huron, Erie and Ontario, Canada solicited the study.

In the present study four groups of zooplankton were observed and represented by rotifera, copepoda, cladocera and ostracods. During the present investigation zooplankton fluctuated in volume, percentage composition as well as in the individual components. The average percentage composition of different zooplankton of all the stations in the observation was rotifera 48%, copepoda 9%, cladocerans 21%, ostracods 13%, and others 9%.

In the study period the distinct fluctuation of zooplankton population was observed in different months as well as in season. Similar results were noted by Ali *et al.* (1980), Chowdhury and Sultana (1989), Mathias (1961). The major groups of zooplankton recorded during the study period were rotifera, copepoda and cladocera. Similar observation was noted by Alam *et al.* (1987), Patra and Azadi (1987), Gophen (1988), Ali *et al.* (1989), Johnson and Schlosser (1991), Ohtaka *et al.* (1996) and Islam *et al.* (2000).

In all the stations rotifers were 48% of the total micro fauna in the observation. *Filinia longiseta*, *Filinia branchiata*, *Filinia minuta*, *Keratella sp*, *K. canadensis*, *K. taurocephala*, *K. heimalis*, *K. volga*, *Asplanchna sp*, *Monostylla bulla*, *Brachionus plicatilis*, *B. bidentata*, *B. calyciflorus*, *Platyias patalus*, *Platyias sp.* were identified during the observation. *Keratella sp.* was found from March to June. *Monostylla bulla* was very rare. *Keratella volga* (51 units/l) was in lesser number and *Filinia longiseta* (214 units/l) was available. *Asplanchna sp.* and *Brachionus plicatilis* were perennial during the study period.

The highest number of rotifers (11,125 indiv./l) was recorded in March in station-3 and lowest in July in station-2. Many workers observed the maximum number of rotifers in winter. This observation was made by Habib *et al.* (1984), Patra and Azadi (1987), Ali *et al.* (1989) and Bhuiyan and Nessa (1998b) from different habitats. George (1964) observed the dominance of *Brachionus sp.* during winter from Indian reservoir. In this investigation *Brachionus calyciflorus* was *Brachionus quaridentata* dominant during the month January to March. Islam *et al.* (2000) also observed *Brachionus sp.* as the most dominant genus.

During the observation period the average percentage composition of copepods was 9% in the Gulshan lake. The copepod number varied from 200 to 2,025 units/l during the study period. The lowest number (200 units/l) was in August that was 0.88% of the total yearly occurrence and in March the highest number was 2,025 units/l, which was 3.49% of the total micro fauna. In the present study the copepods were 677 units/l, which was 16.55% of the total yearly composition. *Diaptomus sp.*, *Helidiaptomus sp.*, *Diaptomus marshianus*, *Cyclops magnus*, *Eucyclops prionophorus* were found during the investigation period. These species were found frequently. *Helidiaptomus sp.* (160 units/l) was in lowest number and the highest number was *Diaptomus* (604 units/l), *Diaptomus marshianus* (231 units/l), *Cyclops magnus* (333 units/l) were also available in higher in number. In the station-1 copepods were less dominant group (601.25 units/l) of the total micro fauna. Among copepods *Cyclops sp.*, *C. magnus*, *Mesocyclops sp.*, *Diaptomus sp.*, *Eucyclops prionophorus*, *Helicyclops sp.* were identified in the Gulshan lake. During the observation *Cyclops sp.*, *Cyclops magnus* and *Eucyclops prionophorus* were perennial and dominant. These species were found frequently. The lowest number of *Cyclops magnus* (87 units/l) was recorded which 9.21% of the total copepods and the highest was *Cyclops sp.* (268 units/l) which was 29.71% of the total copepod composition.

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The cladocerans varied from 225 to 5,725 indiv/l. The lowest was in September which comprised of 2.7% of the total cladocerans and the highest number was in December which comprised of 18.52% of the total cladocerans. In station-1 cladoceran group was dominant which was 22.54% of the total microfauna. *Daphnia magna*, *D. similis*, *D. longirimes*, *D. ambigua*, *D. laevis*, *D. rosea*, *D. thorata*, *D. pulex*, *D. catawba*, *Moinodaphnia macleayii*, *Moina brachiata*, *Bosminopsis deitersi*, *Bosmina longirostris*, *B. coregoni*, *Drepanothrix dentata*, *Macrothrix rosea*, *Sida crystalina*, *Macrothrix laticornis*, *Lathonura rectirotris*, *Polyphemus pediculus*, *Euryalona sp.*, *Alona sp.*, *A. carua*, *Moina sp.*, *Dudaya macrops*, *Diaphanosoma sp.*, *D. brachyurum*, *D. leuchten* were identified in the first observation. A few number of *Daphnia catawba* (17 units/l) was recorded which was 0.38% of the total cladocerans and the highest number was *Diaphanosoma leuchten* (996 units/l) which was 24.87% of the total cladocerans composition. *D. laevis*, *D. rosea*, *D. thorata*, *D. pulex*, *D. catawba* were very rare. *Diaphanosoma sp.* (986 units/l) *D. brachyurum* (840 units/l) was available and perennial in this observation. In the station-2, the cladocerans were

22.54% of the total microfauna. *Ceriodaphnia* sp., *Polyphemus pediculus*, *Sida crystallina*, *Pseudosida bidentata*, *Daphnia magna*, *D. galatea*, *D. longirimes*, *D. laevis*, *D. rosea*, *D. thorata*, *D. pulex*, *D. catawba*, *Scapholebris kingi*, *Moinodaphnia macleayi*, *Moina* sp., *Bosmina longirostris*, *B. coregoni*, *Macrothrix laticornis*, *Alona carina*, *Dudaya macrops*, *Chydorus piger* were very rare. *Diaphanosoma* sp. (647 units/l) and *D. leuchten* (979 units/l) were available. A few (38 units/l) cladocerans were noted in September which was 0.28% of the total yearly occurrence and the highest number (683 units/l) in February which was 5.20% of the total zooplankton composition. In the present study *Diaphanosoma* sp., *D. brachyurum*, *D. leuchten* were dominant among the cladoceran composition. But this observation is not similar with that of Anadu *et al.* (1991). They observed in Nigeria that *Moina macropa* was dominant among the cladocerans.

During the study period the ostracoda comprised of on an average 13% of the total zooplankton population. In station 1 the ostracoda group was 10% of the total zooplankton. Among the ostracods *Ilyocypris bradyi*, *Candocypris osborni*, *Cyclocypris kinkaidia*, *Cyclocypris serena*, *Centerocypris* sp., *Cypria lacustris*, *Cypridopsis aculeate*, *Encythere insignipes*, *Physocypris posterotuberculata*, *Eucypris virens*, *Cypricureus hirsutus* and *Cypris* sp. were identified in the studied Gulshan lake. The lowest number was *Centerocypris* sp (34 units/l) and the highest number was *Cypris* sp. (166 units/l). Maximum number of ostracodes sp. was found in April (2525 indiv./l) and minimum number was found in July (225 indiv./l). The average number of ostracodes was 2650 indiv./l in station 1 at surface layer of water. Das and Bhuiyan (1974) recorded 8 species of ostracodes from 2 ponds and 2 lakes of Dhaka city.

5.3 Benthos :

The major groups of benthic fauna were observed throughout the study period. The benthic fauna ranged from 503 to 1,158 indiv/m² with an average mean data of 702±152.41 indiv/m² during the study period in the studied lake. Benthic fauna was sorted as major groups of Mollusca, Oligochaeta as well as Chironomidae and other organisms. The molluscs were dominant group among the total benthos followed by oligochaetes, chironomids and other miscellaneous group and their percentage composition was 41%, 31%, 23% and 5% of total benthic fauna respectively. Ahmed

(1993) reported population density to be ranging from 631 to 2415/m² in pond system. Murty *et al.* (1978) reported from 362 to 4231/m². The West Bengal beels were blessed with benthos ranging from 90 to 13,238 indiv/m² and also sometimes 0 to 1763 organisms/m² (CIFRI, 2000). Thienemann (1925) classified a lakebed producing between 1000-2000 indiv/m² as mesotrophic. On the basis of this classification Gulshan lake could be placed as mesotrophic waterbed in nature.

The lowest abundance of benthos was observed in March and highest was in July. Rahman (2000) reported the highest number of benthic fauna in December in Rajdhala beel with an average number 1270.01 ind/m² and the lowest 869.14 indiv/m² during September respectively. Mondal and Moitra (1976) recorded the highest density of benthos in summer. Ahmed *et al.* (1993) recorded the minimum quantity of benthos in November (232 ind/m²) and maximum in January (746 ind/m²). Srivastava (1958, 1959) reported on the bottom fauna of some ponds of Lucknow, which exhibited seasonal fluctuations, its total volume being highest during monsoon months attributable to the dominance of mollusks and oligochaetes. CIFRI (1997) stated productivity of biotic communities like benthos and macrophytes are directly related to the abundance of organic matter and other morphometric characteristics of the reservoirs; lack of organic detritus in the reservoirs substratum as evidenced by the total absence of bottom biota and absence of macro-vegetation have affected establishment of bottom feeders like *Cirrhinus mrigala* and browsers like *Labeo rohita*.

The mulluses showed the highest peak in July (676 ind/m²) and the lowest March (136 ind/m²) during the study period in station-1. Das *et al.* (1981) observed peak of molluscs also in July. Ali *et al.* (1978) recorded the abundance of molluscs in the month of August and October. Among the molluscs, gastropods were the most abundant group in the lake. Sitaramiah (1966) suggested that the abundance of gastropods was associated with the occurrence of filamentous algae and permanent hardness of water.

Oligochaetes were the second dominant group of the benthic fauna of the Gulshan Lake. Similar observation was also made by Das *et al.* (1981), Ali *et al.* (1978, 1981) and Ahmed *et al.* (1991) in Kaptai Lake. During the present study the highest peak of

oligochaetes was recorded in July (392 ind/m^2) and lowest in November (125 ind/m^2) in station-1. Similarly highest peak of oligochaetes also recorded by Das et al. (1981) in July but lowest in December. These findings do not agree with that of Ali et al, (1978, 1981) and Ahmed et al. (1991).

Chironomids showed their highest peak in July (172 ind/m^2) and lowest in summer (86 ind/m^2). Similarly Das et al. (1981) also found the highest abundance of chironomids in December. Mondal and Moitra (1976) found the highest peak of chironomids in February and May. The chironomid larvae were more prominent both in number and biomass.

Other miscellaneous group observed during the present studies included culicine larvae, leeches, etc. were not regular in occurrence in the samples of different months and constituted minor group. This group showed their highest peak in March where Chaoborus larvae were dominated. Their occurrence as minority group may be due to the fact that the ecological conditions of the lake were not optimum for them. Krishnamurthy (1966) stated that dipterous larvae were most abundant in August. Sitaramiah (1966) classified the oligochaetes depending on their abundance in response to environmental temperature into three types viz., stenominimothermal, stenomaximothermal and stenooptimothermal forms. He also reported that the size of the population of chironomid remained small from October to December but was large in January and February.

The frequency of availability of macro benthos varied in different points, months and seasons. These differences may have been due to the differences of bottom habitat (Reid, 1961) and various physico-chemical as well as other environmental conditions. The differences may also be due to the difference of the volume of mud collected by the Dredge. Munro (1966) reported that usually in samples high content of decaying leaves, plant stems and other detritus, the number of benthic invertebrates of all types varied proportionally with volume of the mud brought by the sampler.

The numerical abundance of the bottom fauna under study fluctuated with month, season etc. The highest number of organisms collected in July and this might be due to the environmental suitability of water body, food available in the bottom soil,

relatively high temperature, etc. in the lake. Similar indication was given by Welch (1952).

5.4 Food and Feeding habit of Fish and their growth :

The detailed examination of major food groups found in the gut contents of *C. catla*, *L. rohita* and *L. calbasu* were cyanophyceae, chlorophyceae, bacillarophyceae, plant parts, rotifers, crustaceans, benthos, animal parts, semi-digested materials and mud & debris. These food groups are represented by a large variety of genera and a good number of these are common to the three species of fishes. Despite the fact that rational cultivation of economically important fish species was found to be inconceivable without knowledge of the basic problem of their food and feeding habits. Food and feeding habit of fish is one of the important biological factors for selecting these fishes for raising in pond and impoundments, where, they will not compete with others for food but will live in association, and utilize to the maximum, all the available food.

Three methods were followed (namely occurrence, points and fullness method) to get a detailed idea of the food materials of the gut. No single method is adequate for gut analysis. The food and feeding habits of *C. catla*, *L. rohita* and *L. calbasu* was studied to average size groups (160mm-360 mm) to observe whether the type of food (Quantitative or Qualitative) varied due to three species of fish. The present study showed interesting food preference. All the fishes fed more or less same food, which were common in the lake.

Algae, which condensed into groups of blue-green algae, green algae and diatom were found in the stomach of three species of fish throughout the year. From the present study, it was found that *C. catla* showed comparatively greater feeding preference for blue-green algae in October, November and minimum in April and *L. calbasu* showed maximum in January and negligible in November and December. It is of interest that consumption of blue-green algae increased with the increase in size of the fish. These findings of the present study are more or less in conformity with the findings of Alikunhi (1957).

Green algae showed a second remarkable variation with respect to three species of fish in different months. *C. catla* showed highest rate of consumption on green algae in December while *L. rohita* showed highest rate in February followed by July and *L. calbasu* showed highest rate in January. Minimum intake was observed in May in case, of *C. catla* and *L. rohita* was minimum in September, *L. calbasu*, while it was minimum in April. Similar result was observed by Mustafa *et al.* (1981) in a *Colisa fasciata*. Hynes (1950) reported that the composition of food varied throughout the year and each important food tended to have a maximum importance at certain season.

Maximum diatoms were recorded in March in case of *C. catla*, while in the stomachs of *L. rohita* it was maximum in November, maximum diatoms were recorded in November in case of *L. calbasu*. Minimum intake of diatom was recorded in December in case of *C. catla* followed by February in case of *L. rohita*. Minimum diatom was recorded in April in case of *L. rohita* and *L. calbasu* and *L. calbasu* showed negligible in August. Islam & Saha (1975) reported that phytoplankton production was maximum in June, July and October and minimum in March. From the present investigation, it is evident that fish showed increasing demand for diatoms with the increase in size and fish to fish by percentage of occurrence and by point's method.

Presence of considerable quantities of plant parts including aquatic plants, roots, parts of leaves more or less common feature throughout the year in the gut contents of three species of fish. Maximum intake of plant parts was recorded from the gut contents of *C. catla* followed by *L. rohita* and *L. calbasu*. *L. calbasu* showed comparatively lower preference for this item *L. rohita* and *L. calbasu* showed negligible in August and October, November, July, respectively. Similar findings were also reported by Mustafa *et al.* (1981) on *Puntius sarana*. *C. catla* was found to consume maximum quantity of plant parts in November and maximum in July, followed by *L. rohita* showed maximum in November and minimum in July, while *L. calbasu* showed maximum in September and minimum April. Most probably plant parts were ingested incidental food. Ahmed *et al* (1993) also observed plant parts with a less quantity in the stomach of *Mystus vittatus* which was predominantly a carnivore.

The amount of rotifers showed a considerable variation in different length groups. *C. catla* showed maximum value for rotifers in September both in terms of occurrence and percentage composition of food items. This might be due to the fact that the physico-chemical variables of the water body were optimum in these months for the rich abundance of rotifers.

Crustaceans were recorded as occasional food item for three species of fish. Among crustaceans categories by copepods, cladocera and ostracods were included crustacean consumed the highest percentage of food item in the stomach of *L. rohita* followed by *L. calbasu* and *C. catla*. Similar findings were reported by Rao (1981) on Lizard fish, *Saurida tumbil*.

Benthos was occasional food item of three species of fish *L. calbasu* showed the maximum value for benthos in November followed by *L. rohita* and *C. catla*. It was found only few months in the stomach of fishes with negligible quantity in their stomachs. Qassim (1977) reported that immature fishes preferred insects significantly. Semi-digested materials included parts of filamentous algae, plant tissues and unidentified maximum digested pulpy material. Stomach contents of three species of fish showed the presence of considerable quantities of semi-digested material in February to July. Presence of greater quantity of semi-digested materials may be attributed to the increasing feeding intensity in the post spawning seasons. It is apparent from the present study that mud and debris were normally eaten and covering most of the stomach contents as basic food item for three species of fish. Moreover, this food item was found to increase with the increased size of fish.

Highest percentage of mud & debris was recorded in February in case of *L. calbasu* followed by *L. rohita* and *C. catla*. Sugunan *et al.* (1995) observed that *Mugil corsula* consumed about 73.17% mud & detritus and reported the fish as a mud-feeder. Though the observation on the feeding intensity of three species of fish based on average index of fullness the co-efficient of correlation of average index of fullness between of correlation of average index of fullness between *C. catla* & *L. rohita*, *C. catla* & *L. calbasu* and *L. rohita* & *L. calbasu* were less correlated. It is evident from the present study that in case of three species of fish there is a lowering tendency in both average index of fullness. A similar observation was also made by Mustafa *et al.* (1979) in case of *N. nandus*.

Chapter -6

Summary

The present investigation was carried out in Gulshan Lake of Dhaka city during the period from August 1999 to January 2002. The qualitative and quantitative assessment of zooplankton composition, benthos abundance, food and feeding of some fishes in the above lake were made along with the measurement of physico-chemical parameters of the lake water which included air temperature, water temperature, transparency, P^H , dissolved oxygen, free carbondioxide, alkalinity, hardness, ammonia and nitrite. The data on different aspects have been analyzed and discussed. The major findings are summarized below:

6.1 Physico-chemical parameters :

During the study period, it was observed that there was no significant variation of physico-chemical parameters between surface and bottom layers of the lake. The average range of air and water temperature varied from $19.33^{\circ}\text{C} - 35.0^{\circ}\text{C}$ and $18.67^{\circ}\text{C} - 35.67^{\circ}\text{C}$ respectively. The mean value of standard deviation of transparency was 38.36 ± 10.58 . The maximum transparency was observed during August and minimum was during March. It was observed probably due to high solar radiation and less plankton population. The average dissolved oxygen content ranged from 3.06 mg/l to 7.24 mg/l. The lower values of dissolved oxygen were recorded during spring (December - April) and higher values were in rainy and summer months. Carbondioxide level found to fluctuate from average 7.00 mg/l to 15.74 mg/l at different sampling stations during the study period. The mean value of standard deviation was 11.27 ± 2.39 . The hydrogen ion concentration (P^H) in the water samples collected from three different sampling stations of the Gulshan Lake varied from 7.06 to 8.01 during the study period. The average alkalinity concentration ranged from 90.2 mg/l to 138.4 mg/l during the study period. The highest value was observed in May where as the lowest value was revealed in November. The average value of hardness ranged from 92.1 mg/l to 138.8 mg/l respectively. It showed a low but gradual increase from December to April. The monthly average ammonia concentration ranged from 1.2 mg/l to 3.7 mg/l. Nitrite concentrations varied from 0.04 mg/l to 0.21 mg/l during the study period.

6.2 Zooplankton :

The present study quantitative observations were made at fortnightly intervals on the zooplankton community of three selected sites in the Gulshan Lake. It appeared that the range of zooplankton had fluctuated numerically during the course of the study. From the accumulated data during the study period abundance of Zooplankton varied from 21.325 indiv/l in February 2000 to 1.225 indiv/l in July 2000 with an average of 6.426 indiv/l. In all the selected sites seasonal influence on the abundance and diversity of zooplankton were profound. The most dominant group was Rotifera comprising 48% of the total zooplankton population followed by Cladocerans (21%), Ostracods (13%) and copepods (9%). The pattern of dominance was more or less similar in the different layers of the water body. The values of *t* were 0.71, 0.37 and 0.59 in cases of surface, middle and bottom layer, which indicated that abundance of zooplankton in different layers were almost similar. Zooplankton abundance varied in different stations of the studied lake. The highest abundance was recorded in station 3 (8144.77 indiv/l) followed by station 1 (7812.50 indiv/l) and station 2 (6184.08 indiv/l). It was observed that relatively higher zooplankton abundance was found in the morning.

During the study period, a total of 37 genera and 41 species of zooplankton were identified in the studied lake. The average value of rotifers abundance was 3440.69 indiv/l. The abundance of rotifers were increased from January to till March and then gradually decreased till June. The lowest abundance was observed in August. *Brachionus* spp was the most dominant rotifers. Seven *Brachionus* species were identified in the studied lake. *Filinia* was the second dominant rotifers genus. The third dominant rotifers genus was *Keratella*. Among the rotifers *Asplanchna* was fourth dominant genus in position. *Polyarthra* was fifth dominant genus in position. Among the rotifers *Monostyle* was sixth dominant genus in position. *Trichocera* was seventh dominant genus in position. Besides, other rotifers such as *Cephalodella*, *Pedalia*, *Lecana*, *Lepadella*, *Epipheanes*, *Lindia* etc. were also identified from the samples of the pretest study. Most of these species were generally abundant from December to May.

Copepodes were the forth-abundant group of zooplanktons in all the studied areas. The average abundance of Copepods was 598.86 indiv/l. in the Gulshan Lake. The

only *C. sternus* was identified among the collected samples. Cladocera were recorded as second abundant group of zooplankton in all the studied areas. The average Cladocerans abundance was 1560 ± 1356 indiv./l. *Bosmina longirostris* was the most dominant identified genus in the studied lake during the study period. Ostracoda were identified as the third abundant group of zooplankton in all studied areas. The average abundance of Ostracoda was 960.50 indiv/l in the studied lake.

6.3 Benthos :

The benthic fauna ranged from 503 to 1,158 indiv/m² with an average mean data of 702 ± 152.41 indiv/m² during the study period in the studied lake. The abundance of benthos on an average was 672 ± 154.92 indiv/m² in station 1, 733 ± 154.02 indiv/m² in station 2 and 703 ± 152.76 indiv/m² in station 3 respectively. The lowest abundance of benthos was observed in March and highest was in July. There were no significant variation of benthos abundance from August to February and sudden fall in March and then increasing their abundance till July. Benthic fauna was sorted as major groups of Mollusca, Oligochaeta as well as Chironomidae and other organisms. Important organisms were systematically analyzed.

Mollusca were found as the most dominant group in the lake comprised of 41% of the total benthic fauna. The monthly average abundance of mollusca was 260 ± 108 indiv/m² in station 1, 279 ± 106 indiv/m² in station 2 and 272 ± 108 in station 3, respectively. Important identified genus was *Bythinia*, *Viviparus*, *Pila* & *Lymnaea* spp.

Oligochaeta was the second dominant group of the benthic organisms of the Gulshan Lake. They constituted 31 % of the total benthic fauna. The monthly average density was 216 ± 65 indiv/m² in station 1, 232 ± 66 indiv/m² in station 2 and 221 ± 66 in station 3. The maximum number of Oligochaete was found in July (392 ind/m²) and minimum in November (125 ind/m²). Some important animals were *Nais*, *Dero*, *Tubifex*, *Limnodrilus*, spp.

Chironomid was the third in position of dominancy, comprised of 23% of the total benthic fauna. The monthly average abundance of mollusca was 163 ± 35 indiv/m² in station 1, 178 ± 34 indiv/m² in station 2 and 171 ± 35 in station 3, respectively.

Identified genuses were *Chironomus*, *Tanypus* & *Pelopia* spp. The density of other benthic organisms was very low. Other animals included Culicinae and other insect larvae.

6.4 Food and Feeding habit of Fish and their growth :

The major food items found in the stomach of *Catla catla*, *Labeo rohita* and *L. calbasu* were (1) algae -blue green algae (*Microcystis*, *Oscillatoria*, *Spirulina*), Cyanophyceae (*Anabaena*, *Nostoc*), green algae (*Chlorella*, *Ulothrix*, *Oedogonium*, *Spirogyra*) (2) plant parts (aquatic plants, root, parts of leaves) (3) rotifers (*Rotaria*, *Lecane*, *Keratella*) (4) crustaceans (*Cyclops*, *Dhapni* and *Cypris*) (5) benthos (6) animal parts (fish remains, fish scale, barbles) (7) semi digested materials and (8) mud and debris.

Analysis the occurrence of each of the food items in the stomach of *C. catla* it was found that the algae, especially blue-green, algae, green algae and diatom, plant parts, rotifers and mud & debris were the most common. Crustacean benthos and animal parts were represented as occasional food items. Frequency of occurrence of food items in the stomach of *L. rohita* showed that algae, plant parts, rotifers and mud & debris were the common food item. Crustaceans, benthos and animal parts were represented as occasional food items. Analysis the occurrence of each of the food items in the stomach of *L. calbasu* it was found the algae, benthos, plant parts, mud & debris were the most common food items. Plant parts, rotifers, crustaceans and animal parts were represented as occasional food items.

6.5 Relationship between physico-chemical and biological parameters :

The zooplankton population was highly influenced by DO and significant negative correlation exists between them. The more concentration of zooplankton was found between 4.5 mg/l and 6.8 mg/l. level of DO. Benthos was positively correlated with DO and highest concentration was found between 3.5 to 4.5 mg/l level of DO. There were positive correlation between free CO₂ and abundance of zooplankton and benthos. The concentration of zooplankton and benthos was found between 7.5 - 12 mg/l. and 7.5 - 13 mg/l level of CO₂ respectively. A significant positive correlation was observed between zooplankton and P^{II} in the studied lake and highest

concentration of zooplankton was found between 7.3 and 7.7 P^H level. There was no significant relationship exist between benthos and the pH value. The abundance of zooplankton in the studied lake was significantly influenced by the concentration of alkalinity. A strong positive correlation was existed between them and higher concentration of zooplankton population was observed between 98 mg/l to 115 mg/l alkalinity level. Benthos was positively correlated with alkalinity. A significant positive correlation was observed between zooplankton and hardness. Higher concentration of zooplankton population was existed between 95 mg/l to 110 mg/l hardness level. Benthos was positively correlated with hardness. A positive correlation was observed between zooplankton and nitrite while benthos correlated negatively. Higher concentration of zooplankton and benthos were found between 0.05 mg/l to 0.13 mg/l and 0.07 mg/l to 0.15 mg/l nitrite level. The abundance of zooplankton was highly influenced by the ammonia concentration and there existed a strong positive correlation. Benthos showed negative correlation with ammonia.

Chapter -7

Conclusion

The present investigation has been conducted on physico-chemical parameters, zooplankton, benthos and feeding habit of some fish of Gulshan Lake in Dhaka city. The duration of study was two and half years. The data of different aspects have been analyzed and discussed. The fluctuation of DO concentration varied in different months and mainly influenced by dissolved organic materials, plankton and bottom vegetation. The study revealed that the concentration of DO was more or less fair for aquatic organisms except during December to April, when lethal condition was exist. It was found that free CO₂ concentration was high in summer that was appeared to be erratic. The high CO₂ content during summer was possibly due to the high temperature and heavy rainfall with heavy drainage, which speeded up the decomposition of organic materials. The P^H values were alkaline in nature. Ammonia concentration was remained quite over to oligotrophic limit of 0.1 mg/l reflecting the level of pollution in the lake. The seasonal variation of zooplankton abundance and their diversity was profound. Gnerally zooplankton was more abundant during the months from February to May. This was due to lower concentration of DO and higher concentration of alkalinity, hardness. Zooplankton abundance was negatively influenced by DO. The abundance of benthic fauna fluctuated numerically with months and seasons. On the basis of benthos abundance during the study, Gulshan Lake could be classified as mesotrophic waterbed in nature. The major food items found in the stomach of studied fish were algae, plants parts, rotifers, crustaceans, benthos, animal parts, semi-digested materials, mud and debris. Zooplankton and benthos occupied the most of the food items of those fish.

One of the major problems associated with Lake culture was that it was open for all for fishing previously by nearby people and the practice prevails, as culture activities are not familiar as yet. And as residencies surround it, there is always a chance of fish poaching. So, there should be a strong management authority to guard against poaching of fish from such Lake. According to the scheme of most authors, Gulshan Lake falls under mesotrophic category but moving very fast toward eutrophication. After overall study it is found that the main cause of pollution in the water body is heavy pressure of localized human activity such as outlet of sewer, cloth washing, bathing and disturbance in the farm of cattle wading, entry of people to remove the aquatic vegetation and run off passing through nurseries and private gardening.

From the above study we see that the Lake was moderately productive and little improvement may make it more productive and important fish resource. Once the fish bio-diversity of the Study Lake was extensive. The stock was replenished from the wild source. However, due to various reasons, the stock drastically reduced and some of the valuable fishes vanished. The situation has been changed and bio-physico-chemical environment of the Lake improved since the adoption of management policies. The study revealed that without stocking and standardization of the management techniques, enhancement of the Lake production could not be achieved.

So, in order to counteract the increasing and acute shortage of animal protein we should not keep any of our cultural resource unexploited. Lake constitutes a large portion of our fresh water resources. Immediate conservation measures and reconsideration in utilization strategy is required if all such Lakes or beels and other unexploited water bodies under aquaculture program are to be saved for prosperity.

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Appendix: A

Table 7: Fortnightly fluctuation of dissolved oxygen (mg/l) in the water at different stations at 12 PM of Gulshan Lake in Dhaka City.

Sampling Date	Year	Station-1			Station-2			Station-3		
		Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
1 Aug	1999	6.55	6.25	6.05	6.30	6.05	5.75	6.85	6.55	6.30
	2000	7.75	7.20	6.85	7.25	6.90	6.50	8.15	7.50	7.05
	2001	6.85	6.55	6.25	6.55	6.25	6.05	7.05	6.85	6.65
15 Aug	1999	7.25	7.05	6.75	7.10	6.75	6.55	7.60	7.35	7.10
	2000	8.45	8.10	7.60	8.15	7.50	7.15	8.70	8.25	7.80
	2001	7.05	6.85	6.70	6.95	6.70	6.55	7.35	7.15	6.95
1 Sep	1999	6.75	6.50	6.25	6.65	6.40	6.20	7.00	6.70	6.45
	2000	7.20	6.95	6.30	7.30	6.80	6.35	8.10	7.60	7.05
	2001	6.55	6.35	6.05	6.30	6.10	5.95	6.75	6.55	6.30
15 Sep	1999	6.20	6.00	5.85	6.05	5.90	5.75	6.45	6.25	6.10
	2000	6.60	6.25	6.05	6.50	6.05	6.15	7.60	7.05	6.25
	2001	6.05	5.85	5.70	5.80	5.65	5.50	6.05	5.95	5.70
1 Oct	1999	6.05	5.90	5.70	5.90	5.75	5.60	6.40	6.15	5.95
	2000	6.30	6.05	5.50	6.05	5.60	5.45	6.45	6.15	6.00
	2001	6.55	6.25	6.10	6.15	6.00	5.75	6.75	6.50	6.40
15 Oct	1999	5.35	5.15	5.05	5.20	5.05	4.95	5.50	5.35	5.20
	2000	5.75	5.35	5.15	5.50	5.20	5.00	5.90	5.65	5.25
	2001	5.75	5.60	5.45	5.55	5.35	5.25	5.90	5.75	5.55
1 Nov	1999	4.85	4.70	4.55	4.70	4.55	4.30	5.00	4.80	4.65
	2000	5.20	4.55	4.35	5.15	4.65	4.05	5.35	5.05	4.50
	2001	5.15	4.85	4.70	4.90	4.75	4.60	5.50	5.15	4.95
15 Nov	1999	4.15	4.05	3.90	4.00	3.85	3.70	4.25	4.15	4.00
	2000	4.50	4.25	4.05	4.40	4.25	4.05	4.65	4.35	4.15
	2001	4.75	4.55	4.25	4.65	4.50	4.25	4.95	4.80	4.70
1 Dec	1999	3.75	3.60	3.45	3.50	3.40	3.25	3.95	3.80	3.65
	2000	4.15	4.05	3.85	4.20	4.00	3.90	4.25	4.05	3.85
	2001	4.00	3.90	3.75	3.85	3.70	3.55	4.25	4.00	3.85
15 Dec	1999	3.55	3.40	3.25	3.35	3.20	3.05	3.90	3.75	3.60
	2000	4.00	3.70	3.55	3.85	3.65	3.40	4.10	3.90	3.65
	2001	3.85	3.70	3.55	3.65	3.50	3.40	4.00	3.85	3.75
1 Jan	2000	3.90	3.75	3.55	3.80	3.60	3.45	4.00	3.80	3.65
	2001	3.90	3.75	3.50	3.75	3.60	3.35	4.00	3.80	3.55
	2002	4.15	4.00	3.75	4.00	3.85	3.70	4.25	4.15	4.00
15 Jan	2000	4.25	4.05	3.85	4.10	3.95	3.80	4.50	4.25	4.10
	2001	3.70	3.55	3.40	3.60	3.55	3.45	3.80	3.65	3.50
	2002	4.55	4.25	4.15	4.35	4.20	4.05	4.75	4.60	4.45
1 Feb	2000	5.05	4.90	4.75	5.00	4.85	4.70	5.25	5.10	4.95
	2001	3.55	3.40	3.35	3.40	3.15	3.00	3.75	3.60	3.50
15 Feb	2000	4.15	4.05	3.90	4.00	3.85	3.70	4.35	4.15	4.05
	2001	3.45	3.25	3.25	3.15	3.00	2.95	3.50	3.35	3.15
1 Mar	2000	4.25	4.10	3.95	4.05	3.90	3.70	4.50	4.35	4.10
	2001	3.25	3.05	3.00	3.05	2.80	2.65	3.30	3.15	3.00
15 Mar	2000	3.65	3.50	3.35	3.45	3.45	3.25	3.80	3.65	3.50
	2001	3.15	2.90	2.85	2.60	2.35	2.20	3.15	3.00	2.85
1 Apr	2000	3.45	3.35	3.20	3.30	3.20	3.05	3.70	3.50	3.35
	2001	3.50	3.25	3.20	2.80	2.55	2.35	3.50	3.35	3.25
15 Apr	2000	3.95	3.80	3.65	3.85	3.75	3.60	4.15	4.05	3.95
	2001	4.25	4.15	4.00	3.50	3.30	3.15	4.40	4.45	4.15
1 May	2000	4.55	4.30	4.10	4.25	4.15	4.10	4.80	4.70	4.55
	2001	4.75	4.45	4.20	4.10	3.85	3.45	4.90	4.65	4.35
15 May	2000	4.25	4.15	4.05	4.20	4.10	4.05	4.35	4.20	4.10
	2001	5.45	5.30	5.15	4.70	4.55	4.35	5.40	5.25	5.05
1 Jun	2000	4.85	4.70	4.60	4.75	4.55	4.40	5.05	4.90	4.80
	2001	6.35	6.05	5.75	5.15	4.90	4.75	5.30	5.15	5.00
15 Jun	2000	5.35	5.30	5.20	5.25	5.05	4.90	5.55	5.40	5.30
	2001	6.30	6.25	6.05	5.50	5.15	5.00	5.45	5.25	5.20
1 Jul	2000	5.75	5.55	5.40	5.60	5.45	5.35	6.00	5.85	5.75
	2001	6.95	6.75	6.65	6.50	6.35	6.05	6.85	6.65	6.45
15 Jul	2000	5.90	5.80	5.65	5.70	5.55	5.40	6.15	6.00	5.75
	2001	7.35	7.05	6.95	7.15	7.00	6.85	7.55	7.25	7.05

Table 8: Fortnightly fluctuation of Free Carbon Dioxide (mg/l) in the water at different stations at 12 PM of Gulshan Lake in Dhaka.

Sampling Date	Year	Station-1			Station-2			Station-3		
		Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
1 Aug	1999	10.25	10.40	10.75	10.90	11.10	11.25	10.05	10.30	10.45
	2000	07.50	07.85	08.15	07.00	07.35	07.75	08.00	08.30	08.50
	2001	8.25	8.35	8.50	8.75	8.95	9.05	8.00	8.25	8.40
15 Aug	1999	10.80	10.95	11.15	11.00	11.15	11.35	10.55	10.70	10.85
	2000	08.20	08.35	08.50	08.45	08.65	08.85	08.15	08.25	08.55
	2001	8.75	8.90	9.10	8.95	9.10	9.30	8.60	8.75	8.95
1 Sep	1999	11.00	11.25	11.40	11.30	11.45	11.65	10.80	10.95	11.05
	2000	09.60	09.85	09.90	09.70	09.90	10.00	09.65	09.75	09.90
	2001	8.85	9.05	9.15	9.15	9.35	9.40	8.65	8.80	8.95
15 Sep	1999	11.20	11.35	11.50	11.80	11.95	12.15	11.10	11.35	11.55
	2000	10.30	10.45	10.65	09.85	09.95	10.20	10.00	10.30	10.65
	2001	9.35	9.50	9.70	9.65	9.80	9.95	9.15	9.30	9.45
1 Oct	1999	11.95	12.10	12.35	12.15	12.40	12.55	11.75	11.90	12.00
	2000	11.20	11.45	11.65	11.00	11.20	11.45	11.50	11.75	11.95
	2001	9.75	9.90	10.05	9.95	10.05	10.25	9.55	9.75	9.80
15 Oct	1999	12.35	12.55	12.70	12.50	12.65	12.75	12.20	12.45	12.60
	2000	12.50	12.75	12.95	12.85	12.95	13.20	12.75	12.90	13.00
	2001	10.45	10.75	10.90	10.75	10.90	11.15	10.25	10.35	10.50
1 Nov	1999	11.35	11.50	11.75	11.55	11.70	11.85	11.25	11.45	11.60
	2000	11.20	11.45	11.65	11.50	11.60	11.75	11.40	11.60	11.85
	2001	9.15	9.35	9.40	9.30	9.55	9.65	9.00	9.15	9.35
15 Nov	1999	10.75	10.95	11.05	10.90	11.10	11.25	11.45	11.60	11.75
	2000	09.80	10.00	10.25	10.20	10.35	10.50	10.00	10.30	10.60
	2001	8.80	8.95	9.15	8.95	9.10	9.35	9.00	9.20	9.35
1 Dec	1999	09.50	10.05	10.25	10.15	10.45	10.60	10.50	10.75	10.90
	2000	08.50	08.75	08.90	08.80	08.95	09.00	09.50	09.60	09.80
	2001	8.10	8.25	8.40	8.35	8.45	8.60	7.95	8.10	8.35
15 Dec	1999	09.00	09.15	09.45	09.35	09.45	09.60	09.50	09.70	09.85
	2000	09.85	10.00	10.15	10.00	10.35	10.55	09.90	10.05	10.25
	2001	7.55	7.65	7.85	8.00	8.25	8.45	7.25	7.55	7.70
1 Jan	2000	09.65	09.80	09.90	09.75	10.00	10.25	09.70	09.85	10.05
	2001	10.50	10.70	10.85	10.75	10.90	11.00	10.40	10.60	10.75
	2002	7.40	7.55	7.65	7.75	7.80	7.95	7.25	7.35	7.60
15 Jan	2000	09.15	09.35	09.50	09.50	10.15	10.35	09.10	09.35	09.55
	2001	13.00	13.15	13.25	13.30	13.45	14.05	12.50	12.65	12.75
	2002	7.10	7.25	7.40	7.30	7.55	7.75	7.00	7.25	7.40
1 Feb	2000	11.30	11.45	11.60	11.40	11.65	11.80	11.15	11.35	11.55
	2001	12.50	12.65	12.80	12.70	12.90	13.00	12.60	12.70	12.85
15 Feb	2000	11.65	11.80	11.95	11.75	12.00	12.25	11.70	11.95	12.10
	2001	16.50	17.00	17.30	18.25	20.05	18.75	15.35	15.50	15.60
1 Mar	2000	14.25	14.45	14.60	14.50	14.70	14.95	14.15	14.35	14.60
	2001	15.40	15.65	15.85	15.90	15.95	16.25	12.50	12.55	12.70
15 Mar	2000	13.45	13.55	13.70	13.50	13.70	13.95	13.05	13.25	13.65
	2001	16.95	17.05	17.10	19.25	19.65	19.75	15.85	15.90	16.00
1 Apr	2000	11.30	13.55	13.80	13.70	13.95	14.25	11.05	11.35	11.70
	2001	12.55	12.75	12.70	12.80	12.85	13.05	12.70	12.75	12.90
15 Apr	2000	12.05	12.45	12.80	12.65	12.90	13.15	11.65	11.80	12.10
	2001	15.50	15.85	16.10	15.90	16.00	16.25	15.15	15.35	15.55
1 May	2000	14.75	14.95	15.25	15.20	15.55	15.80	14.55	14.90	15.15
	2001	12.50	12.75	12.90	12.80	13.00	13.20	12.25	12.25	12.75
15 May	2000	15.80	16.05	16.45	16.35	16.75	16.90	15.60	16.10	16.55
	2001	11.70	11.85	11.95	12.00	12.20	12.45	11.05	11.25	11.35
1 Jun	2000	16.35	16.70	16.95	16.75	16.95	17.25	16.50	16.80	17.25
	2001	10.05	10.25	10.35	10.45	10.85	10.90	09.95	10.05	10.45
15 Jun	2000	18.45	18.65	18.70	18.95	19.45	19.80	18.20	18.65	18.90
	2001	08.25	08.45	08.55	08.50	08.65	08.70	09.75	09.80	09.95
1 Jul	2000	15.20	15.55	15.90	15.75	16.05	16.60	15.05	15.65	15.90
	2001	09.15	09.25	09.65	09.00	09.25	09.30	09.50	09.65	09.80
15 Jul	2000	13.40	13.80	14.05	14.00	14.50	14.85	13.25	13.75	14.15
	2001	07.50	07.55	07.85	08.05	08.15	08.45	08.50	08.65	09.90

Table 9: Fortnightly fluctuation of pH concentrations (p^H) in the water at different stations at 12 PM of Gulshan Lake in Dhaka City.

Sampling Date	Year	Station-1			Station-2			Station-3		
		Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
1 Aug	1999	7.65	7.70	7.85	7.75	7.80	7.90	7.55	7.60	7.75
	2000	7.30	7.35	7.55	7.50	7.55	7.75	7.25	7.30	7.50
	2001	6.95	7.00	7.10	7.15	7.20	7.30	6.80	6.95	7.05
15 Aug	1999	7.55	7.60	7.70	7.65	7.70	7.85	7.50	7.55	7.65
	2000	7.40	7.45	7.75	7.60	7.65	7.85	7.30	7.35	7.60
	2001	7.15	7.20	7.30	7.25	7.30	7.40	7.05	7.15	7.20
1 Sep	1999	7.50	7.55	7.70	7.65	7.75	7.85	7.40	7.45	7.60
	2000	7.45	7.50	7.75	7.60	7.70	7.90	7.35	7.40	7.70
	2001	7.25	7.35	7.45	7.35	7.40	7.50	7.15	7.20	7.30
15 Sep	1999	7.40	7.45	7.60	7.55	7.65	7.70	7.30	7.40	7.55
	2000	7.50	7.60	7.85	7.70	7.75	7.95	7.45	7.55	7.75
	2001	7.05	7.10	7.20	7.25	7.30	7.40	6.95	7.00	7.10
1 Oct	1999	7.45	7.50	7.65	7.60	7.65	7.75	7.35	7.40	7.50
	2000	7.55	7.65	7.95	7.80	7.80	8.00	7.55	7.65	7.95
	2001	7.15	7.20	7.30	7.30	7.35	7.45	7.10	7.15	7.25
15 Oct	1999	7.35	7.40	7.55	7.50	7.60	7.70	7.25	7.35	7.40
	2000	7.45	7.50	7.75	7.70	7.75	7.85	7.45	7.55	7.80
	2001	7.20	7.25	7.35	7.35	7.45	7.50	7.15	7.25	7.30
1 Nov	1999	7.25	7.30	7.45	7.35	7.40	7.50	7.15	7.25	7.35
	2000	7.40	7.45	7.65	7.60	7.65	7.80	7.35	7.40	7.65
	2001	7.55	7.60	7.65	7.70	7.75	7.85	7.30	7.35	7.45
15 Nov	1999	7.30	7.35	7.50	7.40	7.50	7.65	7.10	7.20	7.25
	2000	7.25	7.35	7.55	7.50	7.55	7.70	7.20	7.25	7.50
	2001	7.65	7.70	7.85	7.70	7.80	7.85	7.40	7.45	7.55
1 Dec	1999	7.35	7.40	7.50	7.45	7.55	7.60	7.25	7.35	7.40
	2000	7.45	7.55	7.70	7.65	7.70	7.90	7.35	7.45	7.65
	2001	7.45	7.50	7.60	7.55	7.60	7.65	7.35	7.45	7.50
15 Dec	1999	7.50	7.55	7.65	7.60	7.65	7.85	7.40	7.50	7.70
	2000	7.55	7.60	7.75	7.70	7.75	7.95	7.45	7.55	7.80
	2001	7.20	7.25	7.35	7.45	7.50	7.65	7.10	7.25	7.30
1 Jan	2000	7.65	7.70	7.85	7.75	7.80	7.95	7.60	7.65	7.75
	2001	7.60	7.65	7.80	7.80	7.85	8.00	7.55	7.65	7.85
	2002	7.35	7.40	7.50	7.50	7.55	7.65	7.25	7.30	7.40
15 Jan	2000	7.80	7.85	8.00	7.90	7.95	8.05	7.70	7.75	7.85
	2001	7.70	7.75	7.95	7.85	7.95	8.05	7.65	7.70	7.95
	2002	7.55	7.60	7.70	7.65	7.70	7.80	7.45	7.50	7.55
1 Feb	2000	7.75	7.80	7.90	7.85	7.90	7.90	7.60	7.65	7.80
	2001	7.80	7.85	8.05	7.90	7.95	8.10	7.75	7.80	8.00
15 Feb	2000	7.65	7.70	7.85	7.75	7.80	7.90	7.55	7.60	7.70
	2001	7.85	7.90	8.10	7.95	8.00	8.15	7.80	7.85	8.05
1 Mar	2000	7.55	7.60	7.70	7.65	7.75	7.90	7.45	7.50	7.65
	2001	7.90	7.95	8.15	8.00	8.05	8.20	7.85	7.90	8.10
15 Mar	2000	7.50	7.55	7.70	7.65	7.80	7.85	7.35	7.45	7.50
	2001	7.80	7.85	8.05	7.95	8.00	8.10	7.80	7.90	8.00
1 Apr	2000	7.60	7.65	7.75	7.70	7.80	7.85	7.50	7.55	7.65
	2001	7.75	7.70	7.80	7.85	7.90	8.00	7.70	7.75	7.85
15 Apr	2000	7.65	7.75	7.85	7.80	7.85	7.95	7.55	7.65	7.70
	2001	7.65	7.70	7.85	7.75	7.80	7.95	7.60	7.65	7.80
1 May	2000	7.40	7.45	7.55	7.60	7.65	7.75	7.25	7.35	7.50
	2001	7.50	7.55	7.80	7.60	7.70	7.80	7.55	7.60	7.75
15 May	2000	7.45	7.50	7.55	7.50	7.55	7.70	7.10	7.15	7.25
	2001	7.60	7.65	7.75	7.70	7.75	7.85	7.50	7.55	7.70
1 Jun	2000	7.35	7.45	7.50	7.45	7.50	7.65	7.00	7.15	7.20
	2001	7.45	7.50	7.65	7.30	7.35	7.55	7.20	7.25	7.45
15 Jun	2000	7.30	7.45	7.55	7.50	7.60	7.70	7.10	7.15	7.25
	2001	7.25	7.35	7.45	7.55	7.60	7.85	7.35	7.45	7.60
1 Jul	2000	7.55	7.65	7.70	7.75	7.80	7.85	7.35	7.45	7.60
	2001	7.15	7.25	7.30	7.45	7.55	7.60	7.25	7.35	7.40
15 Jul	2000	7.40	7.45	7.50	7.60	7.65	7.75	7.20	7.25	7.35
	2001	7.05	7.10	7.20	7.15	7.20	7.30	7.15	7.25	7.30

Table 10: Fortnightly fluctuation of Alkalinity Levels (mg/l) in the water at different stations at 12 PM of Gulshan Lake in Dhaka City.

Sampling Date	Year	Station-1			Station-2			Station-3		
		Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
1 Aug	1999	123.0	119.5	116.0	126.5	123.0	119.5	117.5	114.0	112.5
	2000	116.5	114.0	110.5	118.0	115.5	111.0	112.5	110.0	106.5
	2001	114.00	112.50	109.00	117.00	114.50	111.00	110.00	107.50	105.00
15 Aug	1999	117.5	114.5	110.0	121.5	118.5	116.0	115.5	112.0	109.5
	2000	112.0	109.5	106.5	115.0	111.0	107.5	108.5	105.5	102.0
	2001	111.50	109.00	106.50	115.50	112.00	109.50	108.50	105.50	103.00
1 Sep	1999	113.0	109.5	104.5	117.5	113.5	109.5	109.5	106.5	102.0
	2000	106.5	102.5	100.0	109.5	106.0	102.5	102.5	100.0	098.5
	2001	109.50	107.50	104.50	111.00	108.50	105.50	106.50	103.00	101.00
15 Sep	1999	109.5	106.5	102.5	112.0	108.0	107.5	105.5	102.5	099.0
	2000	091.0	092.5	089.0	096.5	093.5	090.0	091.5	088.5	086.0
	2001	106.00	104.00	102.50	109.50	106.50	103.50	104.50	102.00	100.50
1 Oct	1999	103.0	099.5	096.0	107.5	103.5	100.0	099.5	096.5	092.5
	2000	099.5	096.0	092.0	100.0	097.5	094.0	095.0	091.5	088.5
	2001	102.50	99.50	97.00	105.00	102.50	100.00	99.50	97.00	95.50
15 Oct	1999	095.0	091.5	089.5	098.5	095.5	091.5	092.5	089.5	088.5
	2000	108.5	103.0	101.5	112.5	106.0	103.5	105.5	102.0	098.5
	2001	106.50	102.50	100.00	109.50	106.00	102.50	102.50	100.00	98.50
1 Nov	1999	091.5	089.5	088.0	095.0	092.5	090.0	089.5	088.0	087.5
	2000	114.0	110.5	108.5	117.5	112.5	107.5	112.0	109.5	106.0
	2001	105.50	103.00	101.50	108.50	105.00	102.50	102.00	100.50	98.50
15 Nov	1999	098.0	095.5	091.0	102.5	099.5	096.5	095.5	092.5	089.0
	2000	119.5	115.0	111.0	121.0	116.5	112.5	117.5	114.0	110.5
	2001	108.00	105.50	104.00	111.00	108.50	106.00	105.50	102.00	100.00
1 Dec	1999	106.5	102.5	099.5	110.0	106.5	102.5	102.5	098.5	096.0
	2000	123.0	119.0	116.5	126.5	120.0	118.0	121.0	117.5	113.0
	2001	112.50	110.00	108.50	115.50	112.00	110.50	109.50	106.00	104.50
15 Dec	1999	110.5	107.0	102.5	114.0	111.5	107.0	108.5	105.5	101.0
	2000	125.5	122.0	119.5	128.0	124.5	120.5	123.5	120.5	118.0
	2001	116.00	114.50	112.00	118.50	116.50	114.00	113.50	111.50	109.00
1 Jan	2000	117.5	113.5	109.5	121.0	117.5	114.0	114.5	111.0	108.5
	2001	128.0	124.5	121.0	129.5	126.5	123.0	126.0	123.0	121.5
	2002	119.50	117.00	114.50	122.50	119.00	117.50	116.00	114.50	112.00
15 Jan	2000	119.5	114.0	109.5	123.5	119.5	116.0	116.5	112.5	109.5
	2001	132.5	128.0	126.5	136.5	132.0	129.5	131.5	128.5	125.5
	2002	122.00	118.50	116.00	124.50	121.00	118.50	119.00	117.00	115.50
1 Feb	2000	123.0	119.5	116.0	128.5	125.5	120.5	119.5	116.5	112.0
	2001	136.0	130.5	128.5	139.5	134.5	131.5	133.5	129.5	126.0
15 Feb	2000	127.5	123.5	119.0	132.5	129.0	126.5	123.5	119.5	116.0
	2001	138.5	135.0	132.0	140.0	136.5	133.0	136.0	133.5	129.5
1 Mar	2000	130.5	126.5	123.0	135.5	131.5	128.5	125.5	122.5	120.5
	2001	141.0	137.5	133.5	142.5	137.0	133.5	139.5	134.0	131.5
15 Mar	2000	133.5	129.5	126.0	136.0	133.5	128.5	128.5	126.5	121.0
	2001	139.5	136.0	131.5	140.5	136.5	131.5	137.0	132.5	129.0
1 Apr	2000	137.0	133.5	131.0	142.5	138.5	133.0	130.5	126.5	123.0
	2001	135.5	130.5	127.0	136.0	132.0	129.0	133.5	131.5	126.0
15 Apr	2000	139.5	135.5	132.0	145.0	141.5	138.5	132.5	129.5	126.0
	2001	131.0	126.0	124.5	132.5	128.5	125.0	128.5	123.5	121.5
1 May	2000	141.5	138.5	135.0	148.5	145.0	141.5	135.5	132.5	128.0
	2001	126.5	123.0	121.0	129.0	126.0	122.5	125.0	121.0	119.5
15 May	2000	137.0	133.5	131.0	142.5	138.5	133.0	130.5	126.5	123.0
	2001	123.5	120.5	118.5	125.5	122.0	119.5	121.0	118.5	116.5
1 Jun	2000	133.5	129.5	126.0	136.0	133.5	128.5	128.5	126.5	121.0
	2001	119.0	117.0	115.5	121.5	119.0	116.5	118.5	116.0	114.5
15 Jun	2000	130.5	126.5	123.0	135.5	131.5	128.5	125.5	122.5	120.5
	2001	117.5	114.0	113.5	118.5	117.5	115.0	115.5	112.5	112.0
1 Jul	2000	127.5	123.5	119.0	132.5	129.0	126.5	123.5	119.5	116.0
	2001	115.5	112.5	111.0	115.0	113.5	112.0	114.0	112.5	111.0
15 Jul	2000	123.0	119.5	116.0	128.5	125.5	120.5	119.5	116.5	112.0
	2001	112.5	112.0	109.5	113.5	112.0	110.5	109.5	108.0	107.5

Table 11: Fortnightly fluctuation of hardness levels (mg/l) in the water at different stations at 12 PM of Gulshan Lake in Dhaka City.

Sampling Date	Year	Station-1			Station-2			Station-3		
		Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
1 Aug	1999	121.0	118.0	115.0	125.5	120.0	116.5	118.5	114.5	110.0
	2000	102.5	099.5	097.0	105.0	101.5	098.0	100.5	097.5	095.5
	2001	112.50	109.00	106.50	115.50	108.50	105.00	109.50	106.50	102.00
15 Aug	1999	115.0	112.5	108.5	120.5	116.0	112.0	113.5	110.5	107.5
	2000	094.5	092.5	089.5	099.5	094.5	091.5	091.5	089.0	086.5
	2001	116.00	110.50	108.50	119.50	114.50	110.50	113.50	110.00	107.50
1 Sep	1999	111.5	108.5	104.5	115.5	112.0	108.5	109.5	106.0	102.5
	2000	099.0	096.5	094.0	101.0	098.5	095.5	096.0	092.5	089.0
	2001	119.50	117.00	114.50	122.50	119.00	117.50	123.50	120.00	116.50
15 Sep	1999	108.5	105.5	101.5	112.5	108.0	105.5	106.5	102.5	099.5
	2000	101.5	102.0	099.5	106.5	104.0	101.5	102.5	100.0	097.5
	2001	115.00	112.50	108.50	120.50	116.00	112.00	113.50	110.50	107.50
1 Oct	1999	103.0	099.5	095.5	107.5	104.0	100.0	101.5	098.5	095.5
	2000	109.5	107.0	103.5	111.5	107.0	102.0	107.5	103.5	100.5
	2001	108.50	106.00	102.50	111.50	109.00	106.50	107.50	104.50	102.00
15 Oct	1999	097.5	094.5	091.5	100.5	098.5	094.5	096.5	094.5	092.0
	2000	112.5	109.0	106.5	115.5	108.5	105.0	109.5	106.5	102.0
	2001	104.50	102.00	99.50	106.50	104.00	101.50	102.50	100.00	97.50
1 Nov	1999	093.0	091.5	089.5	097.5	094.5	091.5	092.5	090.5	088.5
	2000	116.0	110.5	108.5	119.5	114.5	110.5	113.5	110.0	107.5
	2001	102.50	99.50	97.00	105.00	101.50	98.00	100.50	97.50	95.50
15 Nov	1999	096.5	092.5	091.5	101.5	098.5	096.5	093.5	091.5	089.0
	2000	119.5	114.0	111.5	123.5	118.0	114.5	116.0	112.5	109.0
	2001	107.50	104.50	102.00	110.50	108.00	106.50	104.00	102.00	100.50
1 Dec	1999	099.5	096.5	092.0	106.5	102.5	100.0	101.0	095.5	094.5
	2000	124.5	121.0	118.0	127.0	122.5	120.0	121.5	119.0	117.5
	2001	109.50	107.00	103.50	111.50	107.00	102.00	107.50	103.50	100.50
15 Dec	1999	104.5	102.0	099.5	106.5	104.0	101.5	102.5	100.0	097.5
	2000	127.0	124.5	120.5	129.5	126.0	123.0	125.0	122.0	120.0
	2001	115.00	112.50	108.50	120.50	116.00	112.00	113.50	110.50	107.50
1 Jan	2000	109.5	107.0	103.5	111.5	107.0	102.0	107.5	103.5	100.5
	2001	130.5	126.0	124.0	133.0	129.0	125.5	129.0	125.0	122.5
	2002	119.50	117.00	114.50	122.50	119.00	117.50	123.50	120.00	116.50
15 Jan	2000	115.0	112.5	108.5	120.5	116.0	112.0	113.5	110.5	107.5
	2001	132.5	129.5	126.0	136.5	133.0	130.5	133.5	130.5	128.5
	2002	127.00	124.50	120.50	129.50	126.00	123.00	125.00	122.00	120.00
1 Feb	2000	121.0	118.0	115.0	125.5	120.0	116.5	118.5	114.5	110.0
	2001	135.0	132.5	130.5	137.0	133.5	131.0	132.0	130.0	129.0
15 Feb	2000	131.0	128.5	125.0	133.5	130.5	128.5	129.5	126.5	123.0
	2001	139.5	135.0	133.0	140.5	136.0	133.5	138.0	135.5	133.5
1 Mar	2000	133.0	129.5	126.0	136.5	133.0	130.5	133.5	130.5	128.5
	2001	142.5	139.0	136.5	145.0	140.5	136.5	141.5	136.0	132.0
15 Mar	2000	137.5	135.0	133.0	140.5	136.0	133.5	138.0	135.5	133.5
	2001	140.0	136.5	133.5	142.0	138.0	135.0	139.0	135.5	131.5
1 Apr	2000	135.0	132.5	130.5	137.0	133.5	131.0	132.0	130.0	129.0
	2001	136.5	131.0	127.5	137.5	134.5	129.0	132.0	129.0	126.5
15 Apr	2000	138.5	135.0	133.0	140.5	136.0	133.5	138.0	135.5	133.5
	2001	131.0	128.5	125.0	133.5	130.5	128.5	129.5	126.5	123.0
1 May	2000	141.5	136.5	133.5	142.0	138.0	135.0	139.0	135.5	131.5
	2001	128.5	125.5	124.0	130.5	126.0	124.5	126.5	123.0	122.5
15 May	2000	139.5	135.0	133.0	140.5	136.0	133.5	138.0	135.5	133.5
	2001	126.5	124.0	122.5	128.5	125.5	121.5	124.0	121.5	119.0
1 Jun	2000	132.5	129.5	126.0	136.5	133.0	130.5	133.5	130.5	128.5
	2001	119.5	117.0	114.5	122.5	119.0	117.5	123.5	120.0	116.5
15 Jun	2000	130.5	126.0	124.0	133.0	129.0	125.5	129.0	125.0	122.5
	2001	116.0	114.5	113.0	117.5	115.0	112.5	116.0	114.5	112.0
1 Jul	2000	126.5	124.0	122.5	128.5	125.5	121.5	124.0	121.5	119.0
	2001	108.5	106.0	102.5	111.5	109.0	106.5	107.5	104.5	102.0
15 Jul	2000	121.0	118.0	115.0	125.5	120.0	116.5	118.5	114.5	110.0
	2001	106.5	103.5	101.0	106.5	103.0	102.5	103.5	102.0	99.5

Table 12: Fortnightly fluctuations of Nitrate (mg/l) in the water at different stations at 12 PM of Gulshan Lake in Dhaka City.

Sampling Date	Year	Station-1			Station-2			Station-3		
		Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
1 Aug	1999	0.11	0.12	0.13	0.12	0.12	0.13	0.13	0.13	0.14
	2000	0.05	0.06	0.07	0.05	0.05	0.06	0.06	0.07	0.07
	2001	0.09	0.09	0.10	0.08	0.09	0.10	0.11	0.11	0.12
15 Aug	1999	0.09	0.10	0.11	0.09	0.10	0.11	0.10	0.10	0.11
	2000	0.07	0.08	0.08	0.06	0.07	0.08	0.08	0.08	0.09
	2001	0.09	0.10	0.11	0.09	0.10	0.11	0.10	0.10	0.11
1 Sep	1999	0.06	0.07	0.08	0.07	0.08	0.09	0.08	0.09	0.09
	2000	0.09	0.09	0.10	0.08	0.09	0.10	0.11	0.11	0.12
	2001	0.12	0.12	0.13	0.09	0.10	0.11	0.13	0.13	0.14
15 Sep	1999	0.03	0.04	0.04	0.04	0.05	0.06	0.05	0.05	0.06
	2000	0.11	0.11	0.12	0.10	0.10	0.11	0.12	0.13	0.14
	2001	0.11	0.11	0.12	0.10	0.10	0.11	0.12	0.13	0.14
1 Oct	1999	0.05	0.06	0.07	0.06	0.07	0.08	0.05	0.06	0.07
	2000	0.14	0.14	0.15	0.12	0.12	0.13	0.15	0.16	0.16
	2001	0.10	0.10	0.11	0.09	0.09	0.10	0.11	0.11	0.12
15 Oct	1999	0.08	0.09	0.09	0.09	0.10	0.11	0.10	0.11	0.12
	2000	0.12	0.12	0.13	0.09	0.10	0.11	0.13	0.13	0.14
	2001	0.09	0.10	0.11	0.07	0.07	0.08	0.12	0.12	0.13
1 Nov	1999	0.12	0.12	0.13	0.07	0.08	0.09	0.12	0.13	0.14
	2000	0.09	0.09	0.10	0.07	0.08	0.09	0.10	0.11	0.12
	2001	0.12	0.12	0.13	0.07	0.08	0.09	0.12	0.13	0.14
15 Nov	1999	0.16	0.17	0.18	0.13	0.14	0.15	0.15	0.16	0.16
	2000	0.05	0.05	0.06	0.04	0.05	0.05	0.06	0.06	0.07
	2001	0.16	0.17	0.18	0.13	0.14	0.15	0.15	0.16	0.16
1 Dec	1999	0.19	0.19	0.20	0.15	0.16	0.17	0.18	0.19	0.19
	2000	0.03	0.03	0.04	0.02	0.03	0.03	0.04	0.04	0.05
	2001	0.21	0.21	0.22	0.19	0.19	0.20	0.22	0.23	0.23
15 Dec	1999	0.16	0.17	0.18	0.13	0.14	0.15	0.15	0.16	0.16
	2000	0.02	0.02	0.03	0.02	0.02	0.03	0.03	0.03	0.04
	2001	0.17	0.18	0.19	0.12	0.13	0.14	0.16	0.17	0.17
1 Jan	2000	0.13	0.13	0.15	0.13	0.13	0.14	0.15	0.16	0.16
	2001	0.04	0.04	0.04	0.03	0.03	0.04	0.04	0.04	0.05
	2002	0.14	0.14	0.15	0.12	0.12	0.13	0.15	0.16	0.16
15 Jan	2000	0.09	0.10	0.11	0.07	0.07	0.08	0.12	0.12	0.13
	2001	0.06	0.06	0.07	0.04	0.05	0.06	0.07	0.07	0.08
	2002	0.12	0.13	0.14	0.10	0.10	0.11	0.13	0.13	0.14
1 Feb	2000	0.04	0.04	0.04	0.04	0.05	0.06	0.05	0.05	0.06
	2001	0.11	0.12	0.13	0.07	0.08	0.09	0.12	0.13	0.14
15 Feb	2000	0.08	0.08	0.09	0.07	0.07	0.08	0.09	0.10	0.11
	2001	0.16	0.17	0.18	0.13	0.14	0.15	0.15	0.16	0.16
1 Mar	2000	0.13	0.13	0.15	0.13	0.13	0.14	0.15	0.16	0.16
	2001	0.19	0.19	0.20	0.15	0.16	0.17	0.18	0.19	0.19
15 Mar	2000	0.11	0.12	0.13	0.09	0.09	0.10	0.12	0.12	0.13
	2001	0.17	0.18	0.19	0.12	0.13	0.14	0.16	0.17	0.17
1 Apr	2000	0.08	0.08	0.09	0.07	0.07	0.08	0.09	0.10	0.11
	2001	0.14	0.13	0.15	0.13	0.13	0.14	0.15	0.16	0.16
15 Apr	2000	0.12	0.12	0.13	0.09	0.10	0.11	0.13	0.13	0.14
	2001	0.11	0.12	0.13	0.09	0.09	0.10	0.12	0.12	0.13
1 May	2000	0.13	0.13	0.15	0.13	0.13	0.14	0.15	0.16	0.16
	2001	0.09	0.10	0.11	0.07	0.07	0.08	0.12	0.12	0.13
15 May	2000	0.09	0.10	0.11	0.07	0.07	0.08	0.12	0.12	0.13
	2001	0.06	0.06	0.07	0.05	0.05	0.06	0.08	0.09	0.09
1 Jun	2000	0.07	0.08	0.08	0.06	0.07	0.08	0.08	0.08	0.09
	2001	0.08	0.08	0.09	0.07	0.07	0.08	0.09	0.10	0.11
15 Jun	2000	0.09	0.10	0.11	0.07	0.07	0.08	0.12	0.12	0.13
	2001	0.11	0.12	0.12	0.09	0.09	0.10	0.11	0.11	0.12
1 Jul	2000	0.08	0.08	0.09	0.07	0.07	0.08	0.09	0.10	0.11
	2001	0.09	0.09	0.10	0.07	0.07	0.08	0.09	0.10	0.10
15 Jul	2000	0.06	0.06	0.07	0.04	0.05	0.06	0.07	0.07	0.08
	2001	0.07	0.08	0.08	0.06	0.06	0.07	0.08	0.08	0.09

Table 13: Fortnightly fluctuations of ammonia (mg/l) in the water at different stations at 12 PM of Gulshan Lake in Dhaka City.

Sampling Date	Year	Station-1			Station-2			Station-3		
		Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
1 Aug	1999	1.3	1.3	1.4	1.1	1.2	1.2	1.2	1.2	1.3
	2000	1.1	1.1	1.2	1.0	1.0	1.1	1.3	1.3	1.4
	2001	1.50	1.55	1.70	1.35	1.45	1.50	1.60	1.65	1.75
15 Aug	1999	1.6	1.6	1.7	1.4	1.5	1.5	1.7	1.7	1.8
	2000	1.4	1.4	1.5	1.2	1.3	1.3	1.5	1.6	1.6
	2001	1.65	1.70	1.75	1.55	1.60	1.75	1.75	1.80	1.85
1 Sep	1999	1.8	1.8	1.9	1.7	1.8	1.8	1.9	1.9	2.0
	2000	1.7	1.8	1.8	1.6	1.6	1.7	1.8	1.8	1.9
	2001	1.95	2.00	2.05	1.85	1.95	2.00	2.05	2.15	2.20
15 Sep	1999	2.1	2.1	2.2	2.0	2.0	2.1	2.2	2.2	2.3
	2000	1.9	1.9	2.0	1.8	1.9	1.9	2.1	2.1	2.2
	2001	2.25	2.30	2.35	2.05	2.10	2.15	2.35	2.45	2.50
1 Oct	1999	1.8	1.8	1.9	1.7	1.7	1.8	2.0	2.0	2.1
	2000	2.2	2.2	2.3	1.9	1.9	2.0	2.4	2.4	2.5
	2001	2.30	2.35	2.45	2.15	2.20	2.25	2.40	2.45	2.50
15 Oct	1999	1.6	1.7	1.7	1.5	1.5	1.6	1.9	1.9	2.0
	2000	2.5	2.6	2.6	2.3	2.4	2.4	2.6	2.7	2.7
	2001	2.45	2.50	2.55	2.30	2.35	2.45	2.55	2.65	2.70
1 Nov	1999	1.2	1.2	1.3	1.1	1.1	1.2	1.3	1.3	1.4
	2000	2.7	2.7	2.8	2.5	2.6	2.6	2.8	2.8	2.9
	2001	2.65	2.70	2.75	2.45	2.50	2.55	2.70	2.75	2.80
15 Nov	1999	1.4	1.4	1.5	1.2	1.3	1.4	1.6	1.6	1.7
	2000	2.8	2.8	2.9	2.7	2.7	2.8	2.9	2.9	>3.0
	2001	2.50	2.55	2.65	2.45	2.50	2.55	2.60	2.65	2.70
1 Dec	1999	1.8	1.8	1.9	1.6	1.6	1.7	1.9	1.9	2.0
	2000	2.9	2.9	>3.0	2.8	2.8	2.9	>3.0	>3.0	>3.0
	2001	2.35	2.40	2.55	2.20	2.25	2.35	2.50	2.55	2.65
15 Dec	1999	2.1	2.1	2.2	2.0	2.0	2.1	2.2	2.2	2.3
	2000	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0
	2001	2.45	2.50	2.55	2.15	2.20	2.25	2.65	2.70	2.75
1 Jan	2000	2.5	2.6	2.6	2.4	2.4	2.5	2.7	2.7	2.8
	2001	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0
	2002	2.60	2.65	2.70	2.35	2.40	2.45	2.75	2.80	2.85
15 Jan	2000	2.8	2.9	2.9	2.6	2.6	2.7	2.9	2.9	>3.0
	2001	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0
	2002	2.85	2.90	2.95	2.55	2.65	2.70	2.80	2.85	2.95
1 Feb	2000	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0
	2001	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0
15 Feb	2000	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0
	2001	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0
1 Mar	2000	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0
	2001	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0
15 Mar	2000	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0
	2001	2.8	2.8	2.9	2.7	2.8	2.8	2.8	2.9	2.9
1 Apr	2000	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0
	2001	2.4	2.4	2.5	2.2	2.3	2.3	2.5	2.5	2.6
15 Apr	2000	2.7	2.7	2.8	2.6	2.7	2.7	2.8	2.8	2.9
	2001	2.1	2.2	2.3	2.0	2.0	2.1	2.1	2.1	2.2
1 May	2000	2.3	2.3	2.4	2.1	2.2	2.2	2.2	2.2	2.3
	2001	1.8	1.8	1.9	1.6	1.6	1.7	1.7	1.8	1.8
15 May	2000	2.0	2.1	2.1	1.8	1.9	1.9	1.9	1.9	2.0
	2001	1.5	1.5	1.6	1.4	1.4	1.5	1.4	1.5	1.6
1 Jun	2000	1.6	1.7	1.7	1.5	1.5	1.6	1.7	1.8	1.8
	2001	1.9	2.0	2.0	1.8	1.9	1.9	2.1	2.1	2.2
15 Jun	2000	1.2	1.2	1.3	1.0	1.0	1.1	1.4	1.4	1.5
	2001	2.3	2.3	2.4	2.1	2.2	2.2	2.4	2.5	2.5
1 Jul	2000	1.6	1.7	1.7	1.5	1.6	1.6	1.8	1.8	1.9
	2001	1.7	1.8	1.8	1.6	1.6	1.7	1.9	1.9	2.0
15 Jul	2000	1.5	1.5	1.6	1.4	1.4	1.5	1.3	1.3	1.4
	2001	1.4	1.5	1.5	1.2	1.3	1.3	1.5	1.6	1.6

Table 14: Fortnightly fluctuations of Transparency (cm) in the water at different stations at 12 PM of Gulshan Lake in Dhaka City.

Sampling Date	Year	Sampling Stations		
		Station-1	Station-2	Station-3
1 Aug	1999	54.0	59.5	52.0
	2000	58.5	63.0	55.5
	2001	56.50	61.00	53.00
15 Aug	1999	51.5	56.0	48.5
	2000	55.0	59.5	51.0
	2001	53.00	58.00	51.50
1 Sep	1999	50.5	54.0	47.5
	2000	52.0	55.5	49.0
	2001	48.50	52.50	45.50
15 Sep	1999	47.0	53.5	44.0
	2000	49.5	53.0	47.5
	2001	44.00	49.00	41.00
1 Oct	1999	44.5	49.0	42.0
	2000	47.0	50.5	45.5
	2001	41.50	44.50	39.50
15 Oct	1999	42.0	46.5	38.0
	2000	45.5	49.0	42.5
	2001	39.00	42.00	36.50
1 Nov	1999	40.0	43.0	38.5
	2000	43.0	46.5	41.0
	2001	36.50	40.00	33.50
15 Nov	1999	38.0	42.5	34.5
	2000	41.5	43.0	39.0
	2001	35.50	38.50	33.50
1 Dec	1999	36.5	39.0	33.0
	2000	39.0	40.5	36.5
	2001	33.00	35.50	31.00
15 Dec	1999	33.5	36.0	31.0
	2000	35.5	38.5	33.5
	2001	32.50	35.00	29.50
1 Jan	2000	31.5	34.0	28.5
	2001	33.0	35.5	31.0
	2002	31.50	34.00	28.50
15 Jan	2000	28.5	31.0	27.0
	2001	31.0	33.5	30.5
	2002	27.00	29.50	24.00
1 Feb	2000	24.5	27.0	22.0
	2001	29.5	31.0	27.5
15 Feb	2000	20.0	24.5	18.5
	2001	27.0	29.5	24.0
1 Mar	2000	22.5	23.0	19.5
	2001	23.5	24.0	21.5
15 Mar	2000	26.0	28.5	24.5
	2001	19.5	20.5	18.0
1 Apr	2000	29.0	31.5	26.5
	2001	22.5	23.0	20.5
15 Apr	2000	27.0	31.5	25.5
	2001	26.0	28.5	25.0
1 May	2000	31.5	33.5	28.5
	2001	28.5	30.0	27.5
15 May	2000	33.5	36.5	30.0
	2001	31.0	33.5	29.0
1 Jun	2000	36.0	39.5	33.5
	2001	33.5	35.0	31.0
15 Jun	2000	39.5	42.5	37.5
	2001	39.0	43.5	36.5
1 Jul	2000	44.5	48.5	41.0
	2001	44.0	49.5	42.5
15 Jul	2000	48.5	55.0	45.0
	2001	49.5	55.5	47.5

Table 15: Fortnightly fluctuations of air and water temperatures ($^{\circ}\text{C}$) at different stations at 12 PM of Gulshan Lake in Dhaka City.

Sampling Date	Year	Sampling Stations		
		Station-1	Station-2	Station-3
1 Aug	1999	29.5/30.0	29.5/29.5	29.5/30.0
	2000	28.0/28.0	28.0/28.5	28.0/28.0
	2001	29.0/29.5	29.5/30.0	29.5/30.0
15 Aug	1999	28.5/29.0	28.5/29.0	28.5/28.5
	2000	28.5/29.0	28.0/28.5	28.5/29.0
	2001	29.5/30.0	29.0/29.5	29.5/30.5
1 Sep	1999	27.5/28.0	27.5/27.5	28.0/28.0
	2000	29.0/29.0	29.5/29.0	29.0/29.0
	2001	30.5/30.0	30.0/30.0	30.5/30.0
15 Sep	1999	29.0/29.5	29.5/29.0	30.0/29.5
	2000	28.5/28.5	28.5/29.0	28.5/28.5
	2001	29.0/28.5	29.5/29.0	29.5/29.0
1 Oct	1999	27.5/26.5	27.5/27.0	27.0/26.5
	2000	28.0/28.0	28.5/28.0	28.0/28.0
	2001	28.5/27.5	28.0/27.0	28.0/27.5
15 Oct	1999	25.5/25.0	25.5/25.5	25.0/24.5
	2000	27.5/26.0	27.5/26.5	26.5/26.0
	2001	27.0/26.0	26.5/25.5	27.0/26.5
1 Nov	1999	24.5/25.5	24.0/25.0	24.5/25.0
	2000	26.0/24.5	26.0/25.0	26.0/25.0
	2001	25.5/24.0	25.0/23.5	25.5/24.0
15 Nov	1999	27.0/27.5	27.5/27.5	27.0/27.5
	2000	25.5/24.5	25.5/24.5	25.0/24.0
	2001	25.0/24.0	24.5/23.5	25.0/23.5
1 Dec	1999	25.5/25.0	25.0/25.0	25.0/24.5
	2000	22.0/21.0	22.0/21.5	22.0/20.5
	2001	22.5/21.0	22.0/20.5	22.5/21.5
15 Dec	1999	22.5/22.0	22.0/22.0	23.0/22.5
	2000	21.5/20.5	21.5/20.5	22.0/20.5
	2001	21.0/20.0	21.5/20.0	21.5/20.5
1 Jan	2000	19.5/19.0	19.5/18.5	19.0/18.5
	2001	20.5/19.5	20.5/19.5	21.0/19.5
	2002	20.0/18.5	20.5/19.0	20.5/19.5
15 Jan	2000	20.5/18.5	20.0/18.5	20.5/19.0
	2001	22.5/21.5	22.5/21.5	22.5/21.0
	2002	19.5/18.5	19.5/18.0	20.0/18.5
1 Feb	2000	24.5/23.0	24.0/23.0	24.5/23.5
	2001	25.0/23.5	25.0/23.0	25.5/23.5
15 Feb	2000	26.5/26.0	27.0/26.0	26.5/25.5
	2001	27.0/25.5	27.0/26.0	27.0/26.0
1 Mar	2000	29.5/29.0	29.0/28.5	29.5/28.5
	2001	28.5/26.5	28.5/26.5	28.0/26.5
15 Mar	2000	31.5/32.0	31.0/31.5	31.5/31.5
	2001	29.5/28.0	29.5/28.5	29.0/28.0
1 Apr	2000	30.0/31.0	30.5/31.0	30.5/31.5
	2001	31.5/30.5	31.5/30.5	31.0/30.0
15 Apr	2000	33.5/33.0	33.5/33.0	33.0/32.5
	2001	32.0/31.0	32.0/31.0	31.5/30.5
1 May	2000	31.5/32.0	32.0/32.5	31.5/32.0
	2001	33.5/33.0	33.5/33.0	33.0/32.5
15 May	2000	35.5/35.5	35.5/36.0	35.5/35.5
	2001	34.0/33.5	34.5/33.5	34.0/33.5
1 Jun	2000	33.5/34.5	34.0/34.5	33.5/34.0
	2001	35.0/35.5	35.0/35.5	35.0/35.5
15 Jun	2000	31.5/32.0	32.0/32.5	31.5/32.0
	2001	33.5/34.0	33.0/33.5	33.5/34.0
1 Jul	2000	33.0/34.0	33.5/34.0	33.0/34.0
	2001	35.5/35.5	35.5/36.0	35.5/35.5
15 Jul	2000	31.0/31.5	31.5/32.0	31.0/31.5
	2001	33.5/34.0	33.5/34.0	33.5/33.5

Appendix: B

Table 16: Fortnightly floristic abundance (indiv./l) in the surface layer water at sampling station-1 at 12 PM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoceras	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	675	350	275	225	275	1800
	2000	625	325	200	250	250	1650
	2001	725	300	225	325	225	1800
15 Aug	1999	550	250	325	350	300	1775
	2000	625	350	250	425	250	1900
	2001	675	225	300	300	275	1775
1 Sep	1999	1025	325	275	450	325	2400
	2000	850	450	250	325	300	2175
	2001	750	425	325	425	350	2275
15 Sep	1999	1450	475	300	275	350	2850
	2000	1550	550	200	450	325	3075
	2001	1250	475	350	525	450	3050
1 Oct	1999	725	350	225	475	475	2250
	2000	1250	525	250	525	425	2975
	2001	1325	500	425	650	525	3425
15 Oct	1999	1625	525	325	675	750	3900
	2000	1750	675	275	725	625	4050
	2001	1550	550	350	825	650	3925
1 Nov	1999	1825	700	250	625	825	4225
	2000	3025	850	325	700	675	5575
	2001	2425	675	325	750	725	4900
15 Nov	1999	2550	950	400	600	700	5200
	2000	2050	1350	425	750	650	5225
	2001	2150	1150	375	625	650	4950
1 Dec	1999	3025	1325	575	925	625	6475
	2000	2750	1150	625	1050	675	6250
	2001	2650	1425	550	1125	625	6375
15 Dec	1999	4225	1825	350	1125	550	8075
	2000	3250	1350	850	1625	475	7550
	2001	3225	1225	925	1750	550	7675
1 Jan	2000	3850	2425	450	1750	850	9325
	2001	4850	2150	1325	1850	825	11000
	2002	4150	1850	1025	2150	725	9900
15 Jan	2000	7525	3125	950	1425	1225	14250
	2001	6250	2650	1675	2050	1150	13775
	2002	5575	2550	1450	2650	1050	13275
1 Feb	2000	8150	4350	1250	2150	1325	17225
	2001	7850	3250	2025	2450	1350	16925
15 Feb	2000	9750	5725	1650	1975	1025	20125
	2001	7250	4125	1625	1650	950	15600
1 Mar	2000	8250	4525	1850	1325	725	16675
	2001	9850	4850	1075	2150	1350	19275
15 Mar	2000	9875	3325	1050	1825	1275	17350
	2001	10250	4475	800	1450	825	17800
1 Apr	2000	7775	2050	1250	2150	650	13875
	2001	8725	2850	825	1250	625	14275
15 Apr	2000	5575	2050	550	1825	550	10550
	2001	7025	2250	675	850	525	11325
1 May	2000	4875	1525	350	1350	450	8550
	2001	4150	1850	400	725	425	7550
15 May	2000	2850	1225	425	550	275	5325
	2001	2475	1350	350	425	525	5125
1 Jun	2000	1825	1025	250	750	375	4225
	2001	1425	775	275	275	350	3100
15 Jun	2000	2175	650	225	325	325	3700
	2001	850	1025	250	450	300	2875
1 Jul	2000	1125	775	200	325	325	2750
	2001	650	650	275	225	375	2175
15 Jul	2000	250	375	225	250	300	1400
	2001	950	425	250	225	275	2125

Table 17: Fortnightly fluctuations of zooplankton abundance (indiv./l) in the mid layer water at sampling station-1 at 12 PM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladocerans	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	650	325	275	300	350	1900
	2000	525	350	200	325	325	1725
	2001	425	375	225	350	425	1800
15 Aug	1999	450	275	325	425	400	1875
	2000	525	275	325	425	300	1850
	2001	325	250	250	475	350	1650
1 Sep	1999	1025	500	350	450	450	2775
	2000	875	525	275	400	425	2500
	2001	850	550	425	550	425	2800
15 Sep	1999	1425	425	300	250	500	2900
	2000	1450	350	225	275	475	2775
	2001	1350	625	350	325	550	3200
1 Oct	1999	775	350	300	475	775	2675
	2000	1225	625	250	350	375	2825
	2001	850	450	375	575	625	2875
15 Oct	1999	1025	425	225	525	575	2775
	2000	1350	475	200	575	550	3150
	2001	1150	550	450	650	550	3350
1 Nov	1999	1375	650	250	500	700	3475
	2000	2550	675	325	575	500	4625
	2001	1425	725	425	725	500	3800
15 Nov	1999	2025	750	350	500	450	4075
	2000	1675	1275	375	650	400	4375
	2001	1850	950	300	650	425	4175
1 Dec	1999	2675	1025	350	750	375	5175
	2000	2350	1025	375	825	425	5000
	2001	2025	1250	325	950	325	4875
15 Dec	1999	4025	1625	450	950	450	7500
	2000	2850	1250	250	1200	550	6100
	2001	3625	1425	525	1025	650	7250
1 Jan	2000	5125	2125	750	1375	450	9825
	2001	3850	1750	375	1425	725	8125
	2002	4850	1850	850	1525	550	9625
15 Jan	2000	6200	2850	1250	1025	700	12025
	2001	5975	2175	650	1650	1000	11450
	2002	5850	2350	725	1125	750	10800
1 Feb	2000	6975	3975	1250	1750	1150	15100
	2001	6875	2750	1025	2025	1225	13900
15 Feb	2000	8750	4975	1850	1550	1450	18575
	2001	6125	4025	1375	1375	1025	13925
1 Mar	2000	10250	4750	1450	1225	1000	18675
	2001	8525	4625	1750	2275	1125	18300
15 Mar	2000	7975	3350	1025	1725	900	14975
	2001	9750	4250	1475	2075	1250	18800
1 Apr	2000	6750	2025	1025	2525	1275	13600
	2001	7250	2875	725	1000	950	12800
15 Apr	2000	5425	1975	1275	1950	800	11425
	2001	5725	2025	750	1025	775	10300
1 May	2000	4750	1375	925	1275	650	8975
	2001	4125	1450	575	750	625	7525
15 May	2000	2850	1025	675	600	450	5600
	2001	1875	1375	350	675	550	4825
1 Jun	2000	875	1000	450	825	425	3575
	2001	1025	825	375	325	475	3025
15 Jun	2000	1875	650	350	525	425	3825
	2001	1325	425	250	500	400	2900
1 Jul	2000	725	375	300	425	375	2200
	2001	625	575	225	200	325	1950
15 Jul	2000	650	350	250	225	300	1775
	2001	1025	350	175	200	275	2025

Table 18: Fortnightly fluctuation of zooplankton abundance (indiv./l) in the bottom layer water at sampling station-I at 12 PM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoceras	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	825	525	350	350	425	2475
	2000	675	550	225	375	375	2200
	2001	725	425	300	275	400	2125
15 Aug	1999	625	350	450	500	450	2375
	2000	750	425	375	475	350	2375
	2001	550	225	325	350	525	1975
1 Sep	1999	1225	625	400	525	500	3275
	2000	1050	675	325	450	425	2925
	2001	1025	450	450	475	575	2975
15 Sep	1999	1675	475	375	325	550	3400
	2000	1850	525	250	425	525	3575
	2001	1750	650	475	500	625	4000
1 Oct	1999	950	425	325	650	850	3200
	2000	1400	775	300	575	450	3500
	2001	1125	725	525	725	800	3900
15 Oct	1999	1425	550	275	700	625	3575
	2000	1725	650	250	750	575	3950
	2001	1650	850	350	850	750	4450
1 Nov	1999	1850	725	225	550	750	4100
	2000	3150	825	350	725	550	5600
	2001	2250	750	325	625	625	4575
15 Nov	1999	2475	975	375	625	525	4975
	2000	2175	1450	425	775	425	5250
	2001	2675	1125	450	450	700	5400
1 Dec	1999	3150	1350	425	950	450	6325
	2000	2800	1175	550	975	550	6050
	2001	3350	1525	550	725	425	6575
15 Dec	1999	4500	1875	650	1025	400	8450
	2000	3325	1350	325	1525	625	7150
	2001	3950	1600	725	1150	575	8000
1 Jan	2000	5725	2550	925	1625	425	11250
	2001	4350	2025	425	1775	850	9425
	2002	5400	2175	875	1475	500	10425
15 Jan	2000	7250	3250	1450	1350	750	14050
	2001	6600	2575	825	1925	1150	13075
	2002	6425	3650	1325	1550	625	13575
1 Feb	2000	7850	4475	1825	2025	1025	17200
	2001	7500	3150	1150	2350	1275	15425
	2002	9875	5675	2150	1825	1550	21075
15 Feb	2000	9875	5675	2150	1825	1550	21075
	2001	6825	4225	1575	1725	1350	15700
	2002	12275	4850	1750	1450	1250	21575
1 Mar	2000	10325	5250	2075	2550	1025	21225
	2001	10750	3725	1225	2150	950	18800
	2002	11675	4700	1850	2250	1550	22025
1 Apr	2000	8725	2575	1150	2850	1475	16775
	2001	9575	3375	925	1525	1050	16450
	2002	6225	2350	1425	2225	850	13075
15 Apr	2000	7525	2675	1050	1250	825	13325
	2001	5275	1850	1025	1550	700	10400
	2002	4500	2075	750	925	750	9000
1 May	2000	3375	1450	850	825	650	7150
	2001	3100	1625	425	750	625	6525
	2002	2225	1250	625	1050	475	5625
15 May	2000	1825	1025	525	450	550	4375
	2001	2475	825	450	600	450	4800
	2002	1250	575	300	625	450	3200
1 Jun	2000	1450	650	350	550	425	3425
	2001	875	750	250	300	375	2550
	2002	825	425	275	275	350	2150
15 Jun	2000	1350	525	175	250	325	2625

Table 19: Fortnightly fluctuations of zooplankton abundance (indiv./l) in the surface layer water at sampling station-2 at 12 PM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoeas	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	525	325	250	175	250	1525
	2000	475	275	275	200	275	1500
	2001	450	250	220	225	225	1370
15 Aug	1999	325	200	250	300	325	1400
	2000	450	325	225	350	275	1625
	2001	275	325	325	250	275	1450
1 Sep	1999	775	275	175	325	300	1850
	2000	625	300	200	250	325	1700
	2001	625	275	350	400	350	2000
15 Sep	1999	1050	375	275	225	300	2225
	2000	1150	425	175	275	350	2375
	2001	775	350	250	350	325	2050
1 Oct	1999	575	275	200	400	425	1875
	2000	1050	450	150	375	400	2425
	2001	950	425	275	475	475	2600
15 Oct	1999	1375	400	175	550	525	3025
	2000	1400	475	150	650	450	3125
	2001	1425	550	325	625	600	3525
1 Nov	1999	1475	525	200	500	650	3350
	2000	2825	675	250	525	525	4800
	2001	1550	625	225	550	625	3575
15 Nov	1999	2150	725	275	450	500	4100
	2000	1850	1250	350	575	475	4500
	2001	2550	850	350	650	550	4950
1 Dec	1999	2675	1175	450	700	425	5425
	2000	2400	1000	550	800	400	5150
	2001	3125	1225	525	825	600	6300
15 Dec	1999	3875	1675	300	975	375	7200
	2000	2750	1250	625	1475	325	6425
	2001	4175	1450	350	1025	450	7450
1 Jan	2000	3375	2125	325	1525	675	8025
	2001	4475	2025	1225	1675	650	10050
	2002	3525	2225	550	1350	550	8200
15 Jan	2000	7025	2825	850	1250	1025	12975
	2001	5775	2475	1450	1675	1000	12375
	2002	7250	2675	725	1025	825	12500
1 Feb	2000	7750	3850	1125	1875	1125	15725
	2001	7250	2925	1825	1750	1250	15000
15 Feb	2000	8275	5250	1450	1650	975	17600
	2001	6675	3875	1350	1325	825	14050
1 Mar	2000	4500	4275	1575	1025	550	11925
	2001	8200	4350	925	1975	1150	16600
15 Mar	2000	8325	3025	925	1650	1125	15050
	2001	9250	4150	650	1275	675	16000
1 Apr	2000	7025	1750	1000	2025	475	12275
	2001	7625	2450	650	1150	450	12325
15 Apr	2000	5025	1975	425	1625	425	9475
	2001	6325	2025	450	575	375	9750
1 May	2000	4325	1375	275	1025	325	7325
	2001	3350	1675	325	575	300	6225
15 May	2000	2550	1025	300	425	225	4525
	2001	2175	1175	275	375	450	4450
1 Jun	2000	1425	875	175	575	300	3350
	2001	1075	625	200	225	275	2400
15 Jun	2000	1875	425	225	275	250	3050
	2001	625	875	200	275	225	2200
1 Jul	2000	975	650	175	250	200	2250
	2001	450	450	250	175	250	1575
15 Jul	2000	225	350	175	200	275	1225
	2001	775	375	150	175	225	1700

Table 20: Fortnightly fluctuation of zooplankton abundance (indiv./l) in the mid layer water at sampling station-2 at 12 PM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoceras	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	475	275	200	275	300	1525
	2000	425	300	150	250	250	1375
	2001	425	225	250	200	250	1350
15 Aug	1999	375	225	250	350	275	1475
	2000	350	200	275	350	225	1400
	2001	325	275	325	325	325	1575
1 Sep	1999	975	375	300	325	325	2300
	2000	625	350	225	250	225	1675
	2001	850	425	375	375	350	2375
15 Sep	1999	1250	275	250	225	325	2325
	2000	1275	300	175	200	400	2350
	2001	925	350	275	300	300	2150
1 Oct	1999	625	275	225	325	625	2075
	2000	1025	450	200	225	300	2200
	2001	750	300	300	350	550	2250
15 Oct	1999	850	325	150	450	525	2300
	2000	1125	400	175	425	375	2500
	2001	925	425	275	525	450	2600
1 Nov	1999	1250	425	225	375	525	2800
	2000	2250	575	275	450	375	3925
	2001	1350	550	400	500	525	3325
15 Nov	1999	1875	575	300	400	325	3475
	2000	1475	1050	325	475	250	3575
	2001	2250	625	450	625	450	4400
1 Dec	1999	2350	850	325	525	275	4325
	2000	1975	875	350	675	250	4125
	2001	2450	950	425	600	350	4775
15 Dec	1999	3850	1425	325	725	300	6625
	2000	2575	1000	375	1000	375	5325
	2001	4225	1300	550	825	450	7350
1 Jan	2000	4750	1975	675	1150	375	8925
	2001	3375	1525	350	1275	550	7075
	2002	4075	1575	750	1050	400	7850
15 Jan	2000	5775	2675	1025	850	550	10875
	2001	5475	1875	575	1425	850	10200
	2002	5225	2275	1125	925	525	10075
1 Feb	2000	6350	3675	1000	1525	1000	13550
	2001	6150	2575	850	1850	1025	12450
15 Feb	2000	8325	4675	1675	1250	1175	17100
	2001	5575	3750	1250	1025	875	12475
1 Mar	2000	9875	4425	1325	975	850	17450
	2001	8325	4125	1550	1875	975	16850
15 Mar	2000	7675	3025	925	1425	725	13775
	2001	9375	4050	1250	1675	1050	17400
1 Apr	2000	6350	1875	975	2325	950	12475
	2001	6850	2650	550	875	725	11650
15 Apr	2000	5125	1750	1050	1650	650	10225
	2001	5375	1875	625	875	550	9300
1 May	2000	4475	1250	850	1025	475	8075
	2001	3875	1025	450	525	425	6300
15 May	2000	2375	850	525	475	375	4600
	2001	1650	1150	275	525	325	3925
1 Jun	2000	650	775	325	650	250	2650
	2001	925	650	300	275	400	2550
15 Jun	2000	1525	475	275	350	375	3000
	2001	1150	300	200	275	250	2175
1 Jul	2000	550	275	250	250	325	1650
	2001	475	300	200	175	300	1450
15 Jul	2000	525	275	225	150	250	1425
	2001	850	300	175	125	200	1650

Table 21: Fortnightly fluctuation of zooplankton abundance (indiv./l) in the bottom layer water at sampling station-2 at 12 PM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoceras	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	650	375	300	275	350	1950
	2000	525	425	175	300	300	1725
	2001	725	425	200	225	250	1825
15 Aug	1999	475	275	325	425	350	1850
	2000	525	300	300	325	300	1750
	2001	550	250	350	450	300	1900
1 Sep	1999	1025	450	250	425	425	2575
	2000	950	525	300	400	400	2575
	2001	950	325	425	475	375	2550
15 Sep	1999	1425	450	325	300	450	2950
	2000	1650	375	175	275	425	2900
	2001	1325	475	375	350	425	2950
1 Oct	1999	725	275	250	475	625	2350
	2000	1325	650	225	450	400	3050
	2001	850	550	325	400	550	2675
15 Oct	1999	1250	500	200	525	500	2975
	2000	1550	475	175	625	425	3250
	2001	1050	625	250	450	625	3000
1 Nov	1999	1675	575	150	425	525	3350
	2000	2850	675	300	600	375	4800
	2001	1825	750	275	475	550	3875
15 Nov	1999	2250	825	325	525	500	4425
	2000	1975	1250	375	650	350	4600
	2001	2450	925	350	550	600	4875
1 Dec	1999	2950	1175	400	775	375	5675
	2000	2625	1025	375	850	425	5300
	2001	3250	1250	525	825	350	6200
15 Dec	1999	4125	1675	525	875	275	7475
	2000	3075	1125	300	1325	450	6275
	2001	4250	1825	650	950	250	7925
1 Jan	2000	5425	2250	725	1450	250	10100
	2001	4025	1875	275	1550	625	8350
	2002	5625	2450	850	1525	350	10800
15 Jan	2000	6950	2875	1025	1150	575	12575
	2001	6125	2325	675	1750	1000	11875
	2002	7250	3125	1175	1250	450	13250
1 Feb	2000	7350	4250	1650	1825	950	16025
	2001	7225	2900	1000	2025	1125	14275
15 Feb	2000	9325	5325	1875	1675	1325	19525
	2001	6450	3975	1250	1550	1150	14375
1 Mar	2000	11575	4450	1350	1225	1025	19625
	2001	9875	4750	1875	2025	925	19450
15 Mar	2000	9750	3350	1025	1875	750	16750
	2001	10275	4450	1675	1950	1250	19600
1 Apr	2000	7750	2175	950	2350	1175	14400
	2001	8725	2975	750	1450	975	14875
15 Apr	2000	5875	1950	1325	2025	625	11800
	2001	7125	2325	975	1075	650	12150
1 May	2000	4850	1675	850	1350	550	9275
	2001	4125	1875	650	750	525	7925
15 May	2000	2975	1125	625	675	475	5875
	2001	2650	1350	375	525	450	5350
1 Jun	2000	1875	1025	450	850	275	4475
	2001	1650	875	375	325	325	3550
15 Jun	2000	2025	650	325	525	300	3825
	2001	1025	450	275	450	350	2550
1 Jul	2000	1275	425	250	425	375	2750
	2001	650	550	175	250	300	1925
15 Jul	2000	575	375	200	225	325	1700
	2001	1075	450	225	200	275	2225

Table 22: Fortnightly fluctuations of zooplankton abundance (indiv./l) in the surface layer water at sampling station-3 at 12 PM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoceras	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	850	450	325	300	350	2275
	2000	725	475	275	350	425	2250
	2001	725	325	250	225	325	1850
15 Aug	1999	650	325	425	475	450	2325
	2000	775	475	275	525	325	2375
	2001	550	250	400	350	425	1975
1 Sep	1999	1125	450	350	575	475	2975
	2000	975	525	375	450	500	2825
	2001	950	375	450	525	450	2750
15 Sep	1999	1550	575	450	425	525	3525
	2000	1725	725	325	575	550	3900
	2001	1225	550	525	650	500	3450
1 Oct	1999	950	475	350	625	625	3025
	2000	1375	650	375	750	550	3700
	2001	1350	625	375	575	550	3475
15 Oct	1999	1950	750	400	850	725	4675
	2000	1875	825	350	975	750	4775
	2001	2025	825	450	725	625	4650
1 Nov	1999	2050	925	325	850	875	5025
	2000	3375	1025	450	925	750	6525
	2001	2350	1000	575	925	750	5600
15 Nov	1999	2875	1150	550	850	800	6225
	2000	2375	1550	575	1025	850	6375
	2001	2975	1225	625	1025	650	6500
1 Dec	1999	3575	1650	625	1350	825	8025
	2000	3025	1250	750	1425	900	7350
	2001	3975	1725	750	1250	775	8475
15 Dec	1999	4575	2025	450	1525	650	9225
	2000	3550	1550	975	1850	550	8475
	2001	4250	2250	825	1325	552	9202
1 Jan	2000	4125	2875	625	1975	925	10525
	2001	5225	2350	1550	2025	1025	12175
	2002	4525	2975	950	2075	850	11375
15 Jan	2000	7975	3375	1025	1650	1325	15350
	2001	6750	2975	1875	2350	1450	15400
	2002	7425	3450	850	1425	1025	14175
1 Feb	2000	8475	4675	1550	2650	1550	18900
	2001	8275	3450	2350	2875	1250	18200
15 Feb	2000	10025	6025	1875	2250	1150	21325
	2001	7750	4650	1975	1875	1025	17275
1 Mar	2000	8450	4975	2025	1525	950	17925
	2001	10050	5125	1350	2625	1000	20150
15 Mar	2000	10550	3875	1250	2150	1425	19250
	2001	11125	4750	925	1675	1050	19525
1 Apr	2000	8125	2350	1450	2450	850	15225
	2001	9125	3125	1025	1525	725	15525
15 Apr	2000	5875	2350	675	2050	650	11600
	2001	7250	2450	725	1025	675	12125
1 May	2000	5125	1675	450	1500	600	9350
	2001	4425	1975	475	950	550	8375
15 May	2000	3150	1450	500	725	425	6250
	2001	2875	1550	450	550	550	5975
1 Jun	2000	2250	1250	325	925	475	5225
	2001	1875	925	425	425	425	4075
15 Jun	2000	2350	850	325	450	375	4350
	2001	1025	1225	275	525	450	3500
1 Jul	2000	1325	875	300	450	475	3425
	2001	750	750	350	325	400	2575
15 Jul	2000	325	525	375	325	450	2000
	2001	1050	475	325	275	375	2500

Table 23: Fortnightly fluctuations of zooplankton abundance (indiv./l) in the mid layer water at sampling station-3 at 12 PM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoceras	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	750	375	325	450	525	2425
	2000	650	425	350	375	450	2250
	2001	825	325	250	300	350	2050
15 Aug	1999	525	325	450	525	475	2300
	2000	650	350	475	550	525	2550
	2001	450	350	325	350	425	1900
1 Sep	1999	1225	550	425	600	550	3350
	2000	1025	625	450	550	500	3150
	2001	725	425	475	525	525	2675
15 Sep	1999	1650	600	500	375	650	3775
	2000	1575	525	325	425	625	3475
	2001	950	550	550	450	600	3100
1 Oct	1999	925	500	400	625	800	3250
	2000	1450	750	425	650	525	3800
	2001	1150	625	425	675	750	3625
15 Oct	1999	1225	525	350	725	725	3550
	2000	1575	625	325	750	700	3975
	2001	1425	750	400	750	700	4025
1 Nov	1999	1675	825	300	650	850	4300
	2000	2850	750	500	725	650	5475
	2001	1750	850	375	825	725	4525
15 Nov	1999	2325	925	525	650	675	5100
	2000	1800	1500	625	850	525	5300
	2001	2450	975	650	775	650	5500
1 Dec	1999	2975	1250	500	925	575	6225
	2000	2650	1100	650	1025	525	5950
	2001	3250	1325	550	950	600	6675
15 Dec	1999	4325	1850	725	1150	600	8650
	2000	3250	1325	425	1400	725	7125
	2001	4425	1950	850	1250	650	9125
1 Jan	2000	5425	2450	925	1550	650	11000
	2001	4125	1975	525	1675	800	9100
	2002	5675	2625	1050	1625	675	11650
15 Jan	2000	6525	2950	1550	1250	875	13150
	2001	6150	2525	850	1850	1125	12500
	2002	6650	3025	1250	1450	750	13125
1 Feb	2000	7225	4125	1325	1975	1250	15900
	2001	7325	3250	1225	2450	1300	15550
15 Feb	2000	9250	5275	2150	1750	1550	19975
	2001	6400	4325	1575	1650	1125	15075
1 Mar	2000	11250	4975	1625	1425	1200	20475
	2001	9150	4850	1975	2650	1275	19900
15 Mar	2000	8325	3650	1525	1975	1000	16475
	2001	9975	4425	1750	2250	1375	19775
1 Apr	2000	7125	2550	1250	2750	1425	15100
	2001	7650	3125	850	1250	1050	13925
15 Apr	2000	5975	2025	1325	2100	975	12400
	2001	6125	2425	925	1250	825	11550
1 May	2000	5225	1550	1050	1375	750	9950
	2001	4450	1650	725	925	700	8450
15 May	2000	3100	1275	850	750	600	6575
	2001	2050	1550	475	825	675	5575
1 Jun	2000	1025	1125	625	975	575	4325
	2001	1250	950	525	450	550	3725
15 Jun	2000	2100	825	550	650	500	4625
	2001	1550	475	325	625	625	3600
1 Jul	2000	850	425	450	600	475	2800
	2001	775	650	375	350	500	2650
15 Jul	2000	725	525	350	450	450	2500
	2001	1200	500	325	325	425	2775

Table 24: Fortnightly fluctuation of zooplankton abundance (indiv./l) in the bottom layer water at sampling station-3 at 12 PM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoceras	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	950	650	525	425	550	3100
	2000	725	725	450	475	525	2900
	2001	700	450	325	350	450	2275
15 Aug	1999	775	525	625	650	600	3175
	2000	875	650	550	625	500	3200
	2001	825	625	450	425	525	2850
1 Sep	1999	1450	750	500	600	650	3950
	2000	1250	825	525	575	625	3800
	2001	1150	775	550	550	675	3700
15 Sep	1999	1875	650	575	525	700	4325
	2000	2025	750	425	650	650	4500
	2001	1525	750	625	550	750	4200
1 Oct	1999	1050	525	475	750	925	3725
	2000	1750	950	500	725	650	4575
	2001	1750	650	500	625	825	4350
15 Oct	1999	1850	725	425	925	800	4725
	2000	1975	825	400	975	725	4900
	2001	1925	700	550	750	900	4825
1 Nov	1999	2050	900	425	800	925	5100
	2000	3450	925	525	900	675	6475
	2001	2250	950	650	850	950	5650
15 Nov	1999	2775	1025	475	850	725	5850
	2000	2425	1675	625	975	550	6250
	2001	2575	1150	725	925	825	6200
1 Dec	1999	3550	1550	575	1025	600	7300
	2000	3250	1350	675	1125	725	7125
	2001	3625	1275	825	1150	650	7525
15 Dec	1999	4750	2025	825	1250	650	9500
	2000	3650	1625	475	1650	700	8100
	2001	4950	1850	950	1350	750	9850
1 Jan	2000	6125	2875	1075	1725	600	12400
	2001	4775	2225	600	1975	975	10550
	2002	6275	2675	1000	1625	725	12300
15 Jan	2000	7650	3450	1675	1650	950	15375
	2001	6900	2975	1025	2150	1200	14250
	2002	7925	3325	1550	1850	850	15500
1 Feb	2000	8125	4875	1975	2325	1125	18425
	2001	7975	3325	1350	2550	1425	16625
	2002	10250	5975	2350	2025	1650	22250
15 Feb	2000	7325	4525	1750	1975	1425	17000
	2001	13250	5125	1975	1650	1350	23350
	2002	12500	5550	2250	2750	1250	24300
1 Mar	2000	11750	3975	1450	2325	1025	20525
	2001	12775	5125	1975	2450	1625	23950
	2002	9450	2875	1325	2975	1525	18150
15 Mar	2000	9975	3550	1050	1775	1125	17475
	2001	6750	2750	1650	2450	1025	14625
	2002	7975	2975	1225	1325	950	14450
1 Apr	2000	5550	2025	1125	1775	825	11300
	2001	4975	2075	925	1125	850	9950
	2002	3625	1625	1025	1050	750	8075
15 Apr	2000	3450	1750	550	925	700	7375
	2001	2425	1425	750	1250	650	6500
	2002	2250	1125	725	625	625	5350
1 May	2000	2750	950	650	825	600	5775
	2001	1650	725	450	700	650	4175
	2002	1750	825	525	750	675	4525
15 May	2000	975	900	400	525	525	3325
	2001	950	550	425	425	550	2900
	2002	1525	700	350	450	500	3525

Table 25: Fortnightly fluctuation of zooplankton abundance (indiv./l) in the surface layer water at sampling station-I at 6 PM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoeas	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	850	550	400	425	475	2700
	2000	725	525	275	400	425	2350
	2001	975	350	250	350	425	2350
15 Aug	1999	800	375	400	550	550	2675
	2000	825	450	425	500	425	2625
	2001	975	350	250	350	425	2350
1 Sep	1999	1250	650	375	550	550	3375
	2000	1000	625	350	525	475	2975
	2001	925	725	425	625	500	3200
15 Sep	1999	1650	450	325	425	575	3425
	2000	1800	575	300	450	550	3675
	2001	1250	550	475	600	550	3425
1 Oct	1999	1075	450	375	675	875	3450
	2000	1450	800	350	600	425	3625
	2001	1425	625	450	750	625	3875
15 Oct	1999	1475	625	300	750	675	3825
	2000	1750	600	275	775	600	4000
	2001	1750	700	375	825	700	4350
1 Nov	1999	1875	775	250	600	775	4275
	2000	3100	750	375	775	525	5525
	2001	2025	925	350	675	725	4700
15 Nov	1999	2450	1000	400	675	625	5150
	2000	2100	1400	450	800	500	5250
	2001	2675	1150	550	750	650	5775
1 Dec	1999	3175	1375	475	1025	525	6575
	2000	2850	1225	600	1000	600	6275
	2001	3350	1425	625	1250	600	7250
15 Dec	1999	4550	1800	625	1075	475	8525
	2000	3375	1375	400	1575	650	7375
	2001	4875	2025	750	1325	550	9525
1 Jan	2000	6200	2575	1025	1750	450	12000
	2001	4925	2075	525	1825	900	10250
	2002	6425	2750	875	1875	525	12450
15 Jan	2000	7275	3275	1550	1550	825	14475
	2001	6650	2500	850	2025	1250	13275
	2002	7550	3325	1250	1650	750	14525
1 Feb	2000	7825	4425	1675	2075	1075	17075
	2001	7550	3175	1200	2375	1300	15600
	2002	9800	5600	2175	1875	1600	21050
15 Feb	2000	6875	4275	1550	1775	1450	15925
	2001	12250	4825	1725	1550	1350	21700
	2002	10350	5275	2000	2575	1075	21275
1 Mar	2000	10775	3750	1275	2175	1000	18975
	2001	11600	4775	1825	2300	1450	21950
	2002	8700	2550	1175	2925	1500	16850
15 Mar	2000	9550	3325	900	1650	1125	16550
	2001	6250	2375	1550	2350	925	13450
	2002	7575	2600	1025	1300	900	13400
1 May	2000	5250	1850	1075	1625	825	10625
	2001	4550	2025	825	975	800	9175
	2002	3350	1475	800	900	725	7250
15 May	2000	3125	1650	450	725	700	6650
	2001	2225	1325	675	1000	550	5775
	2002	1850	1150	500	475	625	4600
1 Jun	2000	2400	775	525	650	500	4850
	2001	1275	625	375	675	525	3475
	2002	1400	725	325	600	500	3550
15 Jun	2000	850	625	300	350	425	2550
	2001	800	525	225	300	400	2250
	2002	1300	450	200	275	450	2675

Table 26: Fortnightly fluctuation of zooplankton abundance (indiv./l) in the mid layer water at sampling station-1 at 6 PM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoceras	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	575	300	225	275	325	1700
	2000	500	325	175	300	300	1600
	2001	650	200	175	150	325	1500
15 Aug	1999	425	250	250	400	350	1675
	2000	500	225	300	450	275	1750
	2001	550	325	200	325	300	1700
1 Sep	1999	1000	425	325	425	400	2575
	2000	850	500	250	375	375	2350
	2001	875	550	300	400	350	2475
15 Sep	1999	1350	400	375	225	425	2775
	2000	1275	325	200	300	450	2550
	2001	1125	525	350	350	450	2800
1 Oct	1999	725	375	275	425	700	2500
	2000	1150	550	225	375	400	2700
	2001	950	450	425	475	575	2875
15 Oct	1999	1000	450	200	500	550	2700
	2000	1300	425	175	525	525	2950
	2001	1225	575	475	625	600	3500
1 Nov	1999	1250	600	225	450	625	3150
	2000	2375	625	300	525	475	4300
	2001	1550	625	400	600	550	3725
15 Nov	1999	2000	725	325	425	425	3900
	2000	1550	1250	350	525	350	4025
	2001	1875	775	450	650	525	4275
1 Dec	1999	2525	1000	375	625	425	4950
	2000	2225	975	325	750	450	4725
	2001	2350	925	475	725	575	5050
15 Dec	1999	4000	1600	425	875	400	7300
	2000	2725	1225	300	1150	500	5900
	2001	3875	1425	625	950	550	7425
1 Jan	2000	4875	2075	625	1250	425	9250
	2001	3750	1725	350	1325	650	7800
	2002	4525	1850	750	1250	500	8875
15 Jan	2000	6125	2825	1125	1000	525	11600
	2001	5875	2125	600	1525	850	10975
	2002	6025	2525	975	1125	600	11250
1 Feb	2000	6775	3925	1150	1650	950	14450
	2001	6650	2700	1000	2000	1025	13375
15 Feb	2000	8625	4925	1725	1450	1250	17975
	2001	6025	4000	1350	1275	950	13600
1 Mar	2000	10125	4725	1425	1150	975	18400
	2001	8475	4550	1650	2250	925	17850
15 Mar	2000	7875	3275	1000	1650	875	14675
	2001	9625	4125	1425	2000	1000	18175
1 Apr	2000	6650	2000	950	2450	1150	13200
	2001	7150	2650	700	950	900	12350
15 Apr	2000	5325	1850	1250	1750	750	10925
	2001	5550	1950	725	975	725	9925
1 May	2000	4625	1250	900	1150	700	8625
	2001	4025	1375	550	675	550	7175
15 May	2000	2725	950	625	550	425	5275
	2001	1625	1250	300	625	500	4300
1 Jun	2000	800	975	425	750	400	3350
	2001	1000	800	325	250	450	2825
15 Jun	2000	1750	575	325	450	375	3475
	2001	1250	400	200	475	350	2675
1 Jul	2000	700	325	275	400	325	2025
	2001	550	525	200	175	300	1750
15 Jul	2000	525	300	200	200	275	1500
	2001	1000	325	150	175	300	1950

Table 27: Fortnightly fluctuation of zooplankton abundance (indiv./l) in the bottom layer water at sampling station-1 at 6 PM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoceras	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	375	225	200	200	300	1300
	2000	450	250	150	250	225	1325
	2001	550	150	250	175	250	1375
15 Aug	1999	250	200	200	275	275	1200
	2000	350	175	250	325	200	1300
	2001	325	250	175	225	300	1275
1 Sep	1999	800	300	250	350	325	2025
	2000	650	350	200	325	300	1825
	2001	325	350	225	325	350	1575
15 Sep	1999	1000	250	325	200	325	2100
	2000	975	225	150	250	400	2000
	2001	650	300	400	300	300	1950
1 Oct	1999	525	250	200	350	550	1875
	2000	850	325	200	300	325	2000
	2001	725	425	425	425	450	2450
15 Oct	1999	800	300	175	350	375	2000
	2000	900	250	150	500	350	2150
	2001	825	475	350	475	400	2525
1 Nov	1999	850	425	200	325	450	2250
	2000	1950	375	250	450	400	3425
	2001	975	550	325	450	500	2800
15 Nov	1999	1625	525	300	375	350	3175
	2000	1450	950	325	450	300	3475
	2001	1550	600	450	500	525	3625
1 Dec	1999	2125	700	300	550	400	4075
	2000	1925	650	250	650	375	3850
	2001	2325	775	500	625	475	4700
15 Dec	1999	3525	1300	400	800	325	6350
	2000	2125	1000	325	1000	425	4875
	2001	3850	1250	550	775	350	6775
1 Jan	2000	4125	1550	450	1125	400	7650
	2001	3250	1325	300	1250	575	6700
	2002	4425	1325	625	1100	450	7925
15 Jan	2000	5825	2350	1000	800	425	10400
	2001	5425	1625	550	1225	700	9525
	2002	6250	1875	825	950	450	10350
1 Feb	2000	6125	3325	950	1325	725	12450
	2001	6250	2450	800	1650	875	12025
15 Feb	2000	8100	4425	1325	1025	1000	15875
	2001	5425	3250	1250	1000	825	11750
1 Mar	2000	9775	4125	1125	925	825	16775
	2001	7850	4250	1325	1950	750	16125
15 Mar	2000	7125	2950	825	1250	800	12950
	2001	8750	3650	1125	1725	850	16100
1 Apr	2000	6500	1625	725	2025	950	11825
	2001	6250	2025	550	725	725	10275
15 Apr	2000	4850	1325	1000	1450	600	9225
	2001	5025	1450	550	750	575	8350
1 May	2000	4125	1000	750	950	625	7450
	2001	3625	1125	500	525	425	6200
15 May	2000	2225	750	550	325	350	4200
	2001	1125	850	250	450	425	3100
1 Jun	2000	600	625	300	525	325	2375
	2001	800	650	250	200	400	2300
15 Jun	2000	1250	550	300	325	300	2725
	2001	950	325	175	350	275	2075
1 Jul	2000	500	250	200	250	250	1450
	2001	450	400	150	150	225	1375
15 Jul	2000	325	250	225	175	200	1175
	2001	700	200	175	150	250	1475

Table 28: Fortnightly fluctuations in zooplankton abundance (indiv./l) in the surface layer water at sampling station-2 at 6 PM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoceras	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	600	400	250	250	325	1825
	2000	550	450	225	275	350	1850
	2001	675	325	225	200	300	1725
15 Aug	1999	450	250	300	400	325	1725
	2000	550	325	275	350	350	1850
	2001	350	225	350	350	350	1625
1 Sep	1999	1000	475	275	400	400	2550
	2000	975	550	250	450	450	2675
	2001	750	550	325	325	350	2300
15 Sep	1999	1450	425	300	325	425	2925
	2000	1600	400	200	300	450	2950
	2001	1175	625	350	450	450	3050
1 Oct	1999	700	300	275	450	600	2325
	2000	1350	675	250	400	475	3150
	2001	1350	450	425	525	550	3300
15 Oct	1999	1200	525	225	500	525	2975
	2000	1500	500	200	550	475	3225
	2001	1550	725	350	600	600	3825
1 Nov	1999	1625	550	225	400	500	3300
	2000	2800	700	325	550	400	4775
	2001	1725	600	300	475	450	3550
15 Nov	1999	2225	850	300	500	550	4425
	2000	1925	1150	350	600	425	4450
	2001	1425	925	375	550	525	3800
1 Dec	1999	2900	1150	425	725	400	5600
	2000	2600	1000	450	750	450	5250
	2001	2675	1250	525	700	475	5625
15 Dec	1999	4025	1725	475	825	300	7350
	2000	3025	1250	325	1250	425	6275
	2001	4350	1875	550	875	350	8000
1 Jan	2000	5250	2325	700	1325	325	9925
	2001	4800	1900	350	1550	550	9200
	2002	5625	2550	825	1425	400	10825
15 Jan	2000	6350	2925	1000	1250	525	12050
	2001	7025	2425	700	1825	800	12775
	2002	6875	3025	950	1325	550	12725
1 Feb	2000	7000	4325	1600	1750	975	15650
	2001	7550	2975	1050	2000	1100	14675
15 Feb	2000	9425	4400	1675	1750	1300	18550
	2001	6525	4025	1350	1625	1050	14575
1 Mar	2000	11750	4325	1425	1325	1000	19825
	2001	9750	4450	1750	2050	950	18950
15 Mar	2000	9625	3150	1000	1925	775	16475
	2001	10350	4350	1550	1900	1200	19350
1 Apr	2000	7950	2050	1025	2125	1150	14300
	2001	8825	2850	850	1550	950	15025
15 Apr	2000	5975	2050	1250	2075	600	11950
	2001	7325	2300	950	1125	625	12325
1 May	2000	4950	1750	825	1250	500	9275
	2001	4350	1625	675	825	550	8025
15 May	2000	3025	1250	600	750	500	6125
	2001	2850	1225	425	650	525	5675
1 Jun	2000	1925	1000	475	825	300	4525
	2001	1725	950	400	425	350	3850
15 Jun	2000	1950	625	350	500	325	3750
	2001	1250	400	300	475	375	2800
1 Jul	2000	1150	450	325	400	400	2725
	2001	725	575	200	325	350	2175
15 Jul	2000	550	400	250	200	375	1775
	2001	1025	425	275	250	300	2275

Table 29: Fortnightly fluctuation of zooplankton abundance (indiv./l) in the mid layer water at sampling station-2 at 6 PM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoceras	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	500	300	225	250	275	1550
	2000	450	275	200	225	300	1450
	2001	525	250	200	175	250	1400
15 Aug	1999	400	200	275	325	325	1525
	2000	375	250	300	300	275	1500
	2001	225	200	250	250	300	1225
1 Sep	1999	925	400	250	350	300	2225
	2000	600	425	275	275	250	1825
	2001	675	425	275	300	325	2000
15 Sep	1999	1200	325	225	200	375	2325
	2000	1225	350	200	250	425	2450
	2001	950	450	300	400	400	2500
1 Oct	1999	675	325	250	375	600	2225
	2000	107	425	275	250	350	1407
	2001	1025	500	350	425	450	2750
15 Oct	1999	900	350	150	425	500	2325
	2000	1150	275	200	475	350	2450
	2001	1250	650	300	450	525	3175
1 Nov	1999	1275	400	250	425	500	2850
	2000	2325	525	225	475	425	3975
	2001	1350	450	250	425	400	2875
15 Nov	1999	1950	500	325	525	450	3750
	2000	1550	950	300	450	325	3575
	2001	1225	725	325	450	450	3175
1 Dec	1999	2250	800	350	575	200	4175
	2000	1850	825	325	625	275	3900
	2001	2250	1025	400	600	400	4675
15 Dec	1999	3725	1400	300	700	250	6375
	2000	2500	950	350	800	425	5025
	2001	3925	1475	425	725	300	6850
1 Jan	2000	4625	1900	625	1000	450	8600
	2001	3250	1500	425	1125	500	6800
	2002	5175	2250	650	1075	350	9500
15 Jan	2000	5700	2625	1000	925	525	10775
	2001	5425	1800	525	1325	725	9800
	2002	6250	2475	725	1250	450	11150
1 Feb	2000	6325	3650	950	1500	900	13325
	2001	6100	2325	875	1625	1000	11925
15 Feb	2000	8250	4450	1550	1125	1100	16475
	2001	5325	3650	1250	1000	825	12050
1 Mar	2000	9550	4250	1300	950	800	16850
	2001	8025	4100	1475	1775	925	16300
15 Mar	2000	7550	2950	975	1325	700	13500
	2001	9125	3950	1200	1550	1000	16825
1 Apr	2000	6025	1775	925	2025	925	11675
	2001	6775	2525	575	925	700	11500
15 Apr	2000	5150	1650	1000	1550	600	9950
	2001	5250	1750	675	925	500	9100
1 May	2000	4400	1125	800	1125	425	7875
	2001	3825	1000	475	550	400	6250
15 May	2000	2300	825	550	450	425	4550
	2001	1625	1100	325	500	300	3850
1 Jun	2000	575	725	375	625	325	2625
	2001	900	625	350	300	450	2625
15 Jun	2000	1500	450	325	375	400	3050
	2001	1125	425	275	300	350	2475
1 Jul	2000	650	325	225	225	375	1800
	2001	425	350	225	200	325	1525
15 Jul	2000	500	325	200	175	300	1500
	2001	750	350	250	150	275	1775

Table 30: Fortnightly fluctuation of zooplankton abundance (indiv./l) in the bottom layer water at sampling station-2 at 6 PM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoceras	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	350	300	200	150	225	1225
	2000	325	250	225	175	250	1225
	2001	600	300	250	250	275	1675
15 Aug	1999	250	225	275	225	300	1275
	2000	325	250	200	300	250	1325
	2001	300	250	325	325	325	1525
1 Sep	1999	525	225	150	350	325	1575
	2000	450	275	275	225	300	1525
	2001	750	450	350	400	375	2325
15 Sep	1999	800	300	200	200	350	1850
	2000	1000	325	150	250	325	2050
	2001	1025	525	400	550	450	2950
1 Oct	1999	450	200	275	325	400	1650
	2000	950	275	175	300	350	2050
	2001	1250	600	450	625	500	3425
15 Oct	1999	1125	300	150	425	500	2500
	2000	1250	325	175	525	425	2700
	2001	1425	725	425	600	600	3775
1 Nov	1999	1275	350	225	425	600	2875
	2000	2575	425	225	400	450	4075
	2001	1550	500	350	550	475	3425
15 Nov	1999	2025	525	250	325	425	3550
	2000	1675	975	300	450	400	3800
	2001	1325	750	450	575	525	3625
1 Dec	1999	2450	1025	350	550	375	4750
	2000	2150	925	425	625	350	4475
	2001	2475	1250	550	750	450	5475
15 Dec	1999	3475	1250	225	750	350	6050
	2000	2575	925	425	1250	300	5475
	2001	4275	1675	600	850	400	7800
1 Jan	2000	3125	1550	250	1350	550	6825
	2001	4250	1625	1000	1275	575	8725
	2002	5350	2475	725	1250	425	10225
15 Jan	2000	4825	2250	750	1150	875	9850
	2001	5550	1825	1325	1325	975	11000
	2002	6425	2825	850	1425	525	12050
1 Feb	2000	6225	3125	1000	1550	1000	12900
	2001	7025	2450	1650	1425	1125	13675
15 Feb	2000	6850	3125	1325	1325	875	13500
	2001	6025	3250	1250	1125	800	12450
1 Mar	2000	4925	3350	1350	1000	500	11125
	2001	7325	3125	900	1850	950	14150
15 Mar	2000	7250	2650	950	1625	925	13400
	2001	8250	3575	550	1125	650	14150
1 Apr	2000	6750	1325	825	1875	425	11200
	2001	6450	2025	525	1000	400	10400
15 Apr	2000	4575	1550	350	1450	450	8375
	2001	5875	1625	325	450	350	8625
1 May	2000	3925	1125	250	1000	300	6600
	2001	3025	1250	300	525	325	5425
15 May	2000	2450	875	250	400	250	4225
	2001	2025	1025	225	350	400	4025
1 Jun	2000	1325	775	200	500	375	3175
	2001	1000	500	150	250	325	2225
15 Jun	2000	1625	350	175	225	300	2675
	2001	600	750	150	325	325	2150
1 Jul	2000	925	525	150	225	175	2000
	2001	475	325	200	200	225	1425
15 Jul	2000	200	300	225	225	250	1200
	2001	575	325	175	200	200	1475

Table 31: Fortnightly fluctuation of zooplankton abundance (indiv./l) in the surface layer water at sampling station-3 at 6 PM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoceras	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	1025	600	550	400	500	3075
	2000	775	675	525	425	475	2875
	2001	850	450	350	350	450	2450
15 Aug	1999	725	650	600	625	525	3125
	2000	825	575	625	575	475	3075
	2001	550	475	475	525	500	2525
1 Sep	1999	1400	725	550	550	625	3850
	2000	1125	800	575	525	675	3700
	2001	975	650	625	625	600	3475
15 Sep	1999	1650	725	500	500	750	4125
	2000	2000	700	450	625	725	4500
	2001	1275	850	725	750	825	4425
1 Oct	1999	1125	550	525	675	900	3775
	2000	1700	900	550	650	750	4550
	2001	1475	675	650	650	750	4200
15 Oct	1999	1825	775	425	900	825	4750
	2000	2025	850	350	1025	700	4950
	2001	2250	950	550	925	675	5350
1 Nov	1999	1975	825	375	850	950	4975
	2000	3250	900	500	975	625	6250
	2001	2425	1025	475	1025	1025	5975
15 Nov	1999	2750	1050	550	875	775	6000
	2000	2400	1725	650	1025	500	6300
	2001	3150	1150	625	1150	850	6925
1 Dec	1999	3475	1500	650	1150	625	7400
	2000	3125	1425	725	1175	775	7225
	2001	3625	1625	750	1325	725	8050
15 Dec	1999	4675	2000	800	1325	700	9500
	2000	3625	1725	525	1725	650	8250
	2001	4875	2275	925	1450	875	10400
1 Jan	2000	6250	2825	1000	1550	575	12200
	2001	4650	2250	675	2025	900	10500
	2002	6300	3025	1125	1725	650	12825
15 Jan	2000	7625	3525	1625	1725	1025	15525
	2001	7025	2875	975	1950	1125	13950
	2002	7850	3675	1750	1925	925	16125
1 Feb	2000	8050	4750	2025	2425	1000	18250
	2001	8125	3425	1425	2450	1250	16675
15 Feb	2000	11250	6025	2125	1950	1450	22800
	2001	7300	4125	1850	2025	1300	16600
1 Mar	2000	13200	5250	2025	1700	1250	23425
	2001	12325	5375	2125	2600	1125	23550
15 Mar	2000	11675	3850	1550	2150	975	20200
	2001	12750	5250	2050	2375	1550	23975
1 Apr	2000	9425	3025	1250	3050	1425	18175
	2001	10025	3325	975	1850	1050	17225
15 Apr	2000	6725	2625	1575	2525	950	14400
	2001	8025	3075	1325	1425	1050	14900
1 May	2000	5425	1975	1050	1850	850	11150
	2001	5050	1850	900	1250	950	10000
15 May	2000	3450	1550	925	1125	825	7875
	2001	3325	1725	625	1050	725	7450
1 Jun	2000	2450	1550	700	1325	600	6625
	2001	2225	1250	650	750	550	5425
15 Jun	2000	2775	1025	575	800	450	5625
	2001	1725	650	525	550	550	4000
1 Jul	2000	1800	750	400	675	625	4250
	2001	1025	850	350	500	550	3275
15 Jul	2000	875	625	475	375	575	2925
	2001	1450	650	425	400	550	3475

Table 32: Fortnightly fluctuation of zooplankton abundance (indiv./l) in the mid layer water at sampling station-3 at 6 PM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoceras	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	700	425	375	400	500	2400
	2000	625	400	400	425	425	2275
	2001	575	325	250	275	325	1750
15 Aug	1999	500	350	475	500	450	2275
	2000	625	325	425	525	425	2325
	2001	400	400	325	350	425	1900
1 Sep	1999	1125	575	500	550	500	3250
	2000	1000	425	425	525	450	2825
	2001	650	550	450	425	450	2525
15 Sep	1999	1550	550	450	425	600	3575
	2000	1450	500	350	400	575	3275
	2001	825	625	500	500	600	3050
1 Oct	1999	900	375	375	500	650	2800
	2000	1425	625	400	625	550	3625
	2001	1025	450	425	475	525	2900
15 Oct	1999	1200	500	325	700	700	3425
	2000	1525	550	300	650	625	3650
	2001	1875	725	375	650	475	4100
1 Nov	1999	1625	800	375	600	725	4125
	2000	2800	725	425	700	525	5175
	2001	2025	675	500	750	825	4775
15 Nov	1999	2300	875	500	625	600	4900
	2000	1850	1350	650	800	500	5150
	2001	2675	625	525	825	650	5300
1 Dec	1999	2750	1150	425	850	525	5700
	2000	2550	1025	600	975	375	5525
	2001	2975	1275	600	1025	550	6425
15 Dec	1999	4125	1750	650	1100	425	8050
	2000	3100	1250	450	1250	550	6600
	2001	4125	1650	750	1250	650	8425
1 Jan	2000	5250	2325	900	1325	475	10275
	2001	4025	1850	575	1550	625	8625
	2002	5470	2425	825	1475	525	10720
15 Jan	2000	6425	2725	1250	1125	800	12325
	2001	6000	2450	950	1750	1000	12150
	2002	6750	2850	1325	1575	700	13200
1 Feb	2000	7125	3950	1125	2050	1125	15375
	2001	7050	3125	1125	2525	1100	14925
15 Feb	2000	9100	5325	2000	1925	1250	19600
	2001	6250	4200	1550	1550	1025	14575
1 Mar	2000	10250	5050	1650	1375	1125	19450
	2001	9000	4725	2050	2750	1150	19675
15 Mar	2000	8025	3750	1425	2025	850	16075
	2001	9750	4325	1825	2325	950	19175
1 Apr	2000	7000	2400	1325	2450	1225	14400
	2001	7550	3000	1025	1325	925	13825
15 Apr	2000	6050	1950	1250	2250	900	12400
	2001	5975	2325	1025	1325	800	11450
1 May	2000	5125	1425	925	1300	725	9500
	2001	4350	1525	700	1025	600	8200
15 May	2000	2950	1250	775	700	550	6225
	2001	1975	1325	425	875	625	5225
1 Jun	2000	975	1200	600	1000	525	4300
	2001	1325	1050	500	550	500	3925
15 Jun	2000	1950	800	575	725	450	4500
	2001	1625	425	375	600	475	3500
1 Jul	2000	825	400	400	650	425	2700
	2001	750	525	325	425	400	2425
15 Jul	2000	700	500	300	400	425	2325
	2001	1125	450	350	300	450	2675

Table 33: Fortnightly fluctuation of zooplankton abundance (indiv./l) in the bottom layer water at sampling station-3 at 6 PM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoceras	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	675	350	300	250	400	1975
	2000	600	250	350	275	325	1800
	2001	625	400	300	325	400	2050
15 Aug	1999	450	275	425	350	350	1850
	2000	550	300	400	350	325	1925
	2001	550	450	375	400	500	2275
1 Sep	1999	725	525	450	375	400	2475
	2000	850	400	400	450	350	2450
	2001	550	450	375	400	500	2275
15 Sep	1999	1150	350	425	250	500	2675
	2000	1025	375	325	275	475	2475
	2001	900	700	550	625	700	3475
1 Oct	1999	750	325	300	325	450	2150
	2000	1125	450	350	400	450	2775
	2001	1150	600	475	525	650	3400
15 Oct	1999	1000	450	250	450	500	2650
	2000	1125	500	200	375	425	2625
	2001	2025	850	450	750	575	4650
1 Nov	1999	1250	750	300	425	525	3250
	2000	2025	625	250	525	425	3850
	2001	2450	700	550	825	900	5425
15 Nov	1999	2125	825	350	400	500	4200
	2000	1625	1125	425	650	400	4225
	2001	2875	725	600	900	725	5825
1 Dec	1999	2425	1000	250	625	425	4725
	2000	2125	950	425	700	275	4475
	2001	3125	1425	700	1175	700	7125
15 Dec	1999	3850	1450	450	800	225	6775
	2000	2950	1125	225	950	350	5600
	2001	4350	1850	850	1425	750	9225
1 Jan	2000	5025	2025	625	925	275	8875
	2001	3750	1625	425	1050	425	7275
	2002	5675	2675	925	1650	675	11600
15 Jan	2000	5925	2525	1000	725	600	10775
	2001	5525	2125	625	1250	800	10325
	2002	7025	3125	1550	1725	825	14250
1 Feb	2000	6625	3750	925	1450	825	13575
	2001	6200	3000	825	1925	900	12850
	2002	7800	4850	1400	1525	850	16425
15 Feb	2000	5425	3925	1050	1150	725	12275
	2001	8750	4550	1150	875	925	16250
	2002	8325	4425	1550	1950	850	17100
1 Mar	2000	7925	3350	1625	1625	650	15175
	2001	8425	3950	1425	1825	750	16375
	2002	6225	2325	825	1750	1025	12150
15 Mar	2000	6725	2550	725	925	725	11650
	2001	5450	1625	950	1650	700	10375
	2002	5250	1825	725	825	600	9225
1 May	2000	4825	1250	825	700	525	8125
	2001	3950	1325	500	825	500	7100
	2002	2750	1125	475	500	450	5300
15 May	2000	1625	1000	225	675	525	4050
	2001	750	1025	400	700	425	3300
	2002	850	925	300	350	400	2825
1 Jun	2000	1250	625	375	425	350	3025
	2001	1325	400	175	400	375	2675
	2002	650	350	250	450	325	2025
1 Jul	2000	525	375	225	325	300	1750
	2001	475	425	200	300	225	1625
	2002	1000	400	250	200	350	2200

Table 34: Fortnightly fluctuations of Zooplankton abundance (indiv./l) in the surface layer water at sampling station-1 at 6 AM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoceras	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	925	625	450	450	500	2950
	2000	750	600	325	500	450	2625
	2001	1125	500	400	350	450	2825
15 Aug	1999	850	400	450	625	575	2900
	2000	900	525	475	575	475	2950
	2001	1025	475	500	550	475	3025
1 Sep	1999	1325	675	400	625	600	3625
	2000	1125	650	450	600	525	3350
	2001	1450	725	550	700	550	3975
15 Sep	1999	1550	525	400	525	625	3625
	2000	1925	625	425	500	600	4075
	2001	1625	600	625	750	650	4250
1 Oct	1999	925	525	450	725	850	3475
	2000	1625	850	475	650	475	4075
	2001	1125	750	750	800	925	4350
15 Oct	1999	1575	675	525	825	600	4200
	2000	1825	650	350	800	650	4275
	2001	1750	800	650	925	750	4875
1 Nov	1999	1925	875	375	700	825	4700
	2000	2950	825	425	825	650	5675
	2001	2225	925	575	875	850	5450
15 Nov	1999	2625	1125	500	725	675	5650
	2000	1975	1550	575	850	550	5500
	2001	2875	1250	700	950	700	6475
1 Dec	1999	3325	1450	525	1125	500	6925
	2000	3125	1025	650	1050	725	6575
	2001	3675	1625	675	1325	675	7975
15 Dec	1999	4325	2075	675	1125	550	8750
	2000	3650	1250	550	1650	625	7725
	2001	4650	2275	800	1475	700	9900
1 Jan	2000	6425	2625	1125	1875	525	12575
	2001	5050	2150	650	1925	850	10625
	2002	6850	2975	1275	1925	750	13775
15 Jan	2000	7650	3450	1650	1450	950	15150
	2001	6975	2625	925	1975	1125	13625
	2002	7925	3550	1825	1650	825	15775
1 Feb	2000	8250	4550	1750	2250	1150	17950
	2001	7875	2950	1325	2425	1425	16000
	2000	10025	5725	2450	2025	1550	21775
15 Feb	2001	7125	4350	1625	1850	1325	16275
	2000	13250	5050	1950	1625	1250	23125
	2001	11125	5425	2325	2750	1000	22625
15 Mar	2000	10875	3650	1450	2250	1150	19375
	2001	12150	4875	2025	2425	1525	23000
1 Apr	2000	9250	2150	1350	3025	1375	17150
	2001	9925	3750	1025	1725	1225	17650
	2000	6550	2025	1625	2425	1025	13650
15 Apr	2001	7325	2425	950	1425	850	12975
	2000	5425	1725	975	1750	875	10750
	2001	4650	1850	900	1025	875	9300
15 May	2000	3450	1650	850	1050	750	7750
	2001	3250	1325	625	850	775	6825
1 Jun	2000	2350	1125	650	1150	600	5875
	2001	2025	1025	600	550	650	4850
	2000	2250	825	575	725	550	4925
15 Jun	2001	1450	750	450	700	575	3925
	2000	1550	700	475	525	625	3875
	2001	925	650	375	425	500	2875
15 Jul	2000	875	600	325	400	450	2650
	2001	1550	525	300	325	525	3225

Table 35: Fortnightly fluctuations of zooplankton abundance (indiv./l) in the mid layer water at sampling station-1 at 6 AM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoceras	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	550	250	200	250	300	1550
	2000	450	300	150	275	250	1425
	2001	850	425	250	300	400	2225
15 Aug	1999	400	225	325	325	325	1600
	2000	450	200	350	375	250	1625
	2001	875	400	325	425	425	2450
1 Sep	1999	925	400	300	250	375	2250
	2000	750	425	200	325	350	2050
	2001	1125	550	450	500	400	3025
15 Sep	1999	1250	350	325	200	400	2525
	2000	1125	300	175	250	425	2275
	2001	1350	525	400	525	450	3250
1 Oct	1999	700	350	225	350	550	2175
	2000	1000	525	200	325	275	2325
	2001	975	600	525	600	725	3425
15 Oct	1999	850	425	175	425	500	2375
	2000	1125	400	150	450	375	2500
	2001	1475	625	400	725	600	3825
1 Nov	1999	1100	525	200	325	600	2750
	2000	2025	550	225	500	425	3725
	2001	1650	750	425	650	700	4175
15 Nov	1999	1850	650	300	350	325	3475
	2000	1325	1000	325	475	300	3425
	2001	2350	875	525	725	550	5025
1 Dec	1999	2250	950	325	550	375	4450
	2000	2050	900	300	525	425	4200
	2001	3125	1125	400	975	625	6250
15 Dec	1999	3825	1425	350	825	350	6775
	2000	2525	1200	250	1000	425	5400
	2001	4050	1750	575	1150	650	8175
1 Jan	2000	4425	1850	450	1125	400	8250
	2001	3350	1550	300	1225	575	7000
	2002	6375	2475	875	1425	600	11750
15 Jan	2000	5850	2625	1000	850	450	10775
	2001	5625	1925	525	1325	725	10125
	2002	7125	3125	1425	1325	725	13725
1 Feb	2000	6550	3625	1125	1350	725	13375
	2001	6325	2450	800	1825	975	12375
15 Feb	2000	8450	4750	1550	1325	1000	17075
	2001	5825	3750	1125	1125	825	12650
1 Mar	2000	9875	4525	1350	1000	950	17700
	2001	8250	4325	1225	2025	850	16675
15 Mar	2000	7650	3125	850	1325	825	13775
	2001	9450	4025	1125	1750	800	17150
1 Apr	2000	6325	1950	750	2125	1025	12175
	2001	7025	2425	550	725	825	11550
15 Apr	2000	5125	1750	1000	1450	725	10050
	2001	5325	1750	650	850	700	9275
1 May	2000	4450	1125	775	1000	625	7975
	2001	3850	1250	525	550	525	6700
15 May	2000	2250	750	600	625	400	4625
	2001	1525	1000	250	525	450	3750
1 Jun	2000	750	825	325	625	375	2900
	2001	925	750	250	200	325	2450
15 Jun	2000	1550	525	275	400	325	3075
	2001	1125	325	175	425	300	2350
1 Jul	2000	650	250	225	325	375	1825
	2001	525	450	175	150	250	1550
15 Jul	2000	500	250	150	175	250	1325
	2001	800	300	175	150	275	1700

Table 36: Fortnightly flu^{Dhaka University Institutional Repository} abundance (indiv./l) in the **bottom layer water** at sampling **station-1** at 6 AM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoeas	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	325	200	175	150	275	1125
	2000	400	275	125	225	200	1225
	2001	625	350	225	250	325	1775
15 Aug	1999	200	175	175	225	250	1025
	2000	325	150	200	275	175	1125
	2001	700	350	300	400	400	2150
1 Sep	1999	650	250	225	300	300	1725
	2000	600	300	175	275	250	1600
	2001	750	425	400	450	350	2375
15 Sep	1999	800	225	250	175	300	1750
	2000	900	200	125	200	275	1700
	2001	925	400	350	475	400	2550
1 Oct	1999	500	225	150	275	425	1575
	2000	725	300	175	250	300	1750
	2001	800	450	425	525	550	2750
15 Oct	1999	650	250	150	300	325	1675
	2000	775	200	125	375	300	1775
	2001	1025	550	350	600	525	3050
1 Nov	1999	725	250	175	300	400	1850
	2000	1600	325	200	400	250	2775
	2001	1150	625	400	550	600	3325
15 Nov	1999	1425	325	250	325	300	2625
	2000	1250	725	300	375	250	2900
	2001	1875	750	450	625	500	4200
1 Dec	1999	1875	650	250	425	375	3575
	2000	1725	600	225	500	300	3350
	2001	3025	825	350	750	450	5400
15 Dec	1999	3125	1200	275	650	275	5525
	2000	2025	950	300	850	400	4525
	2001	3650	1750	425	825	425	7075
1 Jan	2000	3950	1325	400	1000	375	7050
	2001	3125	1125	250	1025	550	6075
	2002	5875	2225	750	1025	400	10275
15 Jan	2000	5625	2125	800	725	400	9675
	2001	5125	1450	450	1125	550	8700
	2002	6850	2850	1125	950	550	12325
1 Feb	2000	5550	3025	725	1200	650	11150
	2001	5975	2250	350	1325	825	10725
15 Feb	2000	7750	4025	1025	925	850	14575
	2001	5325	3050	1000	875	675	10925
1 Mar	2000	9350	3850	975	750	800	15725
	2001	7625	3750	1125	1650	625	14775
15 Mar	2000	6850	2650	700	1000	750	11950
	2001	8450	3075	975	1525	800	14825
1 Apr	2000	6325	1325	650	1850	825	10975
	2001	6025	1750	425	550	700	9450
15 Apr	2000	4600	1025	850	1125	550	8150
	2001	4850	1250	450	625	525	7700
1 May	2000	3850	875	625	750	600	6700
	2001	3425	975	375	450	400	5625
15 May	2000	2025	625	425	300	325	3700
	2001	950	650	200	400	400	2600
1 Jun	2000	425	450	250	450	300	1875
	2001	750	425	225	175	375	1950
15 Jun	2000	1000	350	250	250	250	2100
	2001	725	300	150	300	200	1675
1 Jul	2000	450	200	175	200	225	1250
	2001	400	275	125	125	200	1125
15 Jul	2000	300	200	150	150	175	975
	2001	550	175	150	125	200	1200

Table 37: Fortnightly fluctuation of abundance (indiv./l) in the surface layer water at sampling station-2 at 6 AM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladocera	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	650	425	325	300	350	2050
	2000	575	475	300	325	375	2050
	2001	725	500	250	250	300	2025
15 Aug	1999	500	325	325	350	350	1850
	2000	625	375	300	375	400	2075
	2001	650	450	300	325	425	2150
1 Sep	1999	1150	550	325	425	450	2900
	2000	1050	625	275	475	500	2925
	2001	950	600	350	400	500	2800
15 Sep	1999	1525	500	350	350	525	3250
	2000	1650	450	250	375	475	3200
	2001	1650	650	425	450	550	3725
1 Oct	1999	750	375	325	500	650	2600
	2000	1450	725	300	525	525	3525
	2001	900	525	475	625	700	3225
15 Oct	1999	1325	625	250	550	575	3325
	2000	1625	550	225	575	550	3525
	2001	1425	700	400	700	725	3950
1 Nov	1999	1700	625	250	450	600	3625
	2000	3025	750	375	600	475	5225
	2001	1850	750	425	625	800	4450
15 Nov	1999	2350	925	350	650	625	4900
	2000	2025	1350	375	625	500	4875
	2001	2650	1025	400	700	750	5525
1 Dec	1999	3050	1225	450	800	550	6075
	2000	2725	1125	475	825	625	5775
	2001	3225	1375	550	850	500	6500
15 Dec	1999	4125	1850	525	875	450	7825
	2000	3225	1325	350	1350	475	6725
	2001	4450	2125	650	975	625	8825
1 Jan	2000	5325	2450	750	1425	425	10375
	2001	5075	2125	425	1625	600	9850
	2002	5625	2750	825	1550	600	11350
15 Jan	2000	6425	3125	1150	1250	500	12450
	2001	7125	2550	825	1975	750	13225
	2002	6625	3325	1250	1325	650	13175
1 Feb	2000	7225	4450	1750	1850	1025	16300
	2001	7625	3125	1250	2150	1250	15400
15 Feb	2000	9550	4550	1750	1850	1325	19025
	2001	6625	4250	1425	1750	1250	15300
1 Mar	2000	11850	4450	1625	1425	1125	20475
	2001	10025	4525	1850	2325	1075	19800
15 Mar	2000	9850	3225	1250	2025	850	17200
	2001	10450	4525	1625	2000	1350	19950
1 Apr	2000	8125	2250	1250	2250	1200	15075
	2001	9025	3025	975	1675	1000	15700
15 Apr	2000	6250	2225	1350	2250	700	12775
	2001	7450	2425	1025	1325	725	12950
1 May	2000	5125	1825	950	1300	575	9775
	2001	4450	1700	750	950	600	8450
15 May	2000	3225	1325	675	825	550	6600
	2001	3125	1350	500	725	550	6250
1 Jun	2000	2250	1250	550	875	450	5375
	2001	1850	1050	450	550	425	4325
15 Jun	2000	2150	700	425	550	375	4200
	2001	1325	525	350	525	425	3150
1 Jul	2000	1450	500	400	450	450	3250
	2001	850	625	350	375	400	2600
15 Jul	2000	650	550	300	300	425	2225
	2001	1250	500	325	325	350	2750

Table 38: Fortnightly fluctuation of zooplankton abundance (indiv./l) in the mid layer water at sampling station-2 at 6 AM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoceras	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	450	275	200	225	250	1400
	2000	425	200	200	200	250	1275
	2001	525	250	250	200	225	1450
15 Aug	1999	375	175	250	300	300	1400
	2000	350	200	250	250	250	1300
	2001	325	375	225	250	250	1425
1 Sep	1999	900	350	225	300	275	2050
	2000	525	400	250	225	225	1625
	2001	750	425	300	350	300	2125
15 Sep	1999	1000	300	200	175	325	2000
	2000	1125	325	175	200	400	2225
	2001	925	450	350	300	350	2375
1 Oct	1999	650	300	225	325	450	1950
	2000	950	400	250	225	325	2150
	2001	750	400	300	400	400	2250
15 Oct	1999	850	325	125	400	450	2150
	2000	1025	225	175	425	325	2175
	2001	925	475	275	450	425	2550
1 Nov	1999	1200	250	225	400	450	2525
	2000	2125	500	200	425	400	3650
	2001	1325	400	350	425	500	3000
15 Nov	1999	1850	450	300	500	400	3500
	2000	1425	775	275	425	300	3200
	2001	2050	550	425	550	400	3975
1 Dec	1999	2125	650	325	525	175	3800
	2000	1750	750	300	600	250	3650
	2001	2450	725	400	600	300	4475
15 Dec	1999	3625	1250	275	550	200	5900
	2000	2425	800	325	650	400	4600
	2001	3725	1325	475	700	325	6550
1 Jan	2000	4450	1700	600	850	425	8025
	2001	3125	1350	400	950	450	6275
	2002	4775	1925	725	925	400	8750
15 Jan	2000	5525	2250	800	750	500	9825
	2001	5250	1650	450	1125	650	9125
	2002	5850	2475	900	875	550	10650
1 Feb	2000	6250	3525	725	1250	750	12500
	2001	5850	2025	800	1325	800	10800
15 Feb	2000	7500	4250	1250	1000	875	14875
	2001	5125	3550	1125	800	800	11400
1 Mar	2000	9350	4125	1100	750	650	15975
	2001	7825	3975	1250	1525	750	15325
15 Mar	2000	7250	2850	900	1125	650	12775
	2001	8875	3750	1000	1250	800	15675
1 Apr	2000	5875	1650	900	1850	850	11125
	2001	6450	2500	500	750	650	10850
15 Apr	2000	4850	1525	750	1250	550	8925
	2001	4875	1650	600	750	450	8325
1 May	2000	4250	1025	650	975	400	7300
	2001	3625	875	425	425	350	5700
15 May	2000	2125	650	500	325	400	4000
	2001	1550	950	300	350	250	3400
1 Jun	2000	450	700	325	450	300	2225
	2001	750	550	325	250	425	2300
15 Jun	2000	1250	425	300	325	350	2650
	2001	1000	400	250	250	300	2200
1 Jul	2000	525	300	200	200	325	1550
	2001	400	325	200	175	300	1400
15 Jul	2000	450	300	175	150	250	1325
	2001	700	375	225	125	225	1650

Table 39: Fortnightly fluctuation of zooplankton abundance (indiv./l) in the bottom layer water at sampling station-2 at 6 AM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoceras	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	325	250	175	125	200	1075
	2000	300	225	200	150	225	1100
	2001	450	225	200	200	250	1325
15 Aug	1999	225	200	250	200	250	1125
	2000	300	225	175	250	200	1150
	2001	400	250	325	175	325	1475
1 Sep	1999	500	200	125	300	300	1425
	2000	425	250	250	200	250	1375
	2001	550	300	250	225	250	1575
15 Sep	1999	750	250	150	150	300	1600
	2000	950	300	125	200	275	1850
	2001	800	275	300	250	325	1950
1 Oct	1999	400	175	225	300	325	1425
	2000	900	250	150	250	325	1875
	2001	625	250	350	325	350	1900
15 Oct	1999	1025	275	125	400	375	2200
	2000	1125	300	150	450	400	2425
	2001	800	225	275	425	400	2125
1 Nov	1999	1100	300	200	350	525	2475
	2000	2450	400	175	325	400	3750
	2001	925	350	300	450	450	2475
15 Nov	1999	1850	450	200	300	375	3175
	2000	1550	850	250	400	350	3400
	2001	1425	400	325	400	400	2950
1 Dec	1999	2325	975	300	500	325	4425
	2000	2025	900	375	550	300	4150
	2001	2550	800	350	550	450	4700
15 Dec	1999	3325	1150	200	600	325	5600
	2000	2450	850	400	1000	250	4950
	2001	3625	1275	400	650	400	6350
1 Jan	2000	3025	1250	200	1125	500	6100
	2001	4125	1450	850	1100	525	8050
	2002	3275	1425	450	1050	550	6750
15 Jan	2000	4750	2025	625	1025	800	9225
	2001	5325	1750	1125	1125	750	10075
	2002	4850	2275	700	1325	675	9825
1 Feb	2000	6025	3025	875	1250	850	12025
	2001	6875	2125	1550	1300	1000	12850
	2002	6650	3025	1125	1200	825	12825
15 Feb	2000	5875	3125	1000	1100	650	11750
	2001	4875	3250	1125	850	450	10550
	2002	7250	3000	750	1650	825	13475
1 Mar	2000	7125	2450	775	1550	900	12800
	2001	8025	3325	425	1000	600	13375
	2002	6600	1125	750	1650	400	10525
15 Mar	2000	6325	1875	450	875	350	9875
	2001	4450	1325	300	1250	400	7725
	2002	5750	1450	300	425	300	8225
1 May	2000	3850	1000	225	875	250	6200
	2001	2975	1125	250	500	300	5150
	2002	2325	775	200	375	225	3900
15 May	2000	1950	950	200	300	225	3625
	2001	1250	700	175	450	325	2900
	2002	950	450	125	225	250	2000
1 Jun	2000	1550	325	150	200	275	2500
	2001	550	675	125	300	300	1950
	2002	900	500	125	200	150	1875
1 Jul	2000	450	300	175	175	200	1300
	2001	175	250	200	200	225	1050
	2002	500	275	150	150	150	1225

Table 40: Fortnightly fluctuation of zooplankton abundance (indiv./l) in the surface layer water at sampling station-3 at 6 AM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoceras	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	1125	750	600	425	550	3450
	2000	850	700	625	450	500	3125
	2001	1250	625	550	350	500	3275
15 Aug	1999	750	675	650	650	550	3275
	2000	875	600	675	600	500	3250
	2001	850	700	700	550	575	3375
1 Sep	1999	1450	750	600	650	650	4100
	2000	1175	875	625	625	700	4000
	2001	1325	825	825	725	700	4400
15 Sep	1999	1725	800	550	550	775	4400
	2000	2125	750	525	675	825	4900
	2001	1625	950	700	700	850	4825
1 Oct	1999	1250	600	575	700	975	4100
	2000	1850	950	600	725	825	4950
	2001	1450	750	650	750	1050	4650
15 Oct	1999	1875	825	525	950	875	5050
	2000	2125	900	500	1125	800	5450
	2001	2050	1000	600	825	950	5425
1 Nov	1999	2025	850	525	925	1025	5350
	2000	3325	950	650	1025	700	6650
	2001	2350	950	675	1000	1125	6100
15 Nov	1999	2850	1100	675	900	825	6350
	2000	2525	1875	700	1125	625	6850
	2001	3025	1250	800	1150	1050	7275
1 Dec	1999	3525	1550	725	1250	750	7800
	2000	3250	1625	775	1200	800	7650
	2001	3625	1725	925	1325	925	8525
15 Dec	1999	4725	2225	875	1450	750	10025
	2000	3700	1850	650	1825	725	8750
	2001	4975	2350	1025	1550	800	10700
1 Jan	2000	6325	2925	1150	1625	600	12625
	2001	4725	2325	750	2125	950	10875
	2002	6875	3025	1250	1700	750	13600
15 Jan	2000	7750	3650	1875	1850	1125	16250
	2001	7225	2950	1025	2050	1250	14500
	2002	7950	3775	1750	1925	1325	16725
1 Feb	2000	8250	4825	2125	2550	1075	18825
	2001	8325	3550	1550	2525	1325	17275
15 Feb	2000	11550	6125	2450	2150	1525	23800
	2001	7525	4250	1925	2075	1425	17200
1 Mar	2000	13750	5325	2125	1850	1350	24400
	2001	12450	5550	2250	2725	1250	24225
15 Mar	2000	11775	3925	1625	2250	1050	20625
	2001	12325	5325	2125	2425	1625	23825
1 Apr	2000	9550	3125	1325	3125	1575	18700
	2001	10250	3450	1025	1925	1250	17900
15 Apr	2000	6850	2700	1625	2600	1000	14775
	2001	8250	3250	1450	1550	1125	15625
1 May	2000	5625	2025	1125	1925	925	11625
	2001	5125	1925	1000	1325	1100	10475
15 May	2000	3550	1625	1025	1250	900	8350
	2001	3450	1850	750	1125	850	8025
1 Jun	2000	2550	1625	750	1450	750	7125
	2001	2275	1325	700	825	625	5750
15 Jun	2000	2825	1125	650	850	525	5975
	2001	1825	725	600	625	625	4400
1 Jul	2000	1950	800	450	700	700	4600
	2001	1125	900	400	550	650	3625
15 Jul	2000	925	725	525	400	625	3200
	2001	1550	750	475	450	650	3875

Table 41: Fortnightly fluctuation of zooplankton abundance (indiv./l) in the mid layer water at sampling station-3 at 6 AM of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladoceras	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	650	400	325	350	450	2175
	2000	550	350	300	400	400	2000
	2001	725	350	250	300	400	2025
15 Aug	1999	450	300	425	425	425	2025
	2000	550	300	350	500	400	2100
	2001	550	325	400	400	375	2050
1 Sep	1999	1000	525	375	525	450	2875
	2000	950	400	350	500	400	2600
	2001	900	450	450	575	400	2775
15 Sep	1999	1450	525	400	400	450	3225
	2000	1250	450	300	350	525	2875
	2001	1275	600	500	500	500	3375
1 Oct	1999	825	325	325	450	600	2525
	2000	1125	600	350	600	500	3175
	2001	1150	400	450	525	525	3050
15 Oct	1999	1025	450	300	625	625	3025
	2000	1325	475	250	600	600	3250
	2001	1275	525	325	700	700	3525
1 Nov	1999	1450	675	325	550	700	3700
	2000	2450	650	350	625	500	4575
	2001	1575	700	375	625	650	3925
15 Nov	1999	2125	825	350	450	575	4325
	2000	1625	1100	425	725	450	4325
	2001	2350	900	400	600	550	4800
1 Dec	1999	2450	1000	400	800	500	5150
	2000	2325	950	550	875	350	5050
	2001	2625	1125	450	875	575	5650
15 Dec	1999	3950	1550	475	1000	400	7375
	2000	2975	1125	400	1125	525	6150
	2001	4075	1450	525	1125	525	7700
1 Jan	2000	4750	2025	750	1250	425	9200
	2001	3950	1750	525	1325	550	8100
	2002	5025	2250	825	1350	600	10050
15 Jan	2000	6125	2550	1000	1025	750	11450
	2001	5750	2325	825	1525	950	11375
	2002	6350	2725	1175	1250	625	12125
1 Feb	2000	6850	3625	1025	1950	1025	14475
	2001	6525	3000	975	2325	1000	13825
15 Feb	2000	8750	5125	1950	1750	1125	18700
	2001	5950	4100	1325	1325	925	13625
1 Mar	2000	10000	4875	1425	1125	1050	18475
	2001	8550	4625	1850	2550	1000	18575
15 Mar	2000	7550	3550	1250	1950	775	15075
	2001	9325	4125	1650	2200	850	18150
1 Apr	2000	6650	2225	1125	2350	1125	13475
	2001	7250	2750	950	1100	750	12800
15 Apr	2000	5725	1775	1150	2125	775	11550
	2001	5450	2125	925	1125	700	10325
1 May	2000	4725	1225	850	1100	650	8550
	2001	4175	1325	650	950	550	7650
15 May	2000	2775	1125	700	625	500	5725
	2001	1625	1100	350	825	600	4500
1 Jun	2000	850	1000	450	900	475	3675
	2001	1125	925	425	500	450	3425
15 Jun	2000	1775	625	525	650	400	3975
	2001	1450	400	325	550	425	3150
1 Jul	2000	775	275	350	475	350	2225
	2001	625	350	300	400	325	2000
15 Jul	2000	550	325	250	350	400	1875
	2001	1000	300	300	250	375	2225

Table 42: Fortnightly fluctuations in zooplankton abundance (indiv./l) in the **bottom layer water** at sampling **station-3** at **6 AM** of Gulshan Lake in Dhaka city.

Sampling Date	Year	Rotifers	Cladocera	Copepodes	Ostracods	Unidentified sp.	Total Zooplankton
1 Aug	1999	600	300	250	225	325	1700
	2000	550	200	300	250	300	1600
	2001	525	250	300	250	300	1625
15 Aug	1999	425	225	400	300	325	1675
	2000	500	250	275	325	300	1650
	2001	475	300	325	325	350	1775
1 Sep	1999	650	450	400	325	350	2175
	2000	725	275	350	400	300	2050
	2001	725	400	475	400	400	2400
15 Sep	1999	1000	300	400	225	375	2300
	2000	950	325	300	250	425	2250
	2001	800	350	425	350	475	2400
1 Oct	1999	700	300	250	300	400	1950
	2000	1000	400	300	350	425	2475
	2001	650	375	400	350	425	2200
15 Oct	1999	900	425	225	400	450	2400
	2000	1025	450	175	325	400	2375
	2001	875	475	350	450	500	2650
1 Nov	1999	1125	625	250	400	450	2850
	2000	1875	600	225	450	400	3550
	2001	1000	700	425	500	525	3150
15 Nov	1999	1975	700	300	350	450	3775
	2000	1450	1050	350	500	325	3675
	2001	1575	750	400	450	550	3725
1 Dec	1999	2250	850	225	550	350	4225
	2000	2000	775	400	650	225	4050
	2001	2475	900	350	625	400	4750
15 Dec	1999	3625	1250	425	750	200	6250
	2000	2650	1000	200	800	325	4975
	2001	3850	1325	450	825	375	6825
1 Jan	2000	4750	1875	450	850	250	8175
	2001	3325	1450	400	950	350	6475
	2002	5125	2025	525	875	500	9050
15 Jan	2000	5550	2125	850	700	450	9675
	2001	5125	2000	550	1000	650	9325
	2002	5875	2450	750	900	525	10500
1 Feb	2000	6250	3450	750	1250	675	12375
	2001	6000	2750	700	1750	750	11950
15 Feb	2000	7550	4625	1250	1450	700	15575
	2001	5225	3550	950	1000	650	11375
1 Mar	2000	8450	4325	1000	750	800	15325
	2001	8125	4250	1250	1850	750	16225
15 Mar	2000	7625	3125	1325	1450	625	14150
	2001	8150	3775	1250	1650	700	15525
1 Apr	2000	6000	2250	750	1525	925	11450
	2001	6325	2325	650	850	650	10800
15 Apr	2000	5125	1450	775	1425	625	9400
	2001	4975	1550	650	750	550	8475
1 May	2000	4475	1000	750	650	500	7375
	2001	3650	1125	450	750	450	6425
15 May	2000	2550	975	425	450	400	4800
	2001	1450	950	200	600	450	3650
1 Jun	2000	625	850	325	575	375	2750
	2001	775	775	250	300	275	2375
15 Jun	2000	1000	550	325	400	325	2600
	2001	1125	375	150	325	325	2300
1 Jul	2000	425	300	200	400	300	1625
	2001	400	325	200	300	275	1500
15 Jul	2000	375	400	175	250	200	1400
	2001	750	275	225	175	300	1725

Appendix: C

Table 43: Fortnightly ~~Dhaka University Institutional Repository~~ abundance (indiv./sq.m) at sampling station-1 of Gulshan Lake in Dhaka city.

Sampling Date	Year	Molluscs	Oligochaeta	Chiro-nomidae	Unidentified spp.	Total Benthos
1 Aug	1999	270	219	159	56	704
	2000	215	200	136	40	591
	2001	238	198	187	15	638
15 Aug	1999	236	208	140	39	623
	2000	201	178	156	28	563
	2001	219	168	150	31	568
1 Sep	1999	211	241	196	43	691
	2000	193	215	207	53	668
	2001	229	231	219	27	706
15 Sep	1999	238	209	173	40	660
	2000	203	189	157	19	568
	2001	229	217	169	53	668
1 Oct	1999	265	179	150	22	616
	2000	219	154	123	0	496
	2001	259	169	115	40	583
15 Oct	1999	199	153	192	76	620
	2000	203	173	207	59	642
	2001	179	145	189	40	553
1 Nov	1999	222	139	159	29	549
	2000	265	159	163	51	638
	2001	218	125	140	37	520
15 Nov	1999	231	176	138	0	545
	2000	259	182	151	19	611
	2001	219	167	143	26	555
1 Dec	1999	172	226	176	17	591
	2000	159	203	143	7	512
	2001	169	217	159	27	572
15 Dec	1999	186	192	144	26	548
	2000	167	157	115	19	458
	2001	191	162	132	49	534
1 Jan	2000	198	153	213	39	603
	2001	228	175	241	59	703
	2002	207	159	229	47	642
15 Jan	2000	163	239	133	52	587
	2001	197	261	159	67	684
	2002	173	252	141	48	614
1 Feb	2000	222	262	158	43	685
	2001	239	275	169	51	734
15 Feb	2000	250	169	196	28	643
	2001	283	186	229	19	717
1 Mar	2000	172	176	156	22	526
	2001	165	151	139	14	469
15 Mar	2000	136	189	211	0	536
	2001	161	201	246	39	647
1 Apr	2000	315	211	205	0	731
	2001	287	198	181	0	666
15 Apr	2000	267	198	182	53	700
	2001	251	173	144	36	604
1 May	2000	296	266	165	26	753
	2001	315	284	179	55	833
15 May	2000	361	218	133	31	743
	2001	324	197	115	21	657
1 Jun	2000	444	333	178	52	1007
	2001	417	310	145	31	903
15 Jun	2000	363	379	111	0	853
	2001	389	391	140	56	976
1 Jul	2000	676	314	102	27	1119
	2001	658	294	86	19	1057
15 Jul	2000	453	386	156	37	1032
	2001	497	392	172	51	1112

Table 44: Fortnightly floodplain macroinvertebrate density (indiv./sq.m) at sampling station-2 of Gulshan Lake in Dhaka city.

Sampling Date	Year	Molluscs	Oligochaeta	Chironomidae	Unidentified spp.	Total Benthos
1 Aug	1999	295	241	178	73	787
	2000	271	218	165	62	716
	2001	242	185	143	49	619
15 Aug	1999	269	223	172	67	731
	2000	234	186	153	49	622
	2001	257	159	161	52	629
1 Sep	1999	255	289	215	65	824
	2000	239	254	203	47	743
	2001	245	261	225	51	782
15 Sep	1999	265	226	198	70	759
	2000	239	197	173	57	666
	2001	251	242	181	0	674
1 Oct	1999	289	197	171	49	706
	2000	249	165	152	26	592
	2001	260	187	129	37	613
15 Oct	1999	158	146	179	59	542
	2000	199	155	188	67	609
	2001	185	139	161	56	541
1 Nov	1999	267	158	162	37	624
	2000	295	174	184	61	714
	2001	254	160	173	29	616
15 Nov	1999	261	188	154	32	635
	2000	289	202	175	57	723
	2001	275	198	161	41	675
1 Dec	1999	199	254	182	41	676
	2000	177	231	165	0	573
	2001	183	240	177	29	629
15 Dec	1999	201	217	161	42	621
	2000	179	183	148	31	541
	2001	187	195	163	54	599
1 Jan	2000	225	171	232	51	679
	2001	244	183	257	62	746
	2002	219	166	245	43	673
15 Jan	2000	188	257	149	68	662
	2001	205	278	165	79	727
	2002	179	240	133	57	609
1 Feb	2000	255	289	175	62	781
	2001	274	296	155	75	800
15 Feb	2000	268	180	205	31	684
	2001	290	195	233	0	718
1 Mar	2000	183	194	178	30	585
	2001	167	175	164	19	525
15 Mar	2000	159	202	243	17	621
	2001	178	225	265	56	724
1 Apr	2000	358	254	229	23	864
	2001	312	215	248	7	782
15 Apr	2000	289	214	197	53	753
	2001	271	187	170	0	628
1 May	2000	321	279	181	45	826
	2001	335	290	199	53	877
15 May	2000	378	257	161	49	845
	2001	350	229	129	30	738
1 Jun	2000	403	310	150	49	912
	2001	384	291	137	33	845
15 Jun	2000	387	395	133	24	939
	2001	401	412	169	49	1031
1 Jul	2000	693	333	128	34	1188
	2001	656	314	105	28	1103
15 Jul	2000	478	406	178	48	1110
	2001	521	413	199	71	1204

Table 45: Fortnightly floodplain macroinvertebrate abundance (indiv./sq.m) at sampling station-3 of Gulshan Lake in Dhaka city.

Sampling Date	Year	Molluscs	Oligochaeta	Chironomidae	Unidentified spp.	Total Benthos
1 Aug	1999	282	227	165	61	735
	2000	235	211	149	53	648
	2001	259	198	129	31	617
15 Aug	1999	254	211	169	52	686
	2000	219	180	161	35	595
	2001	238	160	156	46	600
1 Sep	1999	239	178	206	59	682
	2000	227	243	215	60	745
	2001	235	241	239	40	755
15 Sep	1999	244	215	185	63	707
	2000	215	194	160	37	606
	2001	238	230	178	13	659
1 Oct	1999	279	183	164	35	661
	2000	232	160	139	11	542
	2001	279	171	110	0	560
15 Oct	1999	178	150	178	62	568
	2000	224	160	210	61	655
	2001	183	125	170	45	523
1 Nov	1999	253	142	167	33	595
	2000	279	171	173	59	682
	2001	249	133	180	26	588
15 Nov	1999	250	181	143	45	619
	2000	276	191	163	45	675
	2001	263	184	158	33	638
1 Dec	1999	181	241	180	39	641
	2000	165	217	152	11	545
	2001	175	233	168	0	576
15 Dec	1999	197	205	158	33	593
	2000	171	162	129	28	490
	2001	165	179	154	59	557
1 Jan	2000	213	164	220	47	644
	2001	236	189	262	45	732
	2002	225	160	237	48	670
15 Jan	2000	179	249	139	59	626
	2001	201	255	160	71	687
	2002	176	248	139	51	614
1 Feb	2000	237	275	164	58	734
	2001	265	287	164	62	778
15 Feb	2000	263	171	199	27	660
	2001	288	192	231	11	722
1 Mar	2000	189	181	167	27	564
	2001	173	167	158	16	514
15 Mar	2000	149	196	225	13	583
	2001	170	219	254	41	684
1 Apr	2000	349	227	213	19	808
	2001	309	207	198	0	714
15 Apr	2000	278	205	189	43	715
	2001	268	179	161	41	649
1 May	2000	313	270	172	34	789
	2001	323	286	182	60	851
15 May	2000	368	196	157	37	758
	2001	337	209	119	27	692
1 Jun	2000	429	312	163	51	955
	2001	427	301	140	39	907
15 Jun	2000	371	387	120	19	897
	2001	395	406	154	51	1006
1 Jul	2000	681	321	111	31	1144
	2001	666	309	98	23	1096
15 Jul	2000	467	391	162	41	1061
	2001	511	401	185	62	1159

Appendix: D

Table 46. Analysis shows the relationship between different layers zooplankton production with nitrite

		Sum of squares	df	Mean squares	F	Sig.
Surface	Between Groups	5.4E+08	16	3.4E+07	1.195	.310
	Within Groups	1.2E+09	43	2.8E+07		
	Total	1.8E+09	59			
Middle	Between Groups	5.1E+08	16	3.2E+07	1.335	.220
	Within Groups	1.0E+09	43	2.4E+07		
	Total	1.5E+09	59			
Bottom	Between Groups	6.4E+08	16	4.0E+07	1.247	.274
	Within Groups	1.4E+09	43	3.2E+07		
	Total	2.0E+09	59			

Table 47. Analysis shows the relationship between different layers zooplankton production with dissolved oxygen

		Sum of squares	df	Mean squares	F	Sig.
Surface	Between Groups	1.5E+09	39	3.8E+07	2.810	.008
	Within Groups	2.7E+08	20	1.4E+07		
	Total	1.8E+09	59			
Middle	Between Groups	1.3E+09	39	3.3E+07	2.608	.012
	Within Groups	2.5E+08	20	1.3E+07		
	Total	1.5E+09	59			
Bottom	Between Groups	1.7E+09	39	4.4E+07	2.865	.007
	Within Groups	3.1E+08	20	1.5E+07		
	Total	2.0E+09	59			

Table 48. Analysis shows the relationship between different layers zooplankton production with P^{II}

		Sum of squares	df	Mean squares	F	Sig.
Surface	Between Groups	1.1E+09	17	6.3E+07	3.831	.000
	Within Groups	6.9E+08	42	1.6E+07		
	Total	1.8E+09	59			
Middle	Between Groups	8.8E+08	17	5.2E+07	3.317	.001
	Within Groups	6.5E+08	42	1.6E+07		
	Total	1.5E+09	59			
Bottom	Between Groups	1.7E+09	17	6.8E+07	3.293	.001
	Within Groups	3.1E+08	42	2.1E+07		
	Total	2.0E+09	59			

Table 49. Analysis shows the relationship between different stations zooplankton production with ammonia

		Sum of squares	df	Mean squares	F	Sig.
Station 1	Between Groups	1.3E+09	19	7.1E+07	3.831	.000
	Within Groups	4.2E+08	40	1.0E+07		
	Total	1.8E+09	59			
Station 2	Between Groups	1.1E+09	19	5.6E+07	3.317	.001
	Within Groups	3.3E+08	40	8197672		
	Total	1.4E+09	59			
Station 3	Between Groups	1.5E+09	19	7.9E+07	6.811	.000
	Within Groups	4.6E+08	40	1.2E+07		
	Total	2.0E+09	59			

Table 50. Analysis shows the relationship between different stations zooplankton production with CO₂

		Sum of squares	df	Mean squares	F	Sig.
Station 1	Between Groups	1.6E+09	50	3.2E+07	1.577	.237
	Within Groups	1.8E+08	9	2.0E+07		
	Total	1.8E+09	59			
Station 2	Between Groups	1.2E+09	50	2.5E+07	1.388	.312
	Within Groups	1.6E+08	9	1.8E+07		
	Total	1.4E+09	59			
Station 3	Between Groups	1.8E+09	50	3.5E+07	1.588	.234
	Within Groups	2.0E+08	9	2.2E+07		
	Total	2.0E+09	59			

Table 51. Analysis shows the relationship between different stations zooplankton production with nitrite

		Sum of squares	df	Mean squares	F	Sig.
Station 1	Between Groups	5.4E+08	16	3.4E+07	1.195	.310
	Within Groups	1.2E+09	43	2.8E+07		
	Total	1.8E+09	59			
Station 2	Between Groups	4.3E+08	16	2.7E+07	1.179	.322
	Within Groups	9.7E+08	43	2.3E+07		
	Total	1.4E+09	59			
Station 3	Between Groups	1.8E+09	16	3.9E+07	1.266	.262
	Within Groups	2.0E+08	43	3.1E+07		
	Total	2.0E+09	59			

Table 52. Analysis shows the relationship between different stations zooplankton production with dissolved oxygen

		Sum of squares	df	Mean squares	F	Sig.
Station 1	Between Groups	1.5E+09	39	3.8E+07	2.810	.008
	Within Groups	2.7E+08	20	1.4E+07		
	Total	1.8E+09	59			
Station 2	Between Groups	1.2E+09	39	3.1E+07	1.179	.006
	Within Groups	2.1E+08	20	1.0E+07		
	Total	1.4E+09	59			
Station 3	Between Groups	1.7E+09	39	4.3E+07	3.119	.004
	Within Groups	2.8E+08	20	1.4E+07		
	Total	2.0E+09	59			

Table 53. Analysis shows the relationship between different stations zooplankton production with P^H

		Sum of squares	df	Mean squares	F	Sig.
Station 1	Between Groups	1.1E+09	17	6.3E+07	3.831	.000
	Within Groups	6.9E+08	42	1.6E+07		
	Total	1.8E+09	59			
Station 2	Between Groups	8.9E+08	17	5.2E+07	4.276	.000
	Within Groups	5.1E+08	42	1.2E+07		
	Total	1.4E+09	59			
Station 3	Between Groups	1.2E+09	17	7.0E+07	3.831	.000
	Within Groups	7.7E+08	42	1.8E+07		
	Total	2.0E+09	59			