STUDIES OF BENTHIC MACRO FAUNA IN FRESH WATER PONDS WITH SPECIAL REFERENCE TO OLIGOCHAET FAUNA

by

MOHAMMED SHAHADAT ALI

B. Sc. Dacca University, 1961

M. Sc. Dacca University, 1964

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE

REQUIREMENTS OF THE DEGREE OF

Doctor of Philosophy

In The Department

of

Zoology

University of Dacca, Dacca, Bangladesh

November, 1980

BIOGRAPHICAL INFORMATION

NAME : ALI, MOHAMMED SHAHADAT

PLACE AND DATE OF BIRTH :

Baraset, West Bengal (INDIA), March 3, 1941

EDUCATION:

Fazlul Haque Hall, Dacca University, B.Sc., 1961

Fazlul Haque Hall, Dacca University, M.Sc. in Zoology, 1964

Attended Long Term UNESCO Training Course on Ecology of Oligochaetes in Charles University, Prague.

POSITIONS HELD:

Lecturer in Zoology, Jagannath College, Dacca, 1964 - 1968

Lecturer in Zoology, Dacca University, Dacca, 1968 - 1973

Assistant Professor of Zoology, Dacca University, 1973 -

ASSOCIATED WITH SCIENTIFIC BODIES:

Fellow, Zoological Society of Bangladesh

Member, Bangladesh Association for the Advancement of Science

Member, Asiatic Society of Bangladesh

Member, Freshwater Biological Association, Ambleside, U.K.

Member, International Organization of Oligochaete Taxonomists, London, U.K.

PUBLICATIONS:

Published twenty-five scientific papers

SUMMARY

1. The samplings were made at an interval of fifteen days for a period of two years from depths 0.2 m, 1 m, and 3 m of three ponds at Dacca. The main objectives of the investigation were to record the following parameters;

i) Physico-chemical parameters of water and bottom sediments.

ii) Populations of benthic macro~~invertebrates~~ fauna at different depths, their community patterns, quantitative variation in abundance and biomass, mutual association and size group frequency of dominant oligochaete species;

iii) Correlation between abundance of macrobenthos and physico-chemical characteristics of water and soil.

2. The oligochaetes, chironomids and molluscs were the dominant groups and these determined the total abundance of the three ponds. The oligochaetes were the most dominant group, whereas *Limnodrilus hoffmeisteri* was noted to be the most dominant species.

3. The abundance and diversification of macroinvertebrates was noted to vary inversely with depth, the highest was observed at 0.2 m depth and

the lowest at 3 m depth. The highest faunal abundance and diversification was also found in the pond with gentle and gradual slope, and the lowest in the pond with steep slope.

It was noted that the rainfall influenced the occurrence of oligochaete populations. The latter occasionally showed an inverse relationship with the populations of chironomid larvae.

4. It was noted that *Limnodrilus hoffmeisteri* thrived well in the pond receiving sewage outflow, whereas *Lamellidens marginalis*, a filter feeding bivalve, preferred pollution-free water. The larvae of *Chaoborus* sp. were found to be restricted to the deeper bottom.

5. In case of oligochaetes no specific pattern in seasonal abundance was witnessed, whereas the molluscs showed specific seasonal patterns.

6. The dry formalin-weight of macroinvertebrates was noted. The oligochaetes dominated the total biomass in SB pond, whereas in SH and PG ponds the total biomass was mostly dependent on mulluscs. The total biomass was noted to depend largely on *L. hoffmeisteri* in SB pond. The ring snail, *Viviparus bengalensis*, was the dominant species among the molluscs and dominated the total biomass in SH and PG ponds.

7. Mutual association among the dominant oligochaetes was recorded by rank correlation test. It was observed that significant mutual association existed between *Branchiodrilus semperi* and *Dero digitata*.

8. *Limnodrilus hoffmeisteri* and *Branchiodrilus sowerbyi* was found to breed irregularly throughout the year. The maximum breeding occurred between March and July in case of *L. hoffmeisteri* whereas between September and October in case of *sowerbyi*.

9. The simple multiple correlation coefficients between the abundance and the eight physico-chemical parameters of water were calculated. The temperature showed a negative relationship with faunal abundance. The dissolved oxygen content and pH exhibited a positive relationship with the faunal density, whereas carbondioxide, organic carbon, nitrogen, and calcium content showed a negative relationship. The phosphate content of water did not manifest any specific relationship with faunal density. The significant values of multiple correlation coefficient for total organisms and the eight physico-chemical factors of water were noted at depths 0.2 m and 1 m in SB pond.

10. The simple correlation and coefficients between the total abundance of macroinvertebrates and some chemical parameters of soil were studied. The nitrogen and organic carbon content of the sediment showed a negative relationship with the faunal density at depth A (.2 m) and a positive relationship at depth B (1 m). It was further noted that the pond sediment with high amount of available phosphorus and rich bacterial populations supported the highest number of benthic macroinvertebrates.

11. The entire bottom areas of these ponds at the greater depth were almost barren possibly due to the tense shortage of dissolved oxygen, very high content of carbondioxide and presence of hydrogen sulphide gas in water.

12. In course of the investigation the following genera and species were studied:

OLIGOCHAETA: *Nais simplex* Piguet, *Stylaria lacustris* (Linnaeus), *Branchiodrilus semperi* (Bourne), *Dero dorsalis* Ferronniere, *D. digitata* (Muller), *D. indica* Naidu, *Aulophorus furcatus* (Muller), *A. gravelyi* Stephenson, *Limnodrilus hoffmeiteri* (Claparede), *Aulodrilus pluriseta* (Piguet), *Branchiura sowerbyi* (Beddard), *Mesenchytraceas* sp.

MOLLUSCA : *Viviparus bengalensis* (Lamarck), *Digniestoma pulchella* (Benson), *Alocinma orcula* Feranenfled, *Melania tuberculatus* (Muller), *Lymnea* sp., *L. accuminata* (Lamarck), *L. luteola* (Lamarck), *Planorbis exustus* Deshayes, *Lamellideus marginalis* Lamarck.

CHAOBORIDAE: Larvae of *Chaoborus* sp.

In addition to these genera and species there were other organisms belonging to groups Planaria, Hirudinaria, Hydracarina, Ostracoda, Odonata, Chironomidae and Ceratopogonidae present in all the three ponds. Although these latter organisms were not properly identified, these were, however, considered in determining the total abundance and biomass and their periodicity.

TABLE OF CONTENTS

Pages

Pages

Pages

LIST OF TABLES

Pages

TABLE

Pages

TABLE

Pages

TABLE

Pages

TABLE

Pages

TABLE

LIST OF FIGURES

Pages

FIGURE

Pages

FIGURE

Pages

FIGURE

Pages

FIGURE

ACKNOWLEDGEMENTS

The author wishes to express his sincere gratitude to Professor A.K.M. Nurul Islam, Department of Botany, and to Professor K.Z. Hussain, Department of Zoology, for constant guidance, advice and encouragement during the course of this study. A profound indebtedness is also expressed to Professor A.K.M. Nurul Islam for his untiring effort to provide valuable suggestions in preparing the dissertation. Grateful appreciation is extended to Dr. T.T. Macan, Fresh Water Biological Association, Ambleside, U.K., Professor Mahmud-ul-Ameen, Professor S.M.H. Kabir, Dr. (Mrs.) Anwara Begum, Dr. A.H.M.A. Mainuddin Ahmed of Dacca University and Professor S.H. Chowdhury of Chittagong University for many fruitful discussions, helpful suggestions and also the critical reading of the manuscript.

The author is grateful to Professor Aminul Islam, ex-Dean of the Faculty of Biological Sciences, Professor I.U. Ahmed, ex-Chairman, the Department of Soil Science, for providing laboratory facilities in the Department. Professor Aminul Islam also read critically some parts of the manuscript for which the author is expressing his deep sense of gratitude.

The author acknowledges the assistance of the ICDDR,B for laboratory facilities and of the Atomic Energy Centre, Dacca for computer facility.

The financial support provided by the University Grants Commission through a research scheme is gratefully acknowledged. Sincere gratitude is also expressed to Dr. Anwarul Azim Chowdhury, the former Director of Centre for Advanced Studies in Biological Sciences, Dacca University for recommending the above scheme to the U.G.C.

A sincere appreciation is expressed to the author's wife, Lailun, for her patience, unfailing support, and encouragement during the entire period of the work. Thanks are due to Mr. Faruk Reza who helped the author in various ways.

The author is thankful to Mr. Cyril Gomes for meticulous typing the manuscript.

CHAPTER I

INTRODUCTION

The benthic macroinvertebrates perform a vital task in the biological productivity of any water body. The fundamental importance of these organisms in the economy of the natural waters is that they play an important part in the nutrition cycle in aquatic ecosystem. The major point of interest at the present time in production hydrobiology is the relationship of environmental factors to different trophic levels through which energy flows (Lellak, 1965).

Growing population pressure, reckless use of pesticides, increasing rate of irrigation during dry season for cultivation of land, and other human interference with natural waters are all contributing to a drastic decline in fish production in Bangladesh where fish is the main source of protein for common people. The paramount need to increase protein supply for the human population has necessitated the use of all available waters for fish culture, and for this purpose knowledge of the benthic organisms of water bodies is very essential. Vaas & Vaas-van-Oven (1959) observed the importance of different open water and bottom community as food of Indonesian carps in natural fish ponds. Kharitonova (1962) found that oligochaetes are of secondary importance as food for carps and gold fishes in

Ukrainian ponds. Poddubanya (1962) stated that tubificids are in great demand as food for freshwater fishes. Tody (1964, *c.f.* Hall & Hyatt, 1974) summarized the results of several authors and reported that the rainbow trout feeds principally on benthic invertebrates. Krishnamurthy (1966) found that *Puntius kolus* feeds extensively on bottom fauna. Ghabbour (1966) discussed the importance of oligochaete worms in fish culture with special reference to Lake Nasser. Grimas (1968) reports that the study of the bottom animal community yields information about specific bioactivity of various lakes and gives indication for the rate of progress of eutrophication in various lake basins. Raman *et al.* (1975) stressed the importance of bottom fauna in aquaculture as food of fishes. Thus it is evident that the abundance and distribution of bottom dwelling macroinvertebrates have a direct bearing on fisheries.

The benthic macroinvertebrate community is very sensitive to environmental stress (Goodnight, 1973; Harrel *et al.*, 1976). The community structure of macrobenthos is often investigated for determination of pollution stress. In spite of their sensitibility to changes in environment, these organisms take a considerable time to develop a distinct community pattern in an ecosystem. Moreover, due to their modes of life, sedentary habit and central position in food chain, these organisms reflect the environmental conditions of an ecosystem in the past as well as in the present, whereas the physical and chemical survey of water indicates the environmental condition at the time of sampling. Water quality biologists now-a-days thus prefer to detect the effect of environmental perturbation by studying the degree of diversification in the benthic macroinvertebrate community. This further enhances the importance of benthonic study.

The physicochemical factors of water and soil have definite effects on benthic community and other life in water bodies (Raman *et al.*, 1975). Therefore, the investigation of these factors is necessary. Though one of the earliest works on tropical limnology was undertaken in the year 1928-29 on the inland waters of Java, Sumatra, and Bali under German Limnological Simoa Expedition (Ruttner, 1952), Thienemann (1954a) pointed out the dearth of sufficient knowledge of tropical limnology and suggested that warmer water should be investigated with respect to environmental factors and populations therein. However, Pruthi (1933), Sewell (1934), Iyenger (1940), Ganapati (1940, '41, '43), Philipose (1960), Singh (1960), George (1962), Sarker & Rai (1964), Zafar (1964, 1966), Krishnamurthy & Visweswara (1965), Sitaramiah (1966), Sreenivasan (1968), Michael (1968a), Munawar (1970), Seenayya (1971), Rao (1971), Jana (1973), Islam *et al.* (1974), Freshwater Research Centre, Chandpur, (1974), Islam & Saha (1975), Mathew (1975), Islam & Mendes (1976), Islam & Paul (1977), Khan *et al.* (1977), Islam & Paul (1978) and Oppenhiemer *et al.* (1978) carried out some valuable work on the physical and chemical conditions of water in the

Indian and Bangladesh territories. It appears, therefore, that much more work is needed in this line to expand the extent of our understanding on aquatic ecosystems in order to achieve considerable increase in aquatic productivity.

The bottom macroinvertebrates show a great variety of adaptations tc their mode of life. They adapt to the substratum, to the amplitude and rythm of physical and chemical factors and to the exploitation of food resources (Jonasson, 1975). They are found to live on organic residual surrounded by bacteria (Mayer, 1934; Walshe, 1947; Thienemann, 1954b). It has been observed recently that many of the bottom dwelling macroinvertebrates are bacteriophagus (Hruska, 1973; Cook, 1975; Harrel & Duplechin, 1976). Since mass development of bacteria depends primarily on the amount of organic matters and the organically bound nitrogen in mud, these two factors may be taken as indicators of the nutritive value and the energy content of mud which also, as considered by some quarters, reflects the extent of benthic populations. Mortimer (1938) found that the organic productivity of the lakes of English Lake District depended on the nitrogen content of their mud. However, Stangenberg (1949) failed to get the same result while dealing with the ponds and lakes of Poland. According to Lellak (1966) bottom nutrients do not seem to be the factor limiting the food supply of the bottom fauna in Czechoslovakia and it is impossible to use it as a criterion in drawing conclusions as to its quantitative development and production. Cook (1975), and Loveriolge & Cook (1976) found that strong positive correlation existed between mean particle size of sediment and the abundance and biomass of benthos. But they also found a negative correlation between abundance and biomass of benthos and the content of organic carbon in the sediments. However, it seems that more research is necessary to expand our knowledge on soil composition of water bodies and their relationships with the benthic organisms.

Our knowledge of the benthic ecology lags behind that of plankton ecology. The overall concept of benthic environment is either incomplete, or is based on broad generalizations (Buscemi, 1961). Many people have worked with benthos, but there is little information on the possible relationships between them and their physical and chemical environment. Earlier works on the bottom macroinvertebrates from different parts of the world have been mostly confined to larger bodies of water, particularly in the temperate region. Although these information are not that pertinent with respect to smaller tropical water bodies such as ours in Bangladesh, a brief resume however is given below to elucidate the extent and nature of work done in benthological studies. Thus, Moore (1950) pointed out that the littoral zone of Lake Louisiana supported rich faunal abundance and diversification. He further concluded that the above observation was possible due to the diversified physical and chemical conditions of the littoral zone. Similar observation was made by Muttowski (1918), Juday (1922), Eggleton (1937), Northcote & Larkin (1956), Dunn (1961), Grimas (1967), Craven & Brown (1969), Paterson & Fernando (1969a), Thut (1969), Hamilton (1971), Solem (1973), and Darlington (1977). Eggleton (1931) while working in a number of fresh water lakes in U.S.A. found that the concentration of freshwater macrobenthos in the upper profundal and the lower sublittoral zones during summer. He also noted a sharp decline in population per unit area below the upper profundal and above the lower sublittoral zone. Adamstone (1924) and Rawson (1930) recorded similar results. Buscemi (1961) noted the highest biomass of macrobenthos within the range of 0.6 meter to 1.0 meter depth in Parvin Lake in Colorado. Harrel (1973) observed species diversity of benthic macroinvertebrates in Massery Lake, Texas, decreased to zero diversity at 3 meters. On the contrary, while working in Buckeye Lake of Ohio, Tressler *et al.* (1940) observed that depth played an insignificant role in the distribution of benthic organisms.

Humphries (1936) pointed out that the fauna of any lake may be divided according to seasonal variation into: (1) a permanent fauna; and (2) a temporary or seasonal fauna. Berg (1938) while working on European Lakes, found that each lake has its own individuality as to its faunistic composition. Khalilov & Ahmedov (1972), Pupkov (1972), and Kitagwa (1972) made similar observations from different waters in

USSR and Japan. Ashahina (1942, 1943) observed that chironomids dominated the other components of macroinvertebrates in Lake Bepi of Japan. Similar observations were also made by Clampitt *et al.* (1960), Wojcik (1970), and Daniel (1972). Ricker (1952) found that oligochaetes and chironomids were two dominant groups among the benthos of Cultus Lake in Canada. Sivertsen (1973), while working on Lake Huddingsvatn in Norway, also found that these two groups were the major fauna among macrobenthos. Nelder & Pennak (1955) noted that tendipedid larvae and bivalve *Pisidium* were the most abundant forms in the bottom of a Colorado Alpine pond. Lenz (1955) recorded the fluctuation in faunal abundance in different seasons and depths. Mundie (1959) found that many benthic organisms are less static in their distribution than is commonly assumed.

In temperate lakes the ecology, food, feeding and growth of macroinvertebrates have been studied by Petersen (1926), Berg (1938), Jonasson (1948, '64, '70 and '75), Anderson & Hooper (1956), Lellak (1965, '69), Jonnason & Kristiansen (1967), Harrel (1969), Thut (1969), Efford & Hall (1975), Jonasson & Thorhauge (1976), Harrel & Duplechin (1976) and Sepers (1977). Moffet (1943), Welch (1952), Paterson and Fernando (1969a), Hamilton (1971), Cook and Johnson (1974), Young (1975a) and Banu (1976) found that temperature was controlling factor in the distribution and annual fluctuation of aquatic life. Hall *et al.* (1970) recorded a steep reduction in average standing crop with the rise of water temperature. The importance of dissolved oxygen in the distribution and abundance of macrobenthos has been emphasized by Deevey (1941), Jonasson (1969), Daniel (1972), and Hruska (1973). However, Adamstone (1924) and Webb (1965) noted that temperature and oxygen had no apparent significance in the distibution and abundance of bottom organisms. The effect of physical and chemical conditions of bottom deposits on the distribution and density of bottom fauna has been frequently demonstrated by many workers (Adamstone, 1924; Rawson, 1930; Tebo, 1955; Thorup, 1966; Grimas, 1969; Dejoux *et al.* 1971; Krzyzanek, 1973; Gaini & Lucas, 1974; Juget & Gaini, 1974; Gaini & Lavandier, 1977; Darlington, 1977). Northcote & Larkin (1956), Grimas (1967, 1969), Paterson & Fernando (1969b), Cook (1971), and Cook & Johnson (1974) observed that the density of benthic fauna increased with the increase of organic matter in sediment. Dunn (1961) and Timms (1974) emphasized the importance of morphometry of basin in the distribution and density of benthic macroinvertebrates. Muttowski (1918), Rawson (1930), Ball (1948), Grimas (1965), Macan (1965), Hall *et al.* (1970), and Macan & Kitching (1972) found that in a body of water, vegetation influences the distribution and abundance of macroinvertebrates. Goodbody (1961), and Paterson & Fernando (1969a) noted a reduction in faunal abundance caused by rainfall. Thorup (1970) also recorded that the populations of Spring Brook community became reduced remarkably as a result of short term flood.

Desmet (1978) observed that in a shallow and polluted pond the number and diversification of macrobenthos increased with artificial aeration.

Although considerable limnological work has been done in warmer waters in India and Bangladesh (see ref. on p. 3) little is known about the benthic fauna of these regions. However, Parshad (1916), Srivastava (1956 & 1959), Krishnamurthy (1966 & 1971), Sitaramaiah (1966), Michael (1968b), Patnaik (1971), Ghosh *et al.* (1974). Mandal & Moitra (1975), Raman *et al.* (1975), and Gupta (1976) contributed to the knowledge of benthic macroinvertebrates of the Indian freshwaters. From Bangladesh on the other hand, only a limited amount of work have been done so far in this line (Dewan, 1973; Ali *et al.* 1977, 1978, 1979).

The present studies, therefore, were undertaken to throw light on the ecology and community structures of benthic macroinvertebrates with special reference to oligochaetes at different depths in three different types of ponds at Dacca. The main objective of these studies to know the :

(a) Physicochemical parameters of the waters and bottom soils;

(b) Community patterns at different depths and seasonal abundance of macrobenthos, species of oligochaetes, and molluscs;

(c) Biomass study as measured by their dry weight of the bottom fauna;

(d) Size group frequency of dominant oligochaetes and their mutual association;

(e) Correlation between abundance of macrobenthos, oligochaetes, and dominant oligochaete species and some of the physicochemical parameters of water and soil.

The importance and significance of the biotic factors such as predation pressure, feeding habit, and availability of food etc. in the distribution of the organisms was understood but these aspects, however, were not studied in greater depth in the present investigation.

CHAPTER II

MATERIALS AND METHODS

The present field investigation work was started in January 1976, and completed in December 1977. For the study of macrobenthic invertebrates and the limnological parameters, three ponds e.g. Shahidullah Hall pond (SH), Play Ground pond (PG), and the Shahabagh pond (SB) situated in and around the Dacca University Campus were selected. The purpose of selecting these ponds was that although situated within a short distance one from the other, each pond represented a distinct type of ecological environment particularly with respect to depth, shore-line topography and organic pollution. The proximity of these ponds gave an advantage of studying them conveniently both in the field as well as in the laboratory. The descriptions of these ponds are given below.

The bottom contour of all these ponds were determined after recording the depth at various locations with the help of a graduated pole and are shown in figure 2, 4, and 6.

SH pond: Maximum depth 7 meter, steep sides, fed by ground water flow and rain, polluted with human contamination, little macrovegetation.

PG pond: Maximum depth 5 meter, side broken, fed by rain and ground water flow, polluted with dead leaves, excessive bathing, washing and sewage occasionally during monsoon, some macrophytes and rooted vegetation up to 1.5 meter

SB pond: Shallow, shelve gentle, fed by rain and sewage outflow, heavily polluted with sewage, domestic wastes and foul waters, macrovegetation.

General feature of the ponds

Shahidullah Hall Pond (Fig. 1 & 2):

This artificial pond is situated in the Curzon Hall Campus of Dacca University, in front of the Zoology Department, and in between Shahidullah Hall and Fazlul Haque Hall. Earlier, it was known as Nawab Dighi and was excavated by Lieutenant Swinton of East Indian Company in 1766 for domestic use while he constructed the Nimtali palace to accommodate the then Nawab family of Dacca (Taeesh, 1910). The pond was reexcavated in 1921 when Dacca University Campus came into existence. In 1961 the pond was dried up by pumping out its water and remained so for a few days.

The pond is rectangular in shape and it covers an area of 0.97 ha with the maximum depth of 7 m. The slope of the pond is

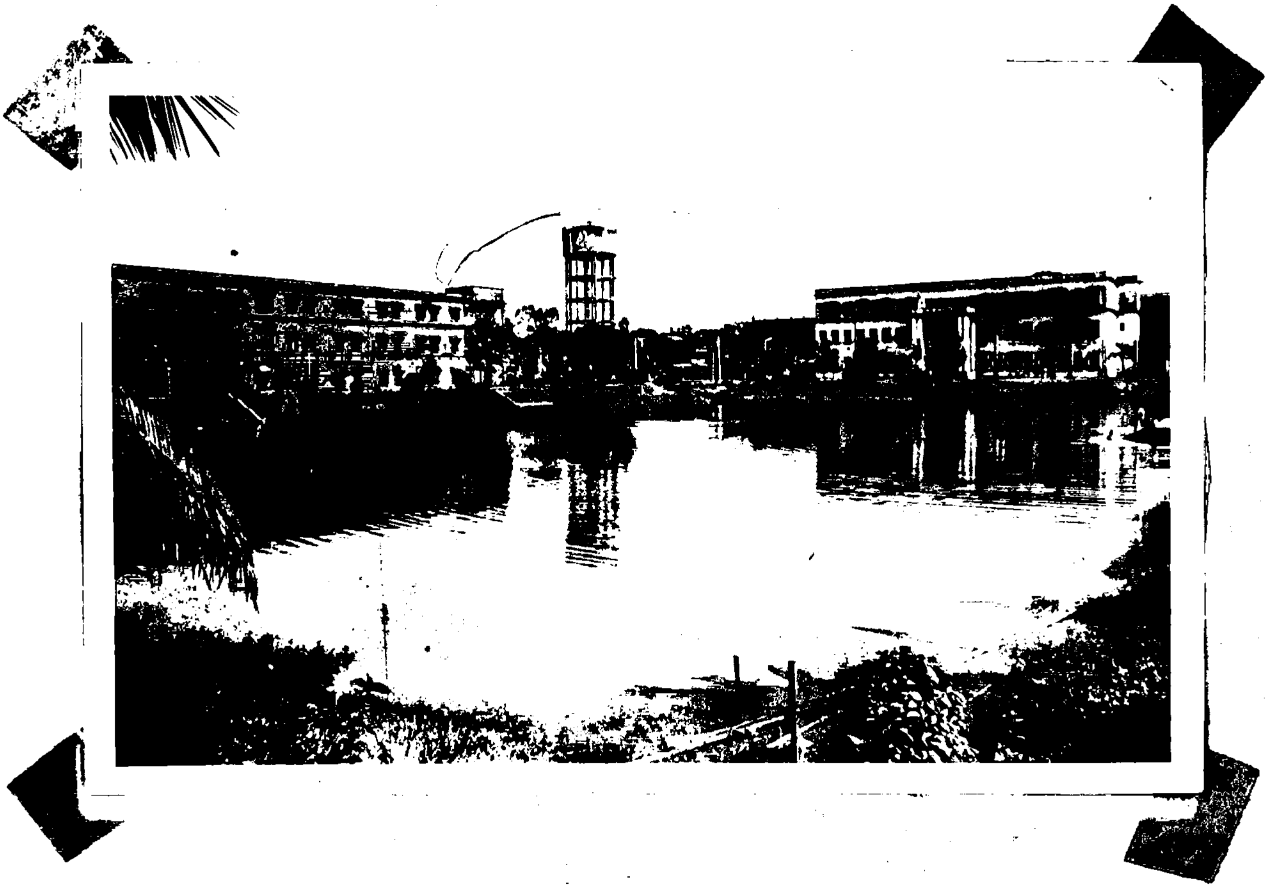

Fig. 1 Showing the picture of Shahidullah Hall pond.

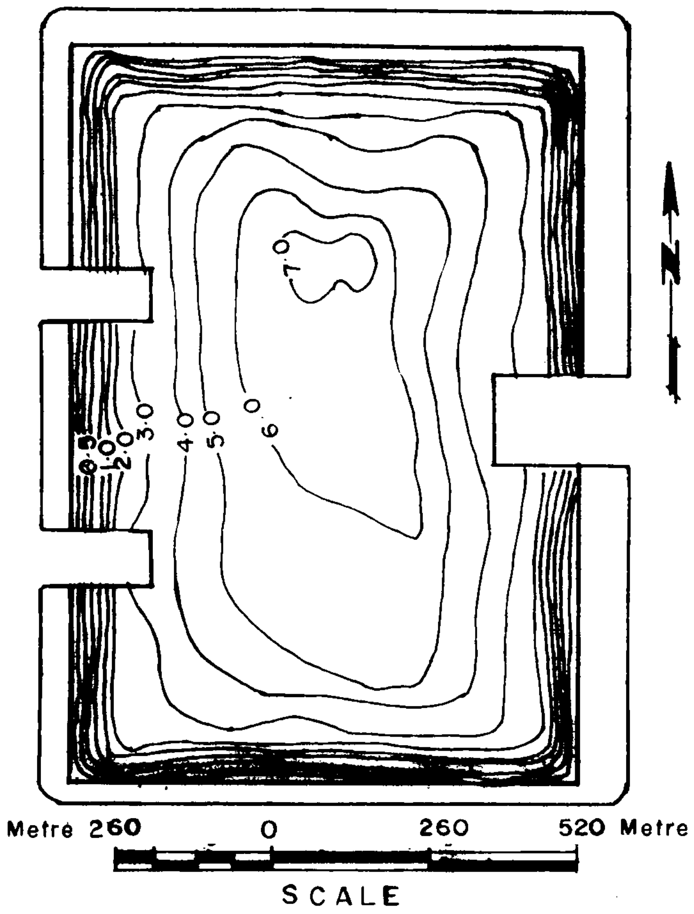

Fig. 2 Showing the contour map of Shahidullah Hall (SH) pond.

sharp and its margins shelve steeply. The pond has no outlet and inlet. It depends entirely upon the rainfall and ground water flow for replenishment of water. The pond water is used by the local people for bathing and washing all throughout the year. In dry season when the water level is reduced its colour becomes turbid due to bloom formation and contamination from human interference. But on the whole the pond is not much polluted. Of the macrovegetation, only *Alternanthera philoxeroides* (Mart.) Griseb and some grasses were found to grow thinly in its shallow margins. However, luxuriant algal flora, some of which forming water bloom, were noted frequently. *Oedogonium crassum* (Hassall) Wittrockex Hirn (Islam & Sarma, 1976), *Euglena* sp., *Microcystis* spp., *Lyngbya* sp. along with different kinds of diatoms have been recorded from the pond (Islam, unpublished).

Play Ground Pond (Fig. 3 & 4)*:

The pond was situated within the Dacca University Play Ground premises. It was constructed in 1766 close to a burial ground by the then Nawab of Dacca (Taeesh, 1910). The pond was triangular in shape. It had a surface area of 0.40 ha with maximum depth of 5 m. The margin of the pond is broken and its slope is not very sharp at the margins and thereafter a gentle slope was recorded. The pond was used extensively for washing and bathing by local people. There were a

* Recently the pond has been filled up in order to extend the play ground.

Fig. 3 Showing the picture of Play Ground pond.

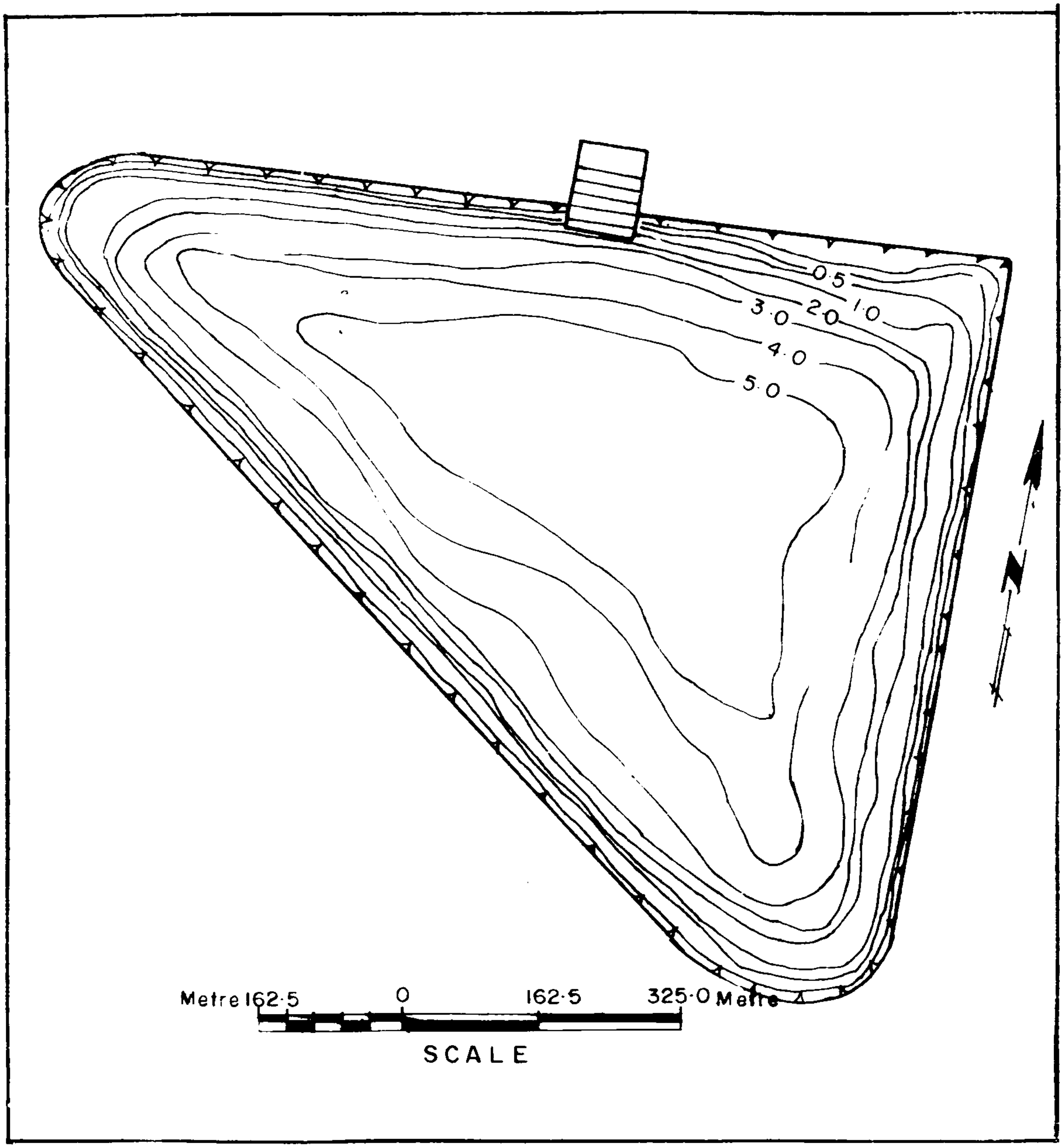

Fig. 4 Showing the contour map of Play Ground (PG) pond.

number of tall trees of *Albizzia richardiana* King and Prain, close to its eastern and southern banks. These trees appeared to have played a vital role in the ecology of the pond by increasing organic carbon content through leaf litter, especially during late winter when countless leaves fell from these trees. The pond did not have any outlet or inlet and depended entirely on rain and ground water flow for its replenishment. However, during monsoon the pond used to be continuous occasionally with the adjacent 'katch'* drain and contaminated by its heavily polluted water which carried waste organic materials and other garbages from the nearby Dacca Medical College hospital.

The dominant macroflora of the pond were *Nymphaea nouchali* Burm b., *Ludwigia adscendens* (L.) Haras, *Alternanthera philoxeroides* (Mart.) Griseb, *Hydrilla verticillata* Casp. The rooted vegetations were noted to extend up to 1.5 meter depth. *Microcystis flos-aquae* (Wittr.) Kirchner and *M. aeruginosa* Kuetz. (blue green algae) were found to form blooms almost throughout the year. The pond may be said to be polluted one.

Shahabagh Pond (Fig. 5 & 6):

This shallow pond is irregular in shape and is situated on the western side of the 'Institute of Post Graduate Medicine and Research' hospital and its surrounding shops. It was a part of the old river

---

* Earthen drain; non-cemented.

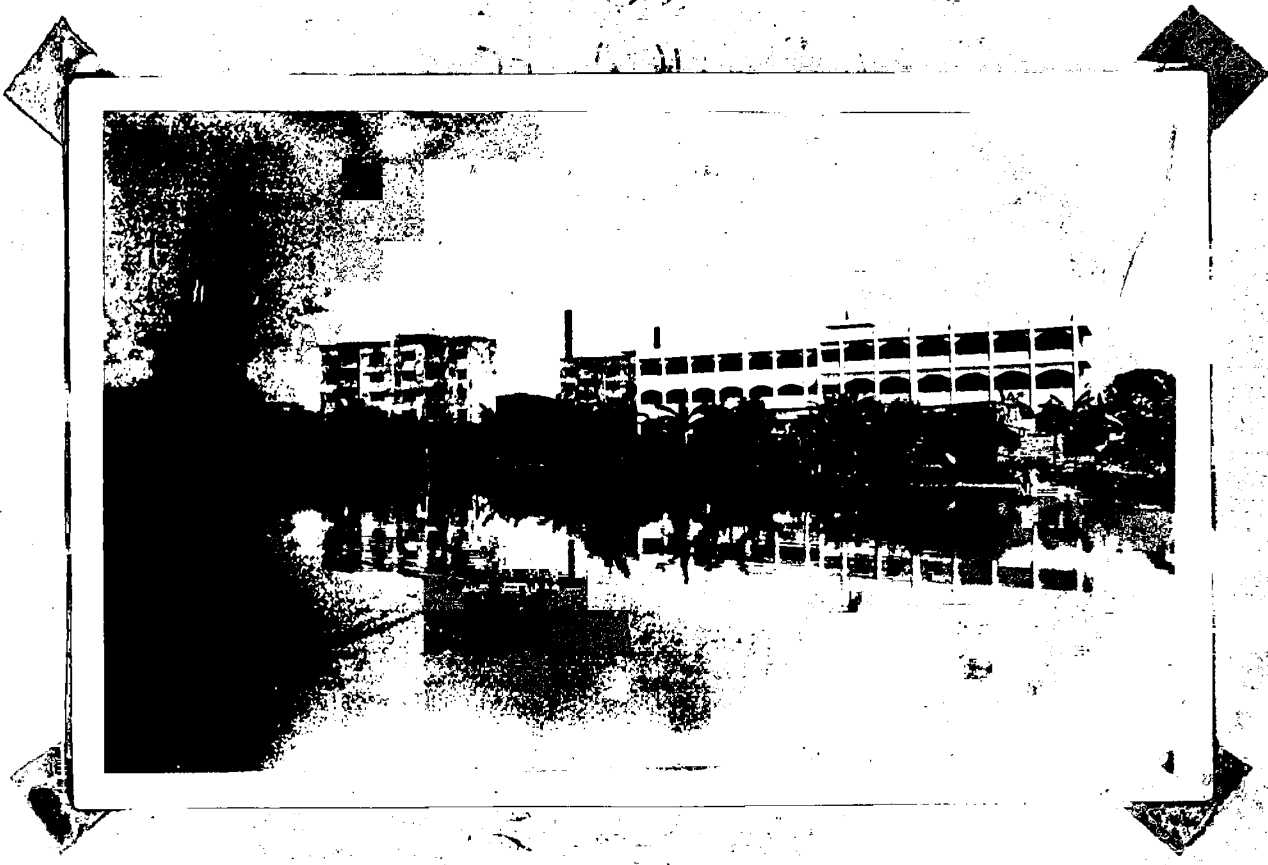

Fig. 5 Showing the picture of Shahabagh pond.

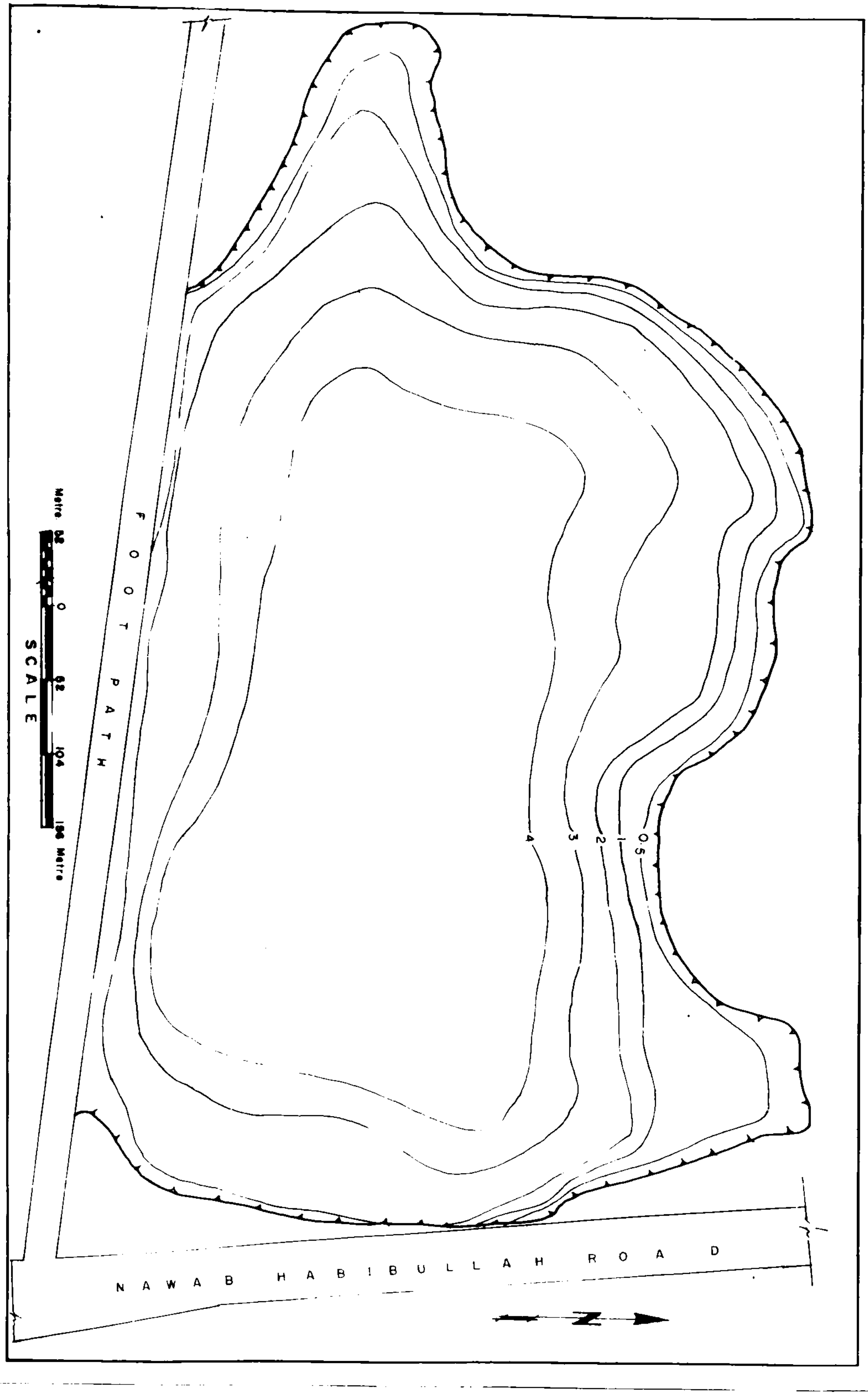

Fig. 6 Showing the contour map of Shahabagh (SB) pond.

system gradullay disappeared. In the early fifties, when new roads were constructed through this area, this pond took its present shape and size. The pond has a surface area of 0.27 ha with the maximum depth of 4 m. and has a gentle slope on its sides. It occasionally receives sewage water through an underground drain. Apart from the sewage water, the pond also receives domestic wastes and foul water from neighbouring areas. The pond may be said to be heavily polluted one.

The pond has the following macrovegetations:

Commelina sp., *Alternanthera philoxeroides* (Mart.) *Griseb*, and *Ipomoea aquatica* Forsk.

Its algal flora consists of:

Chlamydomonas sp., *Pediastrum* sp., *Coelastrum* sp., *Scenedesmus* sp., *Closteriopsis* sp., *Schizomeris* sp., *Closterium* sp., *Spirogyra* sp., *Oedogonium* sp., *Euglena* sp., *Phacus* sp., *Trachelomonus* sp., *Melosira* sp., *Fragilaria* sp., *Synedra ulna* (Nitzsch.) Ehr., *Navicula* sp., *Nitzschia* sp., *Merismopidia* sp., *Microcystis aeruginosa* Kuetz, *Oscillatoria* sp., (Islam & Sarker, unpublished report).

The algal flora was found to form bloom nearly throughout the periods and became luxuriant in winter.

In July 1977 cultivation of transplanted rice plants was found around the shallow marginal water of the pond and the paddy was harvested in early November.

Climate of Dacca City

Dacca lies between latitude 23°41' and 23°52'N and longitude 90°20' and 90°27'E and about 7.3 m above the sea level. Although Bangladesh is customarilly characterized in having six seasons in a year only four of them could be clearly differentiated. These are as follows:

1. Winter (November - February):- Winter is cool and dry. During this period the minimum and maximum air temperatures fluctuate between 10° and 30°C. Rainfall is negligible during this season.

2. Summer (March - May):- It is warm and dry. Occasional heavy showers accompanied by thunderstorm and 'Nor'wester' in late summer are quite common. The minimum and maximum air temperatures vary between 31° and 35°C.

3. Monsoon (June - August):- An average rainfall of about 190 cm occurs during monsoon. Air temperature does not drop significantly and occasional hotter days with about 34°C or more are not uncommon in this season.

4. Autumn (September - October):- Heavy showers are occasionally recorded in early autumn. During this season the minimum and maximum air temperatures vary between 23° and 32°C.

Sampling Procedures

In the present study, only littoral and sublittoral zones could be clearly demarcated because of the lesser depths of the ponds. After preliminary survey it has been observed that the bottoms of all the three ponds were almost devoid of macrobenthic invertebrate population below 3 m depth. Thus, samplings of macrobenthos were restricted up to the depth of 3 m. In each pond samplings were made from three distinct depths, irrespective of the rise and fall of water level in different seasons. These are:

(A) Close to water margin, about 0.2 m in depth.

(B) 1 m depth. Normally rooted vegetation were restricted up to this depth. However, in PG pond *Nymphaea nouchali* was found to grow up to the depth of 1.5 m.

(C) 3 m depth.

Physico-chemical Parameters of Water

The water samples were collected fortnightly between 09:00 and 10:00 a.m. along with macrobenthos from the three depths. Surface water from corresponding B and C depths were also collected. A plastic bucket was used to collect surface water without disturbing the water surface as far as practicable. A Kemmerer's water sampler was used to collect water from the bottom of depth B and C. Immediately after collection, the samples were transferred to glass stoppered bottles and were brought to the laboratory for chemical analyses.

Physical

(a) Rainfall : Data of average monthly rainfall were received from the Department of Meterorology, Government of Bangladesh.

(b) Air temperature : Data of maximum and minimum air temperatures were received from the Department of Meterorology, Government of Bangladesh.

(c) Water temperature : A centigrade thermometer was used to record water temperature. Readings of temperature for bottom water at depths B and C were recorded at the raft immediately after sampling.

Chemical

All chemical analyses of water except pH and H_2S were determined following APHA (1971).

(a) pH value : It was determined by Corning electric pH meter using a glass electrode.

(b) Dissolved Oxygen : DO was determined by azide modification of Winkler method.

(c) Free carbondioxide : Free CO_2 was measured by titrimetric method.

(d) Carbonate and bicarbonate : Carbonate and bicarbonate alkalinity were estimated by alkalinity relationships as obtained from Phenophthalin.

(e) Chloride : It was determined by argentometric method.

(f) Total Nitrogen : It was estimated by Kjeldal's method.

(g) Phosphate : It was measured by stannous chloride method.

(h) Potassium : It was determined by 'Flame photometric' method.

(i) Calcium and Magnesium : Ca and Mg were measured by EDTA method.

(j) Organic Carbon : It was determined by combustion infrared method.

(k) Hydrogensulphide : H_2S was measured by titrimetric method following Golterman (1971).

The values of chemical parameters of water except pH are expressed in ppm.

Physico-chemical Properties of Soil*

Bottom soil was sampled monthly from three depths along with macrobenthos. The following physico-chemical properties of soil were recorded:

(a) Physical

Temperature : It was recorded with a centrigrade thermometer immediately after sampling.

(b) Mechanical analysis : Mechanical analysis of soil was carried out once at each depth of ponds by hydrometer method (Boyoucos, 1928).

(c) Chemical

pH : It was measured electrochemically with a Corning pH meter using a glass electrode in saturated paste condition.

---

* To see the total bacterial population at different depths a preliminary bacterial count was made only once in a year after culturing soil samples from each depths of each ponds following Chowdhury *et al.* (1969). From these an idea could be obtained regarding the bacterial populations and the macroinvertebrate growth. However, the aspect was not persuaded in greater detail. More systematic work is needed in this line.

(d) Total and available nitrogen : Total and available nitrogen were determined by Kjeldehl method following Jackson (1958).

(e) Organic carbon : It was estimated by Walky and Black's rapid titration method following Jackson (1958).

(f) Exchangeable calcium : It was measured by 'Flame photometric' method.

(g) Available phosphorus : It was estimated by the method of Truog (1930). 0.002 NH_2SO_4 (pH - 3.0) was used as the extracting agent (soil and extractant ratio being 1:20 and period of shaking being 1 hour). Phosphorus in extractant was finally determined colorimetrically (Dickman & Bray, 1941, *c.f.* Jackson, 1958).

Populations of Macroinvertebrates Abundance

Two samplings of macroinvertebrates were collected fortnightly from each depth between 09:00 and 10:00 a.m. with the help of an Ekmann grab (225 cm^2). At depth A the grab was pressed into the substratum by hand. At depth B and C the grab was operated with nylon cord. A sieve with 0.4 mm mesh size was used to screen out mud. Then the remaining mud and dirt from the sieve were shifted to a large petridish with black and white back ground, and washed successively in tap water while the sorting of living organisms was made. Organisms were fixed in 4% formalin. It was not possible to sample all the three ponds on the same day, but they were sampled within the same week. Sometimes owing to unavoidable circumstances, monthly samplings were made. In two years a total of 38, 41, and 39 samples were made from SH, PG and SB ponds respectively.

Oligochaetes were identified up to species level following Naidu (1962, 1965), Brinkhurst & Jamieson (1971), Ali (1973), Ali & Issaque (1975), and Ali & Rashiduzzaman (1976). Identification of molluscs were carried out following Satyamurti (1960), and Ali & Begum (1976). Other benthos were separated up to different taxa following Ward & Whipple (1959), Mellanby (1963), and Macan (1964).

Biomass

In order to determine the biomass, individuals of different species of tubificids (Oligochaetes) were separated to three size groups. These are:

(i) 2 - 5 mm in length

(ii) Above 5 - 15 mm in length

(iii) Above 15 mm.

These groups are termed as small, medium, and large respectively. One hundred individuals of each group were kept at 60^{o}C for 48 hours. Dry weight of each size group in five replicates was taken with the help of an electronic balance after cooling the samples in a desiccator. Then the average weight of an individual of each species belonging to respective size groups was calculated. For naidids (Oligochaetes) and molluscs, individuals of a species were not separated into different size groups and dry weight of all the individuals of each species in every sample was noted throughout the period of study. Dry weights of other groups of benthos were recorded similarly.

Mutual association test among dominant oligochaete species was carried out following Pearson & Hartley (1958).

Simple regressions between and density of organisms and environmental factors were calculated from the following models:

$$Y = A + B X + e$$

Where Y = No. of organisms

X = Environmental factors (Physico-chemical properties of water and soil) like temp., pH, DO, CO_2 organic carbon, etc.

A and B are unknown constants.

e = Random error.

Multiple regressions between density of organisms and physico-chemical conditions of water were carried out as per the following models:

$$Y = A + B_1X_1 + \text{----------------} + B_8X_8 + e$$

Where Y = No. of organisms

A, B_1 --------- B_8 are unknown constant

X_1 = Temperature

X_2 = pH

X_3 = Dissolved oxygen

X_4 = Free carbondioxide

X_5 = Nitrogen

X_6 = Phosphate

X_7 = Calcium

X_8 = Organic carbon

e = Random error.

Table 1 : Showing the annual average of physico-chemical parameters (chemical parameters are expressed in ppm) and density of total fauna and its major groups (abundance /m^2) with standard deviation at depth A of three ponds.

	Shahidullah Hall Pond		Play Ground Pond		Shahabag Pond	
	1976	1977	1976	1977	1976	1977
Temp.	26.18 ± 5.239	25.13 ±3.83	24.14 ±5.06	23.095 ±4.618	24.62 ±5.69	23.42 ±4.60
pH	7.44 ± .57	7.96 ±.64	7.00 ±.44	7.13 ±0.25	7.32 ±.63	7.28 ±.60
DO (ppm)	7.26 ±4.01	9.715 ±2.05	6.66 ±2.72	9.155 ±2.69	6.47 ±3.02	8.25 ±2.87
CO_2 (ppm)	4.905 ±4.18	2.49 ±2.23	7.56 ±3.94	6.665 ±2.545	5.905 ±4.93	7.666 ±5.44
HCO_3 (ppm)	62.52 ±19.56	44.63 ±12.09	59.67 ±24.06	50.15 ±16.52	59.4 ±27.955	70.57 ±22.64
Cl (ppm)	24.95 ±4.02	24.29 ±2.88	25.71 ±1.71	25.625 ±2.095	36.75 ±5.75	31.58 ±6.74
N (ppm)	.58 ±.09	.64 ±.11	.748 ±.28	0.86 ±0.10	.75 ±.34	.74 ±.14
PO_4 (ppm)	.05 ±.04	.05 ±.04	.05 ±.04	0.059 ±0.047	.067 ±.04	.07 ±.05
Ca (ppm)	10.03 ±1.7	10.39 ±.93	10.49 ±2.095	9.74 ±1.77	17.48 ±2.975	18.81 ±1.82
Mg (ppm)	5.61 ±.9	5.02 ±.885	4.82 ±.93	4.395 ±.93	8.215 ±1.68	8.24 ±.99
K (ppm)	5.607 ±1.31	6.665 ±2.38	4.37 ±.91	4.455 ±1.48	6.28 ±1.27	6.97 ±1.20
OC (ppm)	64.79 ±14.42	64.16 ±12.15	94.43 ±9.72	97.80 ±9.52	89.35 ±11.67	85.00 ±9.91
Oligochaetes	258.46 ±282.24	429.836 ±251.18	939.58 ±769.375	1232.88 ±747.58	2015.72 ±1492.96	2170.57 ±1446.56
Chironomids	161.24 ±287.47	246.168 ±331.146	193.238 ±357.09	128.76 ±350.398	575.52 ±696.537	1218.336 ±1802.186
Molluscs	52.578 ±36.03	157.378 ±106.976	92.828 ±91.548	328.24 ±330.05	69.74 ±99.45	105.83 ±175.456
Mites	23 ±1.00	5.115 ±14.12	18.11 ±43.54	19.8 ±44.265	520.91 ±721.03	342.768 ±603.50
Ostracoda	13.09 ±35.225	9.20 ±22.04	32.019 ±74.50	9.68 ±29.067	313.86 ±425.9	119.726 ±153.78
Leech	.46 ±1.387	.69 ±1.65	1.257 ±3.155	5.06 ±10.708	1.54 ±3.278	5.326 ±7.84
Planaria	- -	- -	7.33 ±21.48	.44 ±1.35	73.86 ±155.97	6.378 ±11.17
Odonata	- -	- -	10.057 ±11.98	5.94 ±12.136	7.74 ±12.365	2.29 ±3.66
Others	11.81 ±15.10	13.61 ±22.507	[illegible]	1.54 ±2.585	7.26 ±12.385	6.02 ±14.00
Total fauna	497.88 ±481.22	862.057 ±421.888	1576.435 ±1362.957	1587.34 ±878.4	3536.18 ±2269.7	3977.43 ±1824.55

Table 2 : Showing the annual average of physico-chemical parameters (expressed in ppm) and density of total fauna and its major groups (abundance /m²) with standard deviation at depth B of the three ponds.

	Shahidullah Hall pond				Play Ground Pond				Shahabag Pond			
	1976		1977		1976		1977		1976		1977	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
Temp.	26.21 ±5.22	25.11 ±4.9	25.13 ±3.64	24.29 ±3.13	24.33 ±5.14	23.48 ±5.03	23.23 ±4.56	22.375 ±4.03	24.82 ±5.78	23.78 ±5.29	23.39 ±4.59	22.24 ±3.8
pH	7.3 ±.57	6.99 ±.52	7.81 ±.67	7.505 ±.57	6.97 ±.355	6.785 ±.33	7.215 ±.26	6.95 ±.81	7.165 ±.54	6.805 ±.51	7.32 ±.51	7.14 ±.55
DO (ppm)	8.47 ±2.75	5.84 ±2.05	9.51 ±2.195	8.43 ±2.20	6.58 ±2.27	5.30 ±2.73	9.84 ±2.28	8.145 ±2.42	6.97 ±3.31	4.78 ±2.27	8.51 ±2.995	7.71 ±3.35
CO_2 (ppm)	3.91 ±3.31	7.4 ±5.46	2.61 ±2.30	4.03 ±2.97	6 ±3.71	9.43 ±5.24	5.44 ±2.51	8.05 ±2.61	6.189 ±5.06	10.125 ±6.08	6.68 ±3.68	8.27 ±5.51
HCO_3 (ppm)	44.84 ±14.295	74.57 ±18.82	45.79 ±13.99	55.105 ±14.18	47.31 ±20.98	70.14 ±26.76	45.7 ±13.247	57.3 ±23.52	49.789 ±31.28	85.135 ±32.83	79.7989 ±16.04	89.19 ±17.02
Cl (ppm)	25.105 ±4.24	25.47 ±4.59	24.609 ±3.56	24.46 ±3.55	24.19 ±3.84	24.19 ±3.84	26.7 ±4.29	26.3 ±3.26	36.3 ±6	36.4 ±6.51	31.05 ±6.08	31.315 ±6.24
N - (ppm)	.605 ±.27	.794 ±.30	.56 ±.07	.58 ±.085	.73 ±.24	.95 ±.32	.78 ±.10	1.01 ±.26	.75 ±.35	1.09 ±.42	.675 ±.11	.80 ±.19
PO_4 (ppm)	.08 ±.14	.06 ±.03	.05 ±.03	.04 ±.03	.06 ±.04	.09 ±.05	.05 ±.03 9	.06 ±.04	.09 ±.16	.09 ±.04	.08 ±.05	.11 ±.06
Ca (ppm)	10.91 ±1.815	12.00 ±2.21	9.805 ±.705	9.99 ±.79	10.62 ±1.84	11.56 ±1.75	9.21 ±1.11	9.195 ±1.24	16.915 ±2.075	19.02 ±1.20	20 ±1.33	20.47 ±2.48
Mg (ppm)	5.51 ±11.43	5.915 ±1.78	5.19 ±.78	5.21 ±.82	4.82 ±1.06	5.01 ±1.17	4.175 ±.9	4.245 ±1.08	7.825 ±1.14	8.665 ±.92	7.99 ±.998	7.89 ±1.06
K (ppm)	4.40 ±.59	4.48 ±.62	6.53 ±1.93	6.405 ±1.71	4.17 ±.91	4.26 ±1.04	4.495 ±1.53	4.45 ±1.56	6.915 ±1.18	7.06 ±1.07	7.28 ±1.24	7.34 ±1.25
OC (ppm)	72.105 ±8.875	71.79 ±9.97	66.00 ±9.18	68.63 ±9.49	93.48 ±10.99	94.57 ±13.35	94.75 ±8.08	98 ±19.05	86.5 ±7.64	92.46 ±17.27	84.58 ±9.13	81.58 ±14.14
Oligochaetes		225.68 ±316.66		267.936 ±193.22		614.67 ±438.46		979.83 ±421.37		670.12 ±702.498		1215.09 ±865.948
Chironomid		12.48 ±23.42		54.2 ±58.705		70.90 ±151.65		44 ±119.939		113.26 ±252.69		220 ±443.94
Molluscs		105.96 ±94.62		103.52 ±81.32		50.076 ±69.38		104.5 ±168.419		38.5 ±52.41		20.55 ±31.567
Others		.69 ±2.21		1.85 ±2.67		4.81 ±7.08		4.4 ±6.54		34.1 ±56.309		6.02 ±11.09
Total fauna		344.09 ±351.49		426.81 ±207.65		740.51 ±460.64		1132.73 ±414.96		854.88 ±867.77		1461.668 ±961.837

Table 3 : Showing the annual average of physico-chemical parameters (expressed in ppm) and density of total fauna and its major groups (abundance /m^2) with the respective standard deviation at depth C of the three ponds.

	Shahidullah Hall Pond				Play Ground Pond				Shahabag Pond			
	1976		1977		1976		1977		1976		1977	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
Temp.	26.13	24.29	24.95	23.74	24.05	22.595	23.025	21.85	24.575	23.00	23.13	21.47
	±5.25	±4.6	±3.67	±2.86	±5.09	±4.57	±4.41	±3.62	±5.87	±4.96	±4.32	±3.25
pH	7.29	6.83	7.91	7.01	6.96	6.61	7.225	6.725	7.085	6.685	7.355	6.77
	±.57	±.51	±.51	±.39	±.4	±.43	±.32	±.31	±.51	±.47	±.56	±.43
DO (ppm)	7.99	4.54	9.84	6.105	7.25	4.51	10.05	8.09	6.475	3.965	9.28	6.84
	±2.55	±2.63	±1.83	±2.29	±2.05	±2.84	±2.51	±2.05	±2.48	±2.575	±2.87	±3.26
CO_2 (ppm)	4.56	11.33	2.87	10.52	7.25	18.55	6.02	16.6	6.455	16.25	6.09	21.74
	±3.61	±6.87	±2.22	±6.25	±4.26	±8.47	±2.28	±7.48	±5.12	±10.76	±4.09	±22.09
HCO_3 (ppm)	50.315	75.37	43.84	62.13	54.85	95.81	45.65	66.68	73.95	137.8	88.42	157.95
	±17.64	±33.78	±13.15	±13.90	±25.44	±30.75	±14.29	±25.16	±32.45	±33.56	±14.94	±6.29
Cl (ppm)	24.95	25	24.29	24.39	25.71	25.86	25.825	26.075	35	35.5	26.47	26.74
	±3.66	±3.73	±2.87	±2.88	±2.87	±2.90	±2.295	±2.21	±5.13	±5.6	±3.41	±3.74
N (ppm)	.665	1.07	.55	.615	.79	1.065	.84	.85	.725	1.15	.65	.86
	±.21	±.49	±.05	±.06	±.16	±.23	±.12	±.11	±.23	±.39	±.15	±.239
PO_4 (ppm)	.05	.085	.06	.09	.05	.097	.036	.076	.069	.12	.075	.21
	±.02	±.045	±.04	±.07	±.016	±.038	±.01	±.05	±.03	±.04	±.07	±.1
Ca (ppm)	11.34	13.47	9.89	10.39	10.57	12.91	9.31	10.42	18.29	21.45	20.59	23.46
	±2.08	±2.61	±.75	±1.24	±2.07	± 3	±1.22	±2.54	±2.36	±1.43	±3.73	±3.15
Mg (ppm)	5.97	6.68	5.06	5.09	4.85	5.13	4.225	4.385	8.135	8.995	7.92	8.97
	±1.6	±1.955	±.79	±.85	± 1	±.98	±.86	±.96	±.95	±.785	±1.17	±1.39
K (ppm)	4.57	4.79	6.58	6.915	4.15	4.24	4.58	4.46	6.78	7.12	7.31	7.64
	±.59	±.68	±1.96	±2.41	±.77	±.84	±1.64	±1.54	±1.09	±1.22	±1.54	±1.67
OC (ppm)	72.95	81.32	67.53	86.05	98.76	98.24	96.4	97.35	88.3	107.5	82.95	96.79
	±8.43	±17.20	±10.5	±21.51	±23.26	±4.29	±18.03	±10.06	±8.35	±12.51	±13.39	±9.95
Oligochaetes		13.315		3.01		5.657		.88		5.94		.69
		±26.67		±5.298		±11.98		±2.708		±11.795		±2.206
Chironomid		2.53		4.4		3.35		-		1.1		-
		±4.87		±12.786		±7.48		-		±3.46		-
Chaoborus		19.22		25		29.75		27.28		3.08		5.62
		±24.76		±26.553		±47.73		±45.98		±6.71		±11.539
Others		.46		32.41		.838		-		1.98		11.347
		±2.02		±30.56		±2.25		-		±5.615		±33.838
Total fauna		35.74		32.41		39.6		28.16		21.1		17.66
		±51.80		±30.56		±46.335		±46.22		±18.16		±45.096

CHAPTER III

PHYSICAL AND CHEMICAL FEATURES OF WATER

Physico-chemical parameters of the three ponds were studied at an interval of a fortnight, but sometimes these were recorded only once in a month due to some unavoidable circumstances. Data on physical and chemical conditions of water of three ponds are shown in Tables 1 - 5, and Figs. 7 - 15.

RESULTS AND OBSERVATIONS

Temperature

SH Pond (Figs. 7 - 9)

In 1976 the highest surface temperature corresponding to A, B, and C was noted to be 33°, 32°, and 33°C respectively, from late July to August. At B the temperature was found to reach its peak of 32°C in late July, whereas at C the maximum temperature of 31°C was observed from late July to August.

However, in 1977, the maximum surface temperature corresponding to A, B, and C was recorded to be 31°, 30°, and 30°C respectively in May with their corresponding bottom temperature, 29°C, during the same

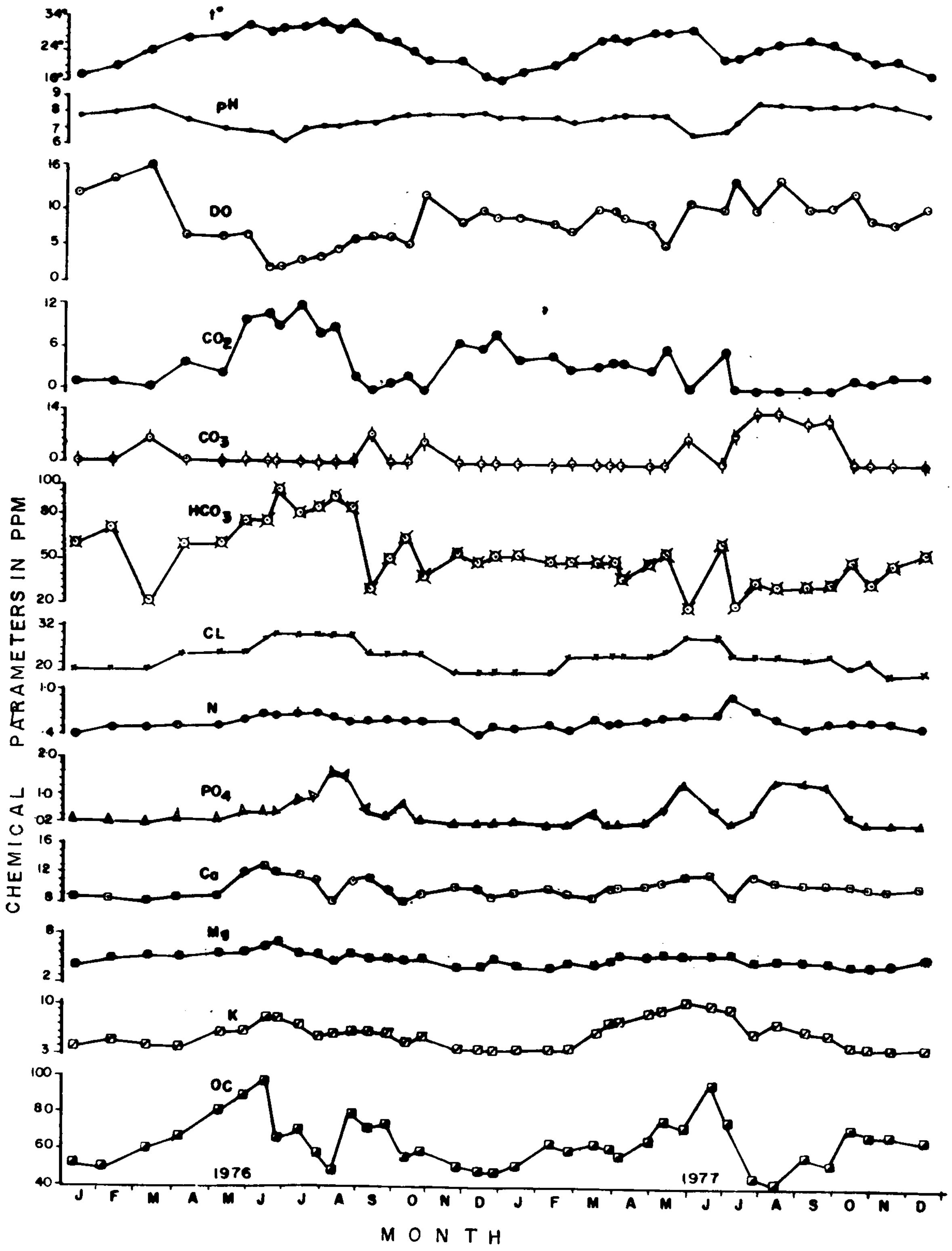

Fig. 7 Graphs showing seasonal changes in temperature, and pH and 11 chemical parameters at depth A in SH pond.

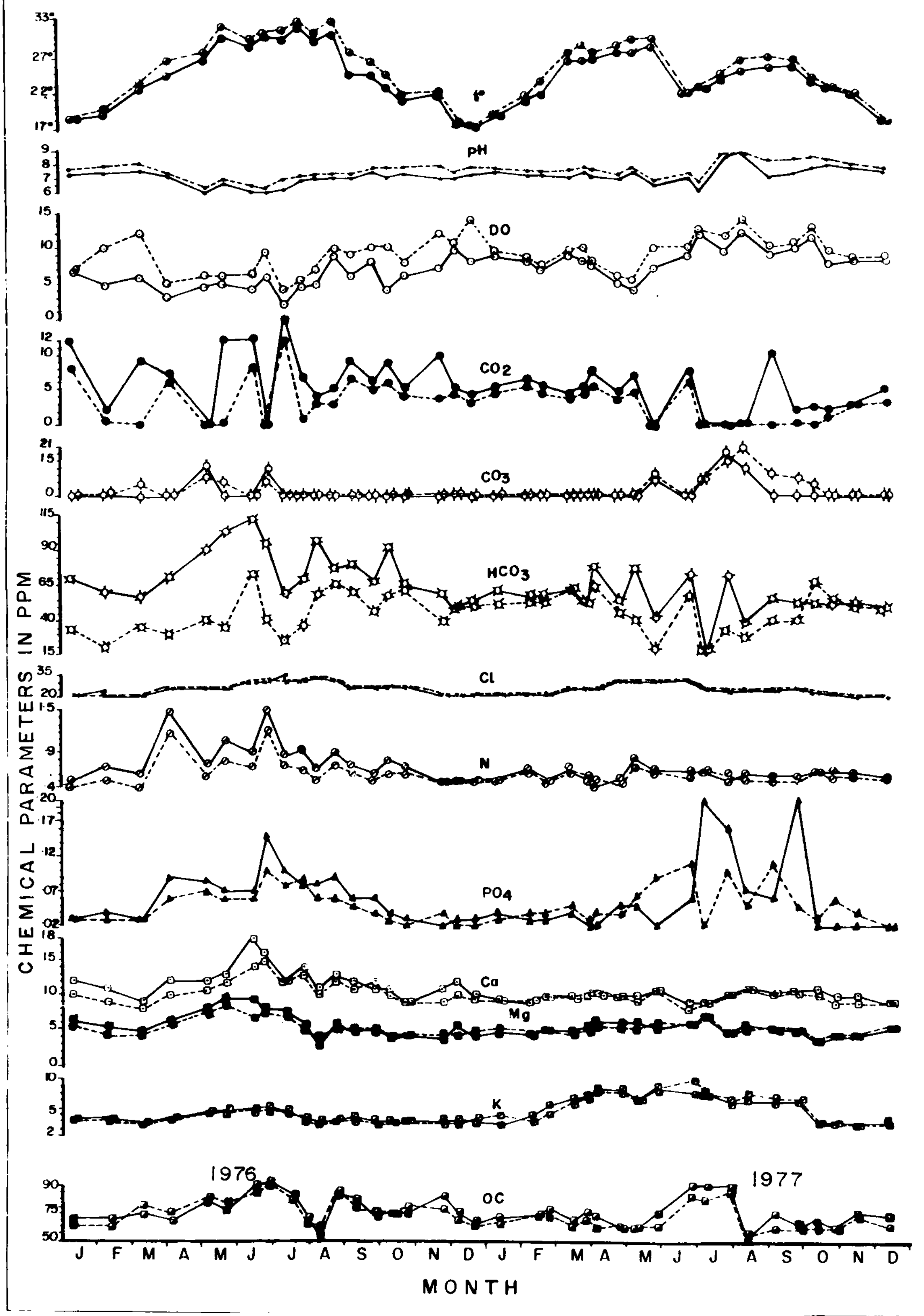

Fig. 8 Graphs showing seasonal changes in temp., pH and 11 chemical parameters at depth B in SH pond. (Broken lines represent surface water, unbroken lines represent bottom water).

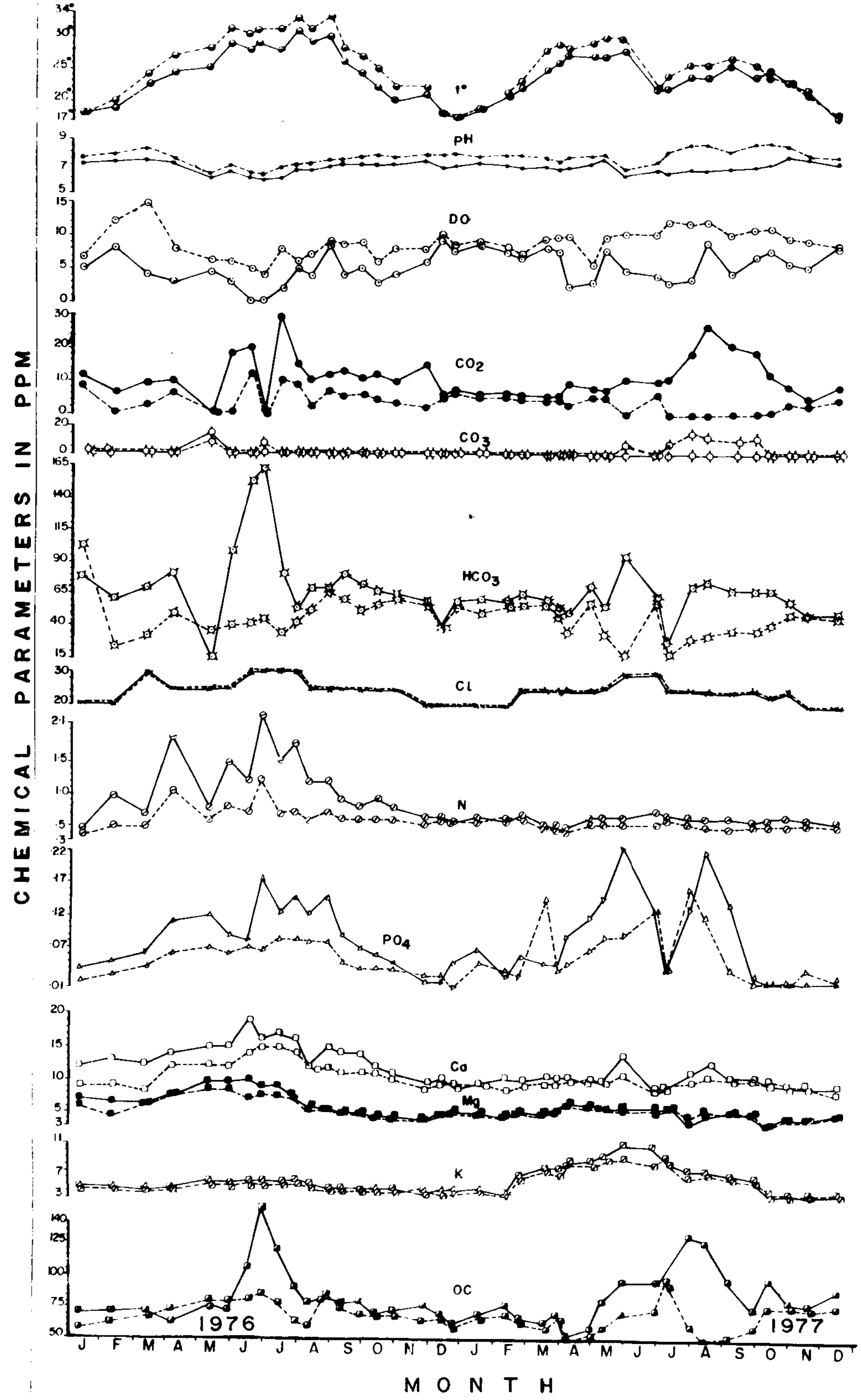

Fig. 9 Graphs showing seasonal changes in temperature, pH and 11 chemical parameters at depth C in SH pond (Broken lines represent surface water, unbroken lines represent bottom water).

month. The minimum surface and bottom temperatures for 1976 and 1977 were found during December in all the three depths.

PG Pond (Figs. 10 - 12)

In 1976 at A the highest surface temperature of 30°C was found during May and August, whereas at B and C the surface temperature was found to be 30°C during May, June, July and August. The maximum bottom temperature of 29.5°C at B was noted during June and August and 29°C at C during August.

The lowest temperatures for surface and bottom waters were observed during December in all the sampling depths.

In 1977 the maximum temperature of 29°C was noted at A in May, at the surface at B in April and May and at C in May. The highest bottom temperature of 28°C at B was noted in May and that of C 27°C in April and May. The lowest surface and bottom temperature at A and B were found in January and December, respectively. At C the surface temperature was minimum during January and the bottom temperature during December.

SB Pond (Figs. 13 - 15)

In 1976 at A the highest temperature of 31°C was noted during July and August and the lowest 15°C during January and December. The maximum temperature of 31°C was recorded in August at the surface corresponding to the depth B and C, whereas the maximum temperature of 30° and 29°C was found respectively at B and C in August and the minimum was 15°C in January.

In 1977 at A the highest temperature of 30°C was noted during April. The highest surface temperature of 30°C was recorded at B and C and the bottom temperature 29°C at B and 27°C at C were found during April and May. The lowest temperature of 15°C for both surface and bottom water was observed during December in all sampling depths.

Thus, among the three ponds, the highest average temperature of 26.2° and 25.1°C was observed in SH pond in 1976 and 1977 respectively. In PG pond the average temperature of 24.1° and 23.4°C and that of SB pond was 24.3° and 23°C in 1976 and 1977 respectively (Table 5).

pH

SH Pond (Figs. 7 - 9)

In SH pond at A pH was noted to vary from 6.2 - 8.2 and 6.7 - 8.7 during the first and second year. At B the lowest and highest pH of surface water was found to be 6.2 and 8.2 in 1976 and 6.3 and 8.9 in 1977, respectively. The pH value of bottom water at B was found to range from 6.0 - 7.6 and 6.7 - 8.9 for the same periods.

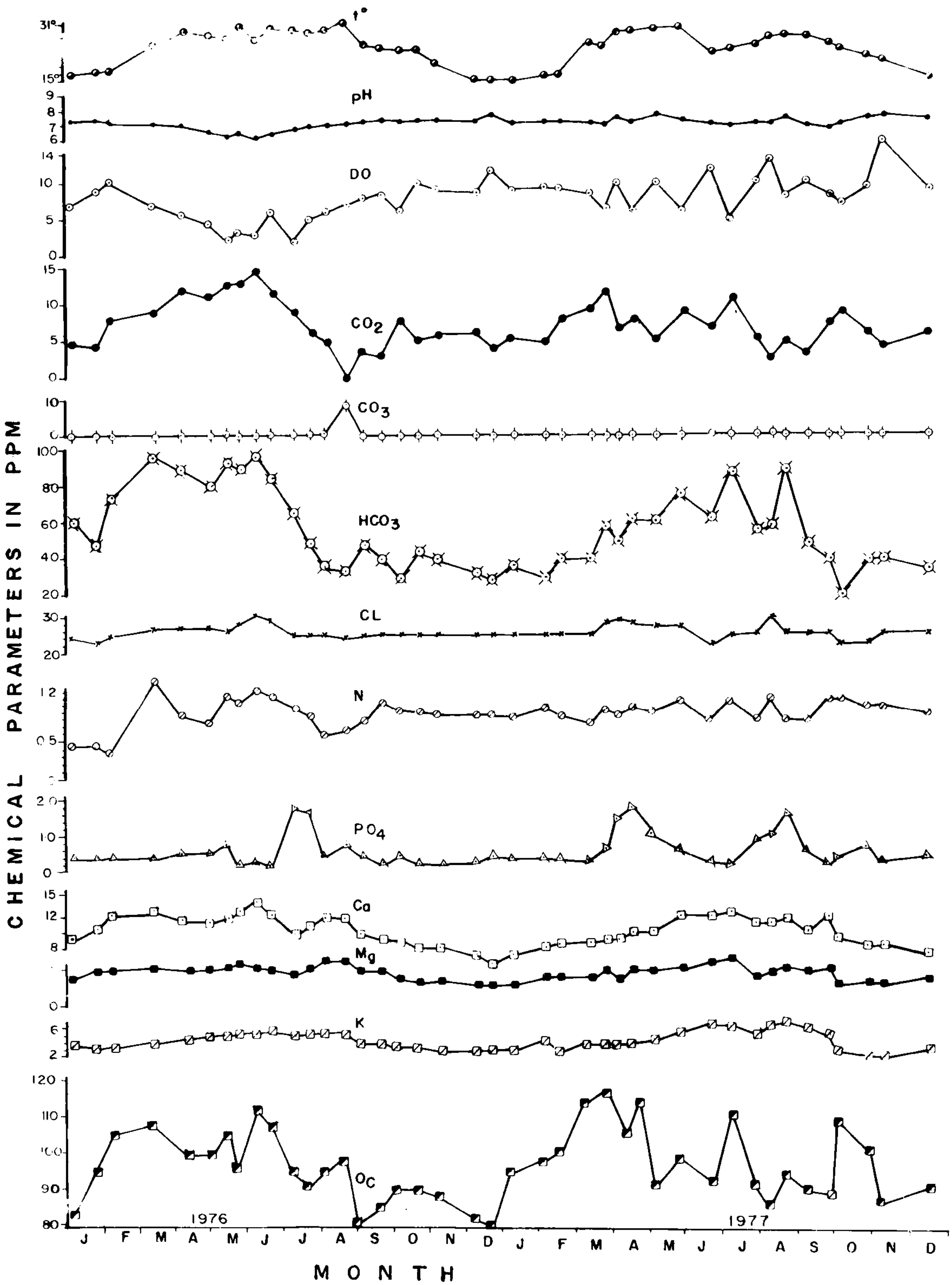

Fig. 10 Graphs showing seasonal changes in temp., pH all 11 chemical paramters at depth A in PG pond.

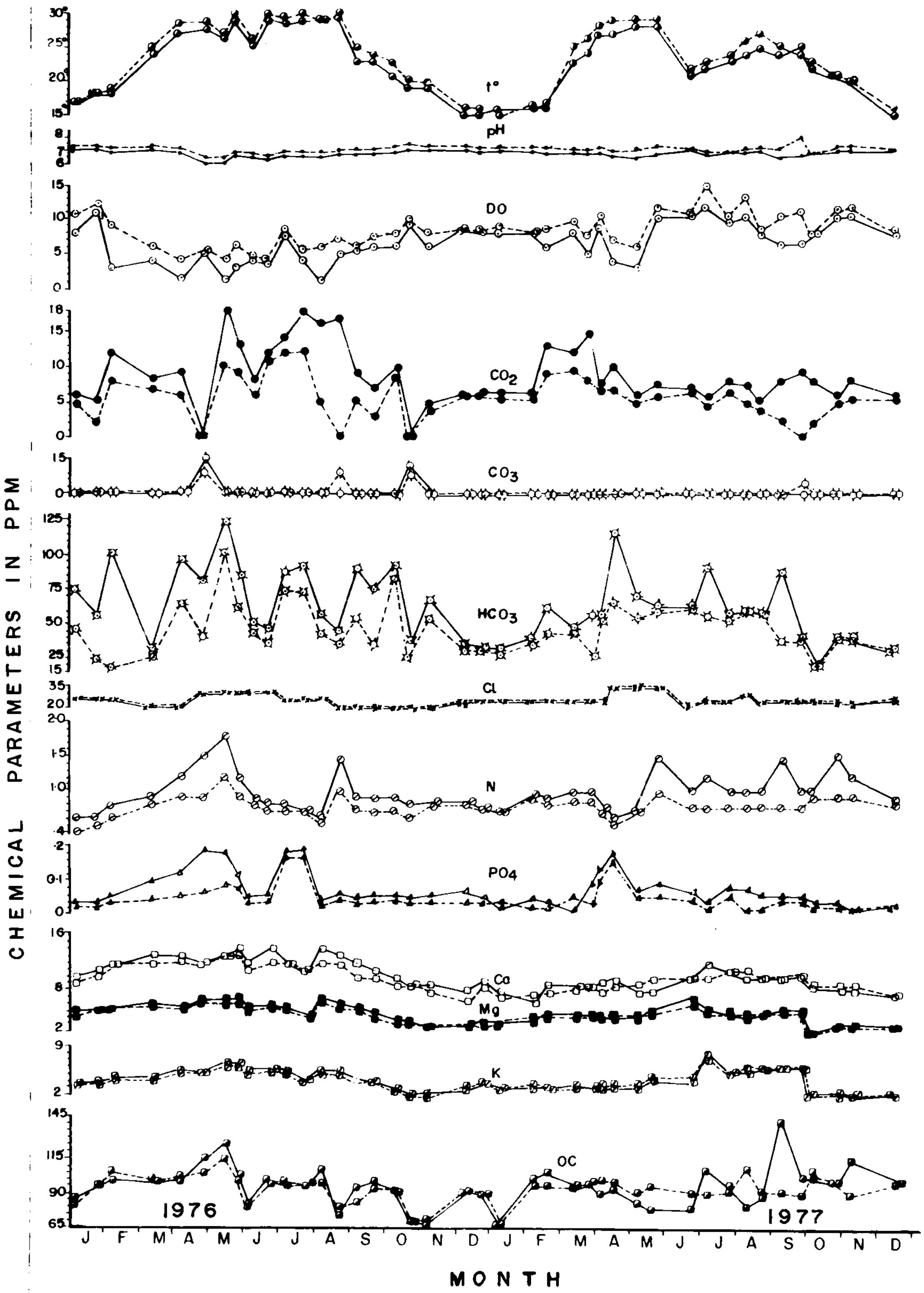

Fig. 11 Graphs showing seasonal changes in temp., pH and 11 chemical parameters at depths B in PG pond (Broken lines represent surface water, unbroken line represent bottom water).

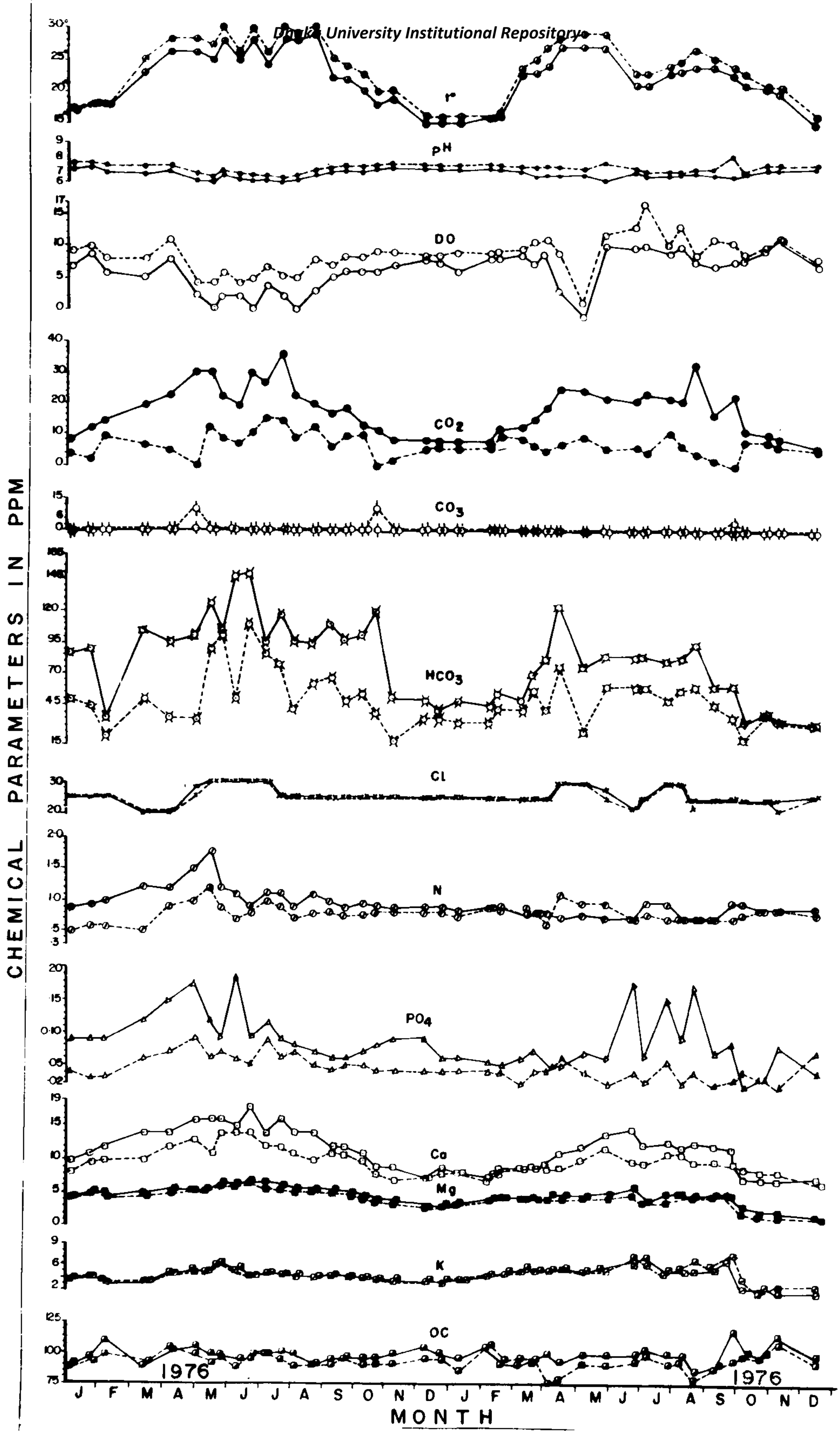

Fig. 12 Graphs showing seasonal changes in temp., pH and 11 chemical parameters at depth C in PG pond (Broken lines represent surface water and unbroken lines represent bottom water).

At C the pH of surface water in 1976 and 1977 was recorded to vary from 6.2 - 8.2 and 7.4 - 8.8, respectively, whereas at bottom, the pH ranged between 5.9 and 7.5, and 6.3 and 7.6, respectively.

PG Pond (Figs. 10 - 12)

At A, pH value was found to vary between 6.2 & 8.2 and 6.6 & 7.6 in the first and second year. The pH value of surface water at B was noted to fluctuate between 6.2 & 7.5 in 1976 and between 6.9 & 8.1 in 1977, whereas that of bottom water was observed to range between 6.1 & 7.3 and 6.6 & 7.3, respectively, during the same periods.

At C, pH of surface water was noted to vary between 6.2 & 7.4 in 1976 and between 6.8 & 8.3 in 1977. The highest and lowest pH of bottom water was 7.2 and 6.9 respectively for the same periods.

SB Pond (Figs. 13 - 15)

At A, pH value was noted to vary between 6.0 & 8.6 and 6.4 & 8.9 during first and second year. pH of surface and bottom water at B was recorded to range from 6.0 - 8.1 and 6.4 - 8.8 in 1976 and 6.0-7.5 and 6.2 - 8.6 in 1977, whereas at C pH of surface and bottom water fluctuated between 6.0 & 8.0 and 6.2 & 8.8 and 6.0 & 7.4 and 6.0 & 7.6 during the first and second year respectively.

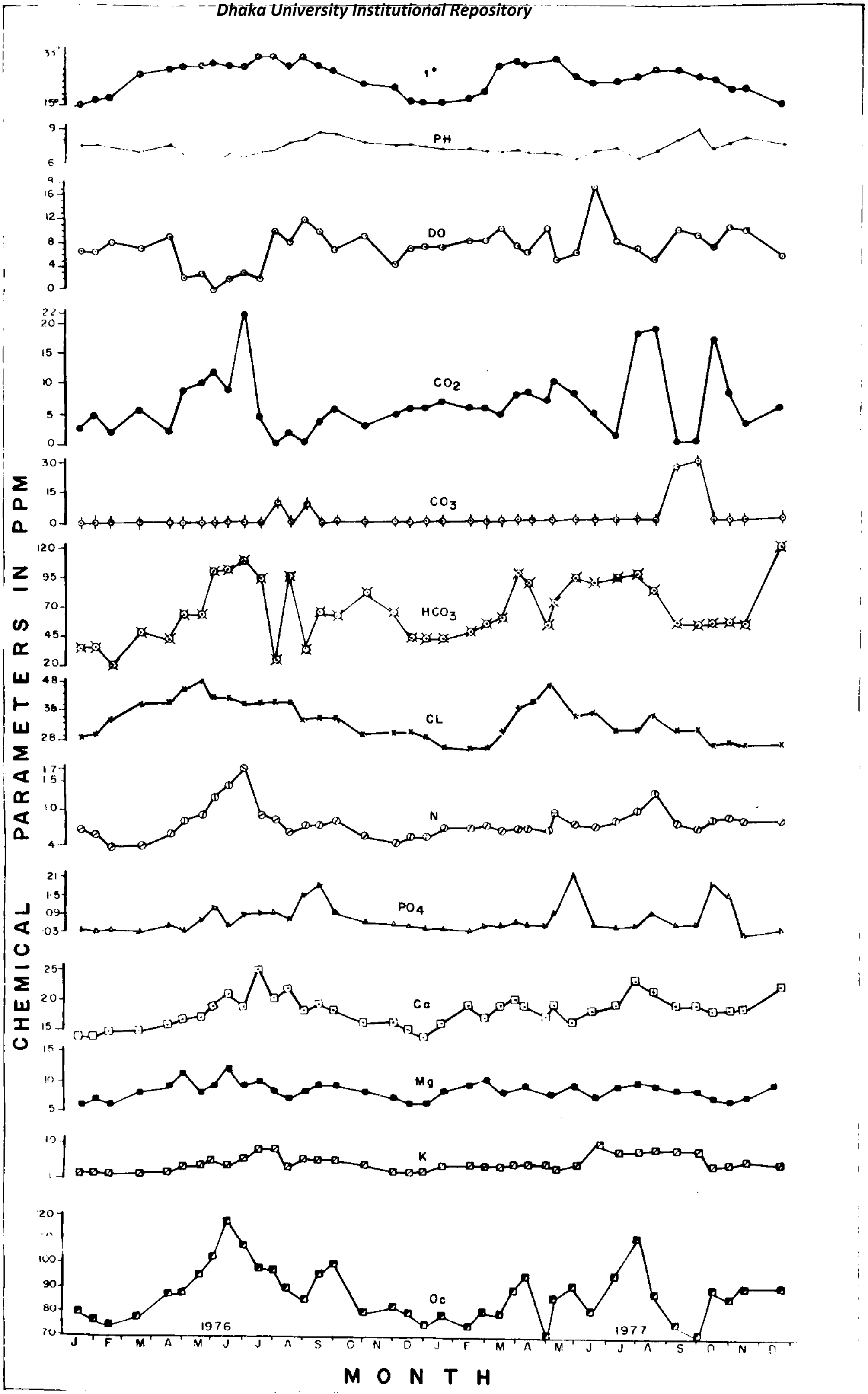

Fig. 13 Graphs showing seasonal changes in temp., pH and 11 chemical parameters at depth A in SB pond.

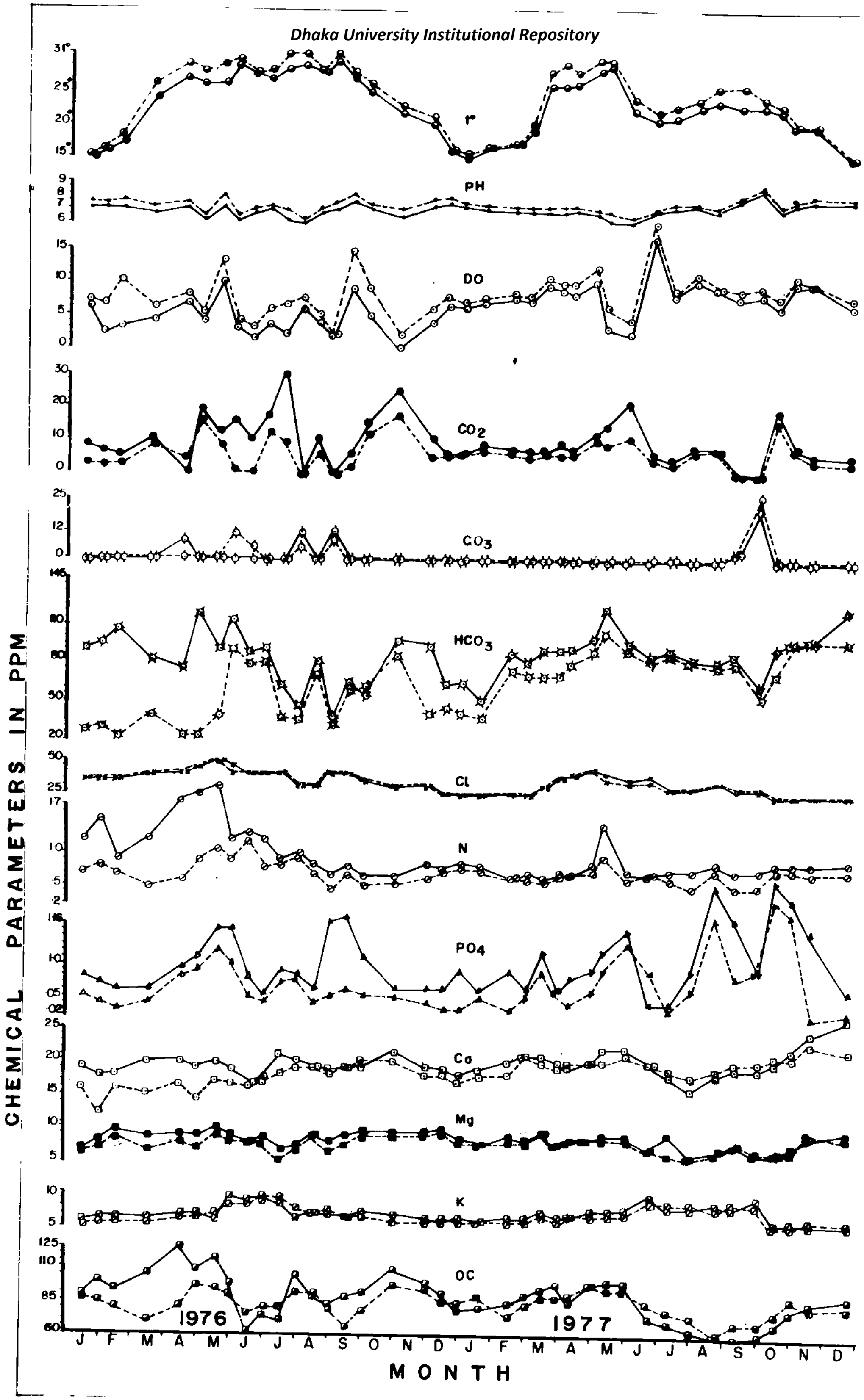

Fig. 14 Graphs showing seasonal changes in temperature, pH and 11 chemical parameters at depth B in SB pond (Broken lines represent surface water, unbroken lines represent bottom water).

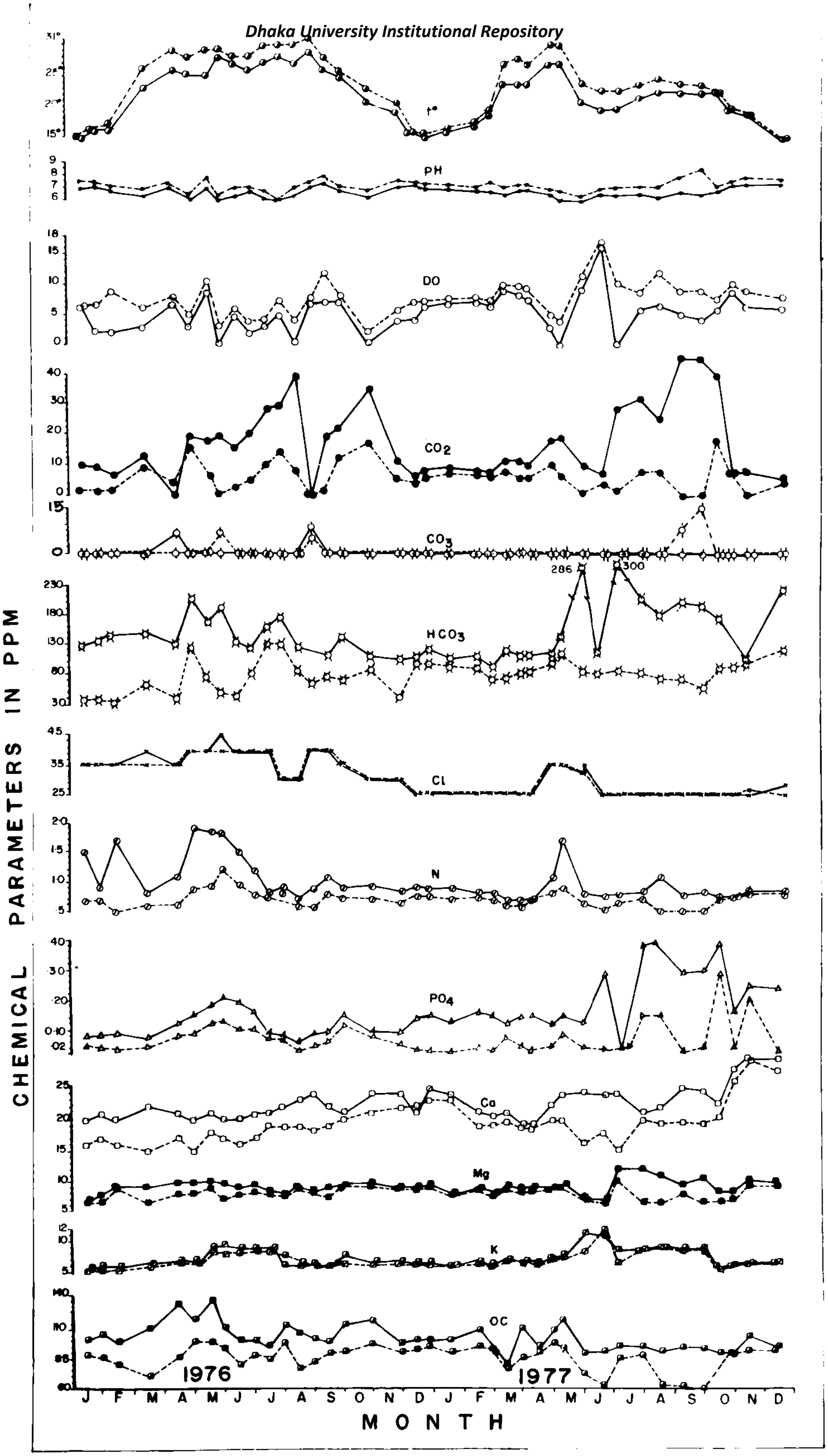

Fig. 15 Graphs showing seasonal changes in temperature, pH and 11 chemical parameters at C in SB pond (Broken lines represent surface water, unbroken lines represent bottom water).

The yearly average pH in SH pond was 7.2 and 7.5 in 1976 and 1977 respectively. In PG pond the yearly average pH was noted to be 6.9 and 7.0 and that of SB pond was 7.0 and 7.2 respectively in 1976 and 1977 (Table 5).

Dissolved Oxygen (DO)

SH Pond (Figs. 7 - 9)

In 1976 at A high DO content was noted from January to March and from late October to December with the highest value 16 in March. The lowest value of DO 2 was found in June. In 1977 DO content at A was recorded to be more or less uniform throughout the period with the exception in July and May when the highest content 14 and the lowest 5 was found.

In 1976 low DO content was observed at surface and bottom at B from April to early August. The lowest value for surface and bottom was 4 and 2 respectively. The highest content 12 of DO in surface water was noted during March and November and in bottom water 9 during August. However, in 1977 DO content of surface and bottom water at B tended to be uniform with the exception in April and May when the low values were noted. The highest content of DO for surface and bottom was recorded to be 14 and 12 respectively during August.

SB Pond (Figs. 13 - 15)

At A the highest DO content 12 was found during August in 1976 and during June 17 in 1977. In 1976 DO was absent at D during May whereas in 1977 the lowest DO content 5 was observed during December.

At B the surface and bottom water contained the highest DO value of 15, and 10 during September and May respectively in 1976 whereas in 1977 the highest DO content was noted to be 17 during June for both surface and bottom.

At C the maximum DO content at surface was found to be 12 and 17.6 during September in 1976 and during June in 1977 respectively. The bottom water showed low DO content throughout the periods of observation with pronounced depletion which occurred occasionally.

Among the three ponds, SH pond showed the highest yearly average value of DO, whereas the lowest value was found in SB pond and PG pond was in intermediate position between the two (Table 5).

Free Carbondioxide (CO_2)

SH Pond (Figs. 7 - 9)

In 1976 at A, the highest amount of 12 free CO_2 occurred during July and CO_2 was noted to be absent in March, September, and

In 1976 the highest DO content 15 was found in surface water of C during March and the lowest 4 during June. The bottom water at C was extremely poor in DO content during 1976 and it was noted to be absent during June and early July. In 1977 the highest DO content at surface and bottom of C was 12.6 and 9.3 and the lowest was 5 and 2 respectively in August and April.

PG Pond (Figs. 10 - 12)

In 1976 at A the highest 12 DO content was noted during December and the lowest 2 during July. In 1977 DO content was maximum 16 during November and the minimum 4.7 during July.

In 1976 low DO content was recorded during April, May, June and late July at surface and bottom of B and the lowest was found to be 4 for surface and 1 for bottom during May. In January during the same period the highest DO content for surface was 12 and for bottom was 11. In 1977 at B the maximum DO value for surface was 15 and for bottom was 12 during July whereas the minimum for surface was 6 and bottom was 3 during May.

At C the surface and bottom water contained low DO value during April to September in 1976 and during April and May in 1977. DO was noted to be absent at the bottom in mid May, late June and early August during first year of observation.

October. In 1977 CO_2 content was the maximum 6 during early May and June whereas it was found to be absent during late May, July, August and September.

In 1976 surface water at B showed the highest amount of CO_2 12 during July and CO_2 was absent during March, May and June. The bottom water at B contained the highest values 24 of CO_2 during July.

In 1977 surface and bottom water at B was dvoid of free CO_2 during late May, July and August and also absent during September from surface water. The highest content 10.4 of CO_2 for the bottom was noted at B during September.

In 1976 CO_2 was found to be absent at surface water at C during February, May and June, whereas the bottom water contained high CO_2 values from June to November with the highest content 30 during July. In 1977 CO_2 was found to be absent at surface water at C during late May, July, August and September. At bottom high CO_2 content were noted from May to September with the highest value 20.9 during September.

PG Pond (Figs. 10 - 12)

At A low CO_2 values were noted during January and July to December in 1976 and more or less similar trend in CO_2 content was found in 1977. The highest amount 15 and 12 was recorded respectively during June in the first year and during March in the second year.

The low CO_2 contents were observed at the surface and bottom waters at B during January, November and December in 1976. It was noted to be absent during late April and late October. High CO_2 values were recorded during the rest of the period and the highest 12 and 18 was found during July for surface and bottom. In 1977 low CO_2 values were also found at this depth during winter and autumn and the highest CO_2 content was found to be 9.5 and 15 during March for surface and bottom respectively.

In 1976 low CO_2 values were noted in surface water at C during January, late October, November and December, whereas in 1977 CO_2 values were found to be low during January and August to December. It was found to be absent during late April and late October in 1976 and during late September in 1977. However, high CO_2 values were found in bottom water at C throughout the periods of study with the highest content of 36 and 33 was noted during July in 1976 and during August in 1977 respectively.

SB Pond (Figs. 13 - 15)

In 1976 at A, CO_2 content was observed to be poor from January to April and August to December whereas in 1977 low CO_2 content was found during June, early July, November, and December. Surface water at A was devoid of CO_2 during late July and late August in 1976 and during September in 1977. The highest value of 22 and 18 was noted during June in first year and during August in second year respectively.

In 1976 at B, the surface content of CO_2 was noted to be low during January, February, mid April, mid September and December and it was found to be totally absent in late May, and mid June and late August. The bottom water at B in 1976 was found to contain high CO_2 from late April to November with the highest value of 18 during April. At the bottom of B the highest content of 21.8 was noted during May.

At station C in 1976 the surface water contained low CO_2 during January, February, mid April, June, November and December and it was found to be absent in May and August. Higher CO_2 value were noted at bottom water throughout the period of observation with the exception in mid April and August when CO_2 was totally absent.

Similar trends in CO_2 content at surface water were noted in 1977. The bottom water in general contained very high CO_2 during the period of study with the highest value of 80 during September.

The SB pond showed the highest value of 8.7 and 10 in annual average content of free carbondioxide during 1976 and 1977 respectively and the lowest value of 5.4 and 4.7 was found during 1976 and 1977 in SH pond. The PG pond, though intermediate in position between the above two ponds, yet a high annual average of free CO_2 contents, 9.7 and 8.7, was recorded in 1976 and 1977 respectively in it. This value is nearly equal to that of SB pond (Table 5).

Carbonate Alkalinity (CO_3)

SH Pond (Figs. 7 - 9)

Carbonate alkalinity was noted to be present occasionally throughout the period of study. At A it was observed to be present during March, September and October in 1976 and during May, July, August and September in 1977. In 1976 at B CO_3 alkalinity was noted during March, May and late June at surface water and during early May and late June at bottom water whereas in 1977 it was recorded to be present at surface during late May, July, August, September, and early October and at bottom during late May, July and early August.

At C carbonate alkalinity was found at surface water during February, early May and late June and at bottom water only during early May and late June in 1976 whereas in 1977 it was noted at surface water during late May, July, August and September. CO_3 alkalinity was recorded to be absent totally at bottom water throughout the period of observation in 1977.

PG Pond (Figs. 10 - 12)

At A CO_3 alkalinity was noted to be absent throughout the period of study except during late August in 1976.

At B in 1976 CO_3 content was observed during late April, late August and late October at surface water and during late April and October at bottom water. In 1977 CO_3 alkalinity was recorded to be absent throughout the period of observation except during late September when it was noted at surface water only.

At C carbonate alkalinity was found at surface water during late April and late October in 1976 whereas in 1977 it was noted at surface water during late September only. Carbonate alkalinity was absent at bottom water throughout the period of observation.

SB Pond (Figs. 13 - 15)

Carbonate alkalinity was also occasionally present in SB pond. In 1976 at A it was noted during late July and late August whereas in 1977 it was recorded during September.

At B in 1976 the surface water was noted to contain CO_3 alkalinity during late May, mid June, late July and late August whereas at bottom water carbonate alkalinity was observed during mid April, late July, and late August. In 1977 carbonate value was found at surface and bottom water during September.

At C the surface water in 1976 was found to contain CO_3 alkalinity during late May and late August whereas at the bottom water it was noted during mid April and late August. In 1977 CO_3 alkalinity was found to occur only at surface water during September.

All the three ponds were noted to be extremely poor in carbonate alkalinity (Table 5).

Bicarbonate Alkalinity (HCO_3)

SH Pond (Figs. 7 - 9)

In 1976 at A bicarbonate values reached the highest point 95 in late June and the lowest value 20 was recorded in March. In 1977 at A bicarbonate showed the highest value 63 also in late June and the lowest 18 in late May and early July.

At B in 1976 the highest bicarbonate values of 73 and 113 were recorded respectively for surface and bottom during June and the lowest values of 24 and 54 were found for surface and bottom during July. In 1977 the highest bicarbonate value of 62 was observed at surface in April and the lowest of 18 in July. For the bottom it was recorded as the highest 78 during May and the lowest 18 during July.

At C in 1976 the highest bicarbonate content of 103 for surface was noted in January and the lowest 35 in May whereas the bottom showed the highest value of 162 during June and the lowest 15 during May. In 1977 at C the highest bicarbonate value of 60 was recorded for surface during late June and the lowest value of 18 during July. The bottom contained the highest bicarbonate alkalinity of 97.5 in May and the lowest 28 in July.

PG Pond (Figs. 10 - 12)

In 1976 at A the highest bicarbonate alkalinity 95 was noted during March and the lowest 29 during December. In 1977 bicarbonate alkalinity reached its peak 87 during July and the lowest value 20 was found during October.

In 1976 at B the highest bicarbonate values of 96 and 125 were noted during May for the surface and bottom respectively. The lowest value of 18 was noted during February for the surface and it was 30 during March for bottom. In 1977 the highest bicarbonate value of 66 and 120 was recorded respectively for surface and bottom during April and the lowest value of 26 and 36 were found during January for surface and bottom.

At C in 1976 the highest bicarbonate value of 110 and 150 was noted during June respectively for surface and bottom whereas the lowest value of 18 was noted during November for surface and that of bottom was 36 during February.

In 1977 at C the highest bicarbonate value of 76 and 125 were noted in April respectively for surface and bottom and the lowest value of 20 was found during October for surface and that of bottom was 32 during December.

SB Pond (Figs. 13 - 15)

In 1976 at A bicarbonate content was noted to be the highest 109 during June and the lowest 18 during February. In 1977 at A bicarbonate alkalinity was noticed to reach its peak of 122 during December and the lowest content of 39 was noted during January.

At B in 1976 the bicarbonate value was found to reach the maximum value of 138 and 188 respectively for surface and bottom during May whereas the lowest bicarbonate alkalinity of 22 and 32 was noted during February and during August respectively for surface and bottom. In 1977 the bicarbonate alkalinity registered the highest value of 105 and 125 for surface and bottom during May and the lowest value of 35 and 50 for surface and bottom during January respectively.

At C in 1976 the bicarbonate value for surface was noted to be the highest 136 during July and for bottom 210 during April. The lowest value of 32 was recorded for surface during February and the lowest value of 70 was found for bottom during late August.

In 1977 the highest bicarbonate value of 122 and 300 was noted respectively for surface during December and for bottom during July. The lowest bicarbonate content of 58 was observed during September for surface and that of bottom was 90 during February.

The highest annual average content of bicarbonate 81.2 and 101.1 was found respectively in 1976 and 1977 in SB pond, whereas the lowest 61.3 and 50.2 was noted in SH pond. PG pond registered an annual average content of 65.5 and 53.1 of bicarbonate (respectively) in 1976 and 1977 and thus PG pond occupies the middle position between the other two ponds (Table 5).

Chloride Value

SH Pond (Figs. 7 - 9)

Chloride values at A, B, and C showed variations between 20 - 30. However, at B the bottom water was found to contain the highest value of 35 during July.

PG Pond (Figs. 10 - 12)

Chloride value at A was noted to vary between 23 - 30 in 1976 and 22 - 30 in 1977.

In 1976 at B the chloride content of surface and bottom water was observed to vary between 20 - 30.

In 1977 at B the chloride content of surface water was noted to vary between 22 - 30 and that of bottom between 24 - 35. At C the chloride content of surface and bottom water were noted to vary between 20 - 30 in 1976 and 22 - 30 in 1977.

SB Pond (Figs. 13 - 15)

At A chloride values were noted to fluctuate between 28 - 48 in 1976 and 24 - 45 in 1977.

Chloride content of surface and bottom water at B were ranged between 25 - 48 in 1976 whereas it was noted to vary between 24 - 45 during 1977.

In 1976 at C chloride contents of surface and bottom water registered variations between 25 - 40 and 25 - 45 respectively whereas in 1977 the variations was noted between 25 - 35 for the surface and bottom water.

SB pond, which receives sewage effluents and domestic wastes, records the highest chloride value, while the SH pond gives the lowest. PG pond registers an intermediate position (Table 5).

Total Nitrogen (N)

SH Pond (Figs. 7 - 9)

High nitrogen values were noted during late summer and monsoon, whereas the low values were observed during winter in all sampling depths throughout the period of observation.

PG Pond (Figs. 10 - 12)

In 1976 at A the highest nitrogen content was recorded in March whereas high nitrogen values were recorded throughout summer. In 1977 high values for nitrogen were noticed during late May and July to October. Low values were found during winter.

At B nitrogen values for surface and bottom water were observed highest during May for both the year whereas the C the peak in nitrogen value was noted in July for surface and bottom water during the said period.

The lowest nitrogen value was recorded during winter in all the sampling depths.

SB Pond (Figs. 13 - 15)

In 1976 at A nitrogen content was noted to reach the highest point in June whereas in 1977 the peak was found in August.

In 1976 at B the highest point in nitrogen value was recorded for surface water during June and for bottom water during May. In 1977 nitrogen content reached its peak during May for surface and bottom water.

In 1976 at C the highest nitrogen content for surface water was noted during May whereas that of bottom water was recorded during April. In 1977 the nitrogen value for surface and bottom water was recorded highest in May. For all the three sampling depths the lowest values of nitrogen were recorded during winter.

In the present study it was observed that the PG and SB pond showed the high amount of total nitrogen and the SH pond registered the lowest amount (Table 5).

Phosphate

SH Pond (Figs. 7 - 9)

At A the highest phosphate values were recorded during autumn whereas the minimum values during winter.

At station B and C the highest phosphate contents of surface and bottom water were noted during June in 1976 and during July 1977.

PG Pond (Figs. 10 - 12)

PG pond showed high values for phosphate during summer and monsoon for all the sampling depths.

SB Pond (Figs. 13 - 15)

In 1976 at A phosphate value was noted highest during September whereas in 1977 the highest value was recorded in April. In 1976 at B the phosphate content of surface water was found to reach peak during May and that of bottom water during August whereas in second year the peak was noted during October for both surface and bottom water.

At C for both surface and bottom water the highest phosphate content was recorded during May in 1976 whereas it was during October in 1977.

The three ponds differ markedly in the annual average in phosphate content. The SB pond records the highest value while the SH pond gives the lowest. The PG pond occupies a middle position.

<u>Calcium (Ca)</u>

SH Pond (Figs. 7 - 9)

In 1976 at A the highest calcium content 13 was noted in June and the lowest value 8 was recorded during March and August. In 1977 calcium content was observed to reach its peak 12 during late June and late July whereas the lowest value 9 was noted during early June.

At B calcium content reached its peak of 15 and 16 respectively for surface and bottom during June in 1976. In 1977 the highest value of 11 was noted during June and August for surface and bottom.

In 1976 at C calcium content of surface water was highest 15 during June and July whereas for bottom the highest content 19 was noted during June. In 1977 the maximum value of 11 and 14 was recorded respectively for surface and bottom during May.

PG Pond (Figs. 10 - 12)

In 1976 at A calcium content was noticed to be highest 14 during June and the lowest 6.2 during December whereas in 1977 the highest calcium content 12.5 was recorded during July and the lowest 7 during December and January.

Calcium content at B and C showed similar trends. It was always high during summer and monsoon and low during winter.

SB Pond (Figs. 13 - 15)

At A the highest values of 25.5 and 23 were recorded during July in 1976 and 1977 respectively. The lowest value was observed during

January and December in 1976 and during January and May in 1977. Sudden rise in calcium value during December in 1977 was also noted.

In 1976 at B calcium content of surface water was noted to be the highest 19 during August and that of bottom 21 during July. In 1977 the highest calcium content for surface and bottom water was 23 and 27 respectively in November and December.

In 1976 at C the highest calcium value was 23 and 25 respectively for surface and bottom during December. In 1977 the highest value of 30 was noted for the surface and bottom during November.

Thus, a well marked difference was noted in the annual average content of calcium between the SB pond and the other two ponds. Then SB pond recorded very high calcium content whereas both SH and PG pond showed low content though PG pond receives huge organic matter through leaf litter (Table 5).

Magnesium (Mg)

SH Pond (Figs. 7 - 9)

In 1976 the highest amount 7.6 of magnesium was found during June and the lowest 4.1 during November. In 1977 magnesium content was noted to be the highest 6.1 during April and the lowest 3.1 during October.

In 1976 at B the magnesium content was recorded to reach peak of 8.5, and 9.5 respectively for surface and bottom during May whereas in 1977 the peak 7 was noted for surface and bottom during July. The lowest content of 4.1 and 3.9 were observed in 1976 during November respectively for surface and bottom. In 1977 the amount of magnesium was recorded the lowest 3.6 during October for surface and bottom respectively.

At depth C Mg content showed the similar trend.

PG Pond (Figs. 10 - 12)

In 1976 at A the highest content 6.2 was observed during August and the lowest 3.1 during December. In 1977 Mg content reached its peak of 6.2 during July and the lowest amount of 2.1 was recorded during October and November.

At B in 1976 the highest amount of 6 and 6.8 was noted during August for the surface and bottom respectively and the lowest 3, for the surface and bottom during November. In 1977 the peak content of 6 and 7 was recorded during June for the surface and bottom respectively. The lowest amount of 2 was found during October for surface and bottom. Mg content were noticed to demonstrate similar trends at depth C.

SB Pond (Figs. 13 - 15)

Mg content showed always high during late summer and monsoon and low during winter in all sampling depths throughout the periods of observation.

The SB pond recorded the highest value in yearly average content of magnesium and the lowest value was found in PG pond. SH pond occupied the middle position.

Potassium (K)

Potassium contents of all depths of three ponds was found to be the highest during summer or early monsoon and the lowest during winter throughout the periods of study. However, in 1976 PG pond showed the highest content of Potassium at C during September.

Organic Carbon (OC)

SH Pond (Figs. 7 - 9)

At A the highest amount 98 and 95 of organic carbon were noted during June for the first and second year respectively. The lowest content 48 and 52 was observed respectively during December in 1976 and during January in 1977.

In 1976 at B organic carbon content reached peak 86 and 90 during June respectively for surface and bottom and the lowest of 60 and 52 during August. In 1977 the highest amount of 90 was recorded for surface and bottom during July whereas the lowest value 55 and 52 was noted during August for surface and bottom.

In 1976 at C the highest content of 89 and 120 was recorded respectively for surface and bottom during June whereas the lowest 62 and 70 was obtained during January. In 1977 OC showed the highest amount 89 and 137 during July whereas the lowest 52 and 55 during April for surface and bottom respectively.

PG Pond (Figs. 10 - 12)

At a in 1976 the highest content of OC was noted to be 112 during June and the lowest 80 during September and December. In 1977 OC content was found to reach peak 112 during March and the lowest content of 85 was observed during August and November.

In 1976 at B the highest content of 115, and 125 was noticed during May for surface and bottom respectively whereas the lowest 70 was found during October for surface and bottom as well. In 1977 the maximum amount of 110 was recorded at surface during August and at bottom it was noted to be 62 during September. The lowest content 70, and 69 was found during January respectively for surface and bottom. At C in 1976 the highest amount of 105 and 110 was recorded respectively for surface and bottom during February. In 1977 OC content of surface water was found to reach its peak of 165 during February whereas bottom water registered the highest content 115 during November.

SB Pond (Figs. 13 - 15)

In 1976 at A the maximum amount 118 of organic carbon was noted during June and the minimum 75 during December whereas in 1977 the highest content 110 was recorded during July and the lowest 70 during April and September.

In 1976 at B the amount of organic carbon was observed to reach its peak of 98 and 125 during April for surface and bottom respectively. The lowest value of 80 was noted respectively for surface during August and for bottom during September. In 1977 the highest values of 99 was recorded during April for surface and that of bottom 101 during June. The lowest value 62 was registered during August for both surface and bottom.

In 1976 the highest organic carbon content was found to be 99 and 138 during May respectively for surface and bottom and the lowest 75, and 95 during August. In 1977 OC content of surface water reached its peak 99 during April and that of bottom was noted to be the highest

120 during May. The lowest amount of 75, and 80 was found during March respectively for surface and bottom.

Thus, the PG and SB pond registered the very high content of organic carbon in comparison to SH pond (Table 5).

H_2S (Table 4)

H_2S values were noted for the seven months in 1977 (June-December). For all the three ponds H_2S values were high during monsoon and post-monsoon period and it was found to decrease as winter approached. The highest amount of H_2S was noted at the deepest depths in all the three ponds except in PG pond where the highest value was recorded mostly at depth B.

Table 4: Showing the amounts of H_2S (expressed in ppm) found during the last seven months of observation at bottom water of depth B and C of SH, PG and SB Ponds

	SH Pond			PG Pond			SB Pond	
Dates	Bottom of B	Bottom of C	Dates	Bottom of B	Bottom of C	Dates	Bottom of B	Bottom of C
22-6-77	1.275	1.05	25-6-77	0.40	0.425	29-6-77	1.27	1.385
6-7-77	0.425	1.275	5-7-77	Trace	Trace	7-7-77	0.425	1.275
26-7-77	0.637	1.487	28-7-77	1.062	0.425	30-7-77	0.851	1.487
12-8-77	0.213	1.063	10-8-77	0.937	0.637	20-8-77	0.91	1.523
6-9-77	0.425	0.852	8-9-77	0.85	0.425	9-9-77	0.85	1.063
26-9-77	0.637	0.852	28-9-77	0.853	Trace	30-9-77	0.425	1.487
11-10-77	0.425	0.625	6-10-77	0.637	0.637	14-10-77	.850	0.850
25-10-77	0.425	0.85	29-10-77	0.640	0.425	31-10-77	0.85	1.063
14-11-77	Trace	0.425	14-11-77	0.640	0.425	15-11-77	0.635	0.85
12-12-77	Trace	0.425	14-12-77	0.637	Trace	22-12-77	0.425	0.6375

Table 5: Showing the annual average content of the physico-chemical parameters (chemical parameters are expressed in ppm) of the three ponds in 1976 and 1977

Physico-chemical parameters	SH Pond		PG Pond		SB Pond	
	1976	1977	1976	1977	1976	1977
Temperature °C	26.2°	25.1°	24.1°	23.4°	24.3°	23°
pH	7.2	7.5	6.9	7.0	7.0	7.2
DO	7.3	8.2	6	9	5.7	8.1
CO_2	5.4	4.7	9.7	8.7	8.7	10
HCO_3	61.3	50.2	65.5	53.1	81.2	101.1
Cl	25	24.4	25	26.1	36	29.3
Total Nitrogen	0.74	0.59	0.86	0.87	.89	.75
PO_4	.065	.059	0.07	0.06	.09	.11
Ca	11.5	10	11	9.3	18.2	20.5
Mg	5.9	5.1	4.9	4.3	8.3	7.7
K	4.7	6.6	4.2	4.5	6.8	7.5
OC	72.5	70.2	96	97	93	86.3

COMMENTS

The temperature is generally regarded as one of the most important factors in aquatic biology. Water temperature of ponds depends on their size and depth, the area exposed to direct sun light, day length, and the density of plankton (Macan & Maudsley, 1966; Sitaramaiah, 1966; Michael, 1968; Munawar, 1970 and Rao, 1971). Of the three ponds, SH pond is the largest in size and greater in depth and it is exposed more or less throughout the day to direct sunlight for the longest period. As such SH pond showed the highest average temperature as compared to PG and SB pond (Table 5). PG pond, though larger than SB pond in size, did not exhibit marked difference in annual average temperature from that of SB pond as because most of the PG pond remained covered under the shade of trees for longer period during the day.

It is evident that temperature influences the amount of dissolved gases in the water, particularly that of free CO_2 and DO. Longer photoperiod in summer causes high oxygen and high pH resulting in depletion of CO_2. This phenomenon was noted in the three ponds (Figs. 7 - 15). However, in the present studies an increase in CO_2 and decrease in DO content were recorded during late summer and monsoon (Figs. 7 - 15). High water temperature in these periods accelerated the process of decay of organic matters, which was also increased through surface run off of surrounding areas, resulting in the formation of a large amount of CO_2 and release of other nutritive elements such as N, K, Ca etc. (Figs. 7 - 15). Some amount of DO was utilized during oxidation of organic matter and also in summer a portion of DO was lost to atmosphere due to high water temperature has lesser capacity to hold DO. Thus, a decrease in DO content was noticed in summer (Figs. 7 - 15). But in 1977, high DO content was observed during late June in PG and SB pond, and late May and early July in SH pond (Figs. 7, 10, and 13). The above observation was probably due to the fact that samplings for those days were made after a heavy rainfall. Pearsall (1923), and Gonzalves & Joshi (1946) have also correlated the high percentage of DO with heavy rain.

In 1977 from July to September surface water of SH pond was devoid of CO_2 and during October to December very low CO_2 was found. In the same year CO_2 was also absent at surface water of SB during September (Figs. 7, 8, 9, 13, 14 and 15). The absence of CO_2 during these months was rather not a normal sequence. It is likely that the total amount of free CO_2 produced in and reached to the surface of these ponds during the said periods had been utilized in the photosynthetic activity as evident from high pH value, presence of $-CO_3$, and algal bloom.

A somewhat inverse relationship between the amount of CO_2 and DO was noted in all the three ponds. On the other hand Pearsall (1930), Ganapati (1943), Gonzalves & Joshi (1946), Rao (1955), and Singh (1960) observed an well marked inverse relationship between these two gases in fresh water bodies. In deeper water bodies where the hypalimnion does not come in direct contact with atmosphere the existence of an absolute inverse relationship between CO_2 and DO is possible. But it would be difficult to establish such a relationship between the two gases in small water bodies as in the present cases. The concentration of CO_2 and DO in shallow water bodies is likely to be controlled by the physical laws of diffusion of gases into liquids and the rate of various metabolic activities of biotic community (Munawar, 1970). This explains why an well marked inverse relationship could not be found in these ponds. Munawar (1970) made a similar observation while studying the limnology of three ponds in Hyderabad in India.

The variations in temperature, pH, DO, CO_2 and other ion at surface and bottom water were noted throughout the periods of study in all the three ponds (Figs. 5, 6, 8, 9, 11 and 12). The variations were tended to increase as the samples were made from deeper depth. Among these three ponds depth wise difference in values of free CO_2 and DO were well marked in SB and PG pond (Figs. 11, 12, 14 and 15). This was possibly due to high accumulation of organic carbon in these two ponds at deeper depths. Saha *et al.* (1971) noted that values of different ions at surface and bottom remained more or less unaltered except those of pH, DO and CO_2 in two ponds. Michael (1968a) however, failed to record any significant difference in values of different physico-chemical parameters at surface and bottom water in a pond located at Barrackpore, West Bengal, India.

SB pond, in comparison to other two ponds, was noted to be the richest in bicarbonate content (with the exception at A in the first year) (Figs. 13 - 15, Table 5), a condition which favoured high productivity (Huet, 1950; Gaufin, 1968). Calcium content was also noted to be the highest in SB pond. Bicarbonate values were found to vary more or less directly with calcium content and inversely with carbonate and pH in all the three ponds (Figs. 7 - 15). The direct relationship between bicarbonates and calcium has been noted by Pearsall (1930), Zafar (1964) and Munawar (1970), whereas the inverse relationship between bicarbonates and carbonate has been found by Ganapati (1940). Zafar (1964) and Munawar (1970) have shown an inverse behaviour of bicarbonates towards carbonate and pH in certain fish ponds.

The bicarbonate value was always higher in bottom than that of surface as insoluble carbonate compound from the substrate was converted to soluble bicarbonate form due to bacterial action (Figs. 8, 9, 11, 12, 14 and 15). This was more evident in summer as high temperature during this period accelerated the bacterial decomposition.

The bicarbonate content in all the three ponds was observed to increase in summer (Figs. 7 - 15). Similar observations were also made by Ruttner (1953), Harrel & Dorris (1968) and Munawar (1970). However, at SB pond sudden increase in bicarbonate content was noticed during December in 1977. It was possibly due to bacterial decomposition of the remains of rice plants which were cultivated at the shallow margins of the pond in the same year. The oxygen curve showed a depression while CO_2 value tended to increase during December. Ca content was also high during this period. All these observations supported the above supposition. The high HCO_3 content in PG pond during late winter was also due to decomposition of leaves fallen from surrounding trees in winter.

The chloride contents of the three ponds increased in summer and decreased in winter (Figs. 7 - 15). Similar observation was also made by Gonzalves & Joshi (1946), Singh (1960), Zafar (1964), and Munawar (1970). It is interesting to note that the three ponds differed in annual average content of chloride (Table 5). SB pond recorded the highest values, while the SH pond showed the lowest. PG pond showed an intermediate position. Tresh *et al.* (1944, *c.f.* Munawar 1970) suggested that higher chloride content of water is an index of pollution of animal origin and it may be logical to assume that the SB pond receives contamination of this type through sewage inflow and domestic wastes.

The PG pond and SB pond showed high values of total nitrogen in comparison to SH pond (Figs. 7 - 15, Table 5). These ponds showed high percentage of organic matter also. Thus, the level of concentration of organic matter in water is an index of nitrogen budget. Similar observations was also made by Munawar (1970). All the ponds showed the higher nitrogen values at the bottom water, because organic matter deposited at bottom sediment is one of the sources of nitrogen supply through the activity of denitrifying bacteria. Nitrogen was thus continuously releasing from the pond sediment which possibly enriched nitrogen values of bottom water. Denitrification is always high during summer. Therefore, during summer the present ponds showed high value of nitrogen.

The nitrogen content was also found to increase in all the three ponds during monsoon (Figs. 7 - 15). Rainfall were the causative factors for the above observation.as the nitrogen content of a water body depends on nitrogen from atmosphere and surface run off of neighbouring areas apart from denitrifying activities of bacteria on organic deposit. However, the human interference through excessive washing and bathing increases the nitrogen content of a water body that jeopardizes the natural phenomenon to a great extent. Thus, the PG pond, which was subjected to the maximum human interference in comparison to other two ponds, showed high nitrogen content also in September and October in 1976 and in October and November in 1977 other than during monsoon. In all the three ponds the nitrogen content was recorded the minimum in winter. This was possibly due to the maximum utilization of nitrogen by algal flora as the bloom formation in these ponds usually noted to be dense in winter.

The phosphate content was found comparatively low in all the three ponds. This was possibly due to the excessive utilization of phosphate by algal flora that formed bloom nearly most of the periods of observation in these ponds. The highest amount of phosphate was noted in SB pond in comparison to other two ponds. Hutchinson (1957) also reports the increase of phosphorus as a result of sewage contamination. SH pond which is subjected to comparatively less contamination and showed the lowest concentration of phosphates.

The amount of phosphate was noted to be high during rainy seasons in all the three ponds. However, in 1977 the highest content of phosphates were noted during October in SB pond. This was probable as the samplings were made after rains. Similar observation was also noted by Michael (1968a). The low content of phosphate was found mostly in winter in all the three ponds. The possible reason for this observation is explained in the earlier paragraph.
Einsele (1936) observed that excess amount of phosphate is deposited to pond sediment which is released in water during oxygen deficiency. SB pond and PG pond exhibited this phenomenon clearly (Figs. 7 - 12).

The higher values of cations (Ca, Mg, K) were noted during summer and monsoon periods in all the three ponds when the water temperature was reasonably high and decomposition of organic matter was also maximum. However, in SB pond high cation values were observed during December in the second year. The possible reason for it was explained earlier (see page 75).

The calcium content was found the highest in SB pond. The PG pond showed significantly low Ca content in spite of the high values of organic matter noted in the sediment. The possible reason will be explained later (page 103).Low content of Ca in SH pond was possibly due to the comparatively less amount of organic matter in pond water and sediment.

Zafar (1964) and Munawar (1970) observed a direct relationship between the content of Ca and organic carbon and the content of Mg and organic carbon. In all the three ponds more or less such relationship was noted. The increased amount of organic matter at higher temperature is expected to release the greater amount of Ca and Mg bicarbonate from insoluble Ca and Mg carbonate which would increase the amount of the said cations of the water.

It was noted that the amount of Ca content was higher in all the three ponds than that of Mg (Table 5). The above observation is possibly due to the preferential behaviour of CO_2 gas with calcium salts when compared with Mg salt. Munawar (1970) also recorded the similar phenomenon.

The dissolved organic carbon (organic matter) in water may be considered as a dilute soil extract, consisting largely of humic, non-humic and many other compounds of organic material produced within the basin or may be brought to the pond through the agencies of surface run off and wind (Vallentyne, 1957; Hutchinson, 1957). These may arise as a result of direct decomposition of organic matter produced within the basin or brought through surface run off. Fogg (1960) observed that a certain amount of organic matter (organic carbon) is usually added to the water in the form of extracellular substances liberated by phytoplankters during their growth.

Of the three ponds, SH pond showed the lowest value of organic carbon as the pond is completely separated from the surrounding area with high bank and thus the pond depends for organic carbon mostly on autochthonous organic matter (Table 5). PG and SB ponds were noted to contain high organic carbon through leaf litter, and sewage outflows and the highest was observed in PG pond.

In all the three ponds in the present investigation organic carbon varied directly with temperature and CO_2 and inversely with DO (Figs. 7 - 15). Similar findings were noted by Ganapati (1943), Singh (1960), Zafar (1964) and Munawar (1970).

An inverse relationship between OC and pH was noted in the present study. But Zafar (1964) and Munawar (1970) observed a positive relationship between pH and organic carbon (organic matter) content of water. It is likely that in the present studies an increased decomposition of organic matter formed CO_2 in excess and water become more acidic resulting a fall in pH.

During summer months high values of organic carbon were noted in all the three ponds. Low concentration of organic carbon were recorded during winter which were partly due to decrease in the rate of decomposition of particulate organic matter at low temperature and partly due to less supply of allochthonous organic matter. However, PG pond showed high values of organic carbon in late winter and early summer as countless leaves began to fall from the surrounding trees during winter. In the 1977 SB pond recorded high values of organic carbon during November and December. Possibly the remaining of rice plant in pond margin during this period increase the OC value of the pond water.

High value of H_2S was noted during monsoon and post-monsoon period in all the three ponds (Table 4). This was due to the increased supply of organic matter carried by rain water from surrounding areas and which possibly enhanced the bacterial decomposition of the organic deposits at a reasonably high temperature during this period. The highest content of hydrogen sulphide were recorded at C in SH and SB pond and at B in PG pond as the bottom sediment at these depths contained the highest amount of organic matter.

CHAPTER IV

PHYSICO-CHEMICAL CONDITIONS OF POND SOIL

The samplings of soil were made once in a month from three depths viz., A, B and C of each ponds. Temperature and pH of soil were noted tc decrease with the increase of depth. In general soils of the three ponds were acidic and in PG it was more acidic due to high organic matter content. In all the three ponds chemical constituents of soil showed almost similar trends in seasonal change. It was always high during summer and rainy season and low during winter.

Physical Aspects

Texture

The texture of the soils was compact in all the three ponds at depth A and it gradually became soft and loose as the higher depths were attained. Undecomposed leaf was found in plenty in the soil of PG pond at B. In general soil of these ponds differed in texture. The soil mostly consisted of sand, silt, and clay in different proportions at different depths. The percentage wise estimations of these soil components at different depths are shown in Table 6. Besides these, total bacterial count of these soils has also been made and shown in Table 7.

Table 6: Showing percentage of sand, silt, and clay of soil at depth A, B and C of three ponds

Pond	Depth	% Sand	% Silt	% Clay
Shahidullah Hall Pond	A	51.04	27	21.96
	B	82.04	10	7.96
	C	70.04	19	10.96
Play Ground Pond	A	37.04	41.3	21.66
	B	73.2	13.14	13.66
	C	52.74	26.3	20.96
Shahabagh Pond	A	47.94	22.45	29.61
	B	71.34	13.2	15.46
	C	60	22.4	14.6

Table 7: Showing the average plate count of bacterial cells in soil of the three ponds in 1976 and 1977

SHAHIDULLAH HALL POND

	1976	1977
Depth A	8 X 10^6 bacteria/gm of soil	8.5 X 10^6 bacterial cell/gm of soil
" B	10 X 10^6 " "	9 X 10^6 " "
" C	14 X 10^6 " "	13.5 X 10^6 " "

PLAY GROUND POND

	1976	1977
Depth A	9.5 X 10^6 bacteria/gm of soil	9 X 10^6 bacterial cell/gm of soil
" B	15.5 X 10^6 " "	14 X 10^6 " "
" C	15 X 10^6 " "	14 X 10^6 " "

SHAHABAGH POND

	1976	1977
Depth A	9 X 10^6 bacteria/gm of soil	8.5 X 10^6 bacterial cell/gm of soil
" B	16.5 X 10^6 " "	15 X 10^6 " "
" C	17 X 10^6 " "	17.5 X 10^6 " "

Temperature

In all the three ponds the temperature of soil at A, B, and C showed variations in different seasons and more or less followed the pattern of water temperature. Soil temperature in these ponds ranged from 14°C to 31°C at different depths. The detailed monthly temperature records for all the three ponds at the three depths are shown in Tables 8 - 16.

Chemical aspects

pH

A noticeable variation in soil pH was noted in these ponds. In PG pond pH fluctuated from strongly acidic to slightly acidic (4.4 - 6.5). In SH pond soil varied from moderately acidic to slightly acidic (5.1 - 6.9). But in SB pond pH remained slightly acidic more or less throughout the periods of observation and it fluctuated between 5.7 and 6.9. Soil pH was noted to decrease with depth in all the three ponds. The detailed monthly records of pH for all the three ponds at depth A, B and C are shown in Tables 8 - 16.

Total Nitrogen

In SH pond at A, B, and C, the highest values of total nitrogen was noted during summer and early monsoon (0.11, 0.17, 0.36%

Table 8: Showing the physico-chemical c nditions of soil at depth A of SH pond with the annual average and standard deviation for the years 1976 and 1977

Dates	t°	pH	Nt %	Na %	OC %	Available phos-phorus mg/100/g	Exchaable Ca %
10-1-76	17°	6.2	.04	.005	.50	6.5	.18
10-2-76	21°	6.3	.05	.005	.40	7	.19
9-3-76	26°	6.8	.06	0.006	.40	6.9	.19
5-4-76	27°	6.9	.08	.006	.50	5.1	.22
7-5-76	28°	5.6	.09	.009	.51	5.4	.24
15-6-76	30°	6.0	.11	.011	.55	5.9	.25
12-7-76	31°	6.3	.10	.009	.55	6	.22
10-8-76	26°	6.3	.10	.010	.48	6.1	.22
10-9-76	22°	6.2	.10	.006	.43	5.8	.24
10-10-76	21°	6.7	.09	.007	.70	5.9	.25
24-11-76	21°	6.5	.05	.007	.50	6.4	.21
11-12-76	18°	6.9	.07	.006	.40	6.9	.18
Average	24.00	6.39	.078	.007	.49	6.16	.215
	± 4.612	±0.389	±0.023	±0.002	±0.085	±0.6	±0.026
13-1-77	18°	6.5	.06	.006	.59	6.7	.21
10-2-77	20°	6.2	.05	.006	.45	6.8	.23
14-3-77	27°	6.5	.08	.007	.51	7.1	.24
4-4-77	27°	6.7	.1	.008	.83	7.4	.21
7-5-77	29°	6.5	.12	.010	.73	6.2	.28
29-6-77	21.5°	6.8	.07	.012	.46	6.0	.23
26-7-77	25°	6.8	.13	.008	.83	6.0	.24
12-8-77	26°	6.3	.12	.009	.75	5.9	.26
26-9-77	23°	6.2	.11	.008	.73	6.4	.25
25-10-77	21°	6.8	.11	.007	.73	6.9	.22
14-11-77	21°	6.7	.09	.007	.65	7.2	.19
12-12-77	18°	6.9	.08	.006	.56	6.8	.18
Average	23.04	6.575	.09	.007	.65	6.616	.228
	± 3.695	±0.245	±0.025	±0.001	±0.135	±0.507	±0.028

Nt = Total nitrogen, Na = Available nitrogen, OC = Organic carbon.

Table 9: Showing the physico-chemical conditions of soil at depth B of SH pond with the annual average and standard deviation for the years 1976 and 1977

Dates	t^o	pH	Nt %	Na %	OC %	Phos-phorus mg/100/g	Exchange able Ca %
10-1-76	17^o	6.0	.07	.008	.63	6.3	.38
10-2-76	20^o	6.0	.04	.009	.70	.7	.3
9-3-76	25^o	6.1	.08	.011	.70	.7	.27
5-4-76	25^o	6.3	.08	.012	.80	5.4	.50
7-5-76	26^o	5.4	.15	.014	.95	6.1	.30
15-6-76	29^o	5.6	.17	.009	.90	6.5	.21
12-7-76	29^o	6.0	.09	.008	.75	6.9	.24
10-8-76	29^o	6.1	.13	.009	.74	5.2	.29
10-9-76	20^o	6.0	.07	.007	.70	5.3	.22
10-10-76	20^o	6.2	.08	.006	.80	6.8	.28
24-11-76	20^o	6.3	.09	.006	.90	7.1	.22
11-12-76	17^o	6.4	.09	.007	.70	6.9	.25
Average	23.08	6.035	.095	.008	.77	6.375	.288
	$\pm$4.6	$\pm$0.287	$\pm$0.036	$\pm$0.002	$\pm$0.099	$\pm$0.714	$\pm$0.081
19-1-77	18^o	6.4	.09	.007	.82	6.8	.23
10-2-77	19^o	6.0	.08	.009	.7	6.0	.20
14-3-77	25^o	6.2	.08	.011	.12	6.4	.26
4-4-77	26^o	6.4	.16	.013	.10	8.2	.29
2-5-77	23^o	6.2	.11	.005	.80	8.1	.32
29-6-77	21.5^o	6.5	.19	.013	.75	7.1	.26
26-7-77	23^o	6.6	.13	.009	.86	7.0	.29
12-8-77	25^o	6.3	.14	.008	.78	8.7	.26
26-9-77	20^o	6.2	.16	.008	.76	7.7	.24
25-10-77	23^o	6.6	.16	.007	.78	7.	.18
14-11-77	20^o	6.5	.09	.007	.69	8.1	.19
12-12-77	18^o	6.9	.11	.007	.76	7.6	.20
Average	22.208	6.4	.125	.008	.66	7.39	.243
	$\pm$3.31	$\pm$0.24	$\pm$0.037	$\pm$ .002	$\pm$0.261	$\pm$0.807	$\pm$0.044

Table 10: Showing the physico-chemical conditions of soil at depth C of SH pond with the annual average and standard deviation for the years 1976 and 1977

Dates	t°	pH	Nt %	Na %	OC %	Phos-phorus mg/100/g	Exchange-able Ca %
10-1-76	16°	5.4	.24	.030	2.6	6.4	.34
10-2-76	18°	5.9	.24	.031	2.8	6.5	.32
9-3-76	24°	5.2	.25	.033	2.9	6.1	.28
5-4-76	23°	5.4	.19	.039	2.9	6.00	.32
7-5-76	26.5°	5.7	.23	.041	3.0	6.5	.38
15-6-76	27°	5.1	.23	.042	2.7	6.8	.30
12-7-76	27.5°	5.5	.36	.038	3.2	6.6	.39
10-8-76	29°	5.2	.35	.035	2.8	7.1	.42
10-9-76	20°	5.5	.30	.033	2.9	7.2	.38
10-10-76	20°	5.0	.31	.032	2.7	6.8	.36
24-11-76	19°	5.2	.32	.031	2.8	6.9	.45
11-12-76	17°	5.2	.21	.029	2.9	6.9	.46
Average	20.25	5.358	.279	.034	2.85	6.65	.3666
	±4.5	±0.26	±0.0593	±0.004	±0.157	±0.37	±0.057
13-1-77	16°	5.4	.21	.028	2.9	7.1	.29
10-2-77	17°	5.2	.24	.031	2.7	7.1	.31
14-3-77	22°	5.6	.26	.032	2.8	6.1	.36
4-4-77	22°	5.4	.30	.035	2.8	8.1	.31
7-5-77	23°	5.2	.34	.037	2.9	6.0	.29
29-6-77	21.5°	5.1	.31	.038	2.7	6.9	.32
26-7-77	23°	5.6	.31	.037	3.1	6.3	.41
12-8-77	27°	5.8	.27	.034	3.0	7.2	.42
26-9-77	19°	5.4	.23	.038	2.8	7.6	.42
25-10-77	23°	5.4	.24	.037	2.9	7.8	.36
14-11-77	18°	5.7	.27	.033	2.7	8.2	.32
12-12-77	17.5°	5.6	.25	.032	2.8	8.1	.34
Average	20.75	5.45	.269	.034	2.84	7.208	.345
	±3.24	±0.215	±0.038	±0.003	±0.124	±0.78	±0.048

Table 11: Showing the physico-chemical condition of soil with annual average and standard deviation of PG pond at depth A for the years 1976 and 1977

Dates	t°	pH	Nt %	Na %	OC %	Available phos-phorus mg/100/g	Exchange able Ca %
4-1-76	17°	5.8	.16	.006	1.17	5	.20
7-2-76	17°	5.9	.19	.006	.95	6.4	.25
12-3-76	21°	5.7	.17	.010	1.96	6.1	.32
7-4-76	28°	5.8	.15	.014	1.6	6.9	.32
15-5-76	27°	5.9	.09	.015	1.6	7.1	.24
10-6-76	26°	5.7	.14	.014	1.5	7.5	.27
7-7-76	29°	6.1	.14	.016	1.6	5.5	.30
5-8-76	29°	5.7	.12	.014	1.5	5.7	.31
7-9-76	28°	5.8	.14	.008	1.6	5.8	.29
7-10-76	23°	5.7	.16	.009	1.5	5.9	.24
7-11-76	19°	5.9	.17	.007	1.2	5.7	.22
9-12-76	18°	6.5	.14	.007	1.03	5.7	.19
Average	23.5°	5.875	.147	.01	1.434	6.108	0.26
	±4.87	±0.23	±0.025	±0.003	±0.29	±0.73	±0.045
10-1-77	17°	6.0	.13	.007	1.1	5.8	.22
7-2-77	19°	6.1	.16	.009	1.4	5.9	.23
11-3-77	21°	5.8	.19	.007	1.5	6.4	.34
2-4-77	28°	5.9	.12	.008	1.27	6.9	.36
6-5-77	29°	6.1	.12	.009	.70	7.2	.32
25-6-77	22°	6.2	.17	.007	.86	8.1	.28
28-7-77	23°	6.3	.18	.011	.90	7.5	.28
20-8-77	26°	5.8	.15	.009	1.2	7.8	.27
28-9-77	24.5°	6.0	.16	.012	.95	6.6	.21
29-10-77	21°	6.1	.12	.007	1.2	6.7	.25
10-11-77	19°	5.9	.14	.006	1.5	6.1	.27
14-12-77	15°	5.7	.14	.005	1.8	6	.26
Average	22.04	5.99	.148	.008	1.198	6.75	.27
	±4.287	±0.178	±0.024	±0.002	±0.318	±0.766	±0.046

Table 12: Showing the physico-chemical condition of soil with annual average and standard deviation of PG pond at depth B for the years 1976 and 1977

Dates	t^o	pH	Nt %	Na %	OC %	Available phos-phorus mg/100/g	Exchange-able Ca %
4-1-76	18.5°	6.0	.25	.012	2.3	5.5	.22
4-2-76	19°	5.8	.28	.011	2.5	6.5	.24
12-3-76	20°	5.4	.29	.016	3.6	6.2	.35
7-4-76	26°	5.7	.21	.017	3.7	6.3	.38
15-5-76	26°	5.0	.24	.015	3.9	7.0	.27
10-6-76	25°	4.4	.26	.021	3.1	7.1	.28
7-7-76	28°	5.4	.26	.024	3.9	5.6	.28
5-8-76	28°	5.6	.10	.019	3.1	6.0	.38
7-9-76	27°	5.5	.13	.05	3.7	6.0	.38
7-10-76	22°	5.4	.19	.016	2.9	5.8	.39
7-11-76	18°	5.7	.18	.012	2.9	5.9	.32
9-12-76	17°	6.4	.16	.009	2.8	5.7	.28
Average	22.875	5.525	0.213	.026	3.2	6.13	.31
	±4.21	±0.497	±0.061	±0.004	±0.547	±0.515	±0.06
10-1-77	16°	5.7	.18	.009	2.9	5.9	.36
7-2-77	18°	5.2	.26	.011	2.9	6.1	.32
11-3-77	20°	5.2	.29	.012	3.4	6.2	.32
2-4-77	27°	5.2	.25	.018	3.9	7.4	.35
6-5-77	28°	5.0	.20	.019	3.5	7.5	.39
25-6-77	21°	6.5	.24	.017	3.1	7.9	.36
28-7-77	22°	5.0	.28	.018	3.9	6.2	.25
20-8-77	25°	5.0	.27	.019	3.41	6.9	.26
28-9-77	24°	5.0	.24	.012	3.11	5.8	.27
10-11-77	18°	5.1	.25	.012	3.0	5.1	.22
14-12-77	14°	5.0	.20	.011	3.0	5.4	.24
Average	21.160	5.258	.24	.014	3.31	6.34	.296
	±4.302	±0.437	±0.033	±0.003	±0.362	±0.885	±0.06

Table 13: Showing the physico-chemical conditions of soil with annual average and standard deviation of PG Pond at depth C for the years 1976 and 1977

Dates	t°	pH	Nt %	Na %	OC %	Available phos-phorus mg/100/g	Exchange-able Ca %
4-1-76	17°	5.7	.20	.024	1.08	6.5	.32
7-2-76	18°	5.8	.21	.024	1.19	7.0	.32
12-3-76	19°	5.7	.23	.028	1.35	6.1	.34
7-4-76	24°	5.2	.18	.031	1.38	7.2	.38
15-5-76	25°	5.1	.18	.042	2.26	7.3	.38
10-6-76	34°	5.2	.20	.043	2.65	7.1	.42
7-7-76	35°	5.4	.24	.049	2.96	7.8	.42
5-8-76	24°	5.0	.24	.046	2.11	6.0	.41
7-9-76	25°	5.0	.21	.039	3.12	6.0	.40
7-10-76	21°	5.2	.19	.031	1.74	6.1	.39
7-11-76	17°	5.2	.21	.028	1.65	6.4	.38
9-12-76	17°	5.4	.22	.026	1.15	6.3	.34
Average	21.33	5.325	.209	.03	1.803	6.65	.375
	±3.498	±0.276	±0.021	±0.009	±0.617	±0.605	±0.036
10-1-77	16°	5.6	.19	.021	1.2	6.6	.39
7-2-77	18°	5.2	.20	.024	1.1	6.8	.34
11-3-77	20°	5.4	.21	.025	1.0	7.2	.38
2-4-77	26°	5.1	.22	.024	1.74	7.9	.39
25-6-77	21°	5.4	.24	.025	1.87	8.2	.38
28-7-77	22°	5.2	.25	.026	1.78	7.1	.45
20-8-77	24°	4.9	.26	.029	1.73	6.9	.42
28-9-77	23°	5.2	.21	.025	1.65	6.8	.39
29-10-77	21°	5.4	.21	.026	1.64	6.7	.37
10-11-77	16°	5.5	.22	.024	1.5	6.2	.38
14-12-77	16°	5.6	.20	.026	1.5	6.5	.36
Average	20.83	5.308	.22	.025	1.486	7.08	.386
	±0.809	±0.21	±0.021	±0.001	±0.31	±0.65	±0.027

Table 14: Showing physico-chemical conditions of soil with annual average and standard deviation at depth A of SB pond for the years 1976 and 1977

Dates	t°	pH	Nt %	Na %	OC %	Available phosphorus mg/100/g	Exchangeable Ca %
15-1-76	15°	6.1	.10	.012	.9	7.0	.28
15-2-76	17°	6.5	.12	.011	1.2	8.9	.24
15-3-76	24°	6.2	.12	.011	1.2	9.5	.36
30-4-76	28°	6.0	.10	.015	.79	11.0	.29
18-5-76	28°	6.1	.12	.014	.90	8.9	.24
16-6-76	28°	6.5	.19	.012	1.2	8.0	.21
15-7-76	31°	6.5	.18	.017	.9	10.2	.18
31-8-76	31°	5.9	.13	.016	1.1	10.0	.16
30-9-76	26°	5.9	.14	.009	1.2	8.0	.19
30-10-76	24°	6.1	.15	.012	1.1	9.9	.24
30-11-76	21°	6.0	.14	.011	.9	6.8	.26
28-12-76	15°	6.1	.13	.012	1.2	6.6	.26
Average	24°	6.15	.139	.012	1.05	8.73	.24
	±5.799	±0.223	±0.03	±0.002	±0.158	±1.454	±0.054
19-1-77	16°	6.7	.11	.01	.80	7.8	.27
24-2-77	17°	6.8	.13	.01	.8	10.2	.27
15-3-77	28°	6.9	.12	.01	.90	12.2	.28
8-4-77	28°	6.8	.16	.012	.99	14.0	.32
9-5-77	30°	6.7	.10	.015	1.5	14.0	.24
22-6-77	22°	6.9	.17	.012	1.6	16.0	.20
30-7-77	24°	6.8	.13	.006	.9	9.0	.19
18-8-77	26°	6.8	.19	.007	1.1	9.2	.17
30-9-77	24°	6.8	.16	.009	1.02	11.0	.18
31-10-77	20°	6.9	.17	0.12	1.02	12.0	.26
15-11-77	20°	6.7	.18	.011	1.1	8.0	.28
22-12-77	15°	6.8	.14	.012	1.49	14	.32
Average	22.5°	6.8	0.15	0.01	1.1	11.45	0.24
	±5	±0.073	±0.029	±0.002	±0.277	±2.88	±0.052

Table 15: Showing the physico-chemical conditions of soil with annual average and standard deviation at depth B of SB pond for the year 1976 and 1977

Dates	t°	pH	Nt %	Na %	OC %	Available phos-phorus mg/100/g	Exchange able Ca %
15-1-76	15°	6	.19	.02	1.7	6.5	.32
15-2-76	17°	6.4	.22	.024	1.5	8.0	.32
15-3-76	23°	6.0	.22	.025	1.75	7.6	.24
30-4-76	27°	6.2	.24	.026	1.5	12.5	.26
16-5-76	27°	6.4	.26	.031	1.5	11.0	.20
16-6-76	27°	6.4	1.29	.018	1.5	8.15	.21
15-7-76	30°	6.4	.29	.019	1.8	10.2	.30
31-8-76	30°	5.8	.24	.024	1.9	10.1	.31
30-9-76	24°	5.8	.20	.024	1.9	9.9	.33
30-10-76	23°	6.0	.23	.019	1.5	9.1	.36
30-11-76	20°	5.9	.20	.016	1.1	8.8	.38
28-12-76	15°	6.0	.19	.018	1.5	8.9	.40
Average	23.166	6.1	.23	0.02	1.595	9.22	0.30
	±5.39	±0.239	±0.035	±0.004	±0.226	±1.62	±0.063
19-1-77	15°	6.7	.20	.02	1.6	9.1	.34
24-2-77	16°	6.8	.22	.021	1.7	11	.38
15-3-77	27°	6.9	.22	.025	1.8	12.6	.42
8-4-77	27°	6.5	.21	.032	1.81	15	.41
9-5-77	29°	6.3	.29	.037	1.8	15.6	.29
22-6-76	21°	6.5	.28	.023	1.8	18	.28
30-7-77	23°	6.6	.26	.025	1.7	19.5	.21
18-8-77	24°	6.7	.20	.36	1.5	10	.20
30-9-77	23°	6.8	.19	.032	1.8	10.2	.26
31-10-77	20°	6.7	.21	.031	1.8	13	.29
15-11-77	18°	6.7	.21	.031	1.7	.14	.22
22-12-77	15°	16.8	.20	.022	1.9	16	.32
Average	21.5	6.666	.22	.05	1.74	13.666	.3
	±4.83	±0.166	±0.033	±0.096	±0.108	±3.287	±0.075

Table 16: Showing the physico-chemical conditions of soil silt annual average and standard deviation at depth C of SB pond for the year 1976 and 1977

Dates	t°	pH	Nt %	Na %	OC %	Available phos-phorus mg/100/g	Exchange-able Ca %
15-1-76	15°	5.9	.31	0.6	1.9	16.7	.35
15-2-76	16°	5.9	.32	.067	1.8	17.0	.33
15-3-76	22°	5.9	.36	.068	2.1	17.2	.32
30-4-76	26°	6.0	.35	.055	1.9	10.1	.35
10-5-76	26°	6.2	.35	.04	1.9	12.4	.24
16-6-76	26°	6.5	.36	.035	2.1	14.8	.22
15-7-76	29°	6.0	.37	.048	2.2	9.0	.28
31-8-76	29°	5.9	.32	.056	1.9	9.1	.35
30-9-76	23°	5.9	.35	.059	1.9	10.2	.36
30-10-76	23°	5.8	.32	.064	1.8	8.5	.38
30-11-76	20°	5.7	.30	.061	1.8	9.1	.42
26-12-76	15°	5.9	.32	.064	1.7	14.2	.48
Average	22.5°	5.966	.335	.056	1.916	12.358	.34
	±5.07	±0.205	±0.023	±0.010	±0.146	±3.44	±0.071
11-1-77	15°	6.2	.33	.052	1.9	9.9	.38
14-2-77	16°	6.7	.32	.057	1.85	14	.42
15-3-77	26°	6.4	.32	.061	1.8	14.9	.44
8-4-77	25°	6.1	.35	.052	1.86	16	.40
9-5-77	28°	6.0	.37	.063	1.9	15.9	.29
22-6-77	20°	6.0	.38	.047	1.76	19	.28
30-7-77	22°	6.3	.39	.042	1.93	19.4	.27
18-8-77	23°	6.4	.37	.057	2.16	14	.36
30-9-77	22.5°	6.5	.34	.06	2.29	14	.38
31-10-77	18°	6.4	.35	.051	1.91	14.8	.39
5-11-77	17°	6.2	.31	.055	1.86	16	.40
22-12-77	15°	6.4	.31	.052	1.92	18	.39
Average	20.63	6.3	.346	.054	1.936	15.49	.366
	±4.457	±0.208	±0.027	±0.006	±0.147	±2.58	±0.056

respectively in 1976 and 0.13, 0.19, 0.31% respectively in 1977). In PG pond total nitrogen values of soils were the highest during late winter and early summer at station A and B whereas those at C were recorded during monsoon for both the years. Bottom soil of SB pond showed the highest values of total nitrogen during late summer and monsoon and the lowest during winter (Table 8 - 16).

Available Nitrogen

Available nitrogen was noted to reach the peak values during summer and monsoon in all the three ponds. The highest and the lowest values were recorded in SB pond and SH pond respectively.

Organic Carbon

Organic carbon content in the soil samples was noted to be the highest in PG pond and the lowest in SH pond, whereas in SB pond it was intermediate between the two. SH pond and SB ponds contained the highest organic carbon during late summer and monsoon and the lowest during winter. PG pond showed the peak value of organic carbon during late winter and early summer. Organic carbon was found to be the highest at C in SH and SB pond and at B in PG pond (Tables 8 - 16).

Available Phosphorus

Among the three ponds, the yearly average content of available phosphorus was found to be the highest in the soils of SB pond as compared to other two ponds during the entire period of investigation. Detailed monthly record of available phosphorus are shown in Tables 8 - 16.

Exchangeable Calcium

Exchangeable calcium was noted to be the highest in PG pond and the lowest in SH pond throughout the periods of observation. But the intermediate position in exchangeable calcium content was recorded in SB pond (Tables 8 - 16).

Relationship between pH and available phosphorus content of soils (Table 17)

The available phosphorus content of the sediment increased with the increase of soil pH. The relationship was noted to be at 5% level of significance at B of SB pond (t = 2.298) and it was found to be at 1% level of significance at A of SB pond (t = 3.17).

Relationship between pH and total Nitrogen content of soils (Table 17)

In the present study an inverse relationship between pH and total nitrogen content of soil was found.

Table 17: Showing correlation coefficient between pH and available phosphorus (A/P), pH, & N/T, and pH and organic carbon of soil at three depth in SH, PG and SB ponds

SH Pond	Depth	-	A	pH	S	A/P	r	0.333	t	1.639
"	"		B		"		r	0.375	t	1.926
"	"		C		"		r	0.005	t	0.046
PG Pond	"		A		"		r	0.148	t	0.711
"	"		B		"		r	-0.292	t	-1.421
"	"		C		"		r	.104	t	0.471
SB Pond	"		A		"		r	0.555	t	3.170 **
"	"		B		"		r	0.437	t	2.298*
"	"		C		"		r	0.32	t	1.584
SH Pond	"		A	pH	S	N/T	r	-0.008	t	-0.039
"	"		B		"		r	-0.069	t	-0.324
"	"		C		"		r	-0.623	t	-3.734 **
PG Pond	"		A		"		r	0	t	0
"	"		B		"		r	-0.092	t	-0.423
"	"		C		"		r	-0.192	t	-0.916
SB Pond	"		A		"		r	-0.40	t	-2.047
"	"		B		"		r	-0.02	t	-0.094
"	"		C		"		r	-0.409	t	-2.105 *
SH Pond	"		A	pH	"	OC	r	-0.013	t	-0.063
"	"		B		"		r	-0.154	t	-0.751
"	"		C		"		r	- .684	t	-4.401 **
PG Pond	"		A		"		r	-0.441	t	-2.298 *
"	"		B		"		r	-0.111	t	-0.519
"	"		C		"		r	-0.428	t	-2.218*
SB Pond	"		A		"		r	-0.163	t	-0.762
"	"		B		"		r	-0.431	t	-2.234 *
"	"		C		"		r	-0.803	t	-6.313 **

* 5% level of significance

** 1% level of significance

Relationship between pH and organic carbon content of soils (Table 17)

Soil pH decreased with the increase of the amount of organic carbon in ponds sediment. The relationship was found to be at 5% level of significance at A (t = - 2.98) and C (t = - 2.218) of PG and at B (t = - 2.234) of SB pond. At C of SH pond (t = - 4.401) and SB pond (t = - 6.313) the relationship was noted to be at 1% level of significance.

Relationship between total Nitrogen and available Phosphorus content of soils (Table 18)

The amount of available phosphorus in sediment was found to increase with the increasing content of total nitrogen at all the depths of three ponds except at depth A of SH pond. The relationship was calculated to be at 5% level of significance at depth B of SH pond.

Relationship between total Nitrogen and organic carbon content of soils (Table 18)

The amount of total nitrogen increased with the increase of the content of organic carbon of soils. The relationship was noted to be at 1% level of significance at depth A of SH pond.

Table 18: Showing correlation coefficient between total nitrogen and available phosphorus, and N/T and organic carbon of soil at three depths in SH, PG and SB ponds

SH Pond	Depth	A	N/T	S	A/P	r	-0.32	t	-1.584	
"	"	B		"		r	0.48	t	2.566	*
"	"	C		"		r	0.03	t	0.141	
PG Pond	"	A		"		r	0	t	0	
"	"	B		"		r	0.184	t	0.858	
"	"	C		"		r	0.23	t	1.108	
SB Pond	"	A		"		r	0.34	t	1.69	
"	"	B		"		r	0	t	0	
"	"	C		"		r	0.25	t	1.21	
SH Pond	"	A	N/T	S	OC	r	0.7528	t	5.432	**
"	"	B		"		r	0.1097	t	0.5148	
"	"	C		"		r		t		
PG Pond	"	A		"		r	0.09	t	0.421	
"	"	B		"		r	0.17	t	0.811	
"	"	C		"		r		t		
SB Pond	"	A		"		r	0.142	t	0.663	
"	"	B		"		r	0.275	t	1.236	
"	"	C		"		r	0	t	0	

* 5% level of significance

** 1% level of significance

COMMENTS

In all the three ponds the highest temperature of bottom soil was found at A (0.2 meter depth) during summer. The lowest temperature was noted at C (3 meter depth) during winter. It seems that soil temperature of ponds, like that of water, depends on angle of incidence of sun light, duration of photoperiod, and volume of water.

In the present observation a noticeable fluctuation in soil pH at different depths was noted in all the three ponds. Soil pH was found to increase at greater depth. The highest pH was found at the margins of the ponds. Accumulation of organic matter, which showed a negative relationship with pH in these studies resulted the low pH. At the deepest bottom these ponds contained very high amount of organic matter and pH was found to be minimum. On the other hand, at A (Pond's margin) the highest pH was recorded where the content of organic matter was the minimum.

During the present investigation available phosphorus showed a positive correlation with pH in all the sampling depths of the three ponds except at B of PG pond where high organic matter and rich bacterial population were recorded (Table 7, 12 and 17). This negative relationship might be due to assimilation of available phosphorus by the bacterial cells. Einsele (1936) and Ohle (1938) also observed a direct relationship between pH and available phosphorus in pond soil.

During the present observation, pH showed negative relationship with total nitrogen of soil. Soil pH exhibited good negative relationship with total nitrogen at C of SH pond (r = - .623). At depth C of SB pond the relationship between pH and total nitrogen was found to be significant at 5% level (r = -.409) (Table 17). Negative relationship between soil pH and total nitrogen content is logical since an increase in organic matter content increases the amount of nitrogen which enhances the bacterial decomposition and this pH of soil is reduced.

In the present study a positive correlation between available phosphorus and nitrogen content was recorded in all the depths of three ponds, except at A of SH pond (Table 18). However, an inverse correlation between available phosphorus and nitrogen of soil was described by various workers (Mortimer, 1941; Stephenson, 1951; Sumitra, 1973).

The highest nitrogen contents in the bottom soil of SB and SH pond were noted during summer and early monsoon, whereas at PG pond the highest value was found during the late winter and early summer (Tables 8 - 16). Concentration of nitrogen in pond sediment depends on the amount of organic matter and temperature which enhance the process of denitrification. PG pond showed the highest organic matter during late winter through leaf litter which increased the nitrogen value of the sediment. Soil temperature was also high in SB and SH ponds during summer and early monsoon which enriched the nitrogen content of the sediment through decomposition of the organic matter present and that brought by rain water from the neighbouring areas. As such in the present study a positive correlation always occurred between organic matter and total nitrogen content of pond soil (Table 18).

In the course of present investigation, the highest deposit of organic carbon was noted at C in SB and SH ponds and at B in PG pond where also more coarse grained sediment was recorded than those at A which contained less organic carbon and course grained sediment. The richness of course grained sediment in deeper zones might be due to sharp slope of the basin. However, Cook (1975) found that course grained sediment tended to be much poorer in organic carbon content than silts and muds with very small particle size.

The exchangeable calcium content of soil has been found to be related directly with pH. Soil pH of SB pond was higher than that of SH pond and it contained higher amount of exchangeable calcium also (Tables 14 - 16). However, in PG pond soil was recorded to contain the highest amount of exchangeable calcium though it had the lowest pH value (Tables 11 - 13). The above anomaly might be due to the influence of some ions like aluminium and hydrogen.

In the present observations, PG pond had the highest exchangeable calcium content followed by SB and SH pond. Comparatively low calcium values were found in the water of PG and SH pond. The highest calcium value was noted in water of SB pond. Utilization of Ca ion from water by molluscan populations in PG and SH ponds might be the possible reason for above observation as these organisms were abundant in these ponds (Appendices 1 - 6). Young (1975) while working with the molluscan fauna reported that these organisms can absorb soluble Ca directly from water for their body requirement. As such high Ca value in SB pond water was noted in spite of low value of exchangeable calcium present in the sediment. However, Saha *et al.* (1971) observed that calcium concentration in pond water varied directly with exchangeable calcium in soil. On the other hand Sumitra (1973) obtained no definite relationship between exchangeable calcium ion in soil and calcium content in water.

CHAPTER V

POPULATIONS OF BENTHIC MACRO~~INVERTEBRATES~~ FAUNA

During two-year period of investigation the macroinvertebrate fauna belonging to planaria, oligochaetes, leeches, chironomids, ceratopogons, ostracods, mites, odonata, and molluscs etc. were studied in three ponds at Dacca. Of these groups special emphasis was given on the study of oligochaetes and molluscs. Beside the taxonomic enumeration other aspects, such as, seasonal variation, ecological distribution and effects of physical and chemical factors on the growth and distribution of these organisms in different depths of the ponds were studied. Detailed taxonomic enumeration of oligochaetes and molluscs of three ponds at different depths is given Table 19.

The occurrence of macrobenthos and their community structure differed characteristically (Tables 20, 21, Fig. 16). SB pond showed the highest number of diversified fauna. SH pond was characterised by poor number and low faunal diversity, whereas PG pond stood intermediate between the two. In all the three ponds the occurrence and diversification of the organisms decreased as the depth increased and at C a remarkable reduction in faunal distribution was noted (Table 20, Fig. 16). However, the observation on macroinvertebrates

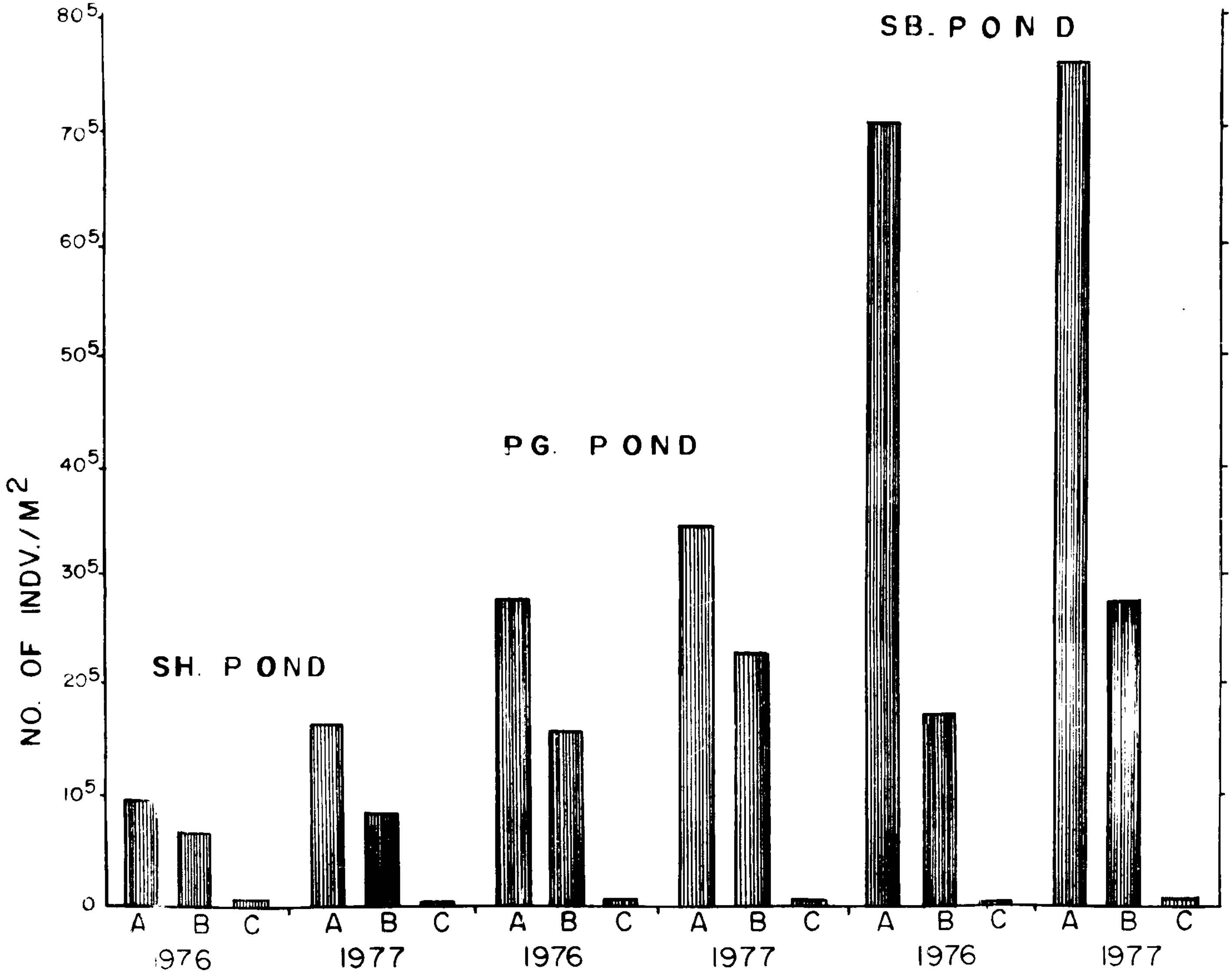

Fig. 16 Graph showing the total number of benthic organisms per meter square at depth A, B and C of three ponds for 1976 and 1977.

Table 19 : Showing the detailed taxonomic enumeration of Oligochaetes and Molluscan species at different depths in the three ponds.

	SH Pond			PG Pond			SB Pond		
	A	B	C	A	B	C	A	B	C
Phylum - Annelida									
Class - Oligochaeta									
Family - Naididae									
Nais simplex	-	-	-	-	-	-	R	-	-
Stylaria lacustris	-	-	-	R	-	-	-	-	-
Branchiodrilus semperi	AB	P	-	AB	AB	-	AB	P	R
Dero dorsalis	R	-	-	AB	P	-	P	R	-
D. digitata	AB	P	-	AB	P	R	AB	P	-
D. indica	-	-	-	-	-	-	AB	R	R
Aulophorus furcatus	-	-	-	P	R	-	AB	R	-
A. gravelyi	-	-	-	-	-	-	R	R	-
Pristina acuminata	R	P	R	P	P	-	P	-	-
Family - Tubificidae									
Limnodrilus hoffmeisteri	AB	AB	R	AB	AB	R	AB	AB	R
Aulodrilus pluriseta	P	P	R	P	P	-	P	R	R
Branchiura sowerbyi	P	R	R	R	R	-	AB	AB	-
Family - Enchytraeidae									
Mesenchytraeus sp.	-	P	R	P	P	-	R	P	-
Phylum - Mollusca									
Class - Gastropoda									
Family - Viviparidae									
Viviparus bengalensis	AB	AB	R	AB	AB	-	R	-	-
Family - Amnicolidae									
Digoniostoma pulchella	AB	AB	-	AB	AB	-	-	R	-
Alocinma orcula	R	-	-	AB	AB	-	AB	AB	R
Family - Melaniidae									
Melania tuberculata	AB	AB	-	-	-	-	R	-	-
Family - Planorbidae									
Planorbis exustus	R	-	-	R	R	-	R	R	-
Family - Lymnaeidae									
Lymnaea acuminata	-	-	-	R	-	-	-	-	-
L. luteola	-	-	-	-	-	-	R	-	-
Lymnaea sp.	R	-	-	-	-	-	-	-	-
Class - Bivalvia									
Family - Unionidae									
Lamellidens marginalis	R	R	-	-	-	-	-	-	-

AB = Abundant
P = Commonly present
R = Rare

Table 20 : Showing the annual gross numbers of organisms belonging to different groups and their percentage per meter square area at depths A, B and C of the three ponds.

Depth	Pond	Year	Oligochaetes		Chironomids		Molluscs		Mites		Ostracod		Leech		Planaria		Odonata		Chaoborus		Others		Total
			Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	
A	SH	1976	48886	51.6	30636	32.32	10386	10.9	44	-	2488	2.64	-	-	-	-	748	-	-	-	308	-	94766
		1977	81620	49.84	46772	28.56	29902	18.26	972	-	1760	1.07	-	-	-	-	704	-	-	-	2120	1.36	163842
	PG	1976	197252	71.8	40580	14.8	19494	7.1	3804	1.4	6724	2.4	264	-	1540	-	2112	-	-	-	2772	-	274542
		1977	246576	71.2	25752	7.4	65648	18.9	3960	1.14	193.6	-	1012	-	88	-	1188	-	-	-	308	-	346468
	SB	1976	393238	55.59	115104	16.27	13948	1.97	104182	14.72	62772	8.8	308	-	14772	2.08	1548	-	-	-	792	-	707324
		1977	412402	54.57	231484	30.63	20114	2.66	65126	8.62	22748	3	1012	-	1286	-	440	-	-	-	1144	-	755706
B	SH	1976	41844	64	2372	3.62	20942	32.03	-	-	-	-	-	-	-	-	-	-	-	-	220	-	65378
		1977	50776	62.6	10298	12.69	19668	24.25	-	-	-	-	-	-	-	-	-	-	-	-	352	-	81094
	PG	1976	129090	83	14890	9.6	10516	6.8	-	-	322	-	132	-	44	-	308	-	-	-	176	-	155508
		1977	195966	86.5	8800	3.88	20900	9.22	264	-	-	-	88	-	-	-	176	-	-	-	352	-	226546
	SB	1976	134028	78.29	22648	13.22	7700	4.49	-	-	-	-	-	-	-	-	-	-	-	-	6820	3.98	171196
		1977	230868	83.11	41800	15.04	3905	1.4	-	-	-	-	-	-	-	-	-	-	-	-	1188	-	277761
C	SH	1976	2530	37.49	480	7.11	-	-	-	-	-	-	-	-	-	-	-	-	3650	54.09	88	1.30	6748
		1977	576	18.68	836	27.11	-	-	-	-	-	-	-	-	-	-	-	-	1672	54.21	-	-	3084
	PG	1976	1188	14.29	704	8.46	-	-	-	-	-	-	-	-	-	-	-	-	6248	74.13	176	2.12	8316
		1977	88	1.59	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5456	98.41	-	-	5544
		1976	1188	49.09	132	9.09	-	-	-	-	-	-	-	-	-	-	-	-	616	25.45	264	16.36	2420
		1977	195	4.48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3056	70.15	1105	25.37	4356

Table 21 : Showing the annual gross number of different species of oligochaetes and molluscs and their percentage composition per meter square area at depth A, B and C of the three ponds.

Depth	Pond	Year	N. simplex		S. lacustris		B. sowerbyi		D. dorsalis		D. digitata		D. indica		A. furcatus		A. gravelyi		P. [illegible]		L. hoffmeisteri		A. pluriseta	
			Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
A	SH	1976	-	-	-	-	4054	4.3	830	*	3144	3.3	-	-	304	*	-	-	522	*	38210	40.3	1088	*
		1977	-	-	-	-	7670	4.7	1380	*	10796	6.67	88	*	44	*	-	-	1144	*	94040	33.4	3520	2.1
	PG	1976	-	-	88	*	37144	13.5	25692	9.3	15742	5.7	-	-	484	*	-	-	8044	2.9	102916	37.5	3226	1.2
		1977	-	-	-	-	40288	11.6	18152	5.2	21324	6.1	-	-	5108	1.4	-	-	19358	5.6	122158	35.6	6908	1.9
	SB	1976	352	*	-	-	65834	9.1	2848	*	31592	4.5	15094	2.1	42198	6	1756	*	-	-	180552	25.5	1344	1[illegible]
		1977	-	-	-	-	51758	6.8	9440	1.2	20904	2.7	12770	1.6	7416	*	6538	*	-	-	219086	29	476	*
B	SH	1976	-	-	-	-	882	1.35	-	-	2790	4.29	-	-	88	*	-	-	1364	2	34408	52.6	1064	1.6
		1977	-	-	-	-	3564	4.4	-	-	4840	5.9	-	-	880	1	-	-	1364	2.7	29892	36.8	6862	8.4
	PG	1976	-	-	-	-	13702	8.8	6864	4.4	4806	3.1	-	-	-	-	-	-	5282	3.39	86456	55.59	4028	2.5
		1977	-	-	-	-	8140	4.15	3652	1.6	6556	2.89	-	-	534	*	-	-	16700	7.5	136900	60.4	5500	2.4
	SB	1976	-	-	-	-	2152	1.2	1692	*	4550	2.6	1612	*	528	*	660	*	-	-	94286	55	2828	1.6
		1977	-	-	-	-	14354	5.2	3242	1.6	1318	*	1320	*	352	*	748	*	-	-	152108	54.7	-	-
C	SH	1976	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	440	6.5	264	3.9
		1977	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	356	11.5	44	1.4
	PG	1976	-	-	-	-	-	-	-	-	748	9	-	-	-	-	-	-	-	-	440	5.29	-	-
		1977	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	176	3.13	-	-
	SB	1976	-	-	-	-	132	5.4	-	-	-	-	44	1.8	-	-	-	-	-	-	792	36.3	132	5[illegible]
		1977	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	44	1	-	-

	?. sowerbyi		[illegible] sp.		L. bengalensis		D. pulchella		A. ocula		M. tuberculata		P. amnutus		L. acuminata		L. luteola		Lymnaea sp.		L. marginalis	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
	742	*	-	-	3138	3.4	1820	1.9	658	*	4274	4.5	-	-	-	-	-	-	264	*	132	*
.1	2457	1.5	481	*	10446	6.4	7826	4.8	1364	*	9210	5.7	264	*	-	-	-	-	-	-	792	*
.2	-	-	3916	1.4	9564	3.5	3784	1.37	5570	2	-	-	44	*	528	*	-	-	-	-	-	-
.9	88	*	13156	3.8	21604	6.2	19350	5.5	24356	7	-	-	264	*	44	*	-	-	-	-	-	-
[illegible]	[illegible]151	5.5	430	*	-	-	-	-	13458	1.9	354	*	-	-	-	-	132	*	-	-	-	-
	[illegible]808	11	166	*	132	*	-	-	10260	2.5	440	*	1144	*	-	-	132	*	-	-	-	-
[illegible]	[illegible]4	1.4	264	*	16840	25.7	1902	2.9	-	-	2156	3.2	-	-	-	-	-	-	-	-	44	*
.4	1716	2	1628	1.7	15552	19	2420	2.9	-	-	1432	1.7	44	*	-	-	-	-	-	-	220	*
.5	1012	*	6860	4.4	7257	4.6	2093	1.3	1166	*	-	-	-	-	-	-	-	-	-	-	-	-
.4	1936	*	15962	7	7258	3.2	7658	3.38	5940	2.6	-	-	44	*	-	-	-	-	-	-	-	-
.6	[illegible]404	14.2	1300	*	-	-	44	*	8132	4.7	-	-	88	*	-	-	-	-	-	-	-	-
	[illegible]226	19.5	3854	1.38	-	-	-	-	3876	1.38	-	-	44	*	-	-	-	-	-	-	-	-
.9		-	1826	27	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
.4	-	-	176	5.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		-	88	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

are discussed here under the following heads: (i) community patterns at different depths in different seasons; (ii) biomass of macroinvertebrates; (iii) size group frequency of dominant tubificids; (iv) mutual association between major oligochaetes; (v) populations of benthic macroinvertebrates and physico-chemical factors of water; (a) simple regression; (b) multiple regression; (vi) populations of macroinvertebrates and some chemical parameters of soil.

(i) Community Patterns

The oligochaetes was the most common group in all the three ponds and these organisms determined the major bulk of the community. In SB pond it was followed by chironomids and molluscs, whereas in SH and PG ponds molluscs occupied the second position followed by chironomids (Figs. 17 - 19). In the present investigation, sometimes an inverse relationship was observed between chironomids and oligochaetes (Fig. 20).

The community patterns at different depths, A, B and C, of the three ponds in different seasons are discussed below.

DEPTH A

The highest number of benthic organisms per meter square was found at A (Fig. 16). Rainfall was noted to have a vital role in

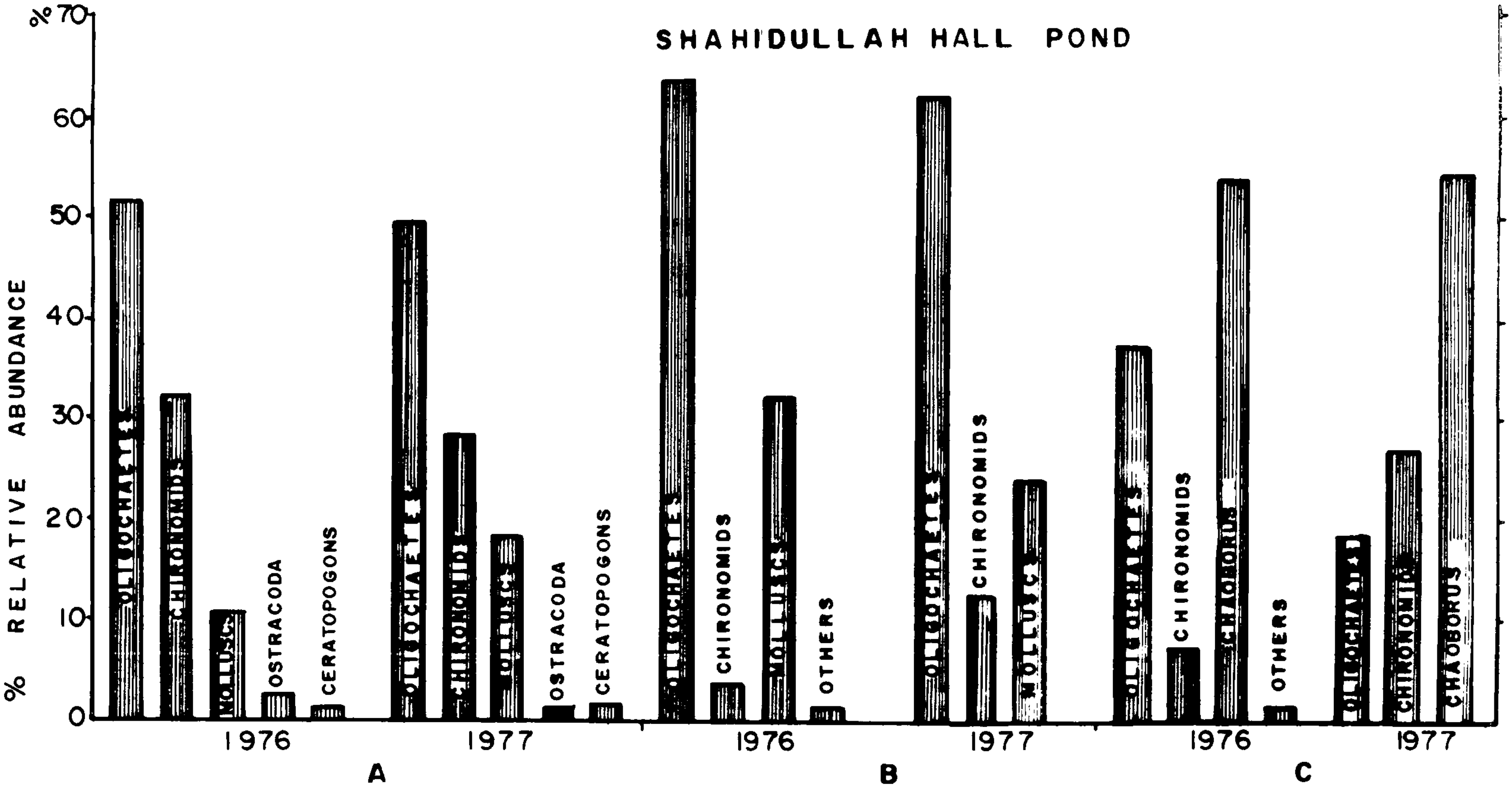

Fig. 17 Graph showing percent relative abundance of major groups of organisms at three depths of SH pond in 1976 and 1977.

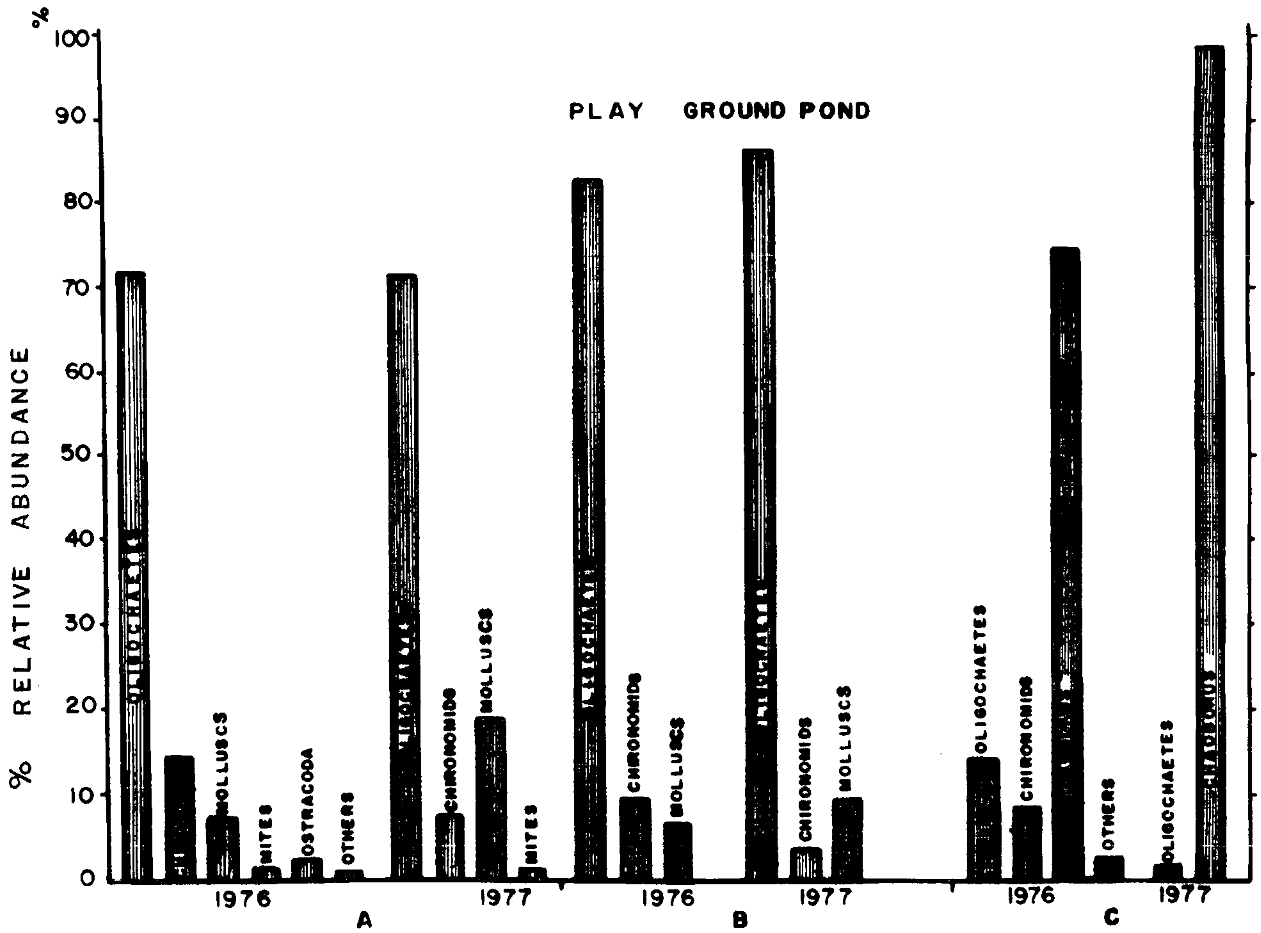

Fig. 18 Graph showing percent relative abundance of major groups of organisms at three depths of PG pond in 1976 and 1977.

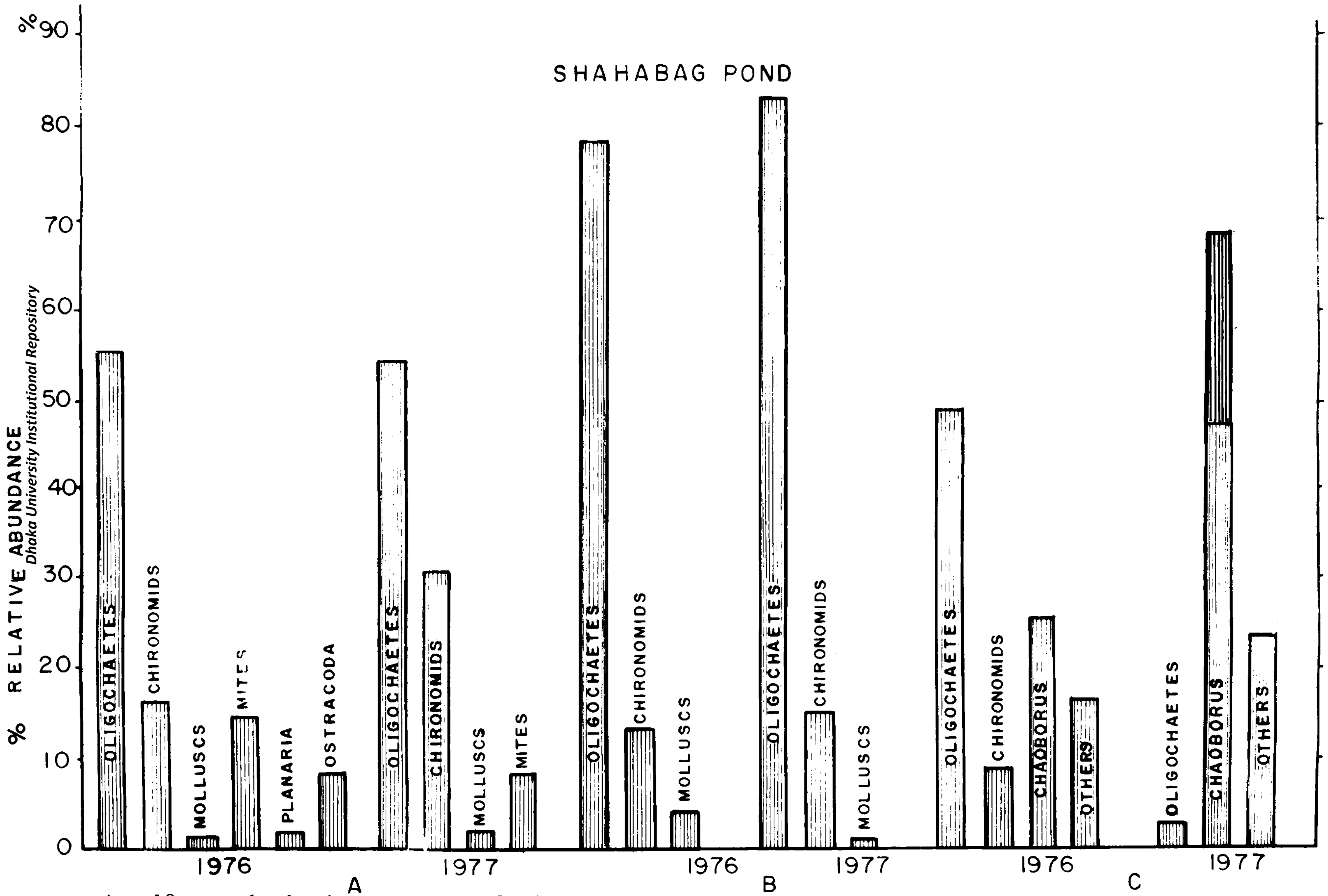

Fig. 19 Graph showing percent relative abundance of major groups of organisms at three depths of SB pond in 1976 and 1977.

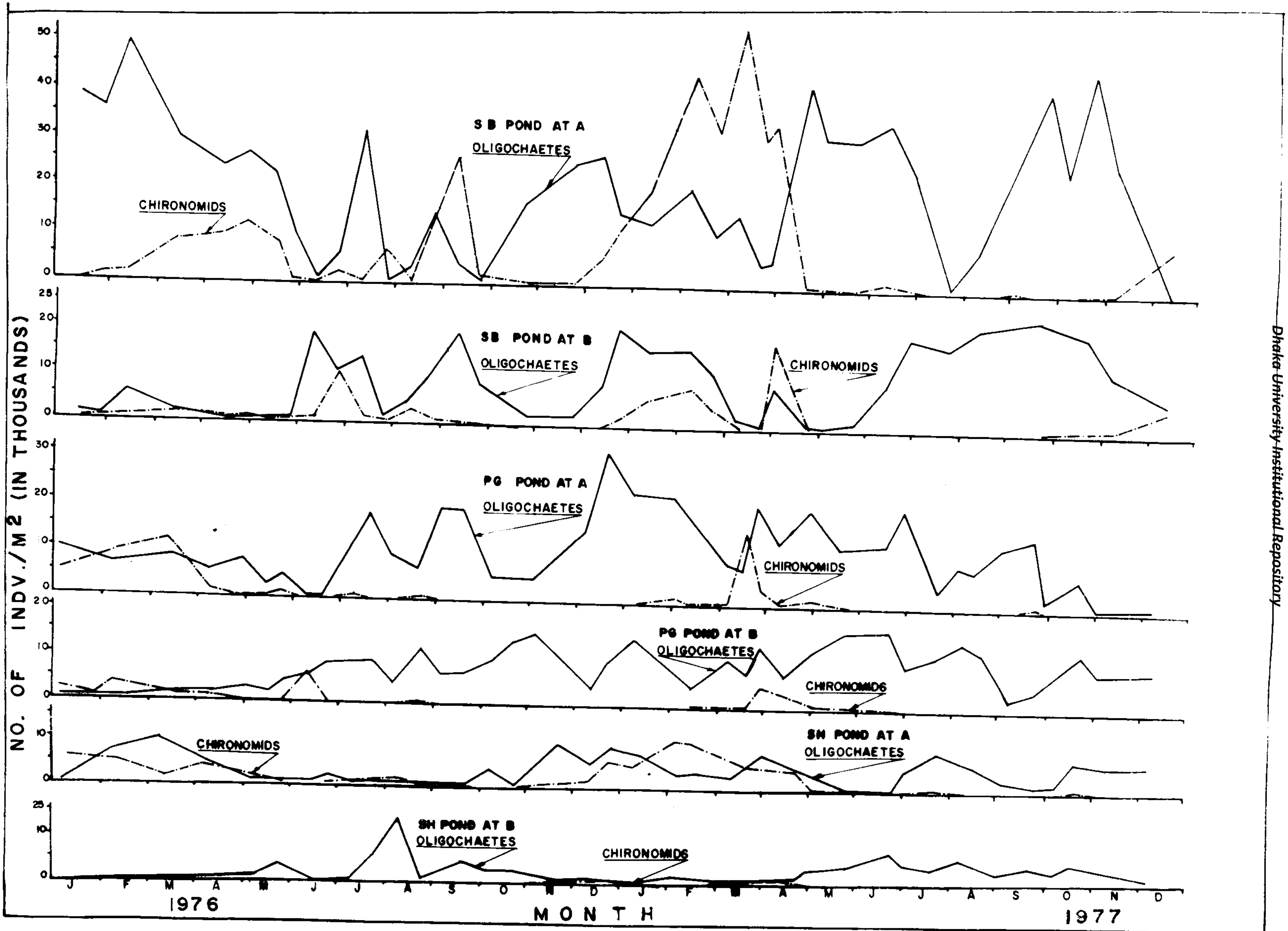

Fig. 20 Graphs showing monthly relationship in abundance between oligochaete and chironomid fauna at depths A and B of the three ponds in 1976 and 1977.

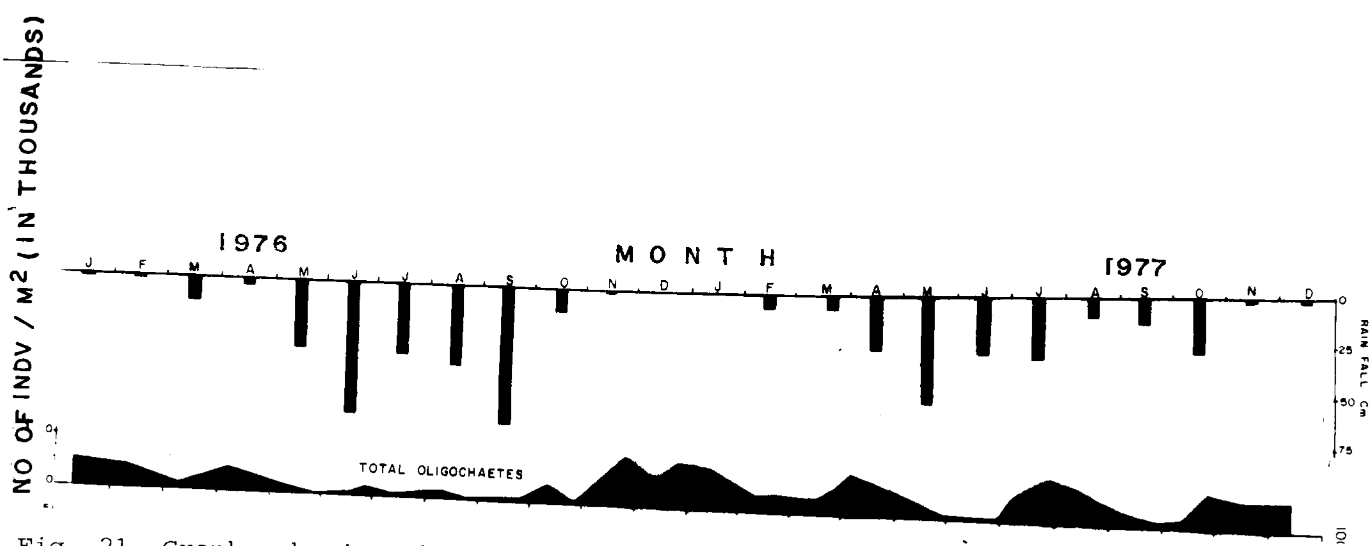

Fig. 21 Graphs showing the rainfall and seasonal abundance of oligochaete fauna at depth A of SH pond in 1976 and 1977.

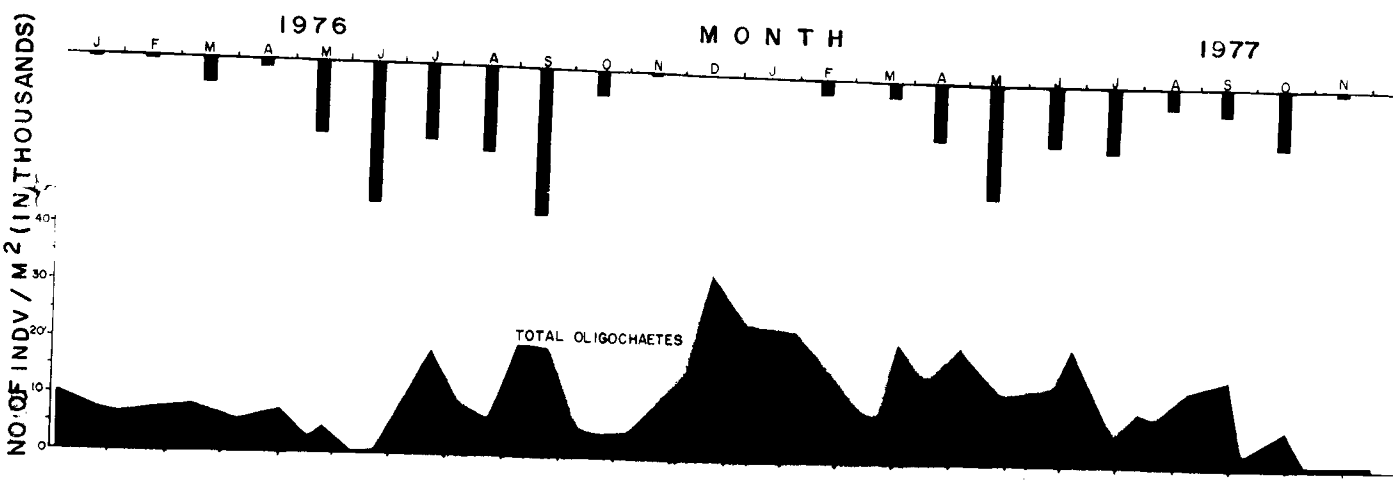

Fig. 22 Graphs showing the rainfall and seasonal abundance of oligochaete fauna at depth A of PG pond in 1976 and 1977.

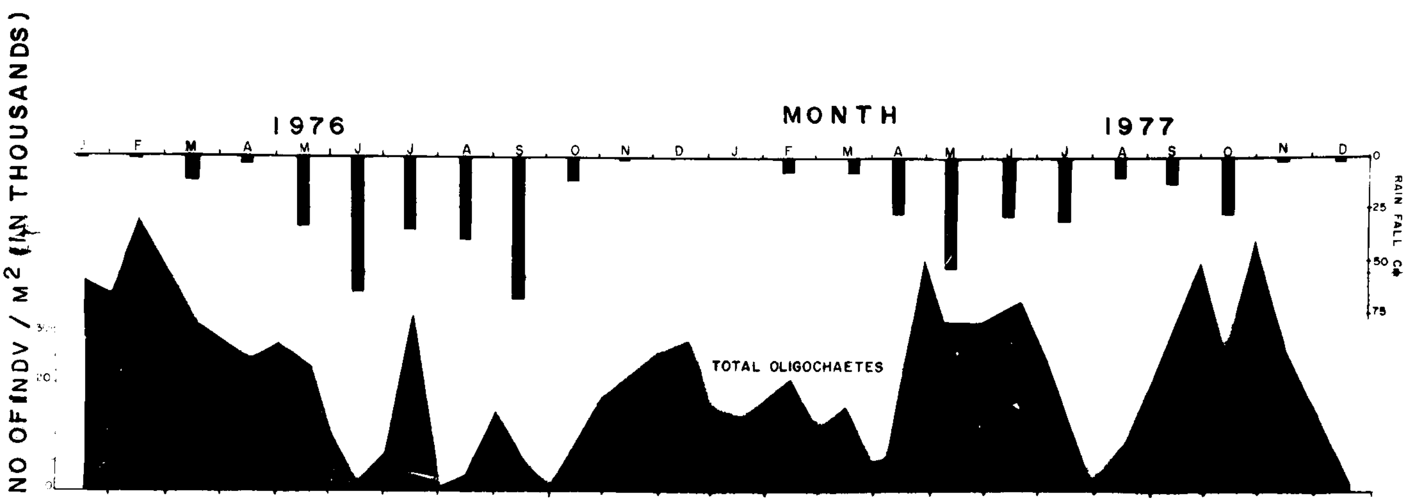

Fig. 23 Graphs showing the rainfall and seasonal abundance of oligochaete fauna at depth A of SB pond in 1976 and 1977.

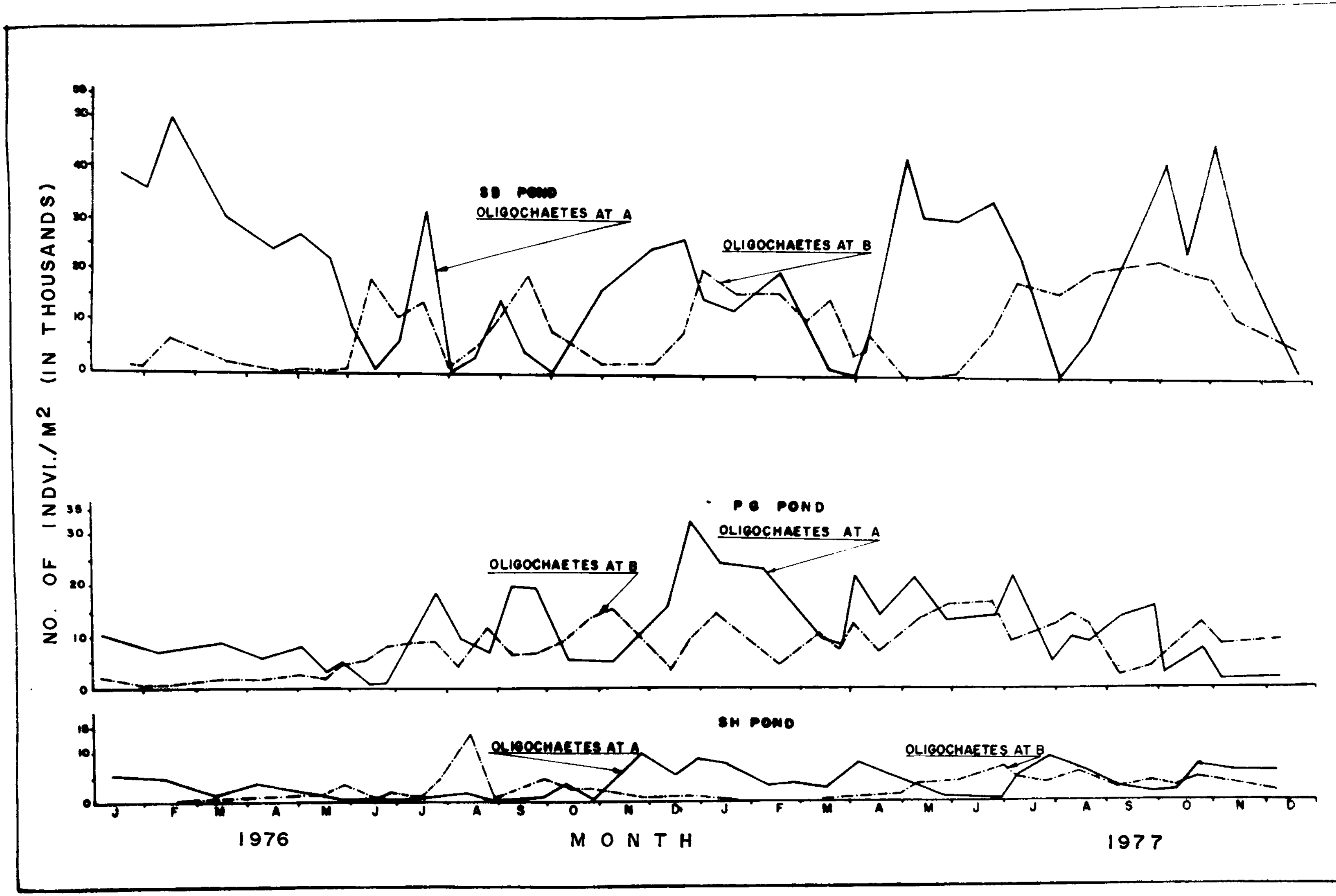

Fig. 24 Graphs showing the relationship in seasonal abundance of oligochaetes at depth A and B of three ponds in 1976 and 1977.

determining the zonal distribution of oligochaete fauna vis-a-vis the total macrobenthos in all the three ponds (Figs. 21 - 23). During monsoon the number of oligochaete fauna at A was usually decreased with simultaneous increase at B (Fig. 24). Thus the abundance of macrobenthos at A and B was found to be affected by rainfall.

SH Pond

The lowest number of total organisms was encountered during late May to September in 1976 and during late May and June in 1977. The maximum number of macroinvertebrates occurred during January through April and October through December in 1976 and January through April and July through December in 1977. The peak growth of 14946 indv./m^2 was noted during December in the first year. The highest number of 14952 indv./m^2 during February in the second year (Fig. 25). In the first year, of the total number of organisms, oligochaetes represented 51.6%, and chironomids and molluscs formed 32.3% and 10.9% respectively. In the second year oligochaetes constituted 49.8%, chironomids and molluscs formed 28.5% and 18.2% of the total macrobenthos respectively (Table 20, Fig. 17). However, Ostracoda, Hydracarina, Ceratopogonidae and Odonata were present but in much smaller number (Table 20, Fig. 17).

Phylum : Annelida; Class : Oligochaeta;

Order : Haplotaxida

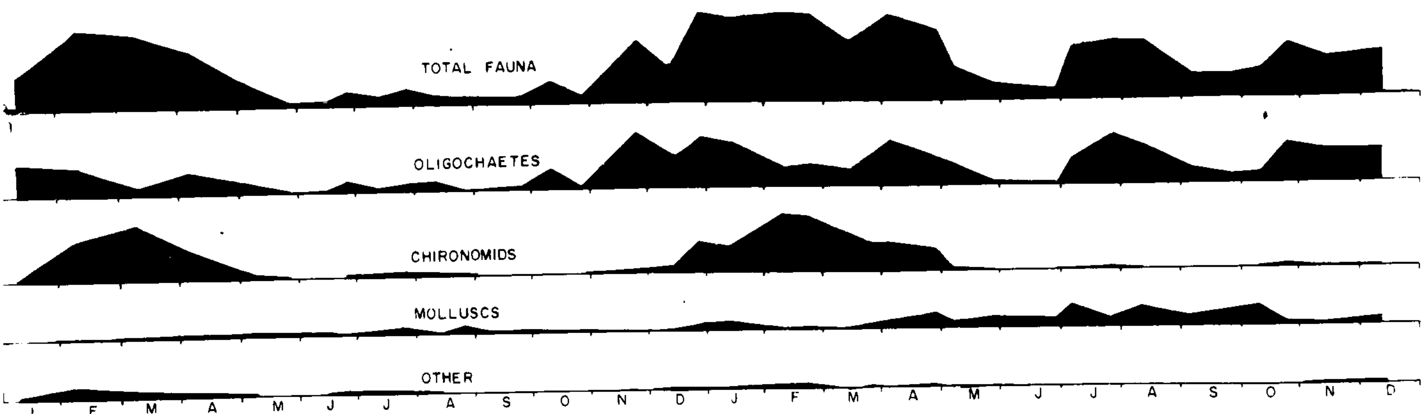

Fig. 25 Graphs showing seasonal abundance of total fauna and their major groups separately at depth A of SH pond in 1976 and 1977.

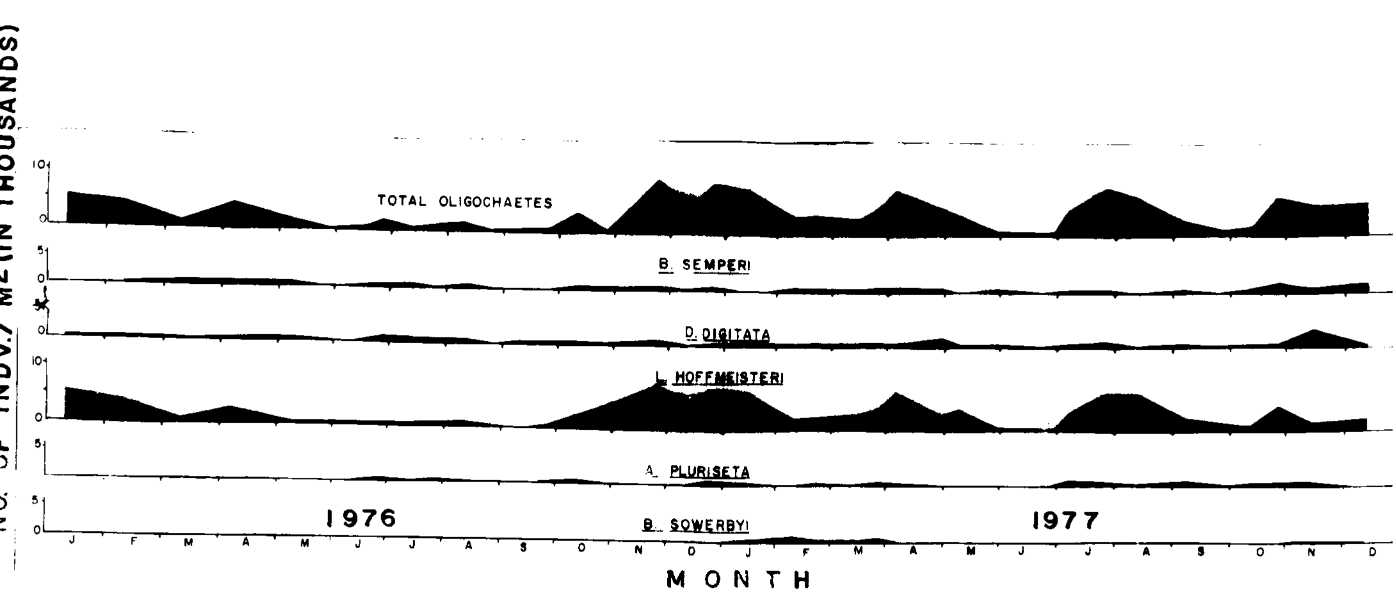

Fig. 26 Graphs showing seasonal abundance of total oligochaetes as well as their species separately at depth A of SH pond in 1976 and 1977.

The largest number of oligochaetes usually occurred at depth A. In 1976 the minimum number was noted during June to September and in 1977 the minimum number was found during June, late September, and early October. The peak growth of 9372 indv/m^2 was found during November in the first year, whereas during the second it was 8008 indv./m^2 in July (Figs. 25, 26). As stated earlier the number was recorded to be influenced by rainfall.

Family:Naididae

Branchiodrilus semperi (Bourne)

B. semperi was found occur more or less throughout the period of observation. But its number was never high. In 1976 the highest occurrence of 702 indv./m^2 was noted during April, whereas in 1977 the peak growth of 1582 indv./m^2 was encountered during late October (Fig. 23). In 1976 it constituted 8.7% of the total oligochaete fauna whereas in 1977 it formed 9.5% of worms (Table 21).

Dero dorsalis (Ferronniere)

D. dorsalis constituted 1.6% of the total oligochaete in both the first and second year. The highest number of 484 indv./m^2 occurred during July in 1976 whereas in 1977 the highest number of 704 indv./m^2 was found during December (Table 21, Fig. 26).

Dero digitata (Muller)

D. digitata was most dominant naidids found in SH pond and in 1976 it comprised 6.6% of the total oligochaetes. The peak of 968 indv./m^2 was noted during late June and November. Its number increased in 1977 and formed 13.5% of the total worm with the maximum abundance of 3068 indv./m^2 during November (Table 21, Fig. 26).

Pristina accuminata (Liang)

P. accuminata was scarcely encountered in the collection and it constituted about 1.1% and 1.4% of the total worms in the first and second year respectively (Table 21).

Family: Tubificidae

Limnodrilus hoffmeisteri (Claparede)

L. hoffmeisteri was the most common oligochaete worm. In 1976 it comprised 77.48% of the total olicochaetes and 41.4% of the total macroinvertebrates with the highest number of 7040 indv./m^2 during late December. In 1977 it constituted 65.86% of total oligochaetes and 3.7% of the total macrobenthos. The maximum number of 6864 indv./m^2 was recorded during January (Table 21, Fig. 26).

Aulodrilus pluriseta (Piguet)

This tubificid was found to occur only occasionally and in small number. In the first year it formed 2.3% of the total oligochaetes and it was noted only once in the second year.

Branchiura sowerbyi (Beddard)

B. sowerbyi was also found rarely at depth A. In 1976 it formed 2.3% and in 1977 about 4.38% of the total oligochaetes (Table 21).

Class : Insecta; Order : Diptera; Family : Chironomidae

The maximum occurrence of the dipteran larvae was noted between January and April for both the years. The peak of 9780 indv./m^2 was found during March in the first year whereas the highest number of 9812 indv./m^2 was recorded during February in the second year (Table 20, Fig. 25). The chironomid larvae were found to be absent during late May, mid June, September and late October in 1976 and during September in 1977. The midge larvae formed 32.3% and 28.5% of the macrobenthos in the first and second year respectively.

Phylum : Mollusca

It constituted 10.9% and 18.26% of the total benthicmacroorganisms during the first and second year respectively (Table 20, Fig. 17).

Class : Gastropoda; Order : Mesogastropoda;
Family : Viviparidae

Viviparus bengalensis (Lamarck)

V. bengalensis was the dominant species among molluscs. It comprised 31.24% of the total molluscs. It was found from May to October in 1976 with the highest population of 1080 indv./m^2 in late August. During November and December the pond snail was also present in negligible number.

In 1977 rise in number occurred from April with a fall during May and June. The peak of 2420 indv./m^2 was found in early October and the population was noted to drop sharply in late October. It slightly increased in November and thereafter the growth declined further during December (Table 21, Fig. 27).

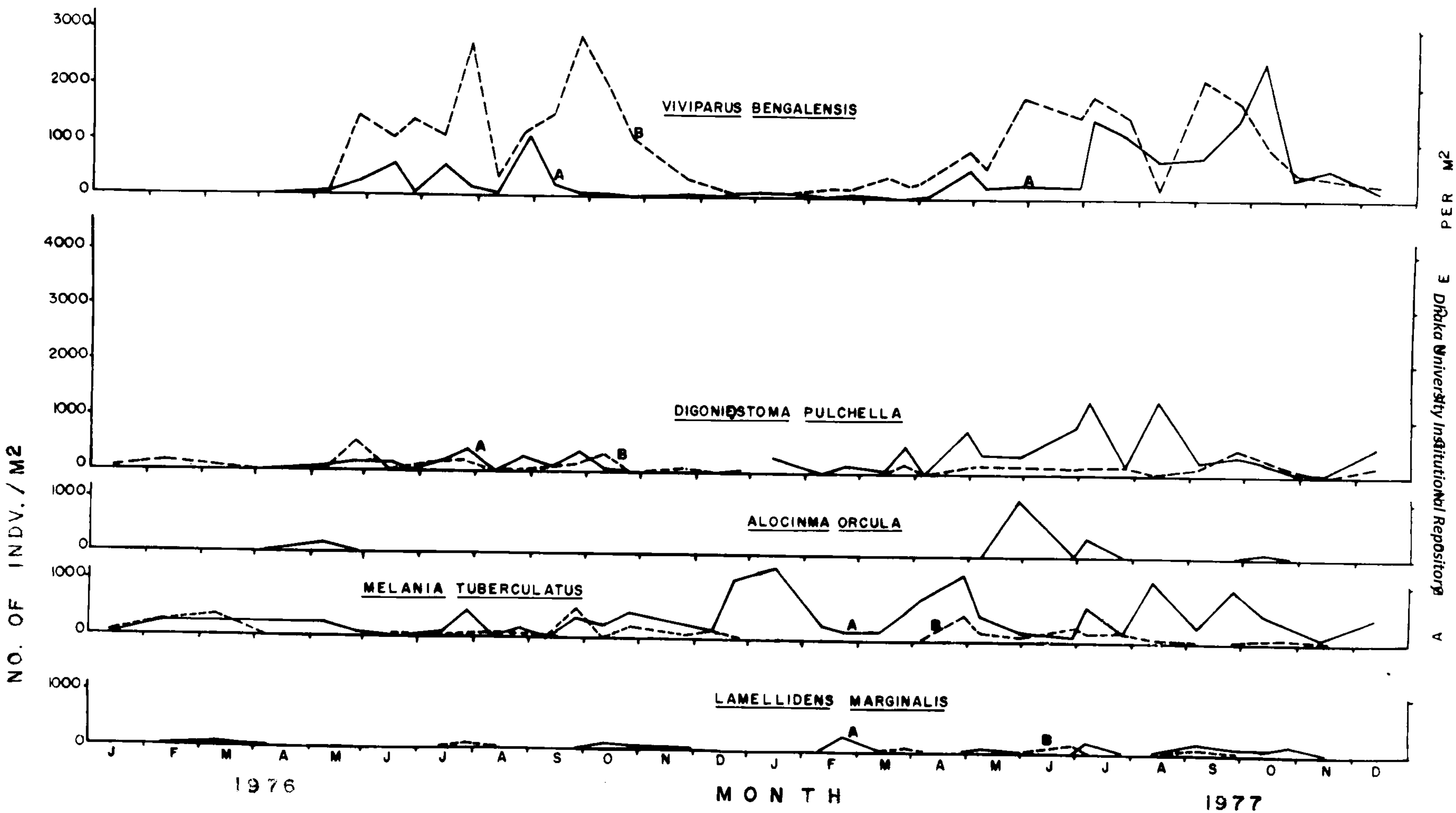

Fig. 27 Graphs showing seasonal abundance of molluscan species at depth A and B of SH pond in 1976 and 1977.

Family ; Aminocolidae

Digoniostoma pulchella (Benson)

In 1976 uniform growth of the gastropod occurred between May and November. However, the snail found absent in the population during late June and early August. The peak of 396 indv./m^2 was noted during late July. In the second year the population *D. pulchella* was recorded to be more or less constant with the peak of 1364 indv./m^2 in early July (Fig. 27). The snail comprised 17% and 26% of the molluscan fauna in the first and second year respectively (Table 21).

Alocinma orcula Frauenfeld

A. orcula was noted to be a rare organism in SH pond and recorded only from depth A. The gastropod was found from January to early May in the first year and during May and July in the second year.

Family : Melaniidae

Melania tuberculatus (Muller)

In the first year *M. tuberculatus* was observed in population more or less uniformly from February to May. The snail was absent from June to early August. From September the population curve of *M. tuberculatus* showed an upward trend with a slight fall in mid October and early December. However, the peak was found in late December with 1012 indv./m^2. In the second year the population curve of *M. tuberculatus* was found to remain almost unchanged (Fig. 27).

Order: Basommatophora Family: Lymnaedae

Lymnea sp.

The snail was found in a few occasions in 1976.

Family: Planorbidae

Planorbis exustus Deshayes

It was recorded occasionally in 1977.

Class : Bivalvia; Order : Eulamellibranchia;

Family : Unionidae

Lamellidens marginalis (Lamarck)

This filter feeding organism occurred only in SH pond. The bivalve was found to be present occasionally in poor quantity during the period of observations (Fig. 24).

PG pond

In the first year maximum number of macrobenthos occurred from January to March and July to December. A sharp decrease in faunal occurrence was found from late March and the lowest number 924 indv./m^2 was noted in late June. Thereafter an increase in faunal number was observed and the peak of 33924 indv./m^2 was recorded in late December (Fig. 28).

In the second year more or less uniform abundance was encountered from January to October with a fall during March and July (Fig. 28). The highest number of 28952 indv./m^2 was found during September. The abundance of macrobenthos dropped and was minimum with 2260 indv./m^2 during November. In December the faunal abundance was noted to increase slightly (Fig. 28).

The oligochaetes were the most abundant members at depth A and formed 71.8% and 72.2%, of the total benthos in 1976 and 1977 respectively. The molluscs were the second dominant group and constituted 7.1% and 18.9% of the total organisms in the first and second year whereas chironomids were the third dominant group and comprised of 14.8% and 7.4% respectively in the first and second year (Table 20 and Fig. 18). Other less abundant groups were Hydracarina, Ostracoda, Planoria, Hirudinaria, Odonata and Ceratopogoniidae, and some unidentified insects.

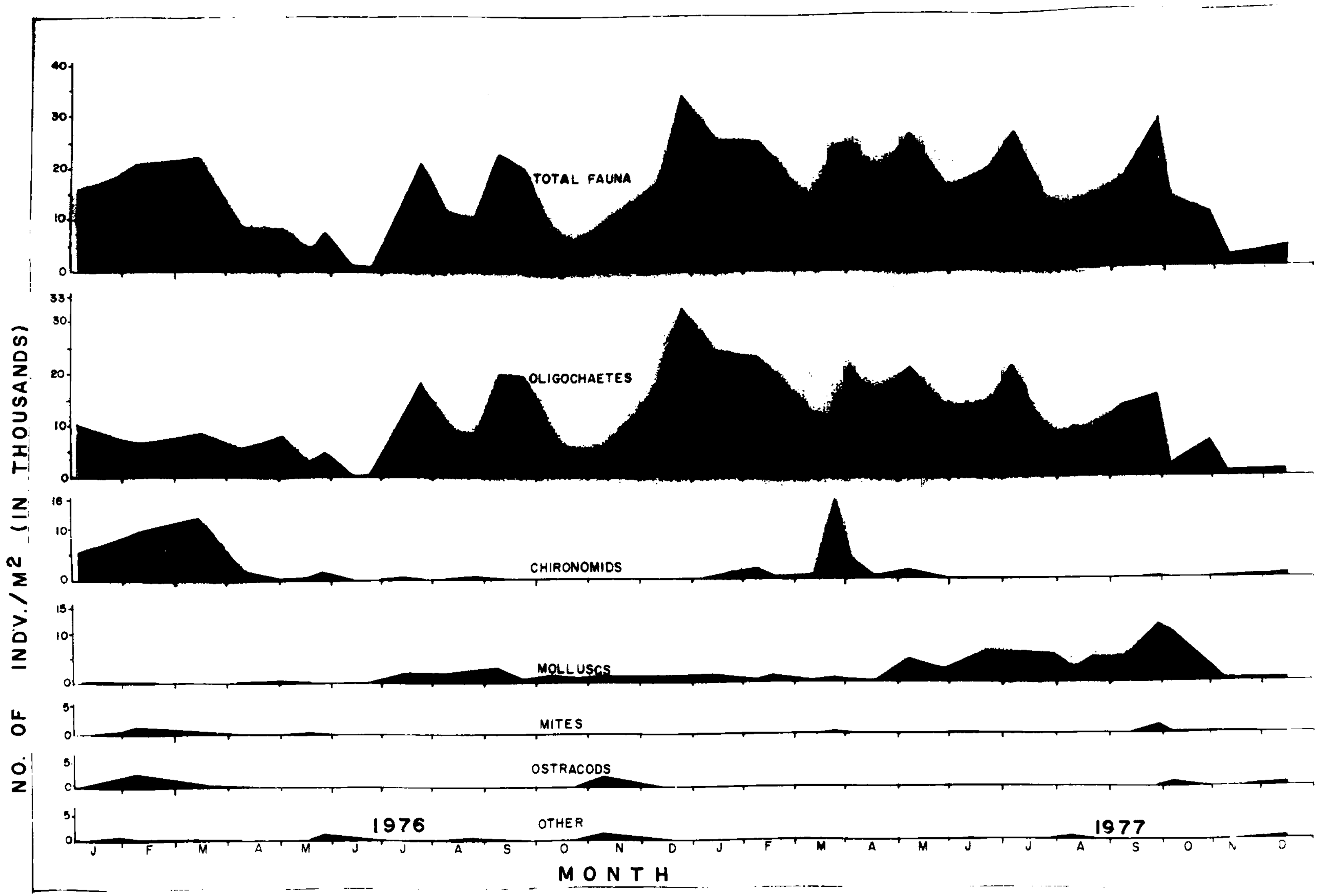

Fig. 28 Graphs showing seasonal abundance of total fauna together and major groups separately at depth A of PG pond in 1976 and 1977.

Phylum : Annelida; Class : Oligochaeta;

Order : Haplotaxida

In the first year uniform populations of oligochaetes were noted from January to April and the faunal abundance decreased from May till June, when the population became the lowest with 352 indv./m^2. The population of these worms increased sharply in July and thereafter an upward tendency of population was noted with depression in curve during August and October. The highest abundance of 32516 indv./m^2 was noted during December. However, in the second year more or less uniform abundance of the worms persisted from January to September with a sudden decrease during late July. The highest number of 23760 indv./m^2 was observed during January. The populations were recorded to drop sharply in October and the minimum abundance of 880 indv./m^2 occurred in November. The populations of oligochaetes showed a tendency to build up during December in 1977 (Fig. 28).

Family : Naididae

Six species of the family Naididae were recorded from depth A.

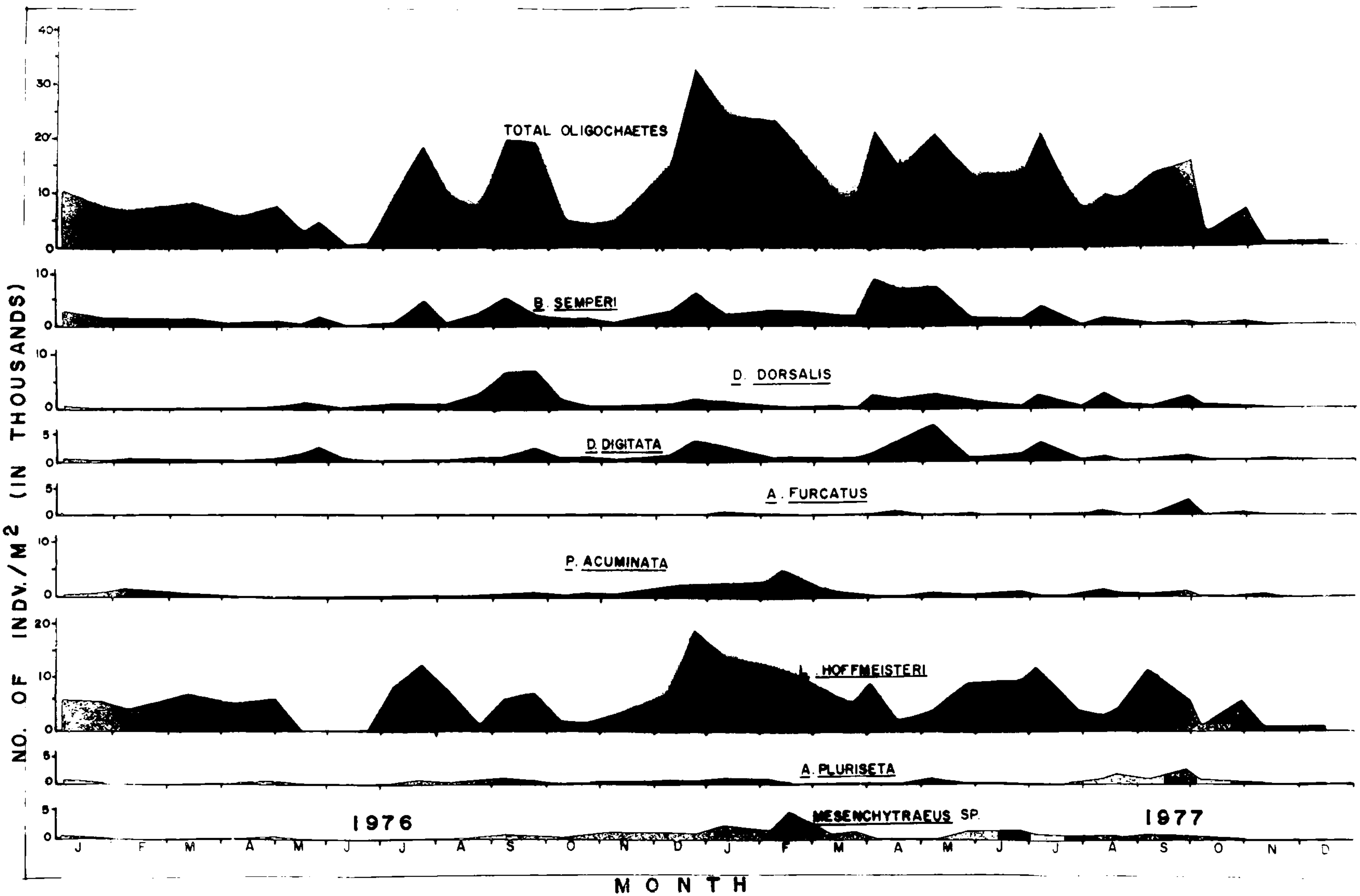

Fig. 29 Graphs showing seasonal abundance of total oligochaetes as well as their species separately at depth A of PG pond in 1976 and 1977.

Stylaria lacustris (Linnaeus)

The species was found only once in 1976.

Branchiodrilus semperi (Bourne)

The worm was the most dominant species among naidids and the second to *L. hoffmeisteri* as dominant species among the oligochaetes. In the first year it registered 18.7% of the oligochaetes with the highest abundance of 5368 indv./m^2 during September. The species formed 16.3% of total oligochaetes in the second year. The maximum number 8800 indv./m^2 occurred during April (Table 21 and Fig. 29).

Dero dorsalis (Ferroniere)

D. dorsalis was the second in abundance among naidids and it formed the third major species among the total oligochaetes fauna. In the first year it constituted 13% of the total oligochaetes and its maximum number of 6820 indv./m^2 occurred during September in the first year. In the second year the worm formed 7.36% of the total oligochaete fauna and the highest number of 2640 indv./m^2 was recorded during May (Fig. 29).

Dero digitata (Muller)

In 1976 the worm constituted 8.19% of the total oligochaete fauna. The highest number of 3344 indv./m^2 occurred during late December. In 1977 it comprised 9% of the total oligochaete worms and the highest number of 6776 indv./m^2 was recorded during early May.

Aulphorus furcatus (Muller)

It was found occasionally throughout the period of observation.

Pristina accuminata (Liang)

It formed 4% of the total oligochaetes in the first year. But population of the species increased to 7.9% in the second year. It showed the highest number of 6358 indv./m^2 during mid February in 1977 (Table 21 and Fig. 29).

Family : Tubificidae

Limnodrilus hoffmeisteri (Claparede)

L. hoffmeisteri was the dominant species. In the first year it formed 51.87% of the total oligochaete fauna and 37.3% of total macroinvertebrates. The highest number of 18436 indv./m^2 of the species was found during late December in 1976. In 1977 the worm constituted 49% of the total oligochaetes and 35.5% of the total macrobenthos. Its highest number was recorded to be 13112 indv./m^2 during January in 1977 (Table 21 and Fig. 29).

Aulodrilus pluriseta (Piguet)

A. pluriseta occurred occasionally in poor number. In the first year it formed 1.6% of the total oligochaetes worms. In the second year the worms comprised 2.8% of the total oligochaetes (Table 21 and Fig. 29).

Family : Enchytraeidae

Mesenchytraeus sp.

The worms were found in poor abundance. It formed only 1.99% of total oligochaetes in the first year. Its number increased in the second year and constituted 5.5% of the total oligochaete worms (Table 21).

Class : Insecta; Order : Diptera;

Family : Chironomidae

In the first year greater abundance of chironomid larvae was noted from January to March and the peak of 12080 indv./m^2 was recorded in March. A sharp fall in population was observed during April. The midge larvae were found to be absent during late April, late June and from late September to early December. The larvae occurred in poor quantity during rest of the period. In the second year the populations of chironomids larvae appeared to build up again in January. A sharp rise in population occurred in March and the peak was recorded with 15752 indv./m^2 during late March. A drastic drop in population was encountered in the following months and the midge larvae was noted to disappear from population between June and early October with the exception in late September when a negligible number of larvae was noted. The larvae were found to appear in the population again during late October and their number was recorded to increase gradually during rest of the period (Fig. 28).

Phylum : Mollusca

In the first year high abundance of molluscs occurred from July to September with the peak of 2816 indv./m^2 in early September. Comparatively rich molluscan fauna was witnessed in 1977. During this later year high abundance occurred between May and October with the peak of 11616 indv./m^2 in late September (Fig. 28).

Class : Gastropoda; Order : Mesogastropoda;

Family : Viviparidae

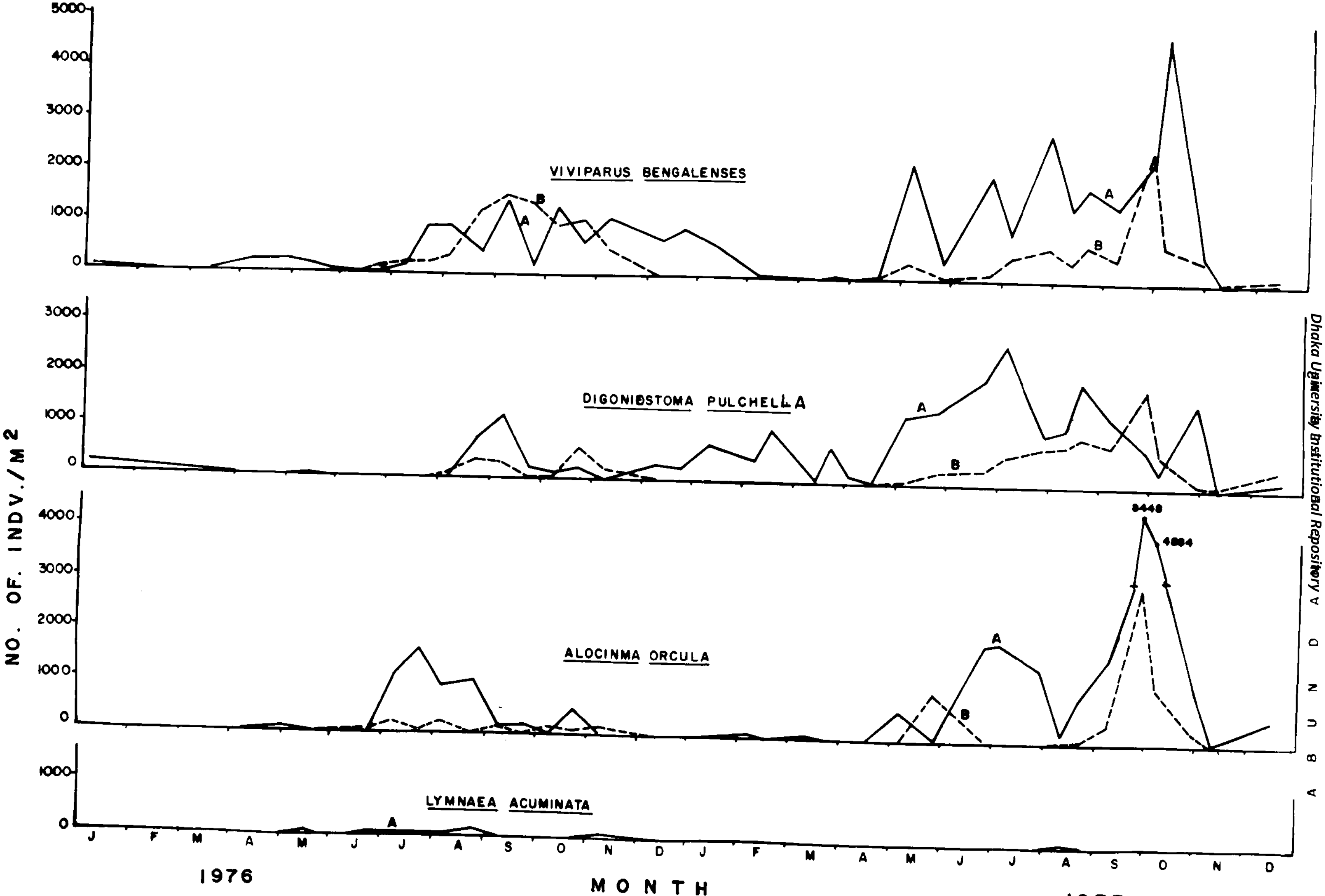

Fig. 30 Graphs showing seasonal abundance of molluscan species at depth A and B of PG pond in 1976 and 1977

Viviparus bengalensis (Lamarck)

V. bengalensis occurred uniformly between July and December in the first year. The peak of 1452 indv./m^2 was observed during early September. In the second year the ring snail was encountered uniformly during May to October with the peak of 4796 indv./m^2 in early October. The snail was not found in the population in November (Fig. 30).

Family : Amnicolidae

Digoniostoma pulchella (Benson)

In the first year minimum number of *D. pulchella* was noted from January to March and in May. The species was absent from the population in April, June and July. In August the population of snail was noted to increase and the peak was recorded with 1232 indv./m^2 during early September. The population decreased suddenly in late September and the snail was absent completely during November. However, its population tended to increase during December.

In the second year the species recorded the peak of 2784 indv./m^2 in early July and the lowest abundance of 44 indv./m^2 was recorded in March and April (Fig. 30).

Alocinma orcula Frauenfeld

In 1976 the species appeared during late April and late June in poor number. A sharp increase in population was recorded during July till the peak was observed with 1672 indv./m^2 in late July. The population decreased gradually and species was found to be absent in November. In the second year a negligible number of the snail was recorded during February and March. The faunal abundance of the organisms increased from May and depression in population curve was noted in August. Thereafter a sharp elevation of the population curve was found till the peak was encountered with 8448 indv./m^2 during late September. The population registered a steady decrease in the following month, and the abundance decreased further during November. In December the population of the snail tended to increase again (Fig. 30).

Order: Basomentophora, Family : Lymnaedae

Lymnaea acuminata (Lamarck)

In 1976 the snail was noted to be present occasionally in negligible number, but in 1977 it was recorded only during August.

Family : Planorbidae

Planorbis exustus (Deshayes)

The snail was found occasionally in 1976 and 1977.

SB Pond

The largest number of macroinvertebrates per square meter occurred at station A of SB pond in comparison to other two ponds (Fig. 16). In 1976 the macrobenthos exhibited a gradual increase in quantity from January till the peak of 74016 indv./m^2 occurred in late April (Appendices 5, 6). In the following months the populations decreased and the minimum was encountered with 2420 indv./m^2 during mid June. The number of organisms was recorded to increase during the rest of the period. However, sudden fall in faunal density was noted during mid August and late September. In the second year more or less uniform faunal abundance was found from January to April and the peak of 77352 indv./m^2 was noted in mid March. The populations declined from May till the lowest number of 5412 indv./m^2 occurred during late July. However, a slight increase in population was noted in June. The faunal number was found to increase during September and October and thereafter unlike the first year the populations of macrobenthos were noted to decline in November and December (Fig. 31).

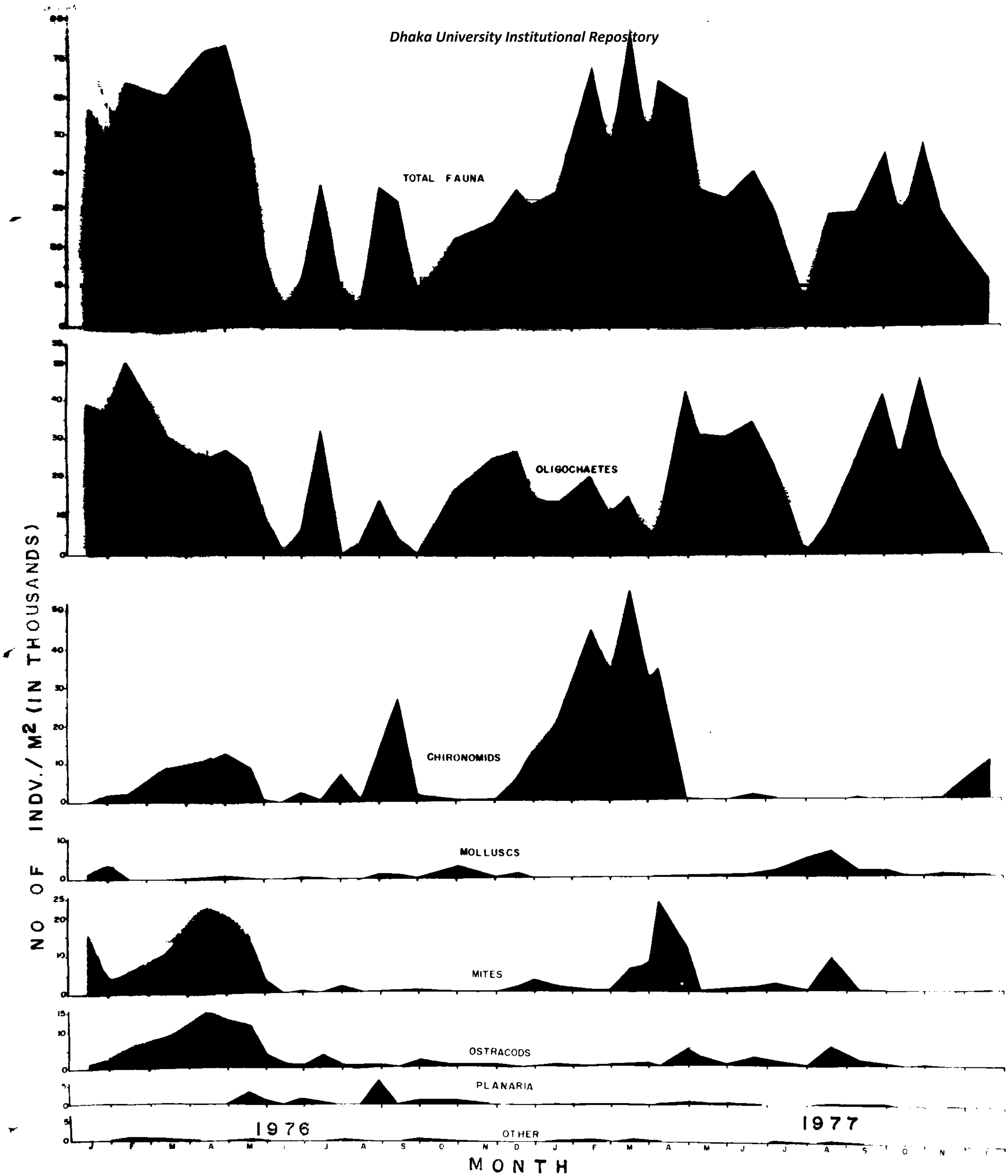

Fig. 31 Graphs showing seasonal abundance of total fauna and major groups of organisms at depth A of SB pond in 1976 and 1977.

In 1976 Oligochaeta comprised 55.6%, Chironomidae 16.3%, Hydracarina 14.7%, Ostracoda 8.8%, Planaria 2%, Mollusca 1.9%, whereas, in 1977 Oligochaeta formed 54.6%, Chironomidae 30.6%, Hydracarina 8.6%, Ostracoda and Mollusca 2.6% of the total macrobenthos (Table 20 and Fig. 19).

Excluding the above mentioned organisms Hirudimaria, Odonata, other unidentified insects were present but their number was very small.

Phylum : Annelida; Class : Oligochaeta;
Order : Haplotaxida

In the first year, the number of oligochaetes increased from January till the peak 50560 indv./m^2 occurred in February. From March the number decreased till June. A sharp rise in populations was noted during mid July. But in July the populations declined suddenly and became the minimum with 202 indv./m^2. From August to November populations increased gradually with a depression in curve during late September. In December the faunal number decline again.

In the second year number of oligochaetes decreased in late March and suddenly populations rose up in late September and the peak was noted with 43203 indv./m^2. The populations remained more or less constant up to early July and in late July a sharp fall occurred and the lowest number of 352 indv./m^2 was recorded.

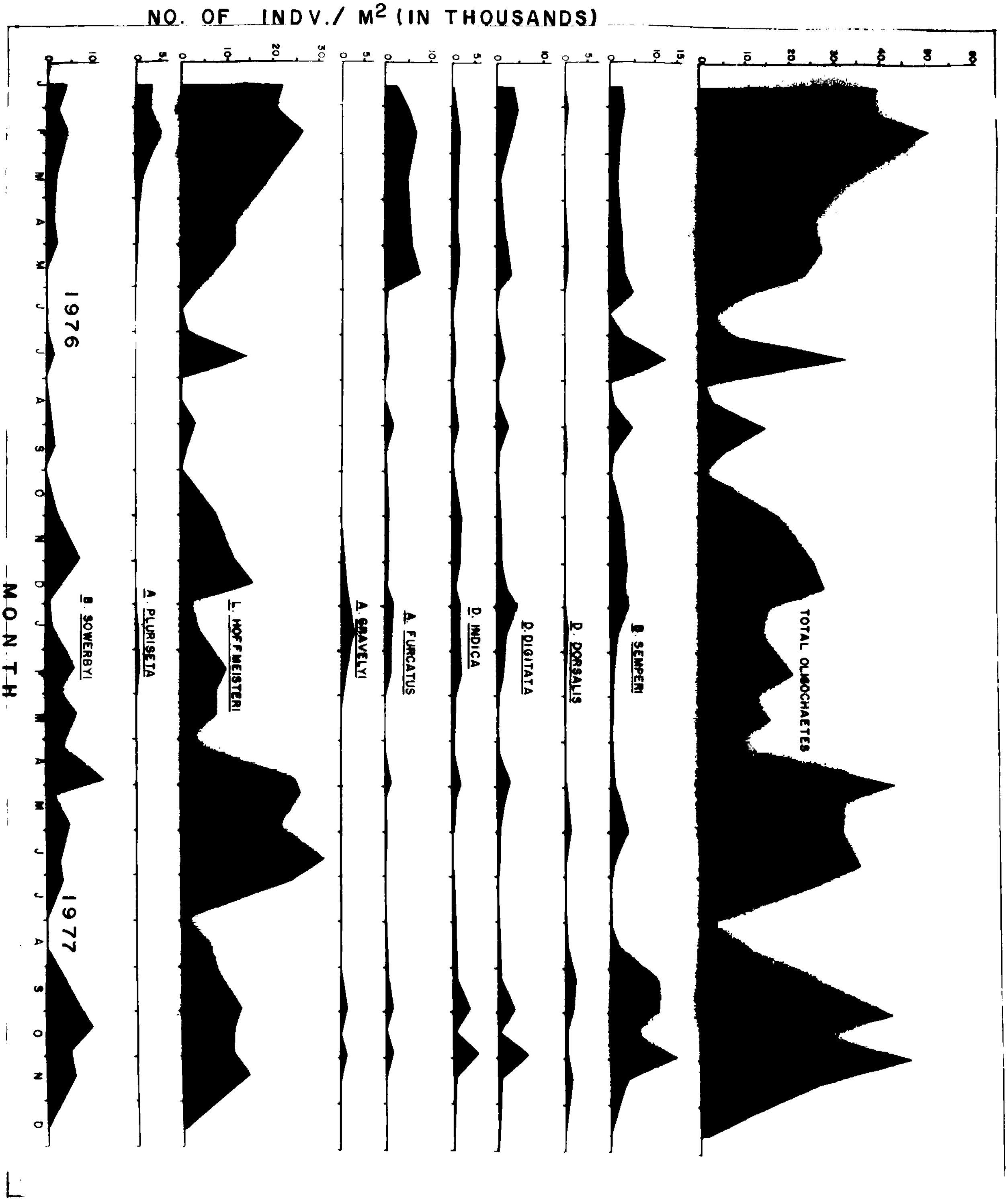

Fig. 32 Graphs showing seasonal abundance of total oligochaetes as well as their species separately at depth A of SB pond in 1976 and 1977.

The faunal abundance increased from August and remained uniform till November. During December the populations was noted to decline again (Figs. 31 and 32).

Family : Naididae

Nais simplex (Piguet)

This species was found only once in 1976.

Branchiodrilus semperi (Bourne)

B. semperi was the most abundant naidids present at depth A. It occupied the second position in faunal composition among oligochaetes and comprised 16.6% and 12.5% of the total oligochaetes in the first and second year respectively. In 1976 the population of *B. semperi* was noted to be nearly uniform from January to May. The worm was observed to be absent completely in mid June. However, sharp increase in population was found in late June and it continued up to mid July when the peak was recorded with 12848 indv./m^2. The individual number of species reduced drastically to zero in late July. The population showed a sudden increase in August and it dropped again in late September. Thereafter the abundance of the species increased gradually till December. In the second year individual number of the species was found to be minimum from

January to June with the exception during late May when it was high. The worm was noted to be absent during late March and July. The species appeared in the community during August and individual number increased till late October when the peak of 14432 indv./m^2 was encountered. The number of worm reduced in November and during December it was recorded to be absent completely (Table 21, Fig. 32).

Dero dorsalis (Ferronniere)

D. dorsalis occurred occasionally throughout the period of study. In the first year the highest abundance of 704 indv./m^2 the worm was recorded during late April, whereas in the second year the highest number was encountered with 2024 indv./m^2 during early September (Fig. 32).

Dero digitata (Muller)

D. digitata constituted 8% and 5% of the total oligochaete fauna in 1976 and 1977 respectively. In the first year the worm occurred more or less uniformly from January to mid May with the peak of 4224 indv./m^2 in late January. A fall in population curve was noted during March. The number was further minimised in late May and it turned to nil in mid June. The abundance of the worm was noted to increase in late June and remained uniform from late June to November and in December the number was recorded to increase again. In the second year more or less similar trend in faunal abundance was found and the highest number of 6600 indv./m^2 the worm was recorded in October (Fig. 32).

Dero indica (Naidu)

A nearly uniform growth of the species was recorded throughout the period of observation with the highest number in October for both the years (Fig. 29).

Aulophorus furcatus (Muller)

A. furcatus was noted in large number in the first year. It constituted 10.8% of total oligochaete fauna. However, in the second year the species was noted to reduce to a great extent and it formed only 1.79% of the total oligochaetes. In 1976 the highest number of 7744 indv./m^2 was found during mid May whereas in 1977 it was recorded during late September and October with 1584 indv./m^2 (Table 21, Fig. 32).

Aulophorus gravelyi (Stephenson)

It occurred occasionally in poor quantity throughout the period of study.

Family : Tubificidae

Limnodrilus hoffmeisteri (Claparede)

L. hoffmeisteri was the most common fauna and it influenced the abundance of total macroinvertabrates to a great extent. In 1976 it formed 45.73% of the oligochaetes and 25.8% of the total macrobenthos. In 1977 the species constituted 53.12% of the oligochaetes and 29.4% of the total macroinvertebrates (Table 21).

In the first year the number of *L. hoffmeisteri* was noted to increase from January till the peak was recorded during February with 26690 indv./m^2. From February the number decreased gradually until mid June. The population went up in late June and a sharp rise was found in mid July with a fall in late July when the minimum number of 132 indv./m^2 was encountered. Thereafter the population was observed to increase up to mid December and during late December the population decreased abruptly.

In the second year more or less similar trend in faunal abundance was recorded with the highest number of 31636 indv./m^2 during June and the lowest during late July with 264 indv./m^2 (Fig. 32).

Aulodrilus pluriseta (Piguet)

A. pluriseta occurred comparatively in large number in the first year and formed 3.49% of the total oligochaete fauna with highest number of 5270 indv./m^2 in February. But in the second year its growth was reduced and was found in the populations on two occasions only (Table 21, Fig. 32).

Branchiura sowerbyi (Beddard)

B. sowerbyi constituted 10% and 20.3% of the total oligochaete worms in the first and second year respectively. In 1976 the population decreased gradually from January to April and in May the species was absent. The population rose up gradually till the peak of 7964 indv./m^2 was encountered during November. However, a fall in growth curve was recorded in September when it was also absent. The number of the species decreased in December.

In 1977 the number of *B. sowerbyi* was noted to increase from January till the peak was recorded with 12584 indv./m^2 during late April. A sharp reduction in number was noted in May and the species were noted to be absent totally in August.

Family : Enchytraeidae

Mesenchytraeus sp.

Mesenchytraeus sp. appeared occasionally in poor number throughout the period of study.

Class : Insecta; Order : Diptera; Family : Chironomidae

In 1976 the population of midge larvae increased gradually from January to April and thereafter it declined till mid June when the lowest abundance of 44 indv./m^2 was encountered. From late June to mid August the population showed an uniform abundance. In late August the number increased sharply and the peak was recorded with 27016 indv./m^2 in mid September. The abundance of midge larvae decreased abruptly in late September and the reduction in faunal density was recorded till November. In December the number of Chironomid larvae increased.

In 1977 more or less uniform trend in growth curve of the larvae was witnessed from January to early April. The peak of 55000 indv./m^2 was noted in mid March. The number of the larvae dropped suddenly in late April. The population was found to be negligible up to November, but it again started to build up in December (Fig. 31).

The midge larvae formed 16% and 30.6% of the total macrobenthos in 1976 and 1977 respectively (Table 20 and Fig. 19).

Phylum : Mollusca

Of the *molluscan* fauna, *Alocinma orcula* (Frauenfeld) was noted to be dominant species. It constituted 98% of the total molluscs. However, *Melania tuberculata* (Muller), *Lymnea luteola* (Lamarck), and *Planorbis exustus* Deshayes were the other species present but their number was negligible. *Viviparus bengalensis* was encountered only once in poor abundance during the second year (Table 20, Fig. 33).

Class : Gastropoda; Order : Mesogastropoda;

Family : Amnicolidae

Alocinma orcula (Frauenfeld)

In the first year the number of the snail decreased from January and the species was noted to be absent during February and March. *A. orcula* was observed to appear in the population from April onward. Two peaks, in late January with 3436 indv./m^2 and in late October with 3168 indv./m^2, of the snail was recorded in 1976. In the second year the abundance of the organisms was found to increase gradually

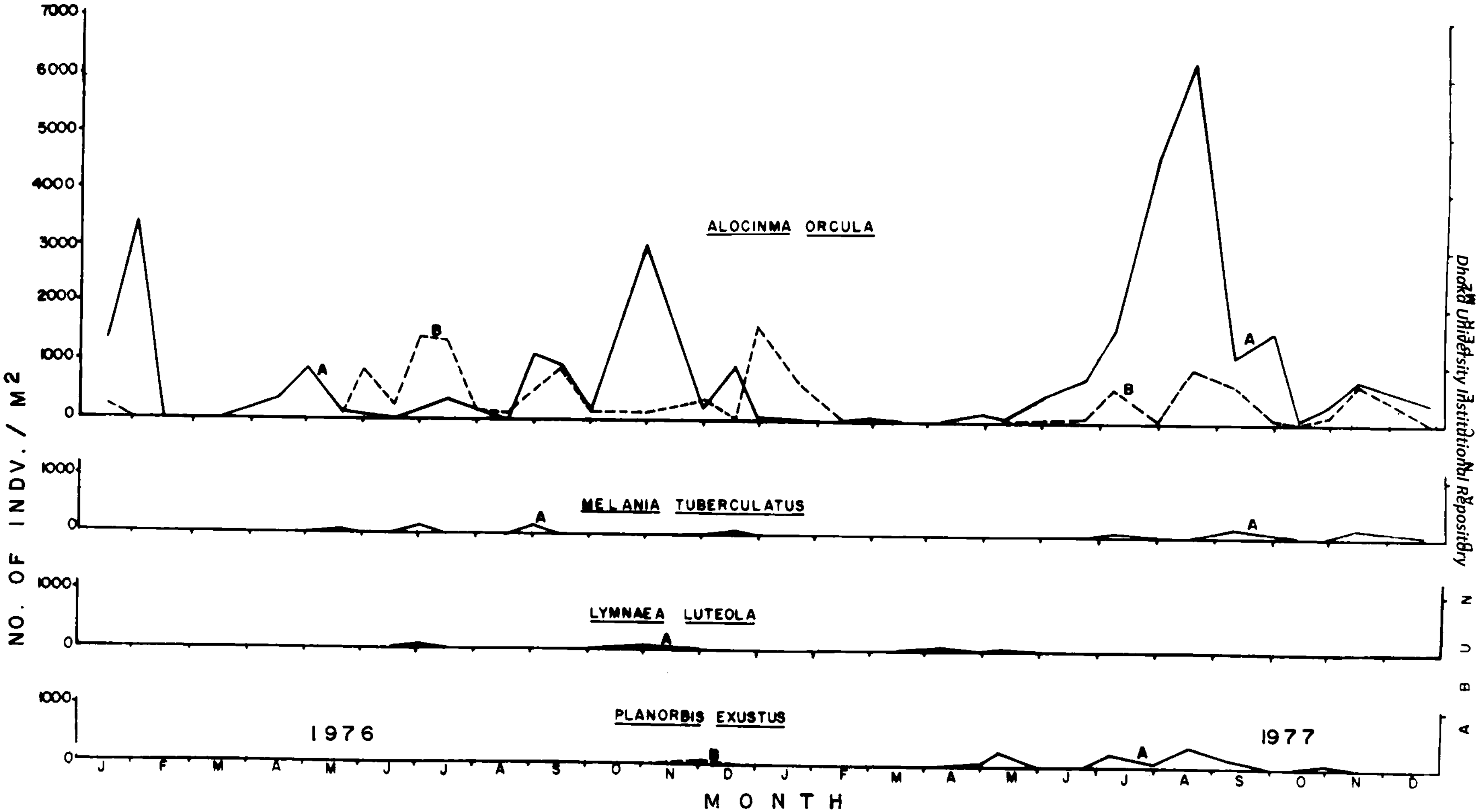

Fig. 33 Graphs showing seasonal abundance of molluscan species at depth A and B of SB pond in 1976 and 1977.

from April until August when the peak was recorded with 6600 indv./m^2. A sharp decline in population was observed during September which reduced further in the following months (Fig. 33).

Class : Crustacea; Subclass : Ostracoda

In 1976 a gradual increase in number of ostracods was recorded from January till mid April when the peak of 14950 indv./m^2. The populations declined from late April and more or less uniform abundance was recorded throughout the rest of period. However, the organisms were found to remain absent during mid September and mid December.

In 1977 a relative poor density of ostracods was recorded from January to March. The number of the organisms was recorded to increase from late April until August when the peak was encountered with 5148 indv./m^2. The faunal abundance registered a gradual decline during rest of the period and in December the organisms was found to be absent from the populations.

Class : Hydracarina (Aquatic mites)

Hydracarina was the third major group of organisms found at depth A. In 1976 the population declined sharply in late January and the abundance of organisms was found to increase gradually from

January until mid April when the peak was encountered with 22440 indv./m^2. In late April the number of mites was noted to decrease and the minimum was observed in mid June with 88 indv./m^2. Uniform population of the organisms occurred from late June to October and in November the mite was noted to be absent. However, the faunal number was found to increase in December (Fig. 31).

In 1977 the number of mites decreased through January to early February. Thereafter the populations increased and the peak of 23980 indv./m2 was registered in April. The populations were recorded a sudden decrease in May. Poor number of organisms was encountered from September to December (Fig. 31).

Planaria, a free living platyhelminth, occurred in poor abundance during the period of observation. However, in the first year the highest number of organisms was found to be 6368 indv./m^2 in late August, but in the second year the abundance of planaria was always negligible.

DEPTH B

The oligochaetes, molluscs, and chironomids were the most common groups at depth B. Individuals of other groups were present occasionally in poor abundance in all the three ponds (Figs. 34, 36, 38).

SH Pond

The oligochaetes was the major group among the macroinvertebrates and comprised 64% and 62% in the first and second year respectively. Molluscs were the second dominant group and constituted 32%, and 24.2% of the total organisms and the chironomids formed 3.6% and 12.69% of the total macroinvertebrates, in 1976 and 1977 respectively. The occurrence of other groups of organisms was negligible (Table 20).

In the first year poor occurrence of total fauna was noted uniformly from January to early May. The faunal density was recorded to increase from late May and continue till the peak was found in early August with 14168 indv./m^2. A sharp fall in number was recorded in late August. More or less similar trend in faunal density was encountered in the second year with the highest abundance of 9372 indv./m^2 occurred in late June (Fig. 34, Appendices 1, 2).

Phylum : Annelida; Class : Oligochaeta;

Order : Haplotaxida

The oligochaetes formed the largest group among the macrobenthos. The highest number of 13772 indv./m^2 was recorded during early August in the first year and in the second year the peak was noted with 7084 indv./m^2 (Fig. 35, Appendices 1, 2).

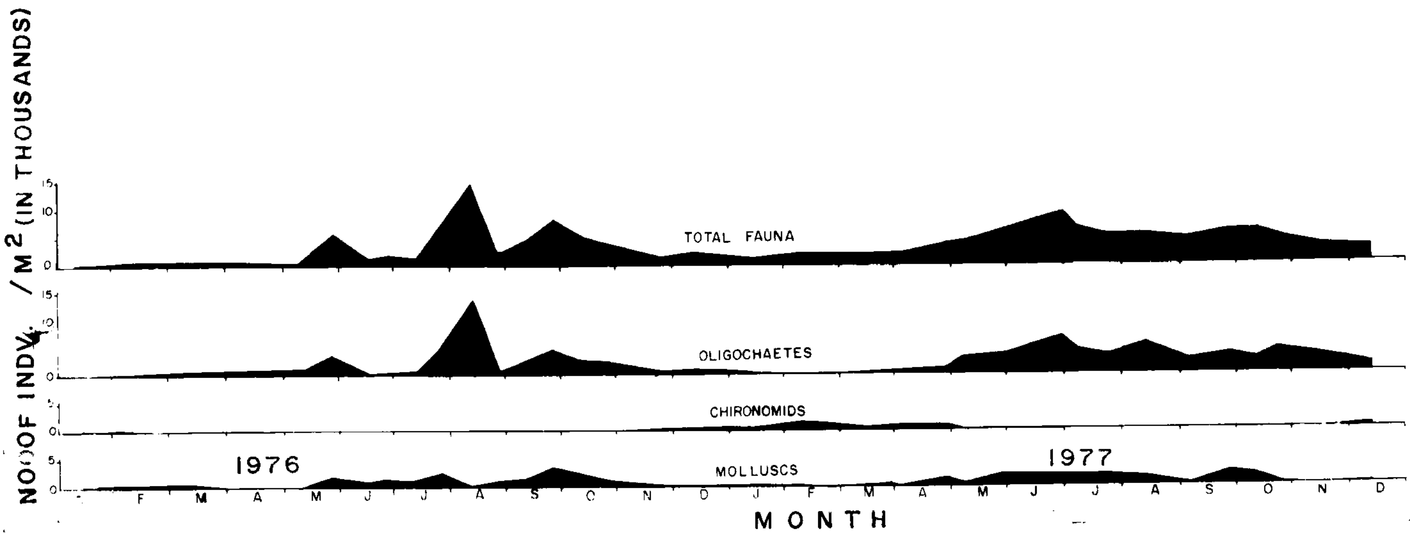

Fig. 34 Graphs showing seasonal abundance of total fauna and major groups of organisms at depth B of SH pond in 1976 and 1977.

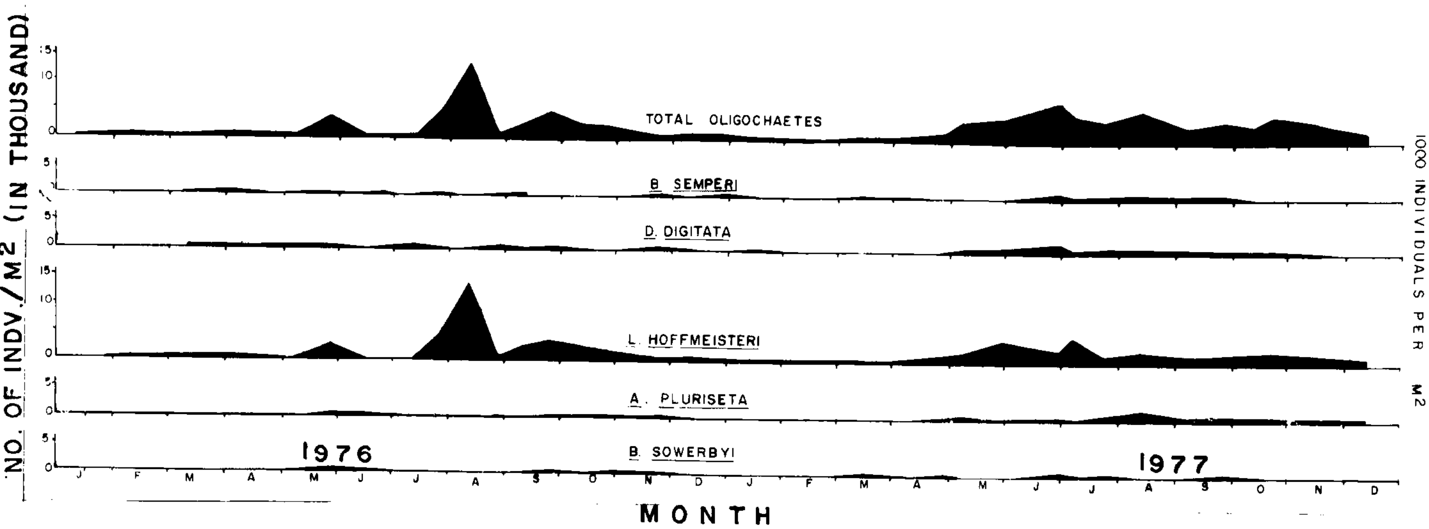

Fig. 35 Graphs showing seasonal abundance of total oligochaetes as well as their species separately at depth B of SH pond in 1976 and 1977.

Family : Naididae

Branchiodrilus semperi (Broune)

In the first year *B. sempri* occurred casually in poor abundance with the highest number of 266 indv./m^2 during December. It comprised 2% of the total macrobenthos. However, the number of species was found to increase in the second year and which formed 6.9% of the total oligochaetes. The highest number of the worm was recorded to be 1012 indv./m^2 during June, 1977 (Table 21, Fig. 35).

Dero digitata (Muller)

In 1976 *D. digitata* was encountered only occasionally in negligible number with the highest abundance of 528 indv./m^2 during November. It formed 6.55% of the total worm. The faunal abundance was noted to increase in the second year and constituted 9.50% of total oligochaetes (Fig. 17). The highest number of 1672 indv./m^2 was found during June in 1977 (Table 21, Fig. 35).

Pristina accuminata (Liang)

P. accuminata occurred only in a few occasions and the worm formed 3.1% and 2.79% of total oligochaetes in the first and second year respectively (Table 21).

Family : Tubificidae

Limnodrilus hoffmeisteri (Claparede)

L. hoffmeisteri was the most abundant species and constituted 82.57% and 58.77% of the total oligochaetes and 54.9% and 37.54% of total macroinvertebrates in the first and second year respectively. In 1976 the number of worm was noted to increase steadily from January till May. In June the abundance decreased abruptly and in late June and early July the worm was noted to be absent completely. The population increased sharply from late July till early August when the peak was noted with 13776 indv./m^2. Thereafter the faunal abundance showed a gradual decrease during the rest of the period. In the second year number of species was recorded to increase slowly till the peak of 4480 indv./m^2 was found in July. An uniform abundance of *L. hoffmeisteri* was observed in the following months (Table 21 and Fig. 35).

Aulodrilus pluriseta (Piguet)

In the first year *A. pluriseta* occurred occasionally in poor number and it formed 2.4% of the total oligochaetes. The highest number was recorded with 360 indv./m^2 in November. In the second year the number of the species increased to a great extent and it comprised of 13.4% of the total oligochaetes. The species was recorded uniformly from April to December with the highest abundance of 1628 indv./m^2 during August (Table 21, Fig. 35).

Branchiura sowerbyi (Beddard)

B. sowerbyi was found to occur but in negligible number throughbout the period of study.

Family : Enchytraeidae

Mesenchytraeus sp.

Mesenchytraeus sp. was observed casually in poor number during the period of observation.

Class : Insecta; Family : Chironomidae

In 1976 the midge larvae occasional occurred in negligible number. But in 1977 the faunal density of the larvae increased greatly (Fig. 34).

Phylum : Mollusca

In the first year the number of molluscan fauna was noted to be poor from January to March. The mollusca was absent in April. The faunal abundance remained more or less uniform from May till the peak of 3520 indv./m^2 was encountered during late September. The populations declined slowly from October. Similar trend in faunal abundance was recorded in the second year with the peak of 2288 indv./m^2 in September. In 1976 the molluscan fauna formed 32% of total macrobenthos, whereas in 1977 it formed 24% of the same (Figs. 17, 34 and Appendices 1, 2).

Class : Gastropoda; Order : Mesogastropoda;

Family : Viviparidae

Viviparus bengalensis (Lamarck)

V. bengalensis was the most dominant species and constituted 81% and 79% of the total molluscs in the first and second year respectively. In 1976 *V. bengalensis* was noted to appear in population during late May. The abundance was recorded to increase from May and the peak was recorded with 2840 indv./m^2 in late September. In 1977 a gradual increase in abundance was found from January and the population curve followed more or less similar trend with the peak of 2112 indv./m^2 in early September (Tables 21, 24 and Fig. 24).

Family : Aminicolidae

Digoniostoma pulchella (Benson)

D. pulchella formed 9% and 12.3% of total molluscs in the first and second year (Table 21). In 1976 the species was recorded in poor number throughout the period with the exception that on several occasions the organisms were totally absent. The highest number was noted to be 528 indv./m^2 in late May (Fig. 24).

In the second year more or less uniform population was found from March to December with the highest abundance of 484 indv./m^2 during late September.

Family : Melaniidae

Melania tuberculatus (Muller)

M. tuberculatus comprised 10.3% and 7.3% of molluscan fauna in the first and second year (Table 21). The snail occurred in poor number and remained absent in some months during the period of study.

Order : Basommatophora; Family : Planorbidae

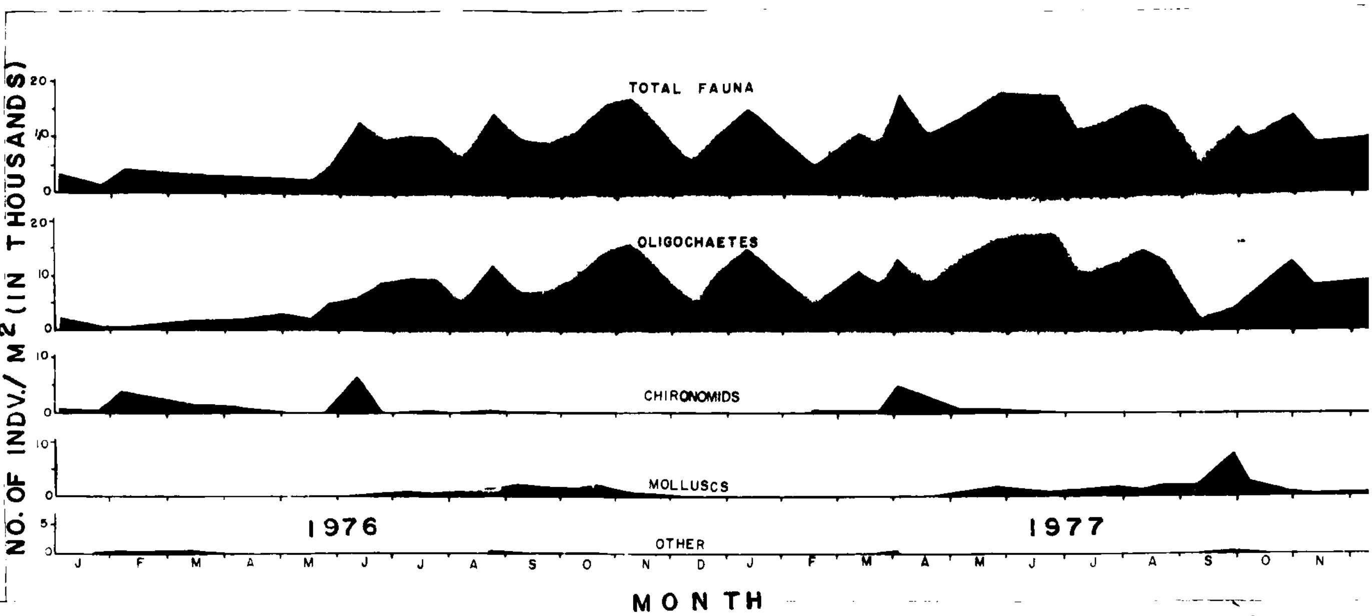

Fig. 36 Graphs showing seasonal abundance of total fauna and major groups separately at B of PG pond in 1976 and 1977.

Planorbis exustus (Deshayes)

It occurred only in one occasion in 1977.

Class : Bivalvia; Order : Eulamellibranchia;

Family : Unionidae

Lamellidens marginalis (Lamarck)

The mussel occurred only once in the first year and thrice in the second year.

PG Pond

The oligochaetes were the most dominant group among the macrobenthos. It comprised 83% and 86.5% of total benthos in the first and second year respectively. The molluscs occupied the second position in faunal abundance. It constituted 6.8% of the total macroinvertebrates in the first and second year respectively. Chironomid larvae formed 9.6% and 3.8% of the total organisms in 1976 and 1977 respectively (Table 20, Fig. 18).

The Planaria, Hirudinaria, Odonata, Hydracarina, Ostracoda, were also present but their number were exceptionally meagre.

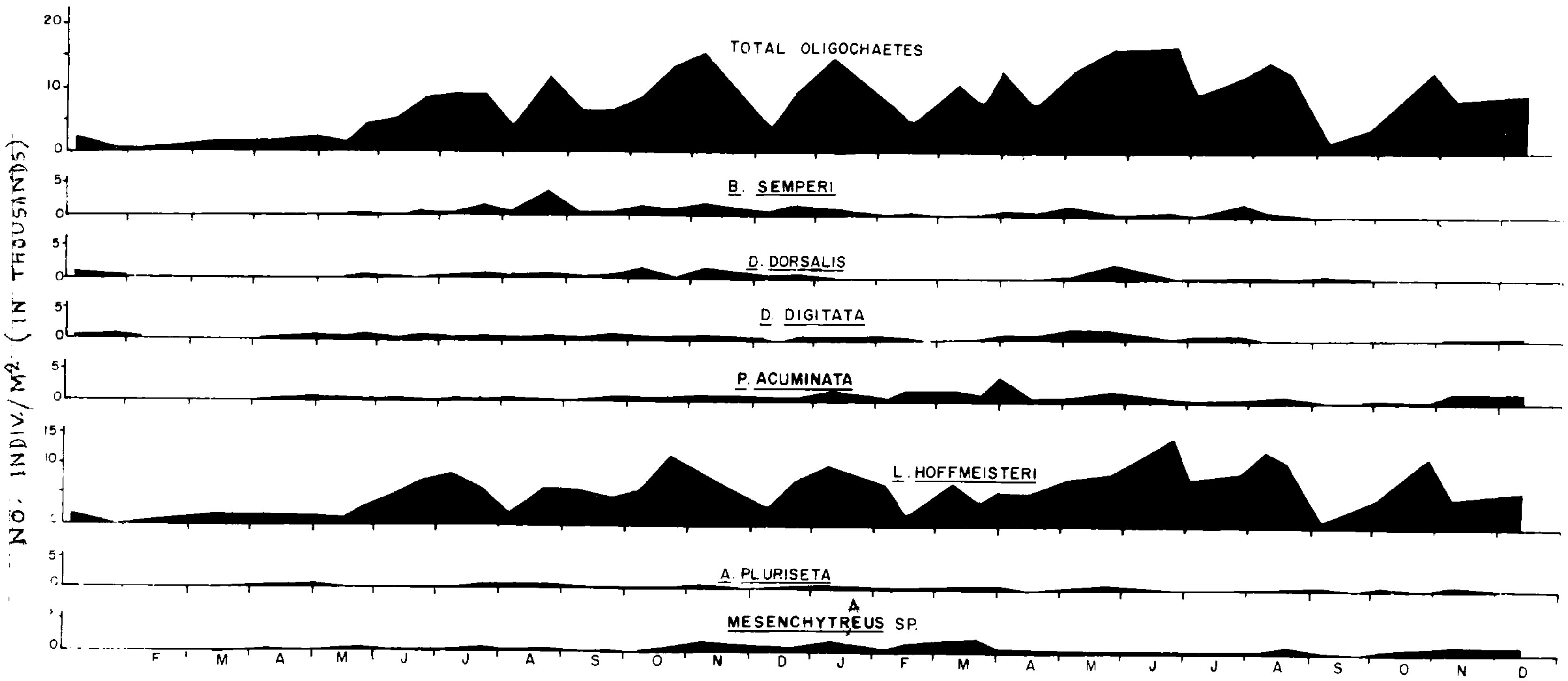

Fig. 37 Graphs showing seasonal abundance of total oligochaetes as well as their species separately at depth B of PG pond in 1976 and 1977.

In the first year the population of macrobenthos was found to remain uniform from January to May and it increased from June onward till the peak of 15488 indv./m^2 was recorded in November. The population was reduced in early December but in late December the growth curve exhibited an upward trend. In the second year a gradual increase in abundance occurred from February till May when the maximum number of worm was encountered 17908 indv./m^2. From June onward the number of worm decreased gradually (Fig. 36).

Phylum : Annelida; Class : Oligochaeta;

Order : Haplotaxida

The oligochaetes weighed more in the total benthos. In the first year uniformly poor populations of the worm were noted from January to mid May with the minimum number of 220 indv./m^2 in February. From late May a gradual increase in number was recorded till the peak was encountered with 15444 indv./m^2 in November. However, a fall in growth curve was found in August. The abundance of worms decreased sharply in early December, but it showed an increase in late December. In the second year the number of the worm decreased in February. The curve showed an upward rise from March till June when the peak was recorded with 16632 indv./m^2. A slight decrease in number was found in late March and mid April. The populations were noted to decrease from July and the lowest number of 1804 indv./m^2 was recorded in early September. During the rest of the period the populations were observed to increase quantiatively (Fig. 37 and Appendices 3, 4).

Family : Naidiaee

Branchiodrilus semperi (Bourne)

In the first year the species constituted 10.6% of the total oligochaetes and occurred between May and December. The peak was recorded during late August with 3639 indv./m^2. Total number of the worm reduced in the second year and it formed 4% of the total oligochaetes. The highest number of 1760 indv./m^2 was found during late July, (Table 21, Fig. 37).

Dero dorsalis (Ferronniere)

In 1976 *D. dorsalis* comprised 5.3% of the oligochaetes and was found continuously between July to December with the peak of 1452 indv./m^2 in November. In 1977 the species was present in poor abundance constituted only 1.8% of the oligochaete. The highest number of 2024 indv./m^2 was noted in May (Table 21, Fig. 37).

Dero digitata (Muller)

D. digitata formed 3.7% and 3.3% of total oligochaete worm in 1976 and 1977 respectively. In the first year nearly uniform population of the worm was found with the exception during February and March when the worms were absent. The highest number of 794 indv./m^2 was encountered during September. More or less similar trend in abundance was noted during the second year and the peak was recorded in May with 1760 indv./m^2 (Table 21, Fig. 37).

Aulophorus furcatus (Muller)

The species was recorded occasionally in poor number during the second year only.

Pristina accuminata (Liang)

The species formed 4% of the total oligochaetes in 1976 and 8.5% in 1977. In the first year the peak of 838 indv./m^2 was recorded during November, whereas in the second year the maximum number was noted during April with 3476 indv./m^2. (Table 21).

Family : Tubificidae

Limnodrilus hoffmeisteri (Claparede)

L. hoffmeisteri was the most abundant species and formed 66.9% and 69.9% of the total oligochaete fauna in 1976 and 1977 respectively.

The species constituted 55.6% and 60.5% of the total macrobenthos in the first and second year respectively (Appendix). The maximum number of 11308 indv./m^2 was recorded during October in the first year and in the second year and the peak was found with 14520 indv./m^2 during June (Table 21, Fig. 37).

Aulodrilus pluriseta (Piguet)

The worm formed 3% and 2.8% of the total oligochaete fauna in the first and the second year. In the first year the highest number of 772 indv./m^2 was recorded in August, whereas the maximum number of 792 indv./m^2 was observed during May in the second year (Table 21, Fig. 37).

Branchiura sowerbyi (Beddard)

B. sowerbyi occurred casually in poor number during the periods of observation.

Family : Enchytraeidae

Mesenchytraeus sp.

The species constituted 5.3% and 7.7% of the total oligochaetes in the first and second year respectively (Table 21).

In 1976 the highest number of worm was found during November with 1408 indv./m^2 and in 1977 the peak of 2112 indv./m^2 was observed during March (Fig. 37).

Class: Insecta; Order : Diptera;

Family : Chironomidae

The populations of midge larvae were noted to be small during the period of observation. In 1976 the highest number was observed in June with 6160 indv./m^2 and in 1977 the peak was noted during April with 4796 indv./m^2 (Fig. 36).

Phylum : Mollusca

Comparatively poor quantity of molluscs was recorded in the first year with the highest number 1980 indv./m^2 during September. In the second year the number increased and the peak was recorded with 7480 indv./m^2 during September (Fig. 36).

Class : Gastropoda; Order : Mesogastropoda;

Family : Viviparidae

Viviparus bengalensis (Lamarck)

V. bengalensis formed 69.6% and 34.7% of the total molluscs in 1976 and 1977 respectively (Table 21). In first year

V. bengalensis was observed in the populations from June to November more or less uniformly with the highest number of 1540 indv./m^2 during early September. In the second year the snail occurred from April to December with the highest abundance of 2596 indv./m^2 during late September.

Family : Amnicolidae

Digoniostoma pulchella (Benson)

In 1976 *D. pulchella* occurred between August and November and formed 18% of the molluscan fauna. The highest number was noted with 616 indv./m^2 during late October. In 1977 the snail was the dominant species among the molluscs and it comprised 36.6% of the molluscs and the peak was noted during late September with 1848 indv./m^2 (Fig. 30).

Alocinma orcula (Frauenfeld)

In 1976 *A. orcula* occurred between June and November and it constituted 10.5% of the molluscan fauna. In 1977 the species was found between May and October the number of the snail was noted to increase and it formed 28.4% of the total molluscs. The maximum number of the snail was recorded during late September with 3036 indv./m^2 (Table 21, Fig. 30).

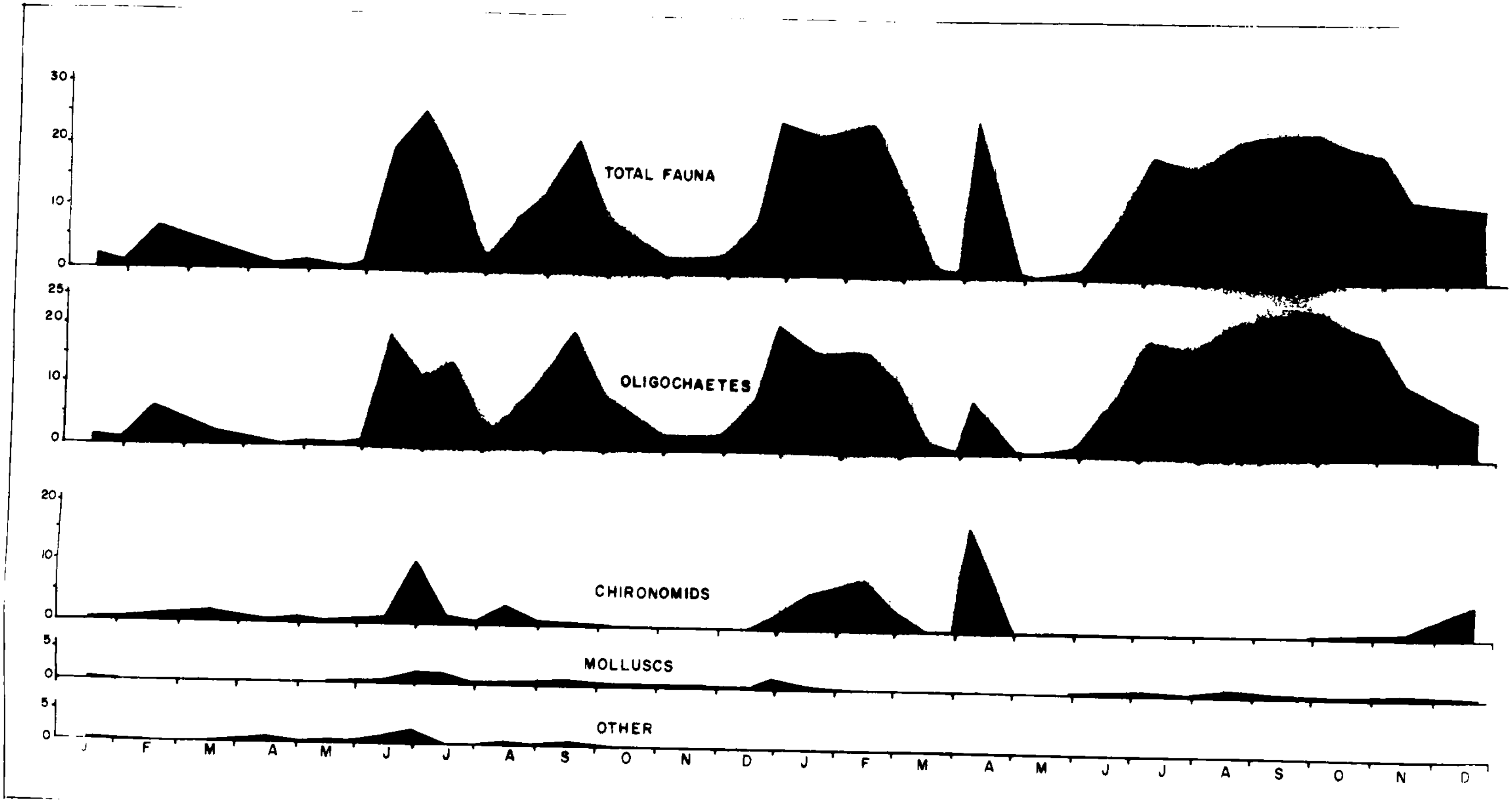

Fig. 38 Graphs showing seasonal abundance of total fauna and major groups of organisms at depth B of SB pond in 1976 and 1977.

Alocinma orcula (Frauenfeld)

In 1976 *A. orcula* occurred between June and November and it constituted 10.5% of the molluscan fauna. In 1977 the species was found between May and October the number of the snail was noted to increase and it formed 28.4% of the total molluscs. The maximum number of the snail was recorded during late September with 3036 indv./m^2 (Table 21, Fig. 30).

Order : Basommatophora;

Family : Planorbidae

Planorbis exustus (Deshayes)

It was found only once in 1977.

SB Pond

The oligochaetes, chironomids and molluscs were the three major groups dominated the population of macrobenthos. Individuals of other groups were present occasionally in small number.

In the first year the number of macrobenthos was noted to increase in February and a gradual decrease in abundance was found from March to May. The populations showed a sharp rise in late

June when the peak was encountered with 25736 indv./m^2. The number of organisms then showed a drastic decline in late July. The populations rose up again in Agust and September and decreased slowly in October and November. However, in December the number was' noted to increase.

In the second year the number of macroinvertebrates was recorded to increase in February and a sudden fall in populations was witnessed in March. The population was noted a sharp increase again in early April when the peak was found with 25784 indv./m^2. The number of organisms dropped to minimum in the late April and in early May the macrobenthos were totally absent. The population increased suddenly in June and continued up to September. The number of macrobenthos was noted to decrease gradually from October to the rest of the period (Fig. 38).

Phylum : Annelida; Class : Oligochaeta;

Order : Haplotaxida

The oligochaetes was the most dominant group. The worm formed 78%, and 83% of the total organism in the first and the second year respectively (Table 20, Fig. 19). The highest number of 21384 indv./m^2 was recorded during late December in the first year and in the second year the peak was noted during late September with 23936 indv./m^2.

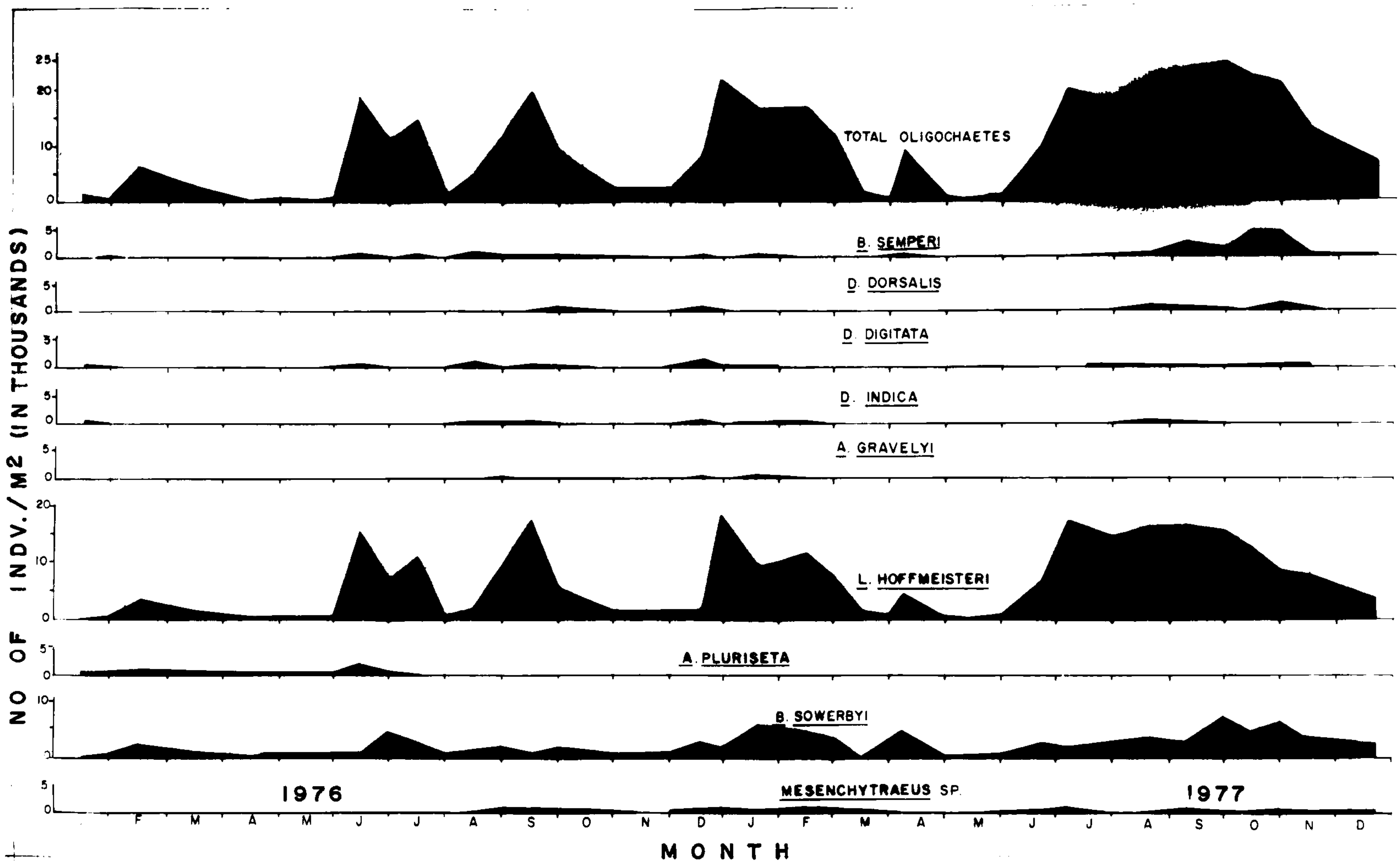

Fig. 39 Graphs showing seasonal abundance of oligochaetes as well as their species separately at depth B of SB pond.

Family : Naididae

Branchiodrilus semperi (Bourne)

In the first year *B. semperi* occurred in poor quantity between May and December with the highest number of 660 indv./m^2 during mid August. It formed only 2. of total benthos but in the second year a noticeable increase in number of the species was encountered and it formed 6.2% of the total organisms. The peak was recorded during October with 4226 indv./m^2 (Table 21, Fig. 39).

Dero digitata (Muller)

In 1976 *D. digitata* was found to form 4.38% of the total organisms. The maximum number of 1408 indv./m^2 was recorded during early December. The number of the worm reduced to a great extent in 1977 and constituted only 0.5% of the oligochaetes (Table 21, Fig. 39).

Dero dorsalis (Ferronniere)

D. dorsalis was noted to appear casually in poor number during the periods of observation.

Dero indica (Naidu)

D. indica was recorded only at a time in poor number.

Aulophorus furcatus (Muller)

A. furcatus was observed only two times during the first and second year.

Aulophorus gravelyi (Stephenson)

Poor number of *A. gravelyi* was recorded casually in the first as well as in the second year.

Family : Tubificidae

Limnodrilus hoffmeisteri (Claparede)

L. hoffmeisteri was the most common species. It comprised 89.6% and 65.7% of the total oligochaetes and 54.4% and 19.5% of the total macrobenthos in 1976 and 1977 respectively (Table 21). In the first year from January to May poor abundance of the worm was noted. The population of the tubificid recorded a sharp increase in June which was followed by a sudden decline in late July. The number of the worm was noted to increase again in August and September. The population showed a gradual reduction in the following months and then rose up suddenly in December when the peak was recorded with 18656 indv./m^2. In the second year a gradual decrease in the abundance of worm was noted from January to May. From June the number of the worm was recorded to increase quickly and the peak was encountered in early July with 17424 indv./m^2. The abundance of the worm showed a gradual fall during the rest of the period (Fig. 39).

Aulodrilus pluriseta (Piguet)

The species occurred occasionally in poor number only in 1976.

Branchiura sowerbyi (Beddard)

B. sowerbyi was recorded more or less uniformly throughout the period. It constituted 22.5% and 23.4% of the oligochaete worm in 1976 and 1977 respectively (Table 21). The highest of 4092 indv./m^2 was noted during late June in the first year and in the second year the peak was found during late September with 6952 indv./m^2 (Fig. 39).

Family : Enchytraedae

Mesenchytraeus sp.

The worm was found to appear only at time in poor abundance.

Class : Insecta; Order : Diptera;

Family : Chironomidae

The chironomid larvae formed 13.2% and 15% of the total macrobenthos in the first and second year respectively. The number of midge larvae were poor but uniform from January to early June in first year (Table 20, Fig. 19). The peak was noted to be 11264 indv./m^2 in late June. In the following months organisms were observed to decrease and these disappeared from the populations during September and October. However, in December the populations of midge larvae were noted to build up again (Fig. 38).

In the second year a gradual increase in populations was found from January to mid February but these decreased in late February and then completely disappeared in March. However, a sharp rise in population was recorded in April when the peak was encountered with 17292 indv./m^2 (Fig. 38).

Phylum : Mollusca

The scanty populations of molluscan fauna were recorded throughout the period of study. In 1976 molluscs formed 4.5% of total organisms and in 1977 these comprised only 1.4% of total invertebrates (Table 20, Fig. 19).

Class : Gastropoda; Order : Mesogastropoda;

Family : Amnicolidae

Alocinma orcula (Frauenfeld)

More or less uniform population of the species was found from April to December in 1976 and from May to November in 1977. In the first year the highest number of 1628 indv./m^2 was encountered during December and in the second year the maximum number was recorded with 934 indv./m^2 during August (Fig. 33).

Digoniostoma pulchella (Benson)

D. pulchella occurred only once during late June in 1976.

Order : Basommatophora; Family : Planorbidae

Planorbis exustus (Deshayes)

P. exustus was found only at times during the periods of observation.

DEPTH C

An exceptionally poor number of macroinvertebrates was recorded from depth C in all the three ponds. The larvae of *Chaoborus* sp. dominated over the other organisms in all the ponds at this depth throughout the period of observation except during 1976 in SB Pond when oligochaetes was noted to be the dominant group (Figs. 16 - 19, Appendices 1 - 6).

SH Pond

In 1976 the highest number of macroinvertebrates was noted with 2156 indv./m^2 during early December but these were found to be absent during March and April. In 1977 the maximum number of 968 indv./m^2 occurred in late October and the organisms were noted to be absent in early March and late July.

Phylum : Annelida; Class : Oligochaeta;

Order : Haplotaxida

The oligochaetes occurred occasionally throughout the period of observation. The highest number of 1144 indv./m^2 was observed in early December during 1976 and in 1977 it was early February. These comprised 37.5% and 18.7% of the total benthos in the first and second year respectively.

Family : Naididae

Pristina accuminata (Liang)

The species was observed only once in 1977.

Family : Tubificidae

Limnodrilus hoffmeisteri (Claparede)

L. hoffmeisteri was found only on four occasions throughout the period of observation.

Aulodrilus pluriseta (Piguet)

It occurred only casually in 1977.

Branchiura sowerbyi (Beddard)

B. sowerbyi was recorded only on two occasions in 1977.

Class : Insecta; Order : Diptera;

Family : Chaoboridae

Chaoborus sp.

Chaoborus sp. was the most dominant component of the benthic macroinvertebrates at C. The highest number of 924 indv./m^2 was found in 1976 during December and in 1977 the maximum number was found to be 968 indv./m^2 during late October. In the first and the second year it comprised 54% of the total macrobenthos (Table 20).

Family : Chironomidae

The chironomid larvae were recorded occasionally in poor number. It formed 7% and 27% of the total organisms in the first and second year respectively (Table 20).

Class : Mollusca

The molluscan fauna was noted to be absent at depth C. However, *Viviparus bengalensis* was found to occur only once in 1977.

PG Pond

The highest number of macrobenthos was noted with 2024 indv./m^2 during late December and in 1977 it was of 1672 indv./m^2 during January.

Phylum : Annelida; Class : Oligochaeta;

Order : Haplotaxida

The oligochaetes occurred only on a few occasions during the present investigation at C. These formed 14% and 1.6% of the total organisms in the first and second year respectively (Table 20).

Class : Insecta; Order : Diptera;

Family : Chaoboridae

Chaoborus sp.

The larvae of *Chaoborus* sp. formed the major bulk in the populations at depth C. It comprised 74% and 98.4% of the total organisms in 1976 and 1977 respectively. The highest number of 2024 indv./m^2 was found during late December in 1977. The maximum number of 1672 indv./m^2 was recorded during January (Table 20).

Family : Chironomidae

The larvae of chironomid occurred casually in 1976. These formed 8.4% of macrobenthos in the first year. In 1977 the midge larvae were found only once in the populations.

SB Pond

The individuals of macrobenthos occurred only at times in poor number throughout the period of study.

Phylum : Annelida; Class : Oligochaeta;

Order : Haplotaxida

In 1976 oligochaetes were present occasionally. These constituted 49% of the total macroinvertebrates. In 1977 the worms were encountered only once (Table 20).

Family : Naididae

Branchiodrilus semperi (Bourne)

B. semperi was noted only once during late January in 1976.

Dero indica (Naidu)

The species was found only once in 1976.

Family : Tubificidae

Limnodrilus hoffmeisteri (Claperede)

It occurred casually in 1976 and the highest number of 440 indv./m^2 was recorded during February. In 1977 *L. hoffmeisteri* was observed only once during June in the populations.

Aulodrilus pluriseta (Piguet)

A. pluriseta was recorded only once during mid January in 1976.

Class : Insecta; Order : Diptera;

Family : Chaoboridae

Chaoborus sp.

The larvae of this species occurred casually during the periods of observation. These formed 25.4% and 47.5% of the total benthic macroinvertebrates in 1976 and 1977 respectively (Table 20).

Family : Chironomidae

The larvae of chironomid were recorded on two occasions during 1976 only.

Family : Mollusca

Among the molluscan species only *Alocinma orcula* was found once in 1976.

From the above investigations it may be inferred that no specific pattern in seasonal abundance could be observed in the three ponds and even the growth was noted to vary from year to year at the same pond (Table 22). However, the maximum number of oligochaetes was found between December and June in these ponds. The most abundant species, *Limnodrilus hoffmeisteri*, showed the peak between

Table 22 : Showing the degree of occurrence of oligochaetes (including three major species) at depth A, and B of the three ponds in 1976 and 1977.

Fauna	Pond	Year	Depth	Peak	Abundant	Absent	Depth	Peak	Abundant	Absent
Oligochaetes	SH	1976	A	Nov.	Jan., Feb., Oct.-Dec.	-	B	Early Aug.	May, Jul. - Nov.	-
		1977	A	July	Jan., Jul., Oct.-Dec.	-	B	Late Jan.	April - Nov.	-
Oligochaetes	PG	1976	A	Dec.	Jan. - April, Jul.-Dec.	-	B	Nov.	May - Dec.	-
		1977	A	Jan.	Jan. - June, Aug. Sept.	-	B	June	Jan., May - Aug.	-
	SB	1976	A	Feb.	Jan. - May, Oct.-Dec.	-	B	Late Dec.	June - Dec.	-
		1977	A	Late Sept.	April.-July, Sept.-Nov.	-	B	Late Sept.	Jan., Feb. Jul.-Nov.	-
B. semperi	SH	1976	A	April	Never	Jan. Sept.	B	Dec.	Never	Jan. Feb. Sept. Oct.
		1977	A	Late Oct.	Never	Jan. June Aug.	B	June	June - Sept.	Jan. Feb. Nov. Dec.
	PG	1976	A	Early Sept.	Mostly	-	B	Late Aug.	July, Nov. May	Jan.-Apr.
		1977	A	Early April	Jan. - Sept.	-	B	Late July	Jan., May, July	Sept.-Nov.
	SB	1976	A	Mid July	Jan.-April, Oct.-Dec.	-	B	Mid Aug.	Never	Jan.-April
		1977	A	Late Oct.	Sept. - Nov.	-	B	Oct.	Sept. - Oct.	May, June
L. hoffmeisteri	SH	1976	A	Late Dec.	Jan. - April, Oct.-Dec.	-	B	Early Aug.	July - Aug.	-
		1977	A	Jan.	Mostly	-	B	Early July	April - Nov.	-
	PG	1976	A	Late Dec.	Jan. - July, Oct.-Dec.	May, June	B	Late Oct.	May - Dec.	-
		1977	A	Jan.	Mostly	-	B	June	April - Aug.	-
	SB	1976	A	Feb.	Jan.-April, Jul. Nov. Dec.	-	B	Dec.	June-Sept. Dec.	Jan.
		1977	A	Late June	April-July, Sept.-Nov.	-	B	Early July	Jan., Feb., June-Nov.	-
B. sowerbyi	SB	1976	A	Late Sept.	Jan.-April, Oct.-Dec.	May	B	Late Dec.	June, July, Dec.	-
		1977	A	Late April	Feb.-July, Sept.-Nov.	Aug.	B	Late Sept.	Jan, Feb., July-Dec.	March

Table 23 : Showing the degree of occurrence of molluscs (including four major species) at depth A, and B of three ponds in 1976 and 1977.

Fauna	Pond	Year	Depth	Peak	Abundant	Absent	Depth	Peak	Abundant	Absent
Molluscs	SH	1976	A	Aug.	Jul. Aug.	-	B	Late Sept.	July-Oct.	April
		1977	A	Early July	April-Sept.	-	B	Early Sept.	May-Sept.	-
	PG	1976	A	Early Sept.	July-Sept.	-	B	Early Sept.	Aug.-Oct.	Jan.-May
		1977	A	Late Sept.	May-Oct.	-	B	Late Sept.	July-Oct.	Jan.
	SB	1976	A	Late Jan.Late Oct.	Jan.,Aug.-Oct.	Feb. March	B	Late June	June-Sept.	Feb. March
		1977	A	Aug.	July.-Sept.	Jan.-March	B	Aug.	Aug.-Sept.	Feb.-April
<u>V. bengalensis</u>	SH	1976	A	Late Aug.	June-Aug.	Jan.-April	B	Late Sept.	May-Oct.	Jan.-April
		1977	A	Early Oct.	July-Oct.	March	B	Early Sept.	May-Sept.	-
	PG	1976	A	Early Sept.	July-Nov.	Feb. Mar. June	B	Early Sept.	Aug.-Nov.	Jan.-May, Dec.
		1977	A	Early Oct.	May-Oct.	November	B	Late Sept.	July-Oct.	Jan. March
<u>D. pulchella</u>	SH	1976	A	Late July	Never	Jan.-April, Nov.	B	Late May	Never	April, Dec.
		1977	A	Early July	March-Aug.	-	B	Late June	Never	Jan.-March
	PG	1976	A	Early Sept.	Aug., Sept.	April, Jan., July	B	Late Oct.	Never	Jan.-July
		1977	A	Early July	Feb., May-Oct.	November	B	Late Sept.	July-Sept.	Feb., April
<u>M. tuberculata</u>	SH	1976	A	December	Sept., Oct., Dec.	Jan., June	B	Late Sept.	Never	April-May
		1977	A	January	Jan., Oct.	-	B	Late June	Never	March
<u>A. orcula</u>	SB	1976	A	Late Jan.Late Oct.	Jan.,Aug.-Dec.	Feb., March	B	June	July, Sept., Dec.	Feb., March
		1977	A	August	May-Sept.	Jan., March	B	August	Aug., Sept., Nov.	Feb.-April

November and July, whereas the *Branchiodrilus semperi* showed its maximum occurrence between April and October. *Branchiura sowerbyi* showed the peak between April and September (Table 22).

On the other hand, molluscan fauna showed a specific pattern in seasonal abundance in these ponds (Table 23). The maximum number of molluscs were recorded between July and October and the minimum between December and April. However, in SB pond a peak of these organisms was noted during January in 1976 and the organisms disappeared from the populations in February and March. In the same year in SH pond a second peak was noted during October.

The most common snail *Viviparus bengalensis* showed the peak between August and October and the number was minimum and even dropped to grow between November and April. *Digoniostoma pulchella* showed the highest occurrence between May and September and the lowest between November and April. The maximum number of *Alocinma orcula* was recorded during January and October in 1976 and during August in 1977 whereas the minimum during winter and early summer (Table 23).

(ii) Biomass of Macroinvertebrates

The biomass of the macrobenthos in three ponds differed distinctly. In SH and PG ponds molluscan fauna influenced the total biomass, whereas in SB pond the biomass of eligochaetes determined the total biomass (Figs. 42, 43).

DEPTH A

The biomass of the molluscs dominated over the other groups. These formed 90.4% and 97% of total biomass in 1976 and 1977 respectively. Oligochaetes was the second dominant group and contributed 7.5% and 1.5% of the total biomass during the same periods (Fig. 42).

Among the molluscs, *Viviparus bengalensis* dominated the total weight and formed 49.3% and 70.48% of the molluscan biomass and 44.5% and 68.8% of the total biomass in 1976 and 1977 respectively. The maximum weight of the snail was noted during June 85 g/m^2 in the first year and during October in the second year 1806 g/m^2 (Tables 30, 31 and Fig. 42).

Among oligochaetes, *Limnodrilus hoffmeisteri* was the most dominant species and comprised 88.7% and 69.4% of the biomass of total oligochaetes. The highest biomass of 12 g/m^2 was noted during

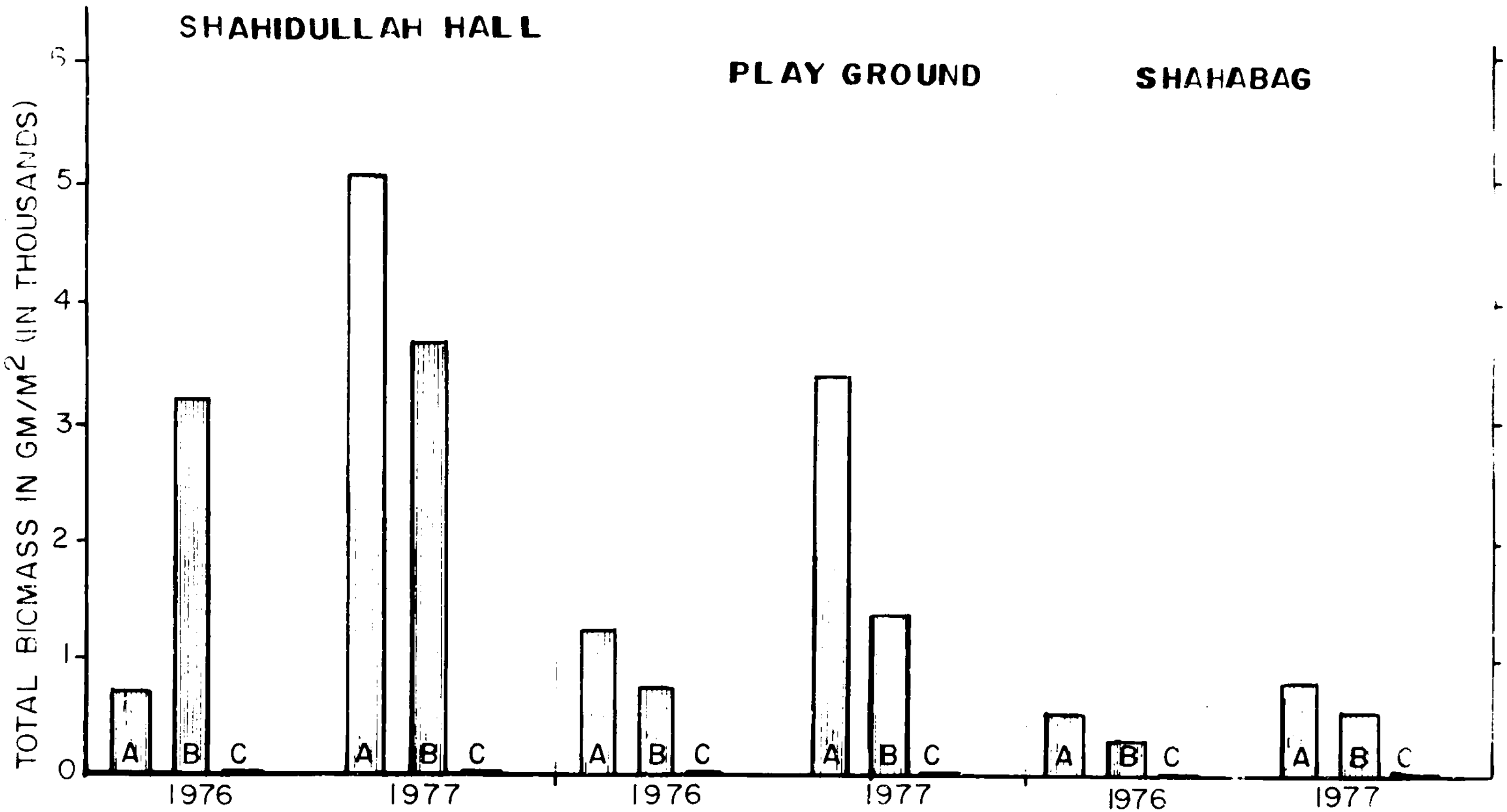

Fig. 40 Graphs showing biomass of total organisms in gm per meter square area at depth A, B and C of three ponds in 1976 and 1977.

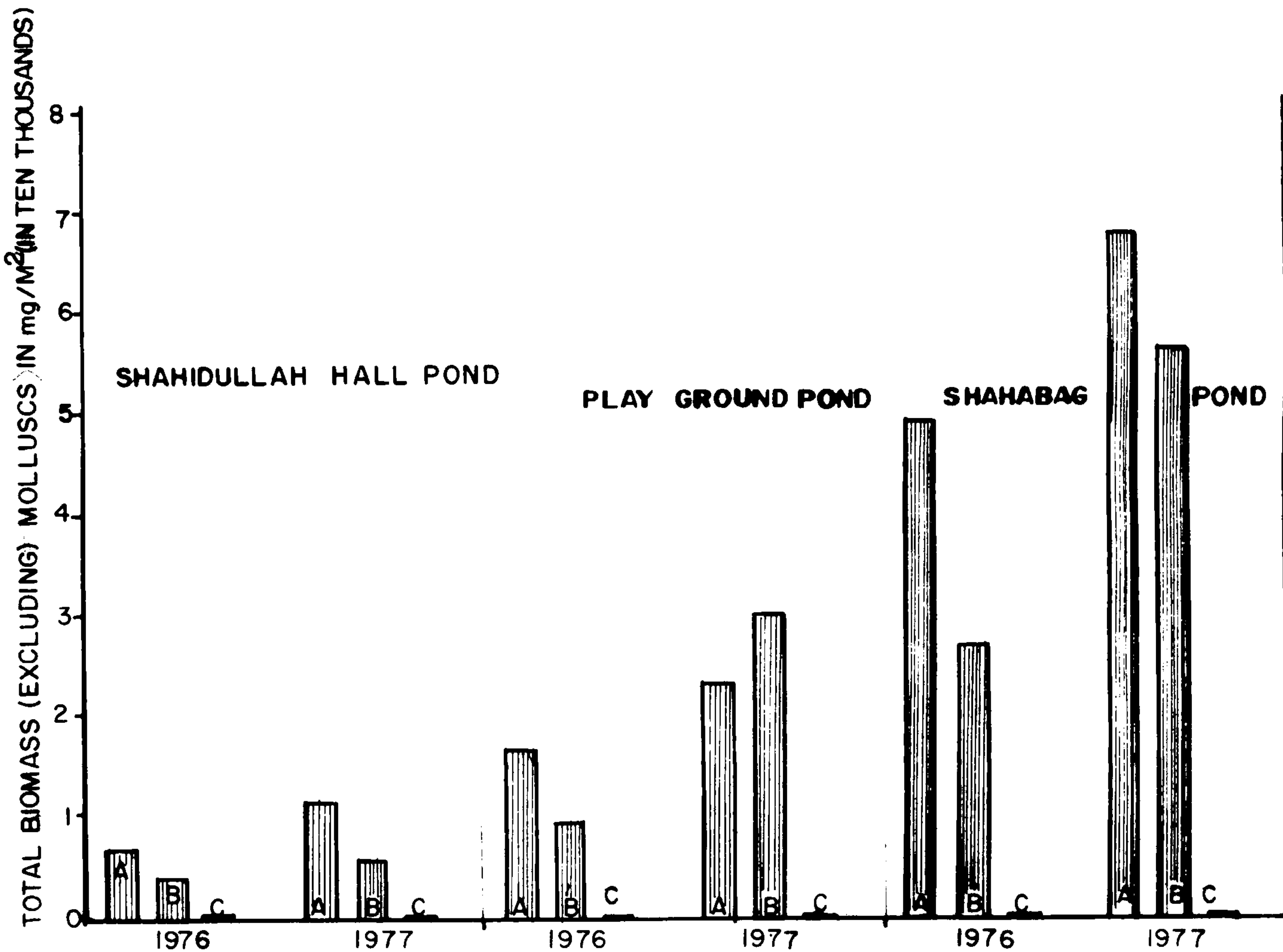

Fig. 41 Graphs showing biomass of total organisms (Excluding molluscan fauna) in mg. per meter square at depth A, B and C of three ponds in 1976 and 1977.

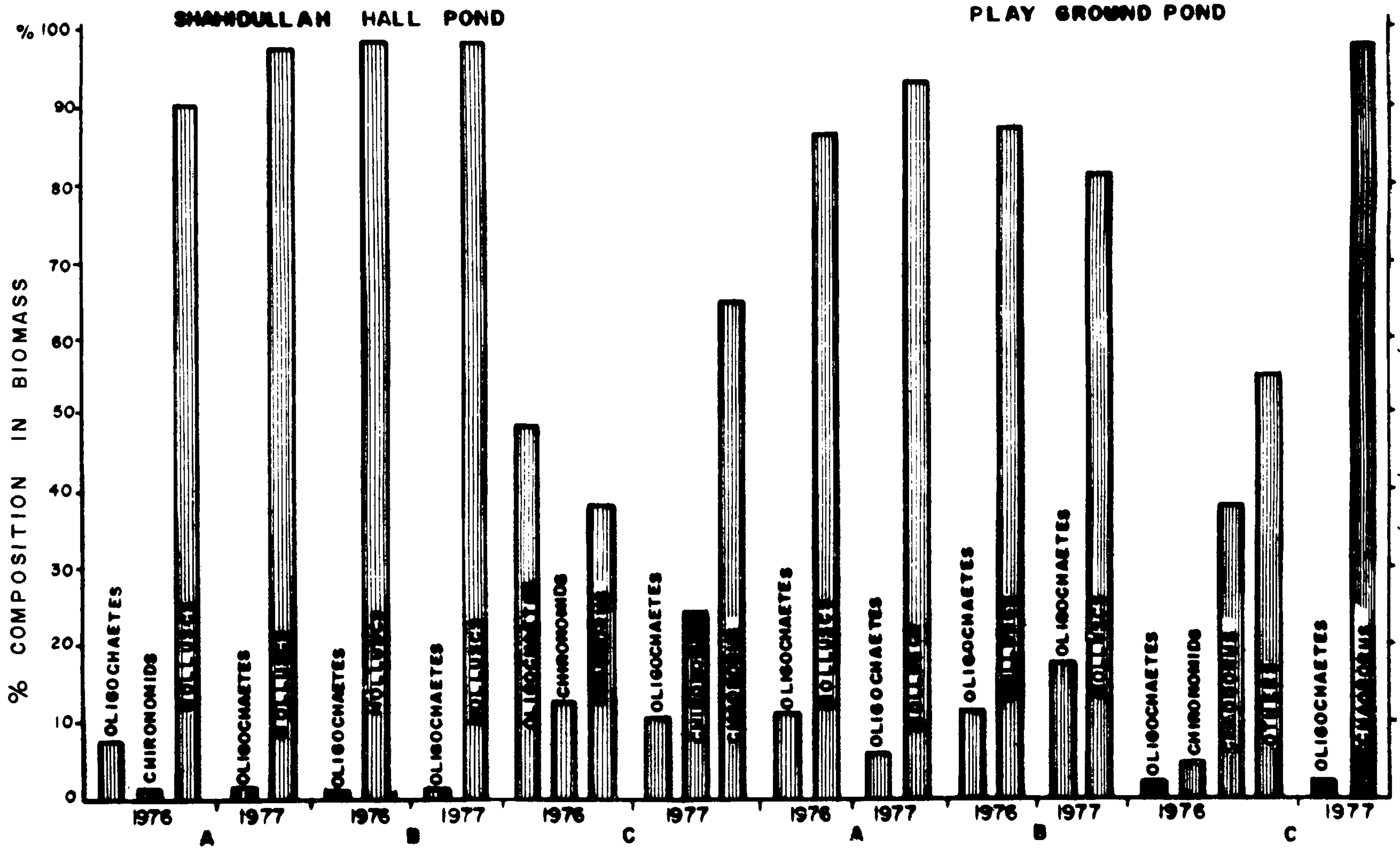

Fig. 42 Graphs showing percentage composition in biomass of major groups of organisms at three depths in SH and PG ponds in 1976 and 1977.

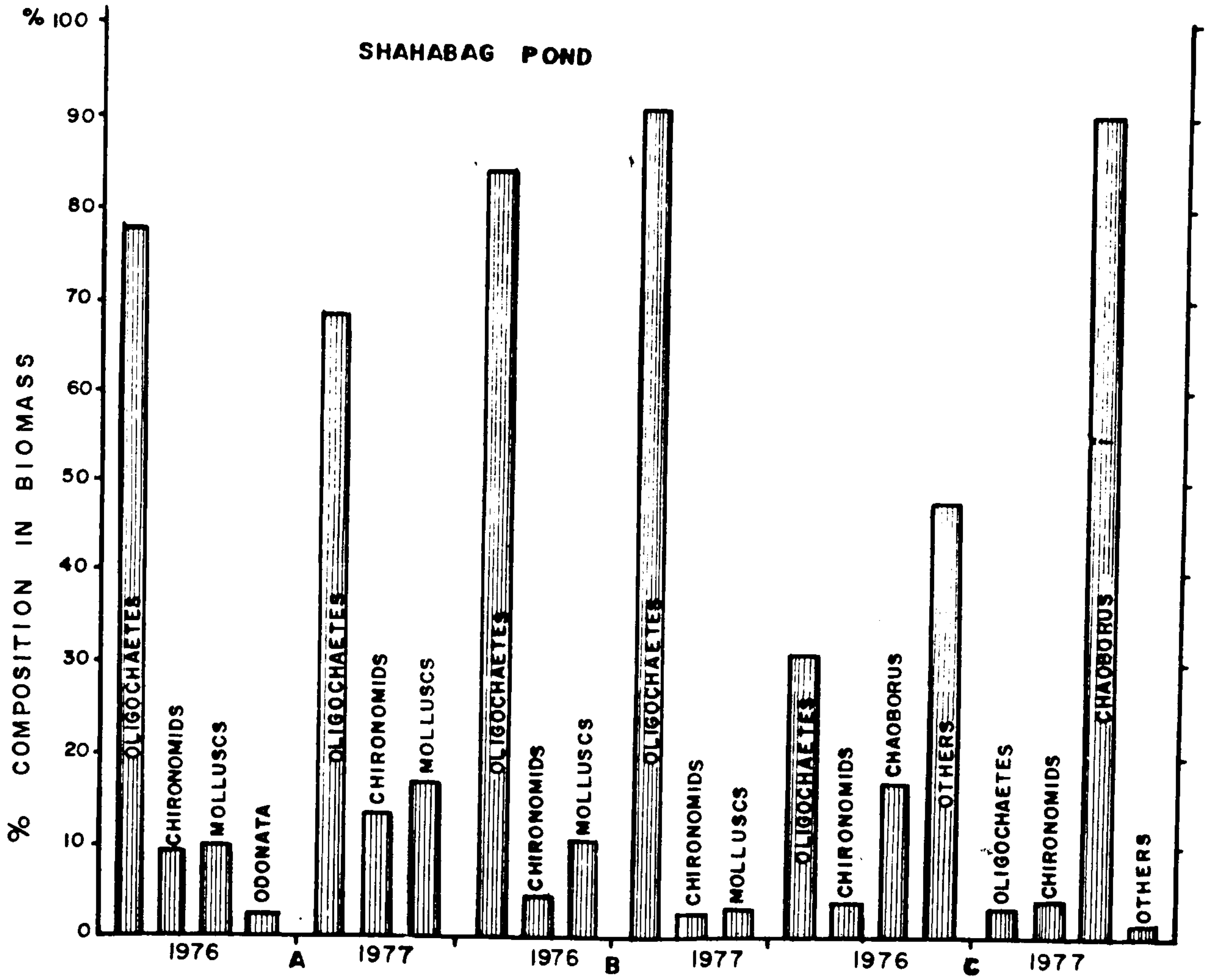

Fig. 43 Graphs showing percentage composition in biomass of major groups of benthic organisms at three depths in SB pond in 1976 and 1977.

November in the first year and in the second year it was of $9.5\ g/m^2$ in January. *Branchiodrilus semperi* was the second abundant species and formed 5.7% and 5.9% of the weight of total oligochaetes during the first and second year (Tables 24, 25) respectively.

PG Pond

The biomass of molluscan fauna dominated over the other groups and constituted 86.8% and 93% of the biomass of total macrobenthos in the first and second year respectively. Oligochaetes was the next dominant group and formed 11.2% and 5.9% of biomass of total macroinvertebrate (Appendices 9, 10 and Fig. 42).

V. bengalensis was the most dominant species among the molluscs and comprised 84.24% and 76% of the biomass of molluscan fauna, and 73% and 71% of biomass of the total macrobenthos in the first and second year respectively. The highest biomass of $167.6\ g/m^2$ was recorded during October in 1976 and in 1977 the maximum biomass of $884.8\ g/m^2$ was found during the same month (Tables 34, 35 and Fig. 42).

Among oligochaetes, *L. hoffmeisteri* constituted 64.9% and 58.7% and *Pristina accuminata* formed 12.16% and 19.3% of biomass of oligochaete fauna during the first and second year respectively.

Table 24 : Showing the weight of different species of oligochaetes in g/m^2 and their percentage composition at depths A and B of SH pond for the year 1976.

Dates	A										B								Total
	B. semperi	D. digitata	D. dorsalis	A. furca-.	P. accum	L. hoff-.	A. pluri-.	B. sowerbyi	Mesen-chyt-.	Total	B. semperi	D. digitata	L. hoff-.	A. pluri-.	B. sowerbyi	Mesen-chyt-.	P. accum	A. furca-.	
10.1.76	-	.01	-	-	-	7.09	.02	-	-	7.12	-	-	.008	-	-	-	-	-	0.008
10.2.76	.21	.01	-	-	-	7.36	-	.13	-	7.71	-	-	.008	-	-	-	-	-	0.008
9.3.76	.28	.007	-	-	-	.83	-	.63	-	1.747	.001	.004	.007	-	-	-	-	-	0.012
5.4.76	.28	.01	-	-	-	2.00	-	.13	-	2.42	.012	.01	.10	-	-	-	-	-	0.122
7.5.76	1.05	.03	-	-	-	.08	-	.05	-	1.21	-	.01	-	-	-	-	-	-	0.01
26.5.76	-	-	-	-	-	.01	-	-	-	0.01	.001	.01	1.46	.05	.30	-	-	-	1.821
15.6.76	-	-	-	-	-	.02	-	-	-	0.02	-	-	.011	.02	.05	-	-	-	0.081
25.6.76	.42	.05	.001	-	-	.02	.62	-	-	1.111	.0008	.01	-	.11	-	-	-	-	0.1208
12.7.76	.22	.01	-	-	-	.01	-	-	-	.24	-	.02	-	-	-	-	-	-	0.02
26.7.76	.001	.013	.01	.003	-	.028	.05	-	-	0.095	.003	-	6.14	.02	-	.008	-	-	6.171
10.8.76	.21	.02	.001	.01	-	.04	-	-	-	0.281	-	-	8.38	-	-	-	-	-	8.38
25.8.76	-	-	.005	-	-	-	-	-	-	0.005	.0008	.01	.09	.22	-	-	-	.003	0.3238
10.9.76	-	.013	-	.003	-	-	-	-	-	0.016	-	-	2.96	-	-	-	-	-	2.96
25.9.76	-	.007	.003	.003	-	.06	-	-	-	0.089	-	.01	5.22	.05	.30	-	1.00	-	6.58
10.10.76	.006	.03	.003	-	.07	.77	.10	-	-	0.979	-	-	1.00	-	.81	-	-	-	1.81
25.10.76	.0008	.002	-	-	-	.08	-	-	-	0.0828	-	-	2.09	.07	.24	.031	.50	-	2.931
24.11.76	.21	.05	-	-	.25	12.35	-	.22	-	13.08	.28	.03	.14	.91	.04	-	.41	-	1.81
11.12.76	.14	-	-	-	.07	5.40	-	-	-	5.61	-	-	.19	.20	-	-	.50	-	0.89
27.12.76	.009	.002	-	-	.66	10.30	.78	-	-	11.743	.005	-	.12	.005	-	.008	.16	-	0.298
Total	3.0368	.258	.023	.019	1.05	46.452	1.57	1.16	-	53.568	.3036	.114	27.924	1.655	1.74	.047	2.57	.003	34.356
%	5.67	*	*	*	1.96	86.71	2.93	2.17			*	*	81.26	4.83	5.06	*	7.48	*	

Table 25 : Showing the weight of different species of oligochaetes in g/m^2 and their percentage composition at depths A and B of SH pond for the year 1977.

Dates	A											B										Total
	B. semperi	D. digitata	L. hoff-	A. pluri-	B. sowar-	Mesen-chyt-	D. indica	A. fur-	P. accum	D. dorsalis	Total	B. semperi	D. digi-	L. hoff-	A. pluri-	B. sowar-	Mesen-chyt-	P. accum	A. fur-	D. dorsa-	D. indi-	
13.1.77	-	.03	9.53	.45	.13	-	-	-	-	-	10.14	-	.01	.28	-	.25	-	-	-	-	-0.	0.54
10.2.77	.64	.007	3.68	-	2.97	-	-	-	-	-	7.297	-	-	.05	-	-	-	-	-	-	-	0.05
23.2.77	.56	.01	4.64	.45	1.04	-	-	-	-	-	6.7	-	-	.40	-	-	-	-	-	-	-	0.40
14.3.77	.21	.005	1.12	-	.22	-	-	-	-	-	1.555	-	-	.10	-	2.38	.008	-	-	-	-	2.488
25.3.77	.88	.57	.51	.30	.79	-	-	-	-	-	3.05	-	-	.01	-	.38	-	-	-	-	-	0.39
4.4.77	.56	.02	9.13	.34	.08	-	-	-	-	-	10.13	.0008	.002	.19	.11	-	-	-	-	-	-	0.3028
28.4.77	.70	.071	.15	.45	-	-	.001	-	.08	-	1.452	-	.002	.48	.22	.51	-	.08	-	-	-	1.292
7.5.77	-	.002	2.46	-	.04	-	-	-	-	-	2.502	.28	.007	.20	.58	-	-	.75	-	-	-	1.817
28.5.77	.006	.007	.03	-	-	-	-	-	-	-	0.043	-	.01	2.38	-	-	-	-	-	-	-	2.39
29.6.77	-	-	.02	-	-	-	-	-	-	-	.02	.43	.10	1.97	.68	.24	.01	.41	.05	.02	.005	3.915
6.7.77	.35	.01	5.03	1.83	.08	-	-	-	-	-	7.3	.14	.01	5.36	-	-	-	-	-	.001	-	6.011
26.7.77	.36	.04	1.71	.68	-	-	-	-	.25	.006	3.046	.49	.04	.75	1.04	-	.08	.25	.003	.003	-	2.656
12.8.77	-	-	5.00	-	-	-	-	-	-	-	5.00	.64	.02	2.37	1.03	.04	-	.16	-	.005	-	4.265
5.9.77	.21	.01	2.73	.68	-	-	-	-	-	-	3.63	.49	.02	.64	.68	-	-	-	-	.006	-	1.836
26.9.77	-	-	2.56	-	-	-	-	-	-	-	2.56	.91	.01	1.39	1.15	.28	.01	-	-	-	-	3.75
11.10.77	.42	.007	.06	.34	-	-	-	-	.16	.006	0.993	-	.002	4.07	1.71	-	.02	-	-	.005	-	5.807
25.10.77	.65	.01	4.30	1.48	-	.03	-	.003	.33	.005	6.838	.0008	.007	3.17	1.71	-	.08	1.60	.006	-	-	6.5738
14.11.77	1.05	.181	.54	1.83	.09	-	.001	-	-	.005	3.667	-	-	3.82	1.40	-	.06	-	-	.005	-	5.285
12.12.77	1.28	.01	4.63	-	.13	.05	-	-	1.33	.02	7.45	-	-	1.21	.90	-	.003	.16	-	-	-	2.273
Total	7.876	.988	57.83	8.83	5.57	.08	.002	.003	2.15	.042	83.37	3.3816	.24	29.34	11.21	4.08	.271	3.41	.059	.045	.005	52.04
%	9.45	1.19	69.36	10.59	6.68	*	*	*	2.58	*		6.5	*	56.38	21.54	7.84	*	6.55	*	*	*	

* Less than 1%

Table 26 : Showing the weight of different species of oligochaetes in g/m^2 and their percentage composition at depths A and B of PG pond for the year 1976.

Dates	A: B. semperi	A: D. digitata	A: D. dorsalis	A: A. furca-.	A: P. accum	A: L. hoff-.	A: A. pluri-.	A: Mesen-chyt-.	A: S. lacus-.	A: Total	B: B. semperi	B: D. dorsa-.	B: D. digi-.	B: P. accum	B: L. hoff-.	B: A pluri-.	B: Mesench-ytraeus	B: I sowerbyi	Total
4.1.76	2.99	.02	.01	-	1.50	1.14	.76	.05	-	6.47	-	.01	.003	-	1.02	-	-	-	1.033
24.1.76	1.06	.01	-	-	1.09	6.99	.0003	.01	.18	9.3403	-	-	.03	-	-	-	-	-	0.03
7.2.76	.94	.04	-	-	3.25	1.07	-	-	-	5.3	-	-	-	-	.04	-	-	-	0.04
13.3.76	.92	.01	-	-	.58	4.41	-	-	-	5.92	-	-	-	-	1.23	-	-	-	1.23
7.4.76	.28	.02	-	-	-	8.78	-	-	-	9.08	-	-	-	-	.86	.006	.01	-	0.876
30.4.76	.57	.03	.01	-	-	10.22	.0003	.01	-	10.8403	-	-	.01	-	.60	.01	.008	-	0.628
15.5.76	.35	.08	.04	-	-	-	-	-	-	0.47	.0008	-	.005	-	.59	-	.08	-	0.6758
24.5.76	.86	.14	.03	-	.13	-	-	.008	-	1.168	.0008	.005	.57	-	2.97	-	.07	-	3.6158
10.6.76	-	.02	-	-	-	-	-	-	-	0.02	-	-	-	.41	8.29	.02	.008	.14	8.868
22.6.76	.35	.005	.008	-	.08	-	-	-	-	0.443	.79	-	.02	-	5.23	-	.06	-	6.1
7.7.76	.14	-	.02	-	-	1.44	-	-	-	1.6	.003	.01	.005	.39	7.84	-	.03	.77	9.048
22.7.76	2.51	.02	.05	-	-	8.79	.51	.03	-	11.91	1.87	.02	.01	.24	2.26	.99	.1	-	5.49
5.8.76	1.42	.007	.04	-	-	6.23	-	-	-	7.697	.22	.01	.002	.51	.82	1.00	.05	-	2.612
22.8.76	.88	.02	.12	-	.08	5.03	.51	-	-	6.64	.42	.02	.01	.52	1.10	1.16	.11	-	3.34
7.9.76	1.56	.03	.26	.006	.28	5.01	.88	.07	-	8.096	.008	.006	.002	.34	3.99	.57	-	-	4.916
22.9.76	1.60	.12	.26	.012	1.17	.56	.54	.02	-	4.282	.35	.01	.04	1.00	2.16	.45	.05	-	4.06
7.10.76	.65	.01	.07	-	.34	.09	-	.008	-	1.168	.79	.05	.01	.91	.73	.10	.03	-	2.62
22.10.76	.58	.03	.013	-	.66	.67	-	.10	-	2.053	.71	-	.002	1.08	9.35	.43	.11	-	11.682
7.11.76	.56	.002	.01	-	.58	3.97	.69	.15	-	5.962	.80	.06	.03	1.58	8.15	.91	.26	-	11.79
9.12.76	1.51	.08	.03	-	3.76	5.37	1.47	.17	-	12.39	.007	.01	-	.66	.44	-	.16	-	1.277
22.12.76	5.70	.20	.06	.02	3.87	22.65	.07	.10	-	32.67	.65	.01	.005	.75	6.28	.07	.10	-	7.865
Total	25.43	.894	1.031	.038	17.37	92.42	5.4306	.726	.18	143.[illegible]19	6.6196	.221	.754	8.39	63.95	5.716	1.236	.91	87.796
%	17.72	*	*	*	12.1	64.4	3.78	*	*		7.54	*	*	9.56	72.84	6.51	1.41	1.04	

Table 27 : Showing the weight of different species of oligochaetes in g/m^2 and their percentage composition at depths A and B of PG pond for the year 1977.

Dates	A										B									Total
	B. semperi	D. dorsalis	D. digitata	A. furca-.	P. accum	L. hoff-.	A. pluri-.	Mesen-chyt-.	B. sower-.	Total	B. semperi	D. dorsa-.	D. digi-.	A. furca-.	P. accum	L. hoff-.	A. pluri-.	Mesench-ytraeus	B. sowerbyi	
10.1.77	.58	.04	.14	.02	5.37	12.48	1.33	.38	-	20.34	.29	-	.01	-	2.44	7.18	.18	.35	-	10.45
7.2.77	1.30	.006	.03	-	11.87	16.25	.80	.22	-	30.476	-	-	.01	-	.66	11.48	.05	.05	-	12.25
17.2.77	1.08	-	.02	-	9.36	11.48	-	3.09	-	25.03	.005	-	-	-	2.59	.68	.68	.20	-	4.155
11.3.77	2.07	.006	.02	-	2.85	5.97	.34	.10	-	11.356	-	.003	-	-	2.67	7.74	.18	.35	-	10.943
23.3.77	.80	-	.01	-	.94	7.92	-	.19	-	9.86	.007	-	.005	-	1.83	2.19	.15	.40	.88	5.462
2.4.77	3.68	.09	.06	-	.33	15.77	.11	.03	-	20.07	.01	.001	.04	-	6.60	5.45	.42	.18	32.65	45.351
16.4.77	4.01	.06	.23	.04	-	.24	-	-	-	4.58	.006	-	.041	.009	1.08	6.47	-	.10	-	7.706
6.5.77	3.34	.10	.40	-	.696	1.27	.97	-	-	6.776	.03	.01	.10	.003	1.10	5.10	.49	.11	-	6.943
26.5.77	2.06	.04	.01	.006	.578	7.47	-	.21	-	10.374	.01	.07	.09	.01	.23	14.07	1.14	.07	.88	16.57
25.6.77	.43	.01	.06	-	1.36	8.72	.34	.22	-	11.14	.01	-	-	-	1.35	23.58	.22	.10	.05	25.341
5.7.77	1.66	.08	.18	-	-	7.39	-	.09	-	9.4	-	.001	.02	-	.36	10.42	.11	.05	-	10.961
28.7.77	.14	.003	.01	-	.35	3.58	.11	.04	-	4.233	.59	.003	.25	-	.50	7.62	.22	.06	-	9.243
10.8.77	.64	.10	.02	.05	2.04	.19	.80	.06	-	3.9	.007	.003	-	-	1.50	12.56	.80	.05	-	14.92
20.8.77	.85	.02	-	-	1.08	.87	2.74	.03	-	5.59	.005	-	-	-	1.78	11.98	.07	.20	-	14.035
8.9.77	.56	.01	.005	-	.68	12.68	.45	.04	-	14.425	-	.01	.005	-	-	.02	.57	.03	-	0.635
28.9.77	1.26	.08	.05	.23	1.42	.34	3.42	.03	-	6.83	-	.001	-	-	.18	3.38	.16	-	-	3.721
6.10.77	-	.01	.005	-	-	.03	.55	.03	-	0.625	-	-	-	-	.33	9.24	1.37	.02	-	10.96
29.10.77	.14	.006	.01	.02	-	3.98	.22	-	-	4.376	-	-	-	-	-	14.00	-	.20	-	14.220
10.11.77	-	.001	.007	-	.16	.86	.02	-	-	1.048	-	-	.005	-	2.90	6.68	2.9	.21	.11	12.805
14.12.77	.21	-	-	-	-	1.75	-	-	.08	2.04	.77	.01	.01	.003	2.27	9.61	.008	.19	.008	12.879
Total	24.81	.662	1.267	.366	39.084	119.24	12.20	4.76	.08	202.469	1.74	.112	.585	.025	30.37	169.45	9.72	2.97	34.578	249.55
%	12.25	*	*	*	19.30	58.89	6.03	2.35	*		*	*	*	*	12.17	67.9	3.89	1.19	13.86	

* Less than 1%

The maximum weight of *L. hoffmeisteri* was noted to be 10.2 g/m^2 during April in the first year and 16.25 g/m^2 during February in the second year (Tables 26, 27).

SB Pond

The oligochaetes were the most abundant fauna and constituted 77.8% and 68.2% of biomass of the total macroinvertebrates in the first and second year respectively. Molluscan fauna formed 10% and 17.9% and chironomid larvae comprised 9.3% and 13.5% of total biomass in 1976 and 1977 respectively (Fig. 43).

Of the oligochaetes, *L. hoffmeisteri* formed 61.5% and 55.2% of biomass of the oligochaetes in the first and second year. The species formed 48.3% and 39.7% of total biomass of the same periods. The highest biomass of the species was noted to be 68.37 g/m^2 during February in the first year and 74.8 g/m^2 during January in the second year. *B. sowerbyi* was the second dominant species and constituted 22.3% and 39.6% of biomass of oligochaete worms for the first and second year (Tables 28, 29).

Among the molluscs, *A. orcula*, was the dominant species. It formed 88.4% and 98.39% of the weight of molluscan fauna and 8.8% and 10.5% of the total weight for the first and second year respectively.

Table 28 : Showing the weight of different species of oligochaetes in g/m^2 and their percentage composition at depths A and B of SB pond for the year 1976.

Dates	A											B										Total
	B. sempari	D. dorsa-.	D. digitata	D. indicata	A. furca-.	A. grave-.	L. hoff-.	B. sower-.	A. pluri-.	Mesen-chyt-.	Total	B. sempari	D. dorsa-.	D. digi-.	D. indi-.	A. furca-.	A. gra-.	L. hoff-.	B. sower-.	A. pluri-.	Mesen cht-.	
15.1.76	3.39	-	.21	.01	.19	-	30.99	9.46	6.11	-	50.36	-	-	.05	.006	.006	-	-	-	.05	-	0.112
30.1.76	4.12	.01	.25	.03	.36	-	47.86	5.98	5.75	-	64.36	.24	-	-	-	-	-	.03	2.00	.005	-	2.275
15.2.76	2.55	-	.18	.06	.47	-	68.37	10.96	4.64	-	87.23	-	-	-	-	-	-	.13	6.62	.33	-	7.08
15.3.76	1.89	-	.05	.04	.34	-	22.15	6.95	1.17	-	32.59	-	-	-	-	-	-	.04	2.90	.13	-	3.07
15.4.76	2.33	.02	.10	.04	.39	-	.50	7.37	1.02	-	11.77	-	-	-	-	-	-	-	-	-	-	0
30.4.76	3.18	.03	.12	.05	.41	-	.65	8.94	.86	-	14.24	-	-	-	-	-	-	.005	2.14	-	-	2.145
18.5.76	2.42	.02	.18	.05	.54	-	1.36	-	.05	-	4.62	-	-	.002	.001	-	-	.28	-	-	-	0.283
30.5.76	1.69	-	.03	.03	.01	-	3.99	-	-	-	5.75	.0008	-	-	-	-	-	.15	2.6	-	-	2.7508
16.6.76	-	-	-	-	-	-	1.47	.51	.11	-	2.09	.56	-	.02	-	-	-	14.88	1.87	1.97	-	19.3
30.6.76	2.97	-	.04	.01	.009	-	1.84	1.02	.57	-	6.459	-	-	-	-	-	-	4.56	14.41	.67	-	19.64
15.7.76	7.42	-	.11	.03	.06	-	28.55	7.22	-	-	43.03	1.05	-	-	.003	-	-	15.95	6.81	-	.04	23.853
31.7.76	-	-	.002	-	-	-	.02	.25	-	-	0.272	-	-	-	-	-	-	.04	3.14	-	.0008	3.1808
16.8.76	.16	-	.02	.07	-	-	.09	.79	-	-	1.13	.43	-	.05	.08	-	-	.31	1.25	-	-	2.12
31.8.76	1.62	-	.13	1.27	.12	-	3.77	1.24	-	-	8.15	.004	-	.001	.005	.01	.01	22.96	7.93	-	.01	30.93
15.9.76	.43	-	.01	-	-	-	1.18	.80	-	-	2.42	.005	-	.02	.007	-	-	49.55	2.22	-	.06	51.862
30.9.76	.001	.01	-	.003	-	-	.04	-	-	-	0.054	.007	.003	.01	-	.01	-	8.84	4.78	-	.05	13.7
30.10.76	1.30	-	.07	.07	.05	.004	5.94	3.42	.18	.008	11.042	.35	.02	.002	-	-	.002	2.95	.87	.08	.02	4.294
30.11.76	1.52	-	.05	.05	.04	-	14.93	15.59	-	.008	32.188	-	-	-	-	-	-	3.10	4.64	-	-	7.74
17.12.76	1.38	.01	.11	.02	.03	.02	28.18	12.54	-	.01	42.3	.005	.05	.08	.02	-	.02	2.88	9.07	-	.03	12.158
28.12.76	1.53	-	.25	.06	.10	.05	1.74	2.37	-	-	6.1	-	-	.02	.007	-	-	40.92	6.58	-	.08	47.607
Total	39.90	.10	1.912	1.893	3.119	.074	263.62	95.05	20.46	.026	426.15	2.6518	.073	.255	.129	.026	.032	167.58	79.83	3.235	.298	254.11
%	9.36	*	*	*	*	*	61.86	22.3	4.8	*		1.04	*	*	*	*	*	65.94	31.42	1.28		

Table 29 : Showing the weight of different species of oligochaetes in g/m^2 and their percentage composition at depths A and B of SB pond for the year 1977.

Dates	A											B									Total
	B. semperi	D. dorsalis	D. digitata	D. indica	A. furcatus	A. gravelyi	L. hoff-.	B. sowerbyi	Mesen-chyt-.	A. pluri-.	Total	B. semperi	D. dorsa-.	D. digi-.	D. indica	A. furca-.	A. gra-.	L. hoff-.	B. sower-.	Mesen-chyt-.	
19.1.77	.65	.01	.16	.44	.08	.11	74.80	15.48	-	.07	91.8	.22	-	.01	.01	.01	.02	21.27	20.13	.008	41.62
14.2.77	.91	-	.07	.07	.07	.02	18.21	16.20	-	.15	35.7	.26	-	-	.007	-	-	31.83	20.76	.06	52.91
28.2.77	.56	-	.007	.02	.009	-	12.18	7.47	-	-	20.246	.002	-	-	-	-	-	19.04	8.15	.15	27.31
15.3.77	.84	.001	.002	.007	.003	.002	10.19	18.80	-	-	29.845	+	-	.005	-	-	-	.15	-	-	0.15
30.3.77	-	-	-	-	-	-	1.73	5.99	-	-	7.72	-	-	-	-	-	-	.10	-	-	0.10
8.4.77	.07	-	.002	.001	-	-	.59	3.36	-	-	4.023	.56	.006	.002	-	.006	2.82	10.18	-	-	13.57
29.4.77	.98	-	.14	.05	.08	-	4.69	64.26	-	-	70.2	-	-	-	-	-	-	.001	.008	.008	0.017
9.5.77	.93	.005	.10	.02	.009	.001	5.82	2.07	-	0	8.955	-	-	-	-	-	-	-	-	-	-
31.5.77	1.50	.04	.03	-	-	-	11.23	11.72	-	-	24.52	-	-	-	-	-	-	.56	1.38	.01	1.95
22.6.77	.28	-	.02	.007	-	-	31.18	5.92	.01	-	37.417	-	-	-	-	-	-	10.96	12.34	.01	23.31
7.7.77	-	-	-	-	-	-	43.47	10.64	-	-	54.11	-	-	.005	-	-	-	44.58	7.88	.06	52.52
30.7.77	-	-	-	.001	-	-	.01	.008	-	-	0.019	.28	.001	.005	.001	-	.002	21.53	13.60	.04	35.45
18.8.77	.72	.01	.04	.01	.01	-	8.65	-	-	-	9.44	.005	.03	.007	.02	-	-	38.07	8.58	-	46.74
9.9.77	3.75	.07	.04	.02	.01	.04	9.39	1.97	.004	-	15.294	.60	.01	.01	.01	-	.003	41.22	11.73	.10	53.68
30.9.77	3.78	.06	.21	.13	.11	.07	17.64	4.90	-	-	26.9	.02	.01	-	-	-	-	40.77	25.68	.04	66.52
14.10.77	3.94	-	-	.003	-	-	19.92	26.96	-	-	50.823	1.54	-	.005	-	-	-	26.20	18.02	.01	45.77
31.10.77	4.18	.02	.39	.21	.11	.06	13.07	4.66	-	-	22.7	.84	.04	.01	-	-	.004	12.24	21.46	.07	34.66
15.11.77	1.81	.04	.04	.01	-	-	22.97	18.00	.024	-	42.894	.77	.001	.005	-	-	-	20.48	9.83	.02	31.10
22.12.77	-	-	-	-	-	-	.51	.74	-	-	1.25	.07	-	-	-	-	-	4.81	11.26	.06	16.23
Total	24.90	.256	1.251	.999	.491	.303	306.25	219.148	.038	.22	553.86	5.167	.098	.064	.048	.016	2.849	343.902	190.808	.646	543.6
%	4.5	*	*	*	*	*	55.29	39.56	*	*		*	*	*	*	*	*	63.26	35.10	*	

* Less than 1%

* [illegible]

Table 30: Showing the weight of different species of molluscs in gm^2 and their percentage composition at depth A of SH pond for the year 1976

Date	*V. bengalensis*	*D. pulchella*	*A. orcula*	*Lymnea* sp.	*M. tuberculatus*	*L. marginalis*	Total
10-1-76	-	2.02	-	-	-	-	2.02
10-2-76	-	1.06	-	-	1.32	-	2.38
9-3-76	-	2.77	-	1.01	28.41	-	42.19
5-4-76	-	3.96	-	1.36	11.5	-	16.82
7-5-76	.47	.88	.46	.46	2.73	-	5.00
26-5-76	13.78	6.6	-	-	1.09	-	21.47
15-6-76	85.05	6.62	-	-	-	-	91.67
25-6-76	.42	-	-	-	-	-	.42
12-7-76	27.72	7.74	-	.90	1.35	-	37.71
26-7-76	26.55	.72	-	.43	12.50	-	40.20
10-8-76	4.97	-	-	-	-	-	4.97
25-8-76	77.61	7.65	-	-	3.70	-	88.96
10-9-76	39.16	3.96	-	-	-	-	43.12
25-9-76	4.62	10.56	-	-	8.91	-	24.09
10-10-76	4.62	2.64	-	-	4.95	137.54	149.75
25-10-76	-	-	-	-	5.65	12.33	17.98
24-11-76	11.22	-	-	-	3.07	-	14.29
11-12-76	-	-	-	-	3.85	-	3.85
22-12-76	22.08	.44	-	-	26.40	-	48.92
Total	318.27	57.62	.46	4.16	125.43	149.87	655.81
%	48.53	8.79	*	*	19.13	22.85	

* Less than 1%

Table 31: Showing the weight of different species of molluscs in g/m and their percentage composition at depth A of SH pond for the year 1977

Date	V. bengalensis	D. pulchella	A. orcula	P. exustus	M. tuberculatus	L. marginalis	Total
13-177	16.90	4.24	-	-	24.88	-	46.02
10-2-77	-	-	-	-	12.95	-	12.95
23-2-77	16.24	2.10	-	-	2.39	129.58	150.31
14-3-77	-	1.01	-	-	1.32	-	2.33
25-3-77	-	11.13	-	-	5.32	-	16.45
4-4-77	.66	9.55	-	-	7.74	-	17.95
28-4-77	29.30	26.73	-	19.93	29.70	-	105.66
7-5-77	60.06	9.15	114.31	-	8.89	-	192.41
28-5-77	17.24	9.38	4.66	4.58	2.11	-	37.97
29-6-77	18.39	24.64	-	1.36	1.67	-	46.06
6-7-77	157.68	48.56	2.03	4.85	12.94	149.82	376.87
26-7-77	170.46	5.07	-	-	2.11	-	177.64
12-8-77	78.58	56.22	-	-	17.38	-	152.18
5-9-77	73.30	8.58	-	-	6.34	146.91	235.13
26-9-77	321.02	15.84	-	-	32.84	99.44	468.13
11-10-77	1806.93	8.45	.23	-	12.14	70.31	1898.06
25-10-77	295.42	2.82	-	-	4.93	250.57	553.74
14-11-77	337.92	1.41	-	-	2.02	-	341.35
12-12-77	60.19	12.14	-	-	5.28	-	77.61
Total	3460.29	257.02	122.02	30.72	192.45	846.63	4909.33
%	70.48	5.24	2.49	*	3.92	17.24	

* Less than 1%

Table 32; Showing the weight of different species of molluscs in g/m^2 and their percentage composition at depth B of SH pond for the year 1976

Date	V. bengalensis	D. pulchella	P. exustus	M. tuberculatus	L. marginalis	Total
10-1-76	-	.93	-	.34	-	1.27
10-2-76	-	3.04	-	1.32	-	4.36
9-3-76	-	1.65	-	2.26	-	3.92
5-4-76	-	-	-	-	-	-
7-5-76	-	-	-	-	-	-
26-5-76	278.78	13.73	-	-	-	292.51
15-6-76	512.72	-	-	.54	-	513.26
25-6-76	417.88	6.16	-	1.05	-	425.09
12-7-76	55.12	7.84	-	-	-	62.96
26-7-76	392.48	7.74	-	1.34	9.24	410.80
10-8-76	44.97	-	-	3.08	-	48.05
25-8-76	151.01	2.11	-	1.84	-	154.96
10-9-76	314.16	4.10	-	1.48	-	319.74
25-9-76	304.92	3.96	-	10.89	-	319.77
10-10-76	203.94	6.16	-	-	-	210.10
25-10-76	269.27	-	-	5.40	-	274.67
24-11-76	78.54	.88	-	1.02	-	80.44
11-12-76	33.66	-	-	3.92	-	37.58
22-12-76	22.38	-	-	1.01	-	23.39
Total	3079.85	58.29	-	35.49	9.24	3182.87
%	96.76	1.83	-	1.12	*	

* Less than 1%

Table 33: Showing the weight of different species of mulluscs in g/m^2 and their percentage composition at depth B of SH pond for the year 1977

Date	V. bengalensis	D. pulchella	P. exustus	M. tuberculatus	L. marginalis	Total
13-1-77	.35	-	-	1.76	-	2.11
10-2-77	39.60	-	-	7.00	-	40.30
23-2-77	63.00	-	-	-	-	63.00
14-3-77	150.48	-	-	-	-	150.48
25-3-77	28.05	13.20	1.10	4.57	-	46.92
4-4-77	19.53	-	-	-	-	19.53
28-4-77	51.92	4.73	-	12.32	-	68.97
7-5-77	37.75	5.98	-	3.04	-	46.77
28-5-77	17.63	4.04	-	.84	-	22.51
29-6-77	125.07	3.43	-	.44	64.23	193.17
6-7-77	231.00	7.04	-	2.22	-	240.26
26-7-77	216.36	6.72	-	2.82	-	225.90
12-8-77	32.38	.48	-	1.28	-	34.14
5-9-77	479.46	5.94	-	-	50.12	535.52
26-9-77	392.96	21.78	-	-	-	414.74
11-10-77	722.13	9.85	-	1.01	-	732.99
25-10-77	361.06	4.22	-	.66	-	365.94
14-11-77	266.11	-	-	-	-	266.11
12-12-77	123.55	4.05	-	-	-	127.60
Total	3358.39	91.46	1.10	31.66	114.35	3596.96
%	93.37	2.54	*	*	3.18	

* Less than 1%

Table 34: Showing the weight of different species of molluscs in g/m^2 and their percentage composition at depth A of PG Pond for the year 1976

Date	V. bengalensis	D. pulchella	A. orcula	L. acuminata	M. tuberculatus	P exustus	Total
4-1-76	33.88	2.75	-	-	-	-	36.63
24-1-76	15.31	2.40	-	-	-	-	17.71
7-2-76	-	3.43	-	-	-	-	3.43
12-3-76	-	2.28	-	-	-	-	2.28
7-4-76	7.92	-	-	-	-	-	7.92
30-4-76	8.21	-	.29	-	-	-	8.50
15-5-76	6.58	1.80	.79	-	-	-	9.17
24-5-76	0.28	-	-	-	-	-	0.28
10-6-76	-	-	-	-	-	-	-
22-6-76	-	-	.19	1.67	-	-	1.86
7-7-76	7.92	-	12.63	.84	-	-	21.39
22-7-76	43.56	-	18.45	.42	-	-	62.43
5-8-76	43.81	-	12.98	.66	-	-	57.46
22-8-76	21.78	18.20	1.72	1.72	-	2.65	59.13
7-9-76	62.44	39.42	1.45	-	-	-	103.31
22-9-76	12.32	4.83	.52	-	-	-	17.68
7-10-76	167.64	2.90	-	-	-	-	170.54
22-10-76	121.77	5.72	3.96	-	-	-	131.45
7-11-76	132.58	-	-	.86	-	-	133.44
9-12-76	161.92	8.00	-	-	-	-	169.92
22-12-76	92.63	9.24	-	-	-	-	101.87
Total	940.56	101.00	66.07	6.17	-	2.65	1116.44
%	84.25	9.04	5.92	*	-	*	

* Less than 1%

Table 35: Showing the weight of different species of molluscs in g/m^2 and their percentage composition at depth A of PG pond for the year 1977

Date	V. bengalensis	D. pulchella	A. orcula	L. acuminata	M. tuberculatus	P. exustus	Total
10-1-77	177.54	29.17	-	-	-	-	206.71
7-2-77	11.26	14.96	.40	-	-	-	26.62
17-2-77	10.96	33.78	-	-	-	-	44.74
11-3-77	-	.84	.36	-	-	-	1.20
22-3-77	4.35	10.00	-	-	-	-	14.35
2-4-77	-	3.69	-	-	-	-	3.69
16-4-77	1.89	.53	-	-	-	-	2.42
6-5-77	94.38	16.48	4.00	-	-	-	114.86
26-5-77	17.82	20.03	2.60	-	-	-	40.45
25-6-77	173.66	61.38	14.43	-	-	-	249.47
5-7-77	60.40	80.52	22.70	-	-	-	163.62
28-7-77	251.68	27.32	9.87	-	-	-	288.87
10-8-77	170.37	34.32	1.04	3.93	-	-	209.66
20-8-77	132.59	83.79	3.25	-	-	-	219.63
8-9-77	94.24	39.60	12.21	-	-	2.71	148.76
28-9-77	149.69	25.43	76.03	-	-	.22	251.37
6-10-77	884.86	9.85	43.96	-	-	.44	939.12
29-10-77	148.15	58.52	7.38	-	-	-	214.05
10-11-77	-	-	1.49	-	-	-	1.49
14-12-77	21.12	3.43	3.34	-	-	-	27.89
Total	2404.96	553.64	203.06	3.93	-	3.37	3168.96
%	75.89	17.47	6.41	*	-	*	

* Less than 1%

Table 36: Showing the weight of different species of molluscs in g/m^2 and their percentage composition at depth B of PG pond for the year 1976

Date	*V. bengalensis*	*D. pulchella*	*A. orcula*	Total
4-1-76	-	-	-	-
24-1-76	-	-	-	-
7-2-76	-	-	-	-
12-3-76	-	-	-	-
7-4-76	-	-	-	-
30-4-76	-	-	-	-
15-5-76	-	-	-	-
24-5-76	-	-	-	-
10-6-76	-	-	.16	.16
22-6-76	6.46	-	.23	6.69
7-7-76	9.90	-	2.09	11.99
22-7-76	9.80	-	.40	10.20
5-8-76	15.85	2.02	3.08	20.95
22-8-76	45.92	11.09	-	57.01
7-9-76	66.22	9.86	1.49	77.57
22-9-76	98.56	.96	-	99.52
7-10-76	122.92	.97	1.10	124.99
22-10-76	162.80	16.01	.72	179.53
7-11-76	61.20	5.13	1.45	67.78
9-12-76	-	-	-	-
22-12-76	-	-	-	-
Total	599.64	46.04	10.72	656.4
%	91.35	7.02	1.63	

Table 37: Showing the weight of different species of molluscs in g/m^2 and their percentage composition at depth B of PG pond for the year 1977

Date	*V. bengalensis*	*D. pulchella*	*A. orcula*	*P. exustus*	Total
10-1-77	-	3.43	-	1.78	5.21
7-2-77	-	-	-	-	-
17-2-77	-	-	-	-	-
11-3-77	-	-	-	-	-
22-3-77	-	-	-	-	-
2-4-77	-	-	-	-	-
16-4-77	1.93	-	-	-	1.93
6-5-77	14.17	1.22	-	-	15.39
26-5-77	2.28	3.70	6.68	-	12.66
25-6-77	12.01	8.62	.31	-	20.94
5-7-77	47.91	17.73	-	-	65.64
28-7-77	58.08	20.19	-	-	78.27
10-8-77	45.41	25.34	-	-	70.75
20-8-77	51.74	29.57	.31	-	81.62
8-9-77	24.55	18.61	3.17	-	50.33
28-9-77	179.12	70.22	70.23	-	319.57
6-10-77	143.57	25.12	12.22	-	180.91
29-10-77	125.35	3.17	1.82	-	130.34
10-11-77	20.24	3.08	-	-	23.32
14-12-77	63.36	14.25	-	-	77.61
Total	793.73	244.25	94.73	1.78	1134.49
%	69.96	21.53	8.35	*	

* Less than 1%

Table 38: Showing the weight of different species of molluscs in g/m^2 and their percentage composition at depth A of SB pond for the year 1976

Date	V. bengalensis	A. orcula	L. luteola	M. tuberculatus	Total
15-1-76	-	5.57	-	-	5.57
30-1-76	-	1.97	-	-	1.97
15-2-76	-	-	-	-	-
15-3-76	-	-	-	-	-
15-4-76	-	2.28	-	-	2.28
30-4-76	-	4.42	-	-	4.42
18-5-76	-	.45	-	.11	.56
30-5-76	-	.40	-	-	.40
16-6-76	-	-	-	-	-
30-6-76	-	.61	.38	.64	1.63
15-7-76	-	1.18	-	-	1.18
31-7-76	-	.88	-	-	.88
16-8-76	-	-	-	-	-
31-8-76	-	5.37	-	.79	6.16
15-9-76	-	4.45	-	-	4.45
30-9-76	-	.54	-	-	.54
30-10-76	-	19.40	2.55	-	21.95
30-11-76	-	.90	-	-	.90
17-12-76	-	-	-	1.89	1.89
28-12-76	-	.19	-	-	.19
Total	-	48.61	2.93	3.43	54.97
%	-	88.43	5.33	6.24	

Table 39: Showing the weight of different species of molluscs in g/m^2 and their percentage composition at depth A of SB pond for the year 1977

Date	V. bengalensis	D. pulchella	A. orcula	L. luteola	M. tuberculatus	P. exustus	Total
19-1-77	-	-	-	-	-	-	-
14-2-77	-	-	-	-	-	-	-
28-2-77	-	-	.17	-	-	-	.17
15-3-77	-	-	-	-	-	-	-
30-3-77	-	-	-	-	-	-	-
8-4-77	-	-	-	2.28	-	-	2.28
29-4-77	-	-	.74	-	-	1.14	1.88
9-5-77	-	-	.45	3.30	-	.40	4.15
31-5-77	-	-	2.64	-	-	-	2.64
22-6-77	-	-	3.88	-	-	-	3.88
7-7-77	-	-	8.87	-	.82	2.00	11.69
30-7-77	-	-	24.72	-	-	1.83	26.55
18-8-77	-	-	36.24	-	-	16.47	52.71
9-9-77	-	-	5.32	-	.54	1.60	7.46
30-9-77	-	-	7.36	-	.32	-	7.68
14-10-77	4.31	-	.46	-	-	-	4.77
31-10-77	-	-	2.00	-	-	2.02	4.02
15-11-77	-	-	3.96	-	1.06	-	5.02
22-12-77	-	-	2.41	-	.57	-	2.98
Total	4.31	-	99.22	5.58	3.31	25.46	137.88
%	3.13	-	71.96	4.05	2.4	18.46	

Table 40: Showing the weight of different species of molluscs in g/m^2 and their percentage composition at depth B of SB pond for the year 1976

Date	D. Pulchella	A. orcula	M. tuberculatus	Total
15-1-76	-	.92	-	.92
30-1-76	-	-	-	-
15-2-76	-	-	-	-
15-3-76	-	-	-	-
15-4-76	-	-	-	-
30-4-76	-	.23	-	.23
18-5-76	-	-	-	-
30-5-76	-	.52	-	.52
16-6-76	-	.95	-	.95
30-6-76	.52	7.04	-	7.56
15-7-76	-	5.31	-	5.31
31-7-77	-	.67	-	.67
16-8-76	-	.69	-	.69
31-8-76	-	2.42	-	2.42
15-9-76	-	4.34	-	4.34
30-9-76	-	.56	-	.56
30-10-76	-	.83	-	.83
30-11-76	-	-	-	-
17-12-76	-	.07	-	.07
28-12-76	-	7.32	-	7.32
Total	.52	31.87	-	32.39
%	1.61	98.39		

Table 41: Showing the weight of different species of molluscs in g/m^2 and their percentage composition at depth B of SB pond for the year 1977

Date	*D. pulchella*	*A. orcula*	*M. tuberculatus*	*P. exustus*	Total
19-1-77	-	2.52	-	-	2.52
14-2-77	-	-	-	-	-
28-2-77	-	-	-	-	-
15-3-77	-	-	-	-	-
30-3-77	-	-	-	-	-
8-4-77	-	-	-	-	-
29-4-77	-	-	-	-	--
9-5-77	-	-	-	-	-
31-5-77	-	.24	-	-	.24
22-6-77	-	.49	-	-	.49
7-7-77	-	3.71	-	-	3.71
30-7-77	-	.25	-	-	.25
18-8-77	-	5.97	-	.14	6.11
9-9-77	-	3.06	-	-	3.06
30-9-77	-	.40	-	-	.40
14-10-77	-	-	-	-	-
31-10-77	-	.71	-	-	.71
15-11-77	-	1.98	-	-	1.98
22-12-77	-	-	-	-	-
Total	-	19.33	-	.14	19.47
%	-	99.28	-	*	

* Less than 1%

The maximum weight of 19.4 g/m^2 was found during October in the first year and in the second year the highest biomass of 7.3 g/m^2 was recorded during December (Tables 38, 39).

DEPTH B

At depth B the biomass of different groups of organisms showed similar trend like that of depth A. Molluscan fauna dominated the biomass in SH and PG ponds, whereas in SB pond the oligochaetes was the most abundant group and influenced the total biomass (Fig. 43).

SH Pond

The molluscs formed 98.8% and 98.4% of the total biomass. *V. bengalensis* was the abundant species and formed 96.7% and 93.4% of the biomass of molluscan fauna in the first and second year respectively. The snail comprised 95.6% and 91.9% of total weight of the said periods. The highest biomass of *V. bengalensis* was recorded to be 512.7 g/m^2 during June in the first year and in the second year it was of 722.13 g/m^2 during October (Fig. 42 and Appendices 7, 8).

Among the oligochaete worm, *L. hoffmeisteri* was the abundant species. It comprised 31.3% and 56.4% of biomass of total oligochaete worm. The maximum weight of the worm was found to be 8.38 g/m^2 during August in the first year 8.38 g/m^2 and in the second year the highest biomass of 7.6 g/m^2 was noted during July (Fig. 42, and Tables 26, 27))

PG Pond

The molluscs formed the dominant group. It constituted 87.5% and 81.7% of the total biomass in the first and second year respectively. *V. bengalensis* was the dominant species and formed 91.35% and 69.9% of molluscan weight and 79.9% and 57% of total biomass in the first and second year respectively. The maximum biomass of the snail was found to be 1628 g/m^2 during October in the first year and in the second year 179.12 g/m^2 was recorded during September (Fig. 42).

L. hoffmeisteri was the abundant species among oligochaete worms and formed formed 72.8% and 67.9% of the biomass (Tables 26, 27). The highest weight of the worm was noted to be 8.4 g/m^2 and 23.6 g/m^2 during June in the first and second year respectively.

SB Pond

The oligochaetes were the most dominant fauna and formed 84% and 91% of the total biomass in the first and the second year. The molluscs were the second abundant group and comprised 10.7% and 3.4% of biomass of macroinvertebrates (Fig. 43).

Among the oligochaete worms, *L. hoffmeisteri* was the abundant species and formed 65.7% and 63.3% of the total biomass in the first and the second year respectively. The maximum weight of 49.5 g/m^2 was recorded during September in the first year 49.5 g/m^2 and in the second year it was 44.6 g/m^2 during July. *Branchiura sowerbyi* was the second abundant species and constituted 31.4% and 35% of the biomass of oligochaete worms (Tables 28, 29).

Alocinma orcula was the abundant species among molluscs. It comprised 10.5% and 3.3% of total biomass. The highest biomass of the snail was found to be 7.3 g/m^2 during December in the first year and in the second year it was of 5.9 g/m^2 (Tables 40, 41).

DEPTH C

The biomass of macrobenthos was noted to be extremely poor in all the three ponds at depth C (Figs. 40, 41, Appendices 7 - 12).

SH Pond

In 1976 oligochaetes formed 48.8%, chironomids, 12.9% and *Chaoborus* sp. 38% of the total biomass. And in 1977 oligochaetes constituted 10.8%, chironomids 24.2%, *Chaoborus* sp. 65% of the total biomass (Fig. 42).

Among the oligochaetes, *Mesenchytraeus* sp. was the most abundant species. The highest biomass of 0.15 g/m^2 was noted during December.

Among the dipteran insects the larvae of *Chaoborus* sp. was most abundant fauna. The maximum biomass of 0.36 g/m^2 was noted during December in 1976 and it was 0.25 g/m^2 during October. Chironomids larvae occurred casually (Appendix 7).

PG Pond

In 1976 oligochaetes constituted 2%, chironomids larvae 4.4%, larvae of *Chaoborus* sp. 38%, other insects 55% and in 1977 oligochaetes formed 2%, larvae of *Chaoborus* sp. 97.9% of the total biomass (Fig. 42).

The larvae of *Chaoborus* sp. was the dominant component of the macroinvertebrate fauna. The highest biomass 0.42 g/m^2 was found during December in 1976 and 0.38 g/m^2 in 1977 the maximum biomass of 0.38 g/m^2 was recorded during January (Appendices 9, 10).

SB Pond

In 1976 oligochaetes formed 31%, chironomids larvae 4%, *Chaoborus* sp. 16%, other insect larvae47.9% of total biomass and in 1977 oligochaetes comprised 3%, chironomid larvae 4%, and larvae of of *Chaoborus* sp. 91% of the biomass of total macrobenthos (Fig. 43).

Among the three ponds, the highest biomass of the total organisms was found in SH pond and the lowest in SB pond, whereas the PG stood the above two (Fig. 40). However, excluding the molluscan fauna, the highest biomass of total organisms was recorded in SB pond and the lowest in SH pond (Fig. 41).

(iii) Size Group Frequency of *Limnodrilus hoffmeisteri* and *Branchiura sowerbyi*

The individual of *L. hoffmeisteri* belonging to three size groups, *viz.*, small, medium and large, were recorded together throughout the period of observation (Table 42, Figs. 41 - 46). The highest number of the species belonging to small-size group occurred between February and July in SB and SH ponds, whereas between July and September in PG pond at depths A and B during the periods of study (Table 42, Figs. 44 - 51).

The maximum number of *L. hoffmeisteri* belonging to large-size group was encountered between November and February at depth A and between July and September at depth B of the three ponds (Figs. 44-49).

The individuals of *B. sowerbyi* belonging to the three size groups, *viz.*, small, medium and large, were also found together during the periods of observation. However, at depth A, the individuals of small-size group were absent during May and July in 1976 and February, and August 1977. At depth A, the highest number of small-size group was recorded during September and November in 1976 and during September and October in 1977. At depth B the number of individuals belonging to small-size group showed more or less similar trends like that of depth A.

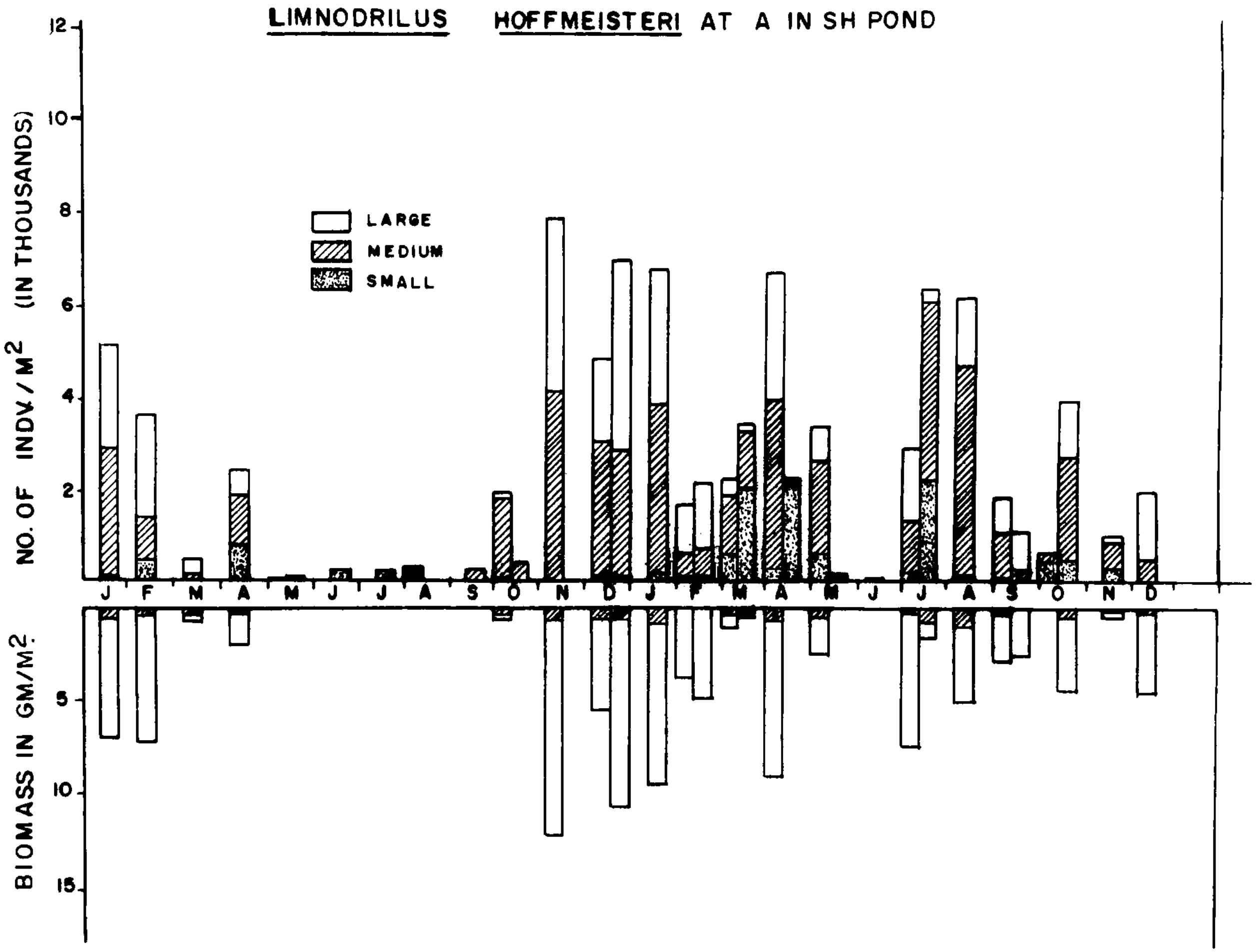

Fig. 44 Graphs showing participation in seasonal abundance and biomass of three size groups of *L. hoffmeisteri* at depth A in SH pond.

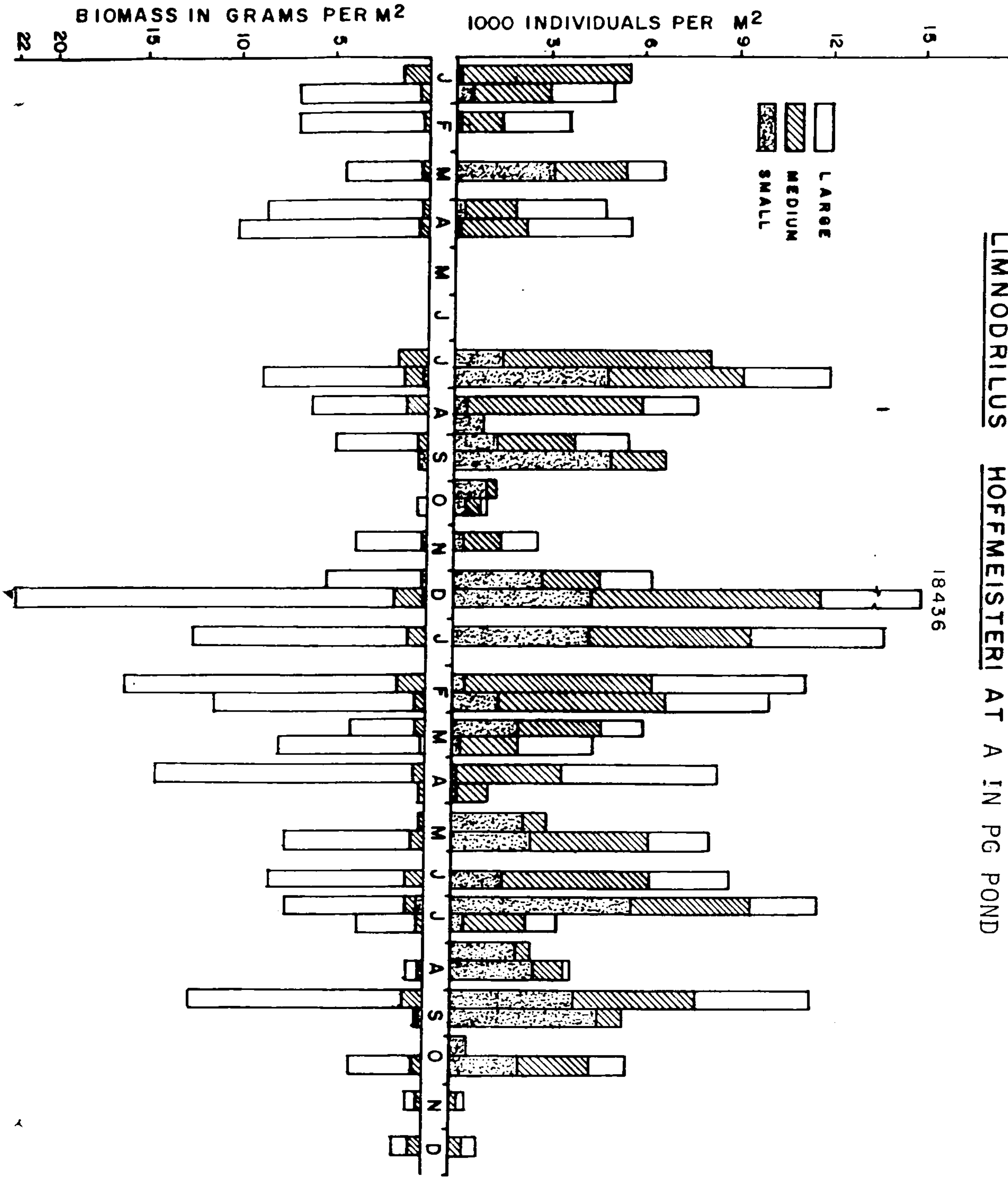

Fig. 46 Graphs showing participation in seasonal abund..ce and biomass of three size groups of L. hoffmeisteri at depth A in PG pond.

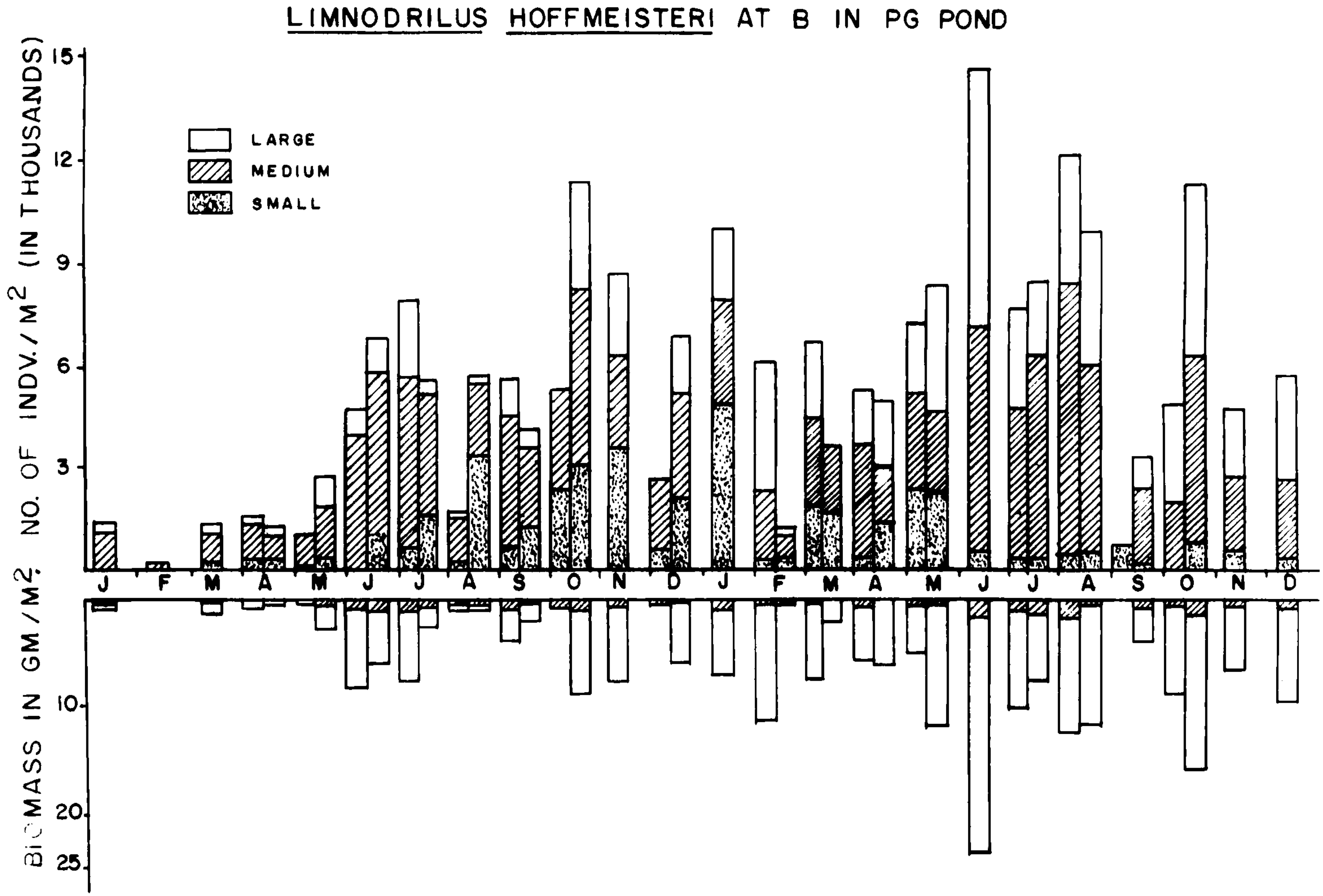

Fig. 47 Graphs showing participation in seasonal abundance and biomass of three size groups of *L. hoffmeisteri* at depth B in PG pond.

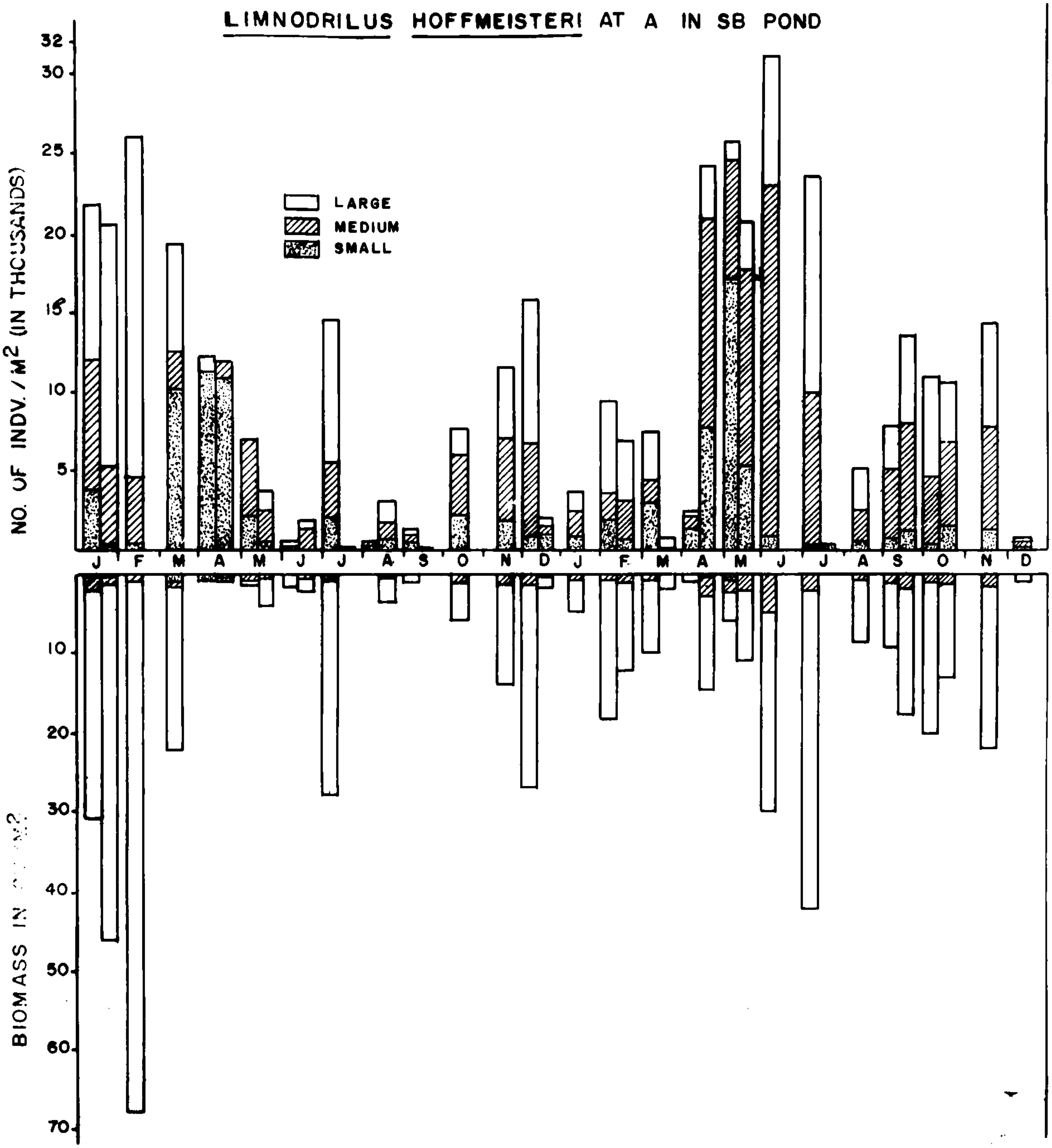

Fig. 48 Graphs showing participation in seasonal abundance and biomass of three size groups of *L. hoffmeisteri* at depth A in SB pond.

LIMNODRILUS HOFFMEISTERI AT B IN SB POND

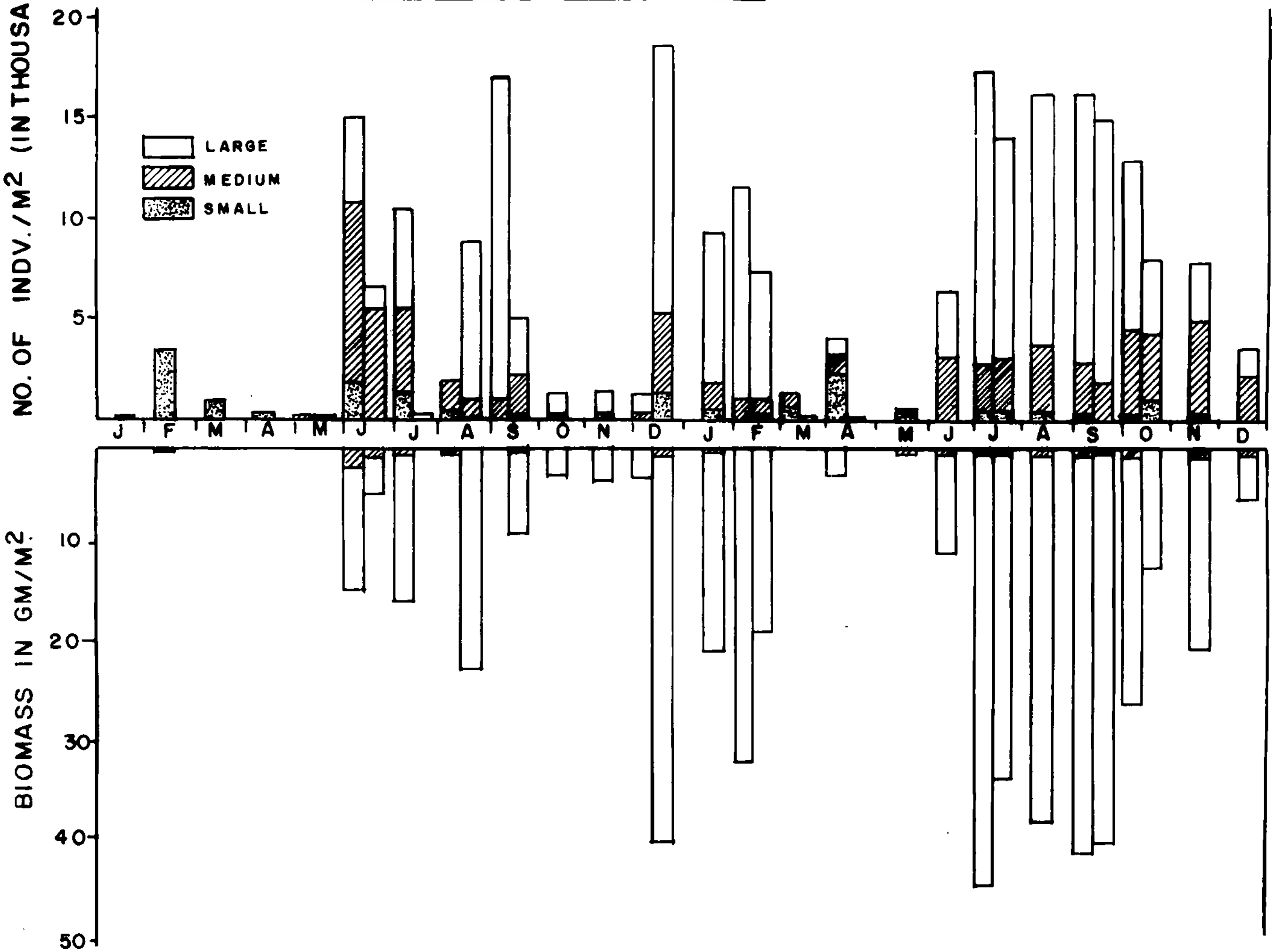

Fig. 49 Graphs showing participation in seasonal abundance and biomass of three size groups of *L. hoffmeisteri* at depth B in SB pond.

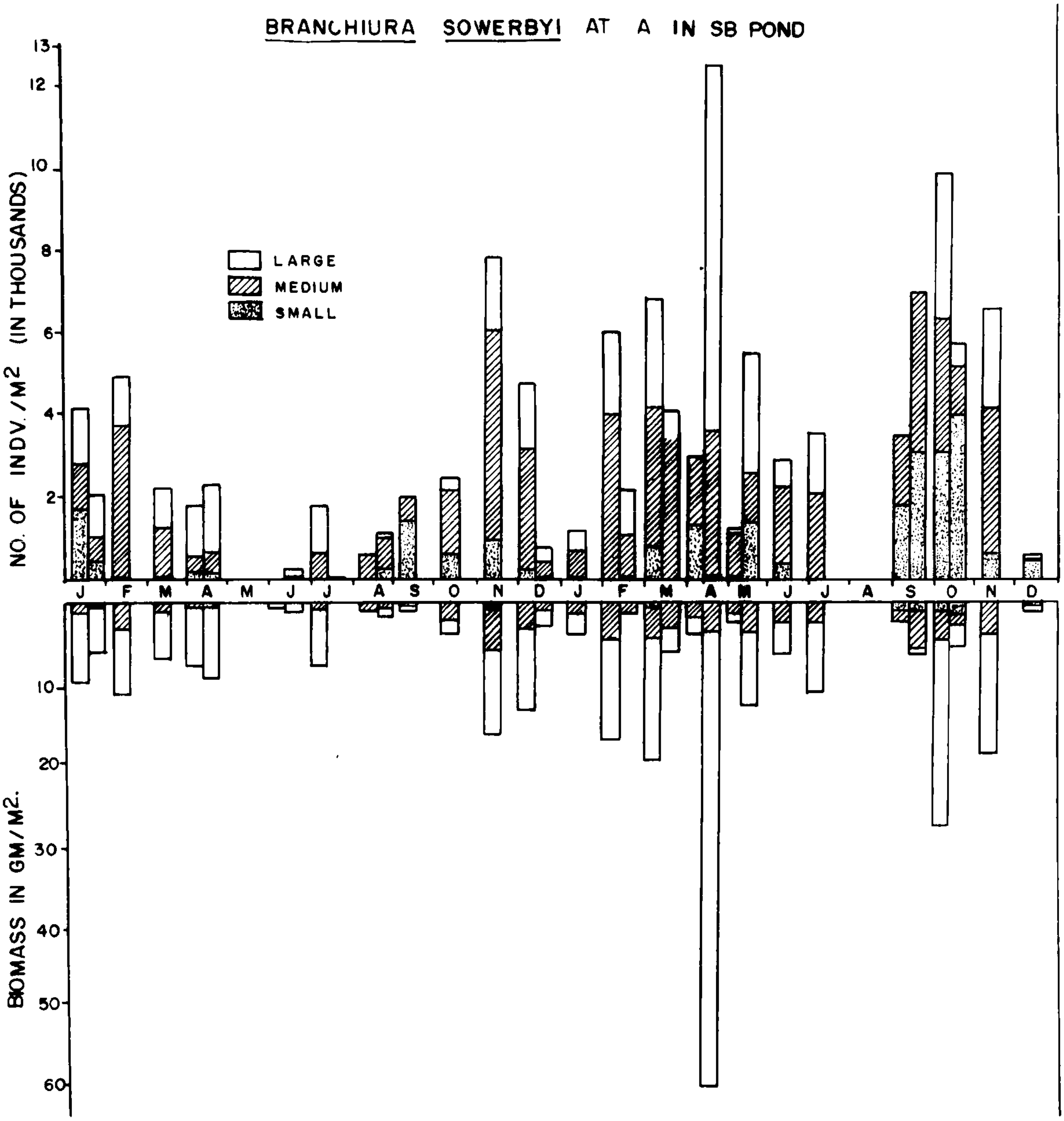

Fig. 50 Graphs showing participation in seasonal abundance and biomass of three size groups of Branchiura sowerbyi at depth A in SB pond.

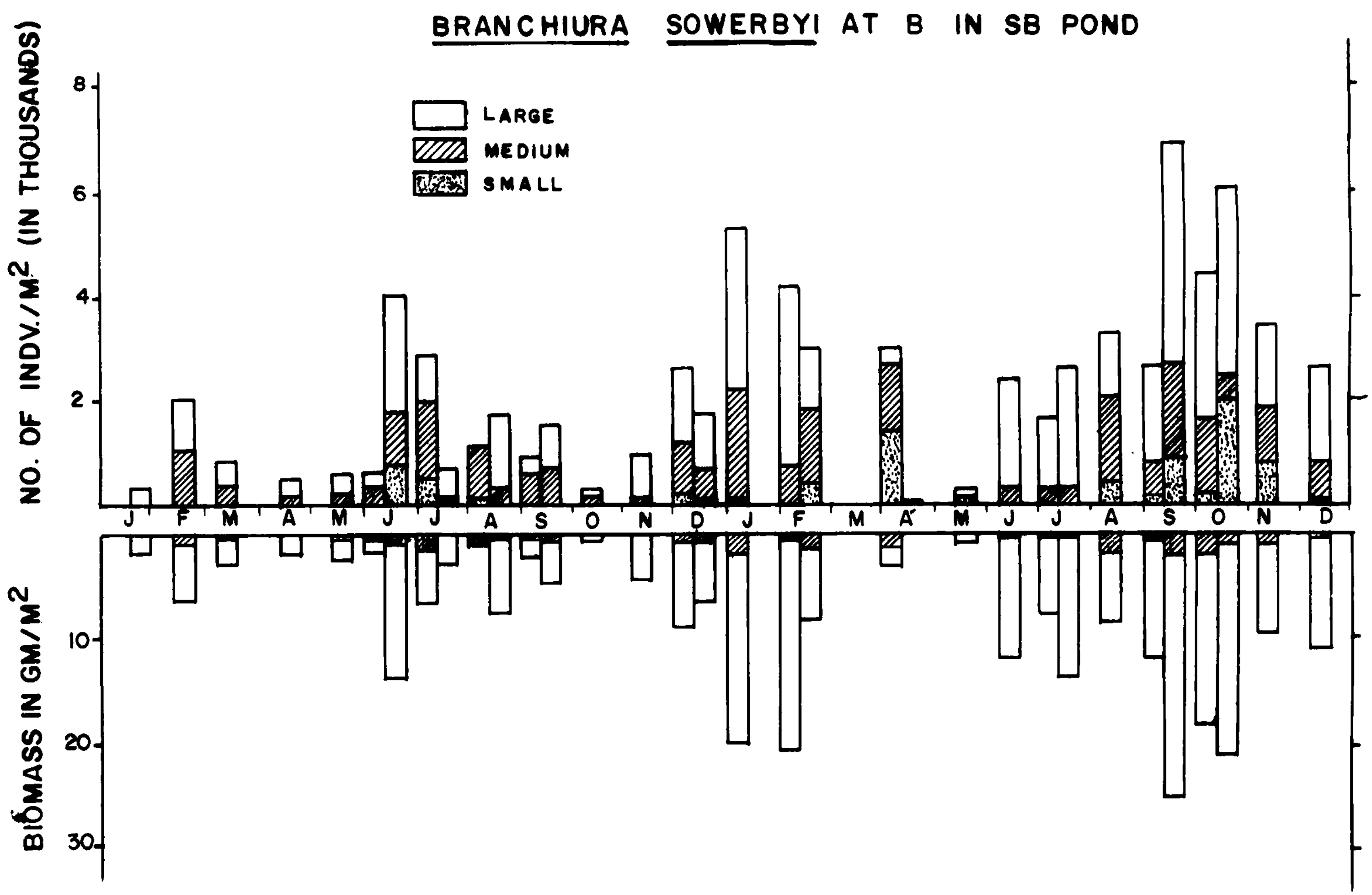

Fig. 51 Graphs showing percentage in seasonal abundance and biomass of three size groups of *Branchiura sowerbyi* at depth B in SB pond.

Table 42 : Showing the occurrence of small size group and sudden drop in total population of <u>Limnodrilus hoffmeisteri</u> at depth A, and B of the three ponds and that of <u>Branchiura sowerbyi</u> in SB pond during 1976 and 1977.

Organism	Pond	Year	Depth	Small size present	Small size abundant	All size scarce	Sudden drop in total population
L. hoffmeisteri	SH	1976	A	February - August	Never	June - September	May
	"	1977	"	All year with gaps	March, April, July	May, June	May
	"	1976	B	Ditto	August	January-June	August
	"	1977	"	Ditto	May	January-April	Always low
	PG	1976	A	Ditto	March, July, Sept., Dec.	None in May, June	August, October
	"	1977	"	All year	March, May, July, Sept.	November, December	July, November
	"	1976	B	All year with gap in Jan., Feb.	June - December	January-May	-
	"	1977	"	All year	January - May	Never	-
	SB	1976	A	Ditto	March, April	July, September	July
	"	1977	"	Ditto	April, May, October	July, August	July
	"	1976	B	All year with gaps	Feb., July, Dec.	January - May	October
	"	1977	"	Ditto	April	March - May	April
B. sowerbyi	SB	1976	A	All year with gaps from May-July	September, November	None in May	May
	"	1977	"	All year with gaps	September, October	None in August	August
	"	1976	B	June - December	Never	Jan., April, May	July
	"	1977	"	All year	April, October	April	April

	Jan.	Feb.	March	April	May	June	July	August	Sept.	October	Nov.	Dec.
Small size group abundant in case of L. hoffmeisteri	I	II	IIIII	IIIII	IIII	I	IIIII	II	III	II	I	III
Sudden drop in total population of L. hoffmeisteri				I	II		III	II		II	I	
Small size group abundant in case of B. sowerbyi				I					II	II	I	
Sudden drop in total population of B. sowerbyi				I	I		I	I				

The highest number of individuals belonging to large-size group occurred at depth A during January, November and December in 1976 and during April in 1977. At depth B the maximum number of large-size group *B sowerbyi* was recorded during June in the first year and during September in the second year (Figs. 50, 51).

The individuals of large and medium-size groups determined the total biomass of *L. hoffmeisteri* and *B. sowerbyi* (Figs. 44 - 51).

The size frequencies in these species are shown in in Table 42 and Figs. 44 - 51.

Thus, it was noted that breeding in *L. hoffmeisteri* and *B. sowerbyi* occurred irregularly throughout the year without showing any specific pattern. Yet the maximum breeding, as revealed from the large number of individuals belonging to small-size group, was recorded between March and July in case of *L. hoffmeisteri* and between September and October in case of *B. sowerbyi* (Table 42).

It was found that sudden decrease in total populations of *L. hoffmeisteri* and *B. sowerbyi* occurred mostly during summer and monsoon (Table 42). It was further noted that in SH and PG ponds, which have sharp slope at the margin, a decrease in population of *L. hoffmeisteri* at depth A resulted an increase of the same population at depth B (Figs. 44 - 47).

(iv) Mutual Association Between Dominant Oligochaetes

The mutual association between *Branchiodrilus semperi* and *Dero digitata*, between *B. semperi* and *Limnodrilus hoffmeisteri*, and between *D. digitata* and *L. hoffmeisteri* was studied by rank correlation and coefficient method. In 1976 the mutual association between *B. semperi* and *D. digitata* was noted at 5% level of significance at depth A of SH and at A and B of SB pond. In 1977 mutual association between the above two species was recorded to improve to 1% level of significance at A and B of SB pond, at A and B of PG pond, and at B of SH pond (Tables 43 - 45).

In 1976 the mutual association between *B. semperi* and *L. hoffmeisteri* was observed at 5% level of significance at depth B in SB pond and at 1% level of significance at depth B in PG pond (Tables 43 - 45).

In the first year the mutual association between *D. digitata* and *L. hoffmeisteri* at 1% level of significance occurred at depth A of SB pond.

The mutual association among the above three dominant species are shown in Tables 43 - 45.

Thus, a significant mutual association was observed between *B. semperi* and *L. hoffmeisteri* at B of PG and SB ponds and between *L. hoffmeisteri* and *D. digitata* at A in SB pond.

Table 43: Mutual associationship among dominant oligochaete species with the values of respective 'r' at depth A and B of SH pond for the year 1976 and 1977

Depth	Year	Organisms	Correlation coefficients 'r'
A	1976	*Branchiodrilus semperi* Vs. *Dero digitata*	0.494*
"	"	" " Vs. *Limnodrilus hoffmeisteri*	0.349
"	"	*Dero digitata* Vs. *Limnodrilus hoffmeisteri*	0.261
"	1977	*Branchiodrilus semperi* Vs. *Dero digitata*	0.219
"	"	" " Vs. *Limnodrilus hoffmeisteri*	-0.030
"	"	*Dero digitata* Vs. " "	0.334
B	1976	*Branchiodrilus semperi* Vs. *Dero digitata*	0.187
"	"	" " Vs. *Limnodrilus hoffmeisteri*	0.121
"	"	*Dero digitata* Vs. " "	-0.236
"	1977	*Branchiodrilus semperi* Vs. *Dero digitata*	0.745**
"	"	" " Vs. *Limnodrilus hoffmeisteri*	-0.107
"	"	*Dero digitata* Vs. " "	-0.057

* 5% level of significance

** 1% level of significance

Table 44: Mutual associationship among dominant oligochaete species with the values of respective 'r' at depth A and B of PG pond for the year 1976 and 1977

Depth	Year	Organisms			correlation coefficients 'r'
A	1976	*Branchiodrilus semperi*	Vs.	*Dero digitata*	0.407
"	"	" "	Vs.	*Limnodrilus hoffmeisteri*	0.227
"	"	*Dero digitata*	Vs.	" "	0.169
"	1977	*Branchiodrilus semperi*	Vs.	*Dero digitata*	0.730**
"	"	" "	Vs.	*Limnodrilus hoffmeisteri*	0.423
"	"	*Dero digitata*	Vs.	" "	0.395
B	1976	*Branchiodrilus semperi*	Vs.	*Dero digitata*	0.229
"	"	" "	Vs.	*Limnodrilus hoffmeisteri*	0.760**
"	"	*Dero digitata*	Vs.	" "	0.076
"	1977	*Branchiodrilus semperi*	Vs.	*Dero digitata*	0.427
"	"	" "	Vs.	*Limnodrilus hoffmeisteri*	0.497*
"	"	*Dero digitata*	Vs.	" "	0.016

* 5% level of significance

** 1% level of significance

Table 45: Mutual associationship among dominant oligochaete species with the values of respective 'r' at depth A and B of SB pond for the year 1976 and 1977

Depth	Year	Organisms			Correlation coefficients 'r'
A	1976	*B. semperi*	Vs.	*D. digitata*	0.503*
"	"	" "	Vs.	*L. hoffmeisteri*	0.434
"	"	*D. digitata*	Vs.	" "	0.707 **
"	1977	*B. semperi*	Vs.	*D. digitata*	0.761 **
"	"	" "	Vs.	*L. hoffmeisteri*	0.304
"	"	*D. digitata*	Vs.	" "	0.303
"	1976	*B. semperi*	Vs.	*D. digitata*	0.463*
"	"	" "	Vs.	*L. hoffmeisteri*	0.560*
"	"	*D. digitata*	Vs.	" "	0.262
"	1977	*B. semperi*	Vs.	*D. digitata*	0.635 **
"	"	" "	Vs.	*L. hoffmeisteri*	0.511*
"	"	*D. digitata*	Vs.	" "	0.493*

* 5% level of significance

** 1% level of significance

(v) Populations of Benthic Macroinvertebrates and Physico-chemical Factors of Water, (A) Simple and (B) Multiple Regressions

The relationship between the populations of macrobenthos and physico-chemical parameters of water was studied. Simple regressions as well as multiple regressions between these populations and parameters of water were calculated. These are shown in details in Tables 46 - 57 and Figs. 52 - 57.

(A) Simple Regressions

The simple regressions between the density of total fauna, oligochaete, their dominant species and temperature, pH, dissolved oxygen, carbondioxide, total nitrogen, phosphate, calcium and organic carbon were calculated. These are discussed below and also shown in Tables 46 - 51 and Figs. 52 - 57.

(1) Total fauna and physico-chemical parameters

a) The density of total fauna increased with the decrease of temperature at all depths of three ponds except at B of SH and PG ponds. At depth A of SH pond the co-efficient between temperature and total fauna was found to be at 1% level of significance ($t = -3.27$).

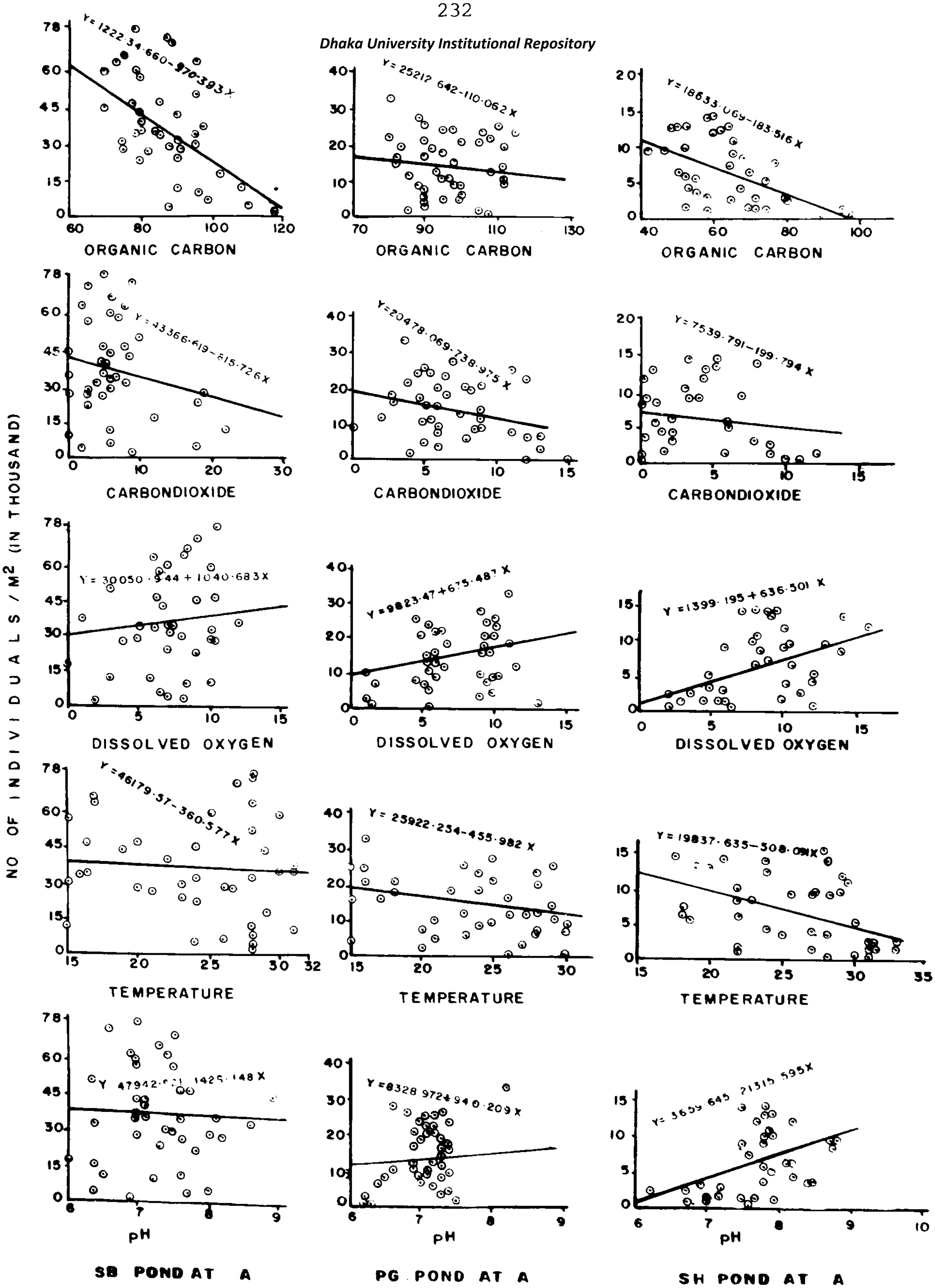

Fig. 52 Graphs showing the relationship between the abundance of total fauna and OC, CO_2, DO, temp., and pH at depth A of the three ponds.

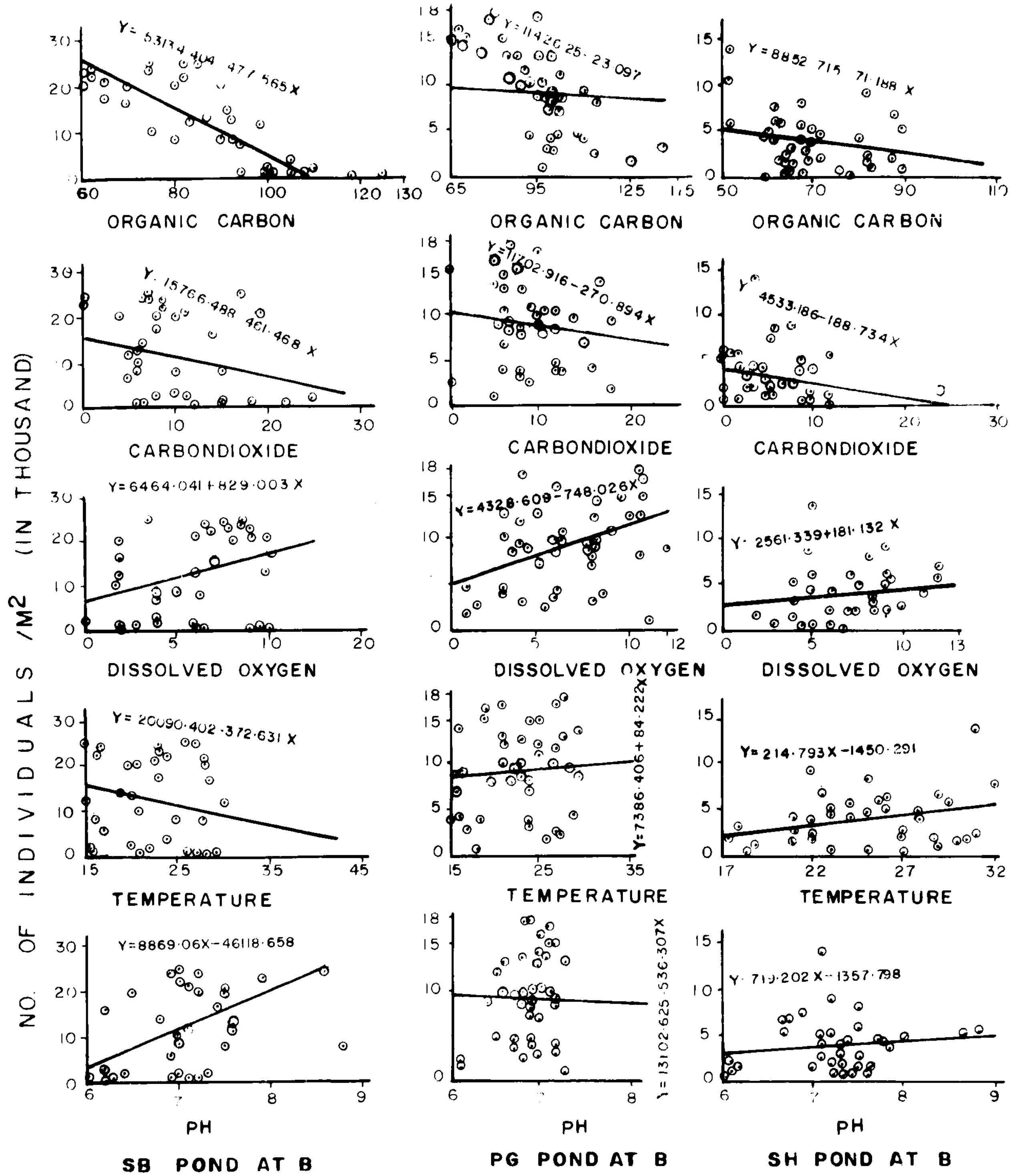

Fig. 53 Graphs showing the relationship between the abundance of total fauna and OC, CO_2, DO, temp., and pH at depth B of the three ponds.

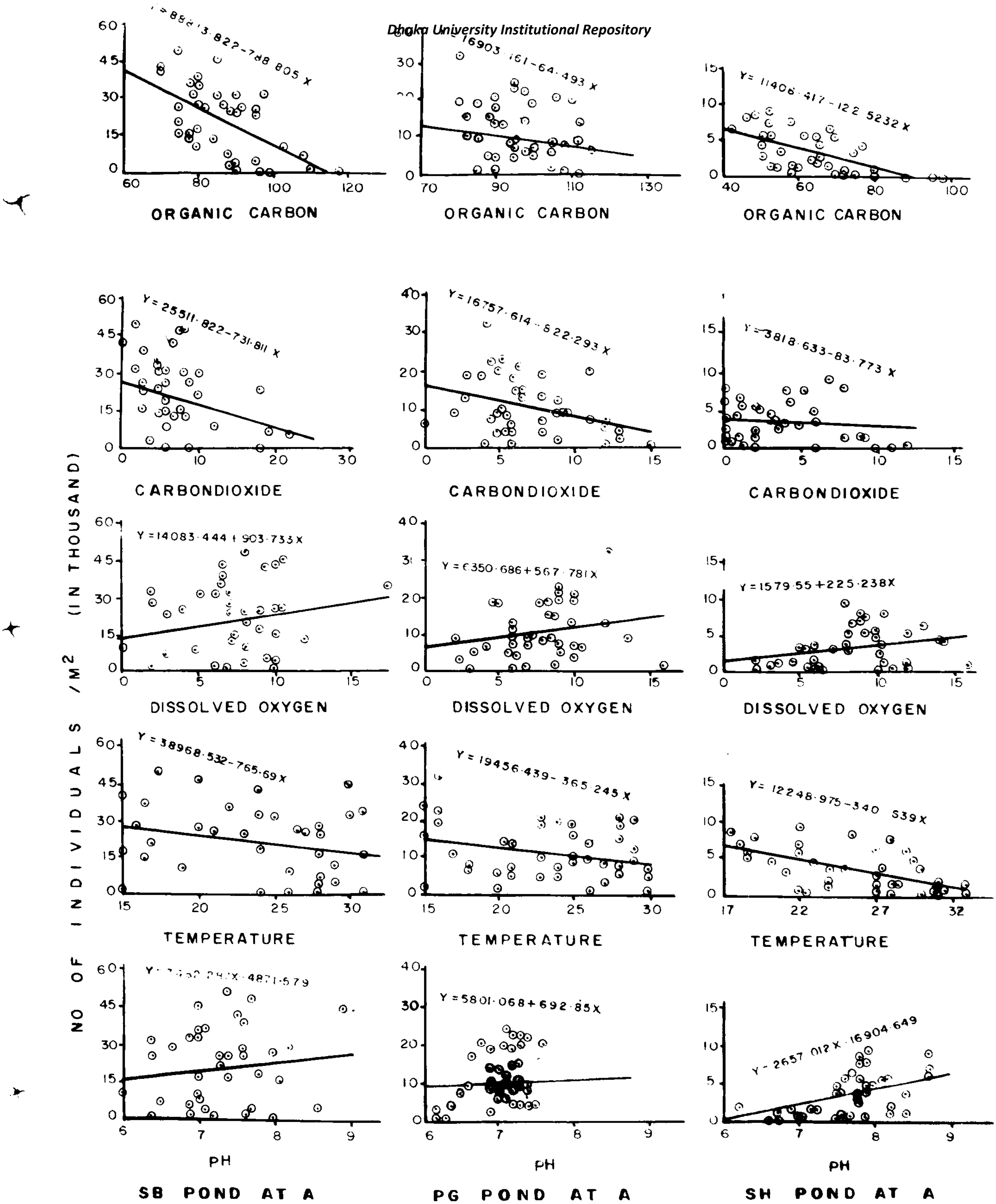

Fig. 54 Graphs showing the relationship between the abundance of oligochaetes and OC, CO_2, DO, temp., and pH and depth A of the three ponds.

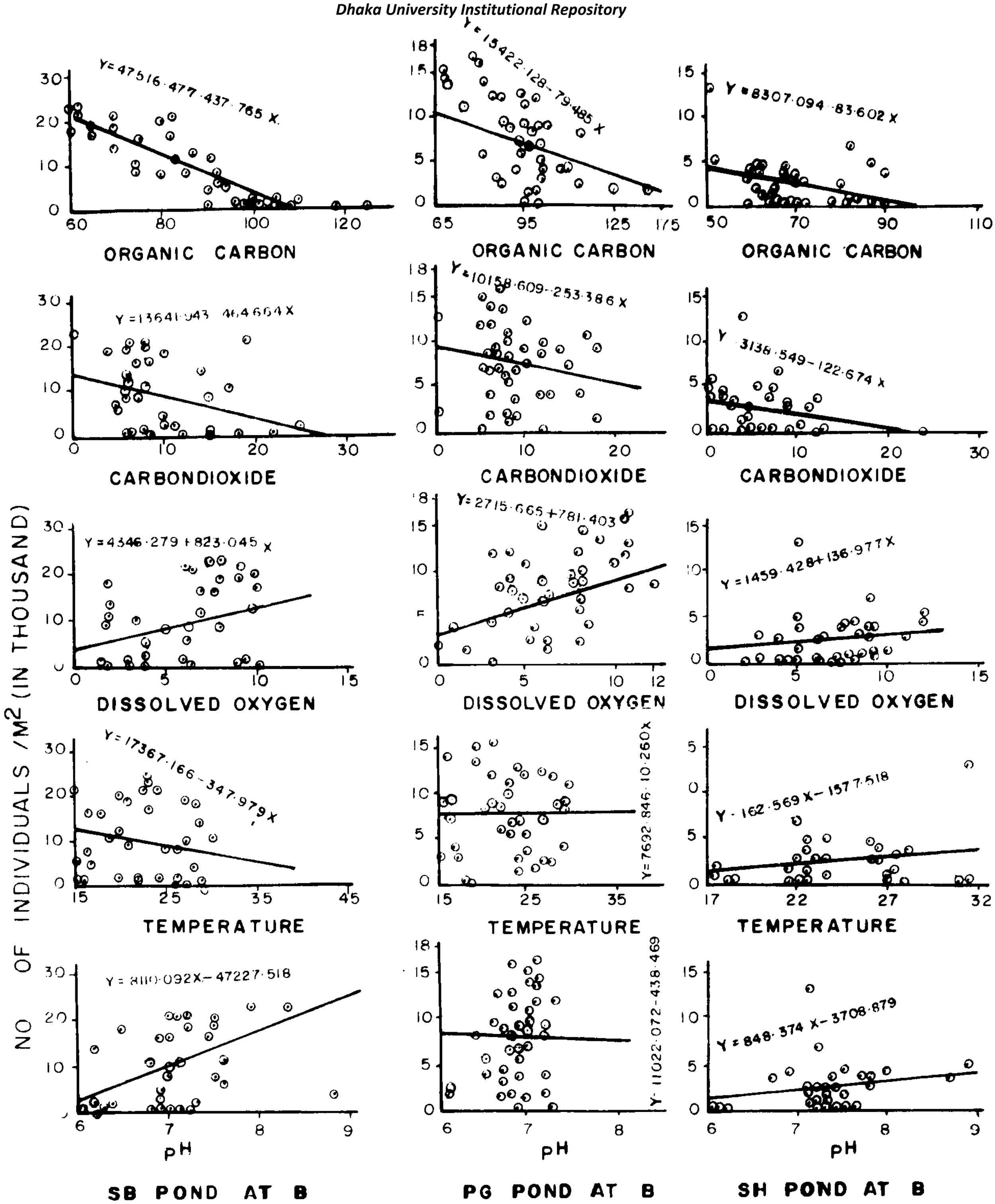

Fig. 55 Graphs showing the relationship between the abundance of oligochates and OC, CO_2, DO, temp., and pH at depth B of three ponds.

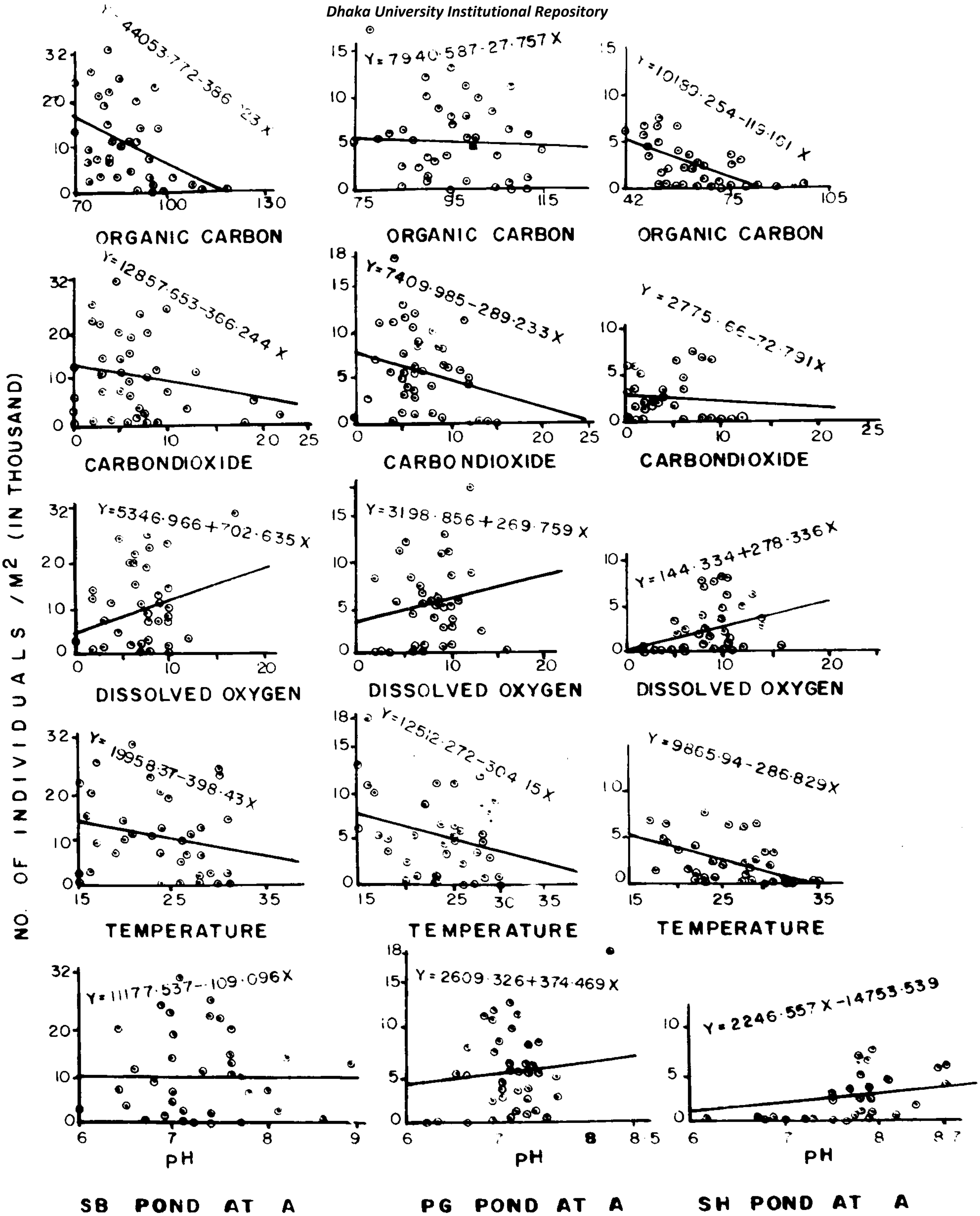

Fig. 56 Graphs showing the relationship between the abundance *L. hoffmeisteri* and OC, CO_2, DO, temp., and pH of depth A of three ponds.

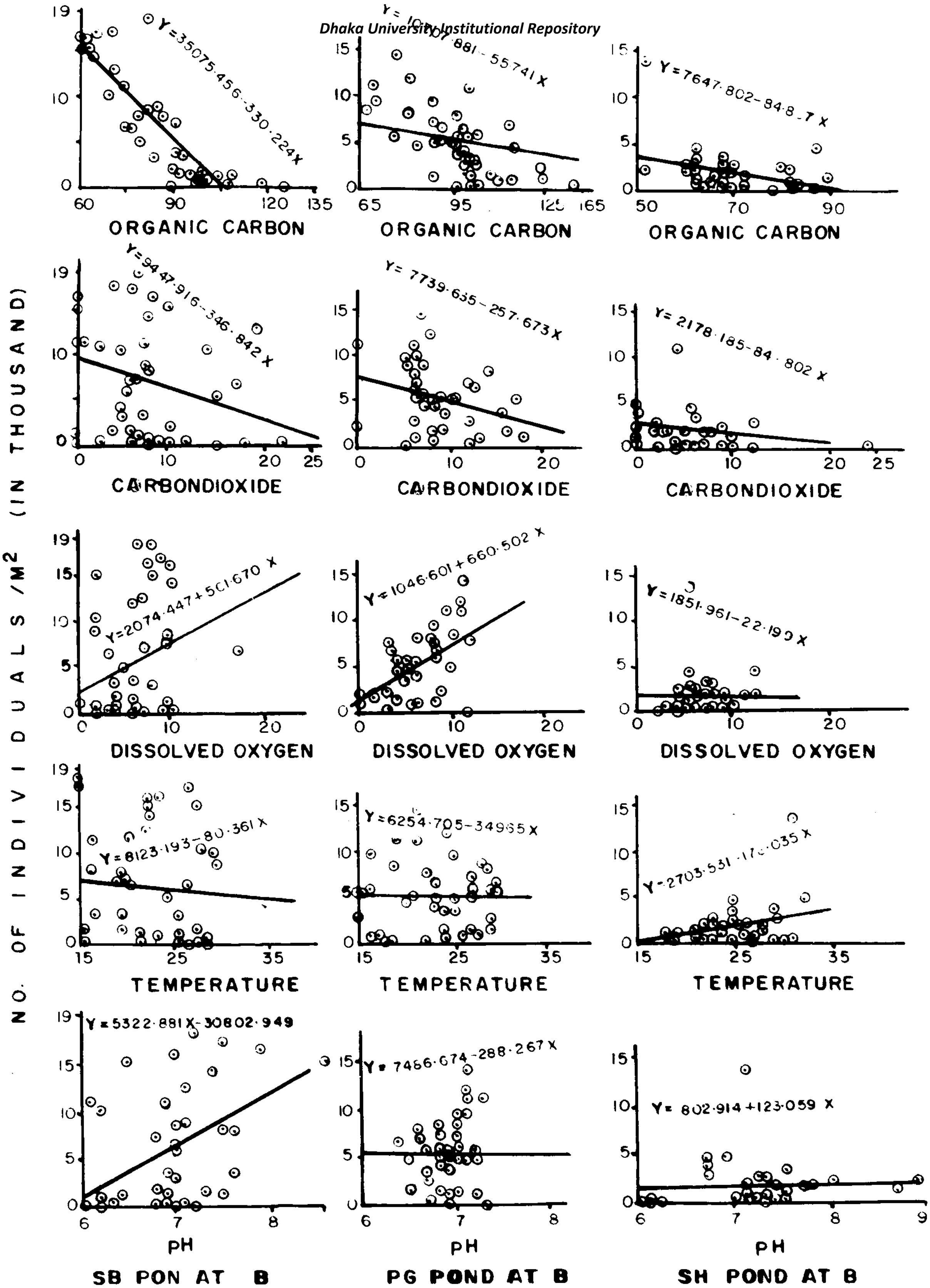

Fig. 57 Graphs showing the relationship between the abundance of *L. hoffmeisteri* and OC, CO_2, DO, temp., and pH at depth B of three ponds.

Table 46 : Simple regression coefficient (B) of organisms (Y) on physico-chemical factors of water (Temp., pH, DO, CO_2, N, PO_4, Ca, OC) with their corresponding intercept (A), standard error and coefficient of multiple correlation at depth A of SH pond.

Y	X	A	B	SE(B)	t	$F_{1,36}$	R^2
Total fauna	Temp.	19837.635	-508.091	2340.820	-3.272	10.703**	0.229
	pH	-21315.595	3659.645	2155.724	2.937	8.630**	0.1933
	DO	1399.195	636.501	2180.841	2.980	8.882**	0.1979
	CO_2	7539.791	-199.794	713.484	-0.882	0.778	0.0211
	N	15195.043	-13802.279	1434.323	-1.835	3.370	0.0856
	PO_4	9850.978	-56260.284	2440.222	-3.443	11.857**	0.2477
	Ca	22585.723	-1545.520	2142.524	-2.915	8.499**	0.1910
	OC	18633.069	-183.516	2447.899	-3.458	11.957*	0.2493
Oligochaetes	Temp.	12248.975	-340.639	1573.392	-3.798	14.425**	0.2861
	pH	-16904.649	2657.012	1565.130	3.770	14.128**	0.2831
	DO	1579.5501	225.2384	789.4570	1.6717	2.795	0.072
	CO_2	3818.6335	-83.7727	299.14309	-0.6134	0.376	0.0103
	N	5943.1343	-4002.6442	415.95199	-0.857	0.734	0.019
	PO_4	5078.9408	-29390.027	1268.4261	-2.8677	8.219**	0.1859
	Ca	9252.7934	-562.4018	779.6452	-1.6493	2.719	0.0702
	OC	11408.4170	-122.5232	1634.2876	-4.009	16.072**	0.3087
B. semperi	Temp.	794.998	-18.3958	84.844	-1.3709	1.879	0.0496
	pH	-201.4885	68.2670	40.20858	0.636	0.404	0.0111
	DO	310.8204	1.4351	3.52681	0.077	0.0059	0.0001
	CO_2	355.4863	-8.7863	31.1734	-0.495	0.245	0.0067
	N	570.8639	-407.5651	42.3537	-0.6703	0.449	0.012
	PO_4	488.2217	-3092.8216	133.481	-2.241	5.022*	0.1224
	Ca	1005.0325	-66.7797	92.5651	-1.501	2.253	0.0588
	OC	389.1763	-11.028	3.2357	-0.216	0.046	0.0012
D. digitata	Temp.	556.4318	-7.3932	33.8353	-0.3697	0.1366	0.0038
	pH	-15.0768	49.6965	29.2679	0.3167	0.10029	0.0027
	DO	524.3236	-18.5683	63.5285	-0.692	0.478	0.0131
	CO_2	390.1601	-6.3351	22.34006	-0.2446	0.0568	0.0016
	N	183.9138	300.6175	31.23979	0.338	0.114	0.0031
	PO_4	512.7475	-2733.2047	117.9606	-1.3044	1.7004	0.0451
	Ca	647.4208	-27.4825	38.0733	-0.4126	0.1702	0.0047
	OC	583.598	-3.363	42.838	-0.4864	0.236	0.0065
L. hoffmeisteri	Temp.	9865.94	-286.8287	1324.8439	-3.8254	14.630**	0.2890
	pH	-14753.539	2246.557	1323.3411	3.8192	14.584**	0.2883
	DO	144.334	278.3358	953.656	2.518	6.340*	0.1497
	CO_2	2775.6604	-72.7907	259.92140	-0.6364	0.404	0.0111
	N	5267.9966	-4540.7128	471.8677	-1.1705	1.370	0.0366
	PO_4	3574.6150	-19993.779	862.8992	-2.2428	5.030*	0.1226
	Ca	5446.0103	-293.9484	605.4318	-1.5206	2.3122	0.0603
	OC	10189.2540	-119.1606	1589.4332	-5.064	25.644**	0.416

* at 5% level of significance
** at 1% level of significance

Table 47 : Simple regression coefficient (B) of organisms (Y) on physico-chemical factors of water (Temp., pH, DO, CO_2, N, PO_4, Ca, OC) with their corresponding intercept (A) standard error and coefficient of multiple correlation at depth B of SH pond.

Y	X	A	B	SE(B)	t	$F_{1,36}$	R^2
Total fauna	Temp.	-1450.2912	214.7928	888.328	1.9177	3.677	0.0926
	pH	-1357.7984	719.2024	436.0719	0.9068	0.822	0.022
	DO	2561.3399	181.1319	440.9862	0.9173	0.8408	0.0228
	CO_2	4533.1859	-118.7341	561.1136	-1.1758	1.382	0.0369
	N	4625.8954	-1120.0622	274.6014	-0.567	0.3214	0.0088
	PO_4	3208.7101	11494.6210	487.569	1.0169	1.034	0.0279
	Ca	7493.1871	-330.9457	647.0109	-1.3644	1.861	0.0491
	OC	8852.7150	-71.1885	702.4931	-1.488	2.215	0.0579
Oligochaetes	Temp.	-1577.5184	162.5688	672.3149	1.580	2.496	0.064
	pH	-3708.8793	848.3742	496.1756	1.148	1.3179	0.0353
	DO	1459.4276	136.9766	333.4813	0.764	0.583	0.0159
	CO_2	3138.5493	-122.6743	579.7354	-1.3505	1.8238	0.0482
	N	3046.8412	-871.6585	239.537	-0.5466	0.2987	0.0082
	PO_4	2021.1125	7306.1092	325.0944	0.7444	0.554	0.0151
	Ca	5935.2783	-318.1440	621.98302	-1.4545	2.115	0.055
	OC	8307.0994	-83.6018	825.0103	-1.9739	3.896	0.0976
D. digitata	Temp.	90.3662	4.3623	17.5614	0.3398	0.115	0.0031
	pH	83.8700	15.7623	9.53787	0.1797	0.032	0.0008
	DO	73.9105	17.3955	42.2819	0.8034	0.645	0.0176
	CO_2	173.1710	4.3623	20.0672	0.3884	0.1508	0.004
	N	199.714	-2.3359	0.5175	-0.0107	0.0001	-
	PO_4	58.1513	2490.9832	105.6603	2.1056	4.433*	0.1096
	Ca	504.9983	-27.9127	54.5356	-1.0414	1.0845	0.0292
	OC	-632.7936	11.8343	116.376	2.3599	5.569*	0.1339
L. hoffmeisteri	Temp.	2703.5307	-178.0353	736.3049	-1.9292	3.721	0.0937
	pH	802.9137	123.0592	71.248	0.1778	0.0316	0.0008
	DO	1851.9606	-22.1986	53.9912	-0.1348	0.018	0.0005
	CO_2	2178.1851	-84.8022	400.7435	-1.0138	1.0277	0.0277
	N	1927.1367	-339.2892	83.1819	-0.2076	0.043	0.0011
	PO_4	1532.1738	2870.9103	121.776	0.304	0.092	0.0025
	Ca	3494.5779	-163.8151	320.260	-0.806	0.649	0.017
	OC	7647.8020	-84.8067	836.9025	-2.2268	4.958*	0.1160

* at 5% level of significance

Table 48 : Simple regression coefficient (B) of organisms (Y) on physico-chemical factors of water (Temp., pH, DO, CO_2, N, PO_4, Ca, OC) with their corresponding intercept (A), standard error and coefficient of multiple correlation at depth A of PG pond.

Y	X	A	B	SE(B)	t	$F_{1,39}$	R^2
Total fauna	Temp.	25922.2640	-455.9819	2225.5318	-1.6906	2.858	0.0682
	pH	8328.9720	940.2090	1238.5971	0.9179	0.8425	0.0211
	DO	9823.4700	675.4866	2021.2098	1.5256	2.327	0.056
	CO_2	20478.0690	-738.9751	2480.8015	-1.9015	3.6157	0.0848
	N	15551.8440	-428.8490	362.6993	-0.266	0.0707	0.0018
	PO_4	15040.8490	1399.1049	186.26137	0.1366	0.018	0.0004
	Ca	20599.7780	-550.5107	1398.054	-1.039	1.079	0.0269
	OC	25212.642	-110.061	138.3156	-0.7958	0.633	0.015
Oligochaetes	Temp.	19456.4390	-365.2451	1782.6663	-1.4798	2.1898	0.0531
	pH	5801.0680	692.8497	912.7345	0.7424	0.551	0.0139
	DO	6350.6860	567.7805	1698.9278	1.4066	1.978	0.0482
	CO_2	16757.6140	-822.2927	2760.5062	-2.387	5.697*	0.1274
	N	11018.7850	-209.3911	179.3393	-0.1448	0.020	0.0005
	PO_4	10767.8690	756.5778	100.7223	0.0813	0.006	0.0001
	Ca	17956.6470	-719.9530	1828.3639	-1.5199	2.31009	0.0559
	OC	16903.1610	-64.4931	1099.0969	-0.8969	0.8044	0.0202
B. semperi	Temp.	1331.0867	23.9007	116.55165	0.3383	0.1144	0.0029
	pH	67.5436	257.6038	431.7796	1.2764	1.629	0.0401
	DO	1177.8449	91.1184	272.6309	0.796	0.633	0.0159
	CO_2	2893.2479	-138.8023	465.2167	-1.3799	1.901	0.046
	N	1763.2736	140.3661	118.712	0.3443	0.1185	0.0030
	PO_4	1651.4713	3232.7994	430.37928	1.272	1.617	0.0398
	Ca	3495.8334	-161.5176	410.1763	-1.210	1.464	0.0361
	OC	3170.5050	-13.5245	229.882	-0.6715	0.4509	0.0114
D. digitata	Temp.	574.3148	14.4690	70.4512	0.3302	0.109	0.0027
	pH	772.3508	19.8439	26.1085	0.1220	0.0148	0.0003
	DO	763.3574	19.4006	57.97401	0.2713	0.0736	0.0018
	CO_2	1007.5298	-12.6614	42.4693	-0.199	0.039	0.0010
	N	946.1723	-31.6743	26.7753	-01251	0.015	0.0004
	PO_4	936.3138	-265.4418	35.3377	-0.1650	0.027	0.0006
	Ca	1019.3040	-10.4042	26.2998	-0.1234	0.015	0.0003
	OC	852.3902	0.6743	12.714	0.054	0.002	-
L. hoffmeisteri	Temp.	12512.2720	-304.1502	1484.4756	-2.225	4.952*	0.1126
	pH	2609.3259	374.4690	493.31036	0.7010	0.4914	0.0126
	DO	3198.8558	269.7583	807.1736	1.1593	1.340	0.0333
	CO_2	7409.9848	-289.2333	973.1877	-1.4088	1.982	0.0484
	N	5459.7500	-142.9466	120.8946	-0.1707	0.029	0.0007
	PO_4	5300.6174	318.2868	42.373	0.0598	0.003	-
	Ca	9590.2287	-430.6192	1093.5813	-1.5938	2.537	0.061
	OC	7940.5869	-27.7567	472.7819	-0.6719	0.4514	0.0114

* at 5% level of significance

Table 49 : Simple regression coefficient (B) of organisms (Y) on physico-chemical factors of water (Temp., pH, DO, CO_2, N, PO_4, Ca, OC) with their corresponding intercept (A), standard error and coefficient of multiple correlation at depth B of PG pond.

Y	X	A	B	SE(B)	t	$F_{1,39}$	R^2
Total fauna	Temp.	7386.4069	84.2225	387.715	0.503	0.253	0.0064
	pH	13102.6250	-536.3070	706.5027	-0.9237	0.853	0.0214
	DO	4328.5094	748.026	2217.529	3.229	10.426**	0.2109
	CO_2	11702.9160	-270.8937	1141.6834	-1.5198	2.309	0.0559
	N	10699.2390	-1231.0247	1129.9659	-1.5033	2.259	0.0547
	PO_4	10164.5920	-8850.5842	1260.6236	-1.6891	2.853	0.0681
	Ca	13061.3160	-369.225	945.0167	-1.2464	1.553	0.0383
	OC	11426.25	-23.0967	590.7855	-0.7706	0.5938	0.0150
Oligochaetes	Temp.	7692.8462	10.2597	47.008	0.0628	0.0039	0.0001
	pH	11022.0720	-438.4686	577.615	-0.7747	0.6001	0.0151
	DO	2715.665	781.403	2316.476	3.545	12.573**	0.2437
	CO_2	10158.609	-253.3859	1067.8955	-1.4598	2.131	0.0518
	N	9140.0735	-1080.387	991.695	-1.3505	1.824	0.0446
	PO_4	8609.8434	-4221.6895	1470.276	-2.0609	4.247*	0.0982
	Ca	12284.8520	-429.7643	1099.973	-1.506	2.268	0.0549
	OC	15422.1280	-79.4855	1718.222	-2.458	6.0417*	0.1341
D. digitata	Temp.	-593.5549	41.4269	194.8112	2.344	5.494*	0.1234
	pH	676.5445	-46.7553	61.5790	-0.6979	0.487	0.0123
	DO	404.3066	-8.6466	25.4579	-0.2889	0.0834	0.0021
	CO_2	750.4673	-45.8774	193.3060	-2.3233	5.3963*	0.1215
	N	326.6447	17.8205	16.3318	0.184	0.033	0.0008
	PO_4	309.4177	384.3511	54.6363	0.6183	0.382	0.0097
	Ca	346.0635	0.0562	2.555	0.0016	0.00002	-
	OC	367.9357	-0.2259	21.059	-0.055	0.003	-
L. hoffmeisteri	Temp.	6254.7054	-34.9653	160.9071	-0.2779	0.0772	0.0019
	pH	7486.6740	-288.2670	379.7461	-0.6586	0.4337	0.0109
	DO	1046.6005	660.5023	1958.0647	4.0148	16.118**	0.2924
	CO_2	7739.6351	-257.6725	1080.1189	-1.9518	3.809	0.0889
	N	6329.4851	-781.711	717.537	-1.2626	1.594	0.039
	PO_4	6049.008	-6237.5933	888.445	-1.5806	2.498	0.0602
	Ca	7768.6029	-228.4597	584.7340	-1.0219	1.044	0.0260
	OC	10707.8810	-55.7405	1204.8337	-2.204	4.857*	0.1107

* at 5% level of significance

** at 1% level of significance

Table 50 : Simple regression coefficient (B) of organisms (Y) on physico-chemical factors of water (Temp., pH, DO, CO_2, N, PO_4, Ca, OC) with their corresponding intercept (A), standard error and coefficient of multiple correlation at depth A of SB pond.

Y	X	A	B	SE(B)	t	$F_{1,37}$	R^2
Total fauna	Temp.	46179.5700	-360.5773	1884.540	-0.554	0.306	0.0082
	pH	47942.821	-1428.1483	884.1808	-0.259	0.067	0.0018
	DO	30050.9490	1040.6832	3402.197	1.009	1.0187	0.0268
	CO_2	43366.5190	-815.7262	4558.623	-1.368	1.87	0.0481
	N	33675.7470	4337.7170	3867.2583	1.1524	1.327	0.0346
	PO_4	44732.243	-11302.570	4584.537	-1.3761	1.893	0.0486
	Ca	100648.860	-3483.7917	8972.5342	-2.9126	8.483**	0.1865
	OC	122234.660	-970.3935	10666.344	-3.639	13.242**	0.2635
Oligochaetes	Temp.	38968.5320	-765.6904	4001.8575	-1.7405	3.027	0.0756
	pH	-4871.5790	3482.2874	2155.9191	0.9115	0.829	0.0219
	DO	14083.4440	903.7327	2954.479	1.2617	1.592	0.0412
	CO_2	25511.8030	-731.8106	3853.4681	-1.671	2.792	0.0701
	N	36712.392	-21651.610	5709.362	-2.595	6.734**	0.154
	PO_4	21440.5060	-12682.140	598.767	-0.2505	0.062	0.0016
	Ca	31070.5850	-595.4966	2310.4288	-0.9785	0.957	0.025
	OC	88813.8220	-783.8048	8615.8448	-4.4714	19.989**	0.3508
B. semperi	Temp.	2816.5164	-4.9110	25.1299	-0.044	.0019	-
	pH	6233.2424	1222.8768	757.095	1.3284	1.763	0.045
	DO	3472.6726	-107.9908	353.0282	-0.6082	0.369	0.009
	CO_2	3235.9964	-79.4808	418.4864	-0.7225	0.521	0.0139
	N	2363.8688	448.5774	118.2861	0.2028	0.041	0.001
	PO_4	1963.5255	106115.743	501.2054	0.8679	0.753	0.019
	Ca	-230.0329	161.5435	415.701	0.7176	0.5149	0.0137
	OC	7387.4440	-53.7537	595.3951	-1.0355	1.071	0.0281
D. digitata	Temp.	3825.7154	-102.4031	535.1816	-2.228	4.964*	0.118
	pH	-2117.2446	476.646	295.095	1.1749	1.380	0.0359
	DO	1258.9484	14.6674	47.839	0.1875	0.0349	0.0009
	CO_2	1704.0095	-50.2592	264.5960	1.0498	1.102	0.028
	N	2233.0516	-1166.9772	307.8439	1.2277	1.507	0.0391
	PO_4	1397.2728	-479.1267	22.6211	.0884	0.007	0.0002
	Ca	6149.7428	-263.9886	679.3319	2.9519	8.714**	0.1906
	OC	6833.9439	-62.7054	694.5785	3.0349	9.2106	0.1993
L. hoffmeisteri	Temp.	19958.370	-398.4303	2082.3792	-1.4337	2.055	0.0526
	pH	11177.5370	-109.0960	67.5396	0.0452	0.002	-
	DO	5346.9660	702.6353	2299.799	1.5931	2.5376	0.0641
	CO_2	12857.653	-366.2439	1928.5118	-.322	1.749	0.0451
	N	17949.6440	-10274.5620	2900.2213	.0510	4.2066*	0.1020
	PO_4	11771.4250	-2008[illegible].017	948.4238	-0.639	0.408	0.0109
	Ca	35873.0400	-1406.5002	3619.4250	.6448	6.9449*	0.159
	OC	44053.7720	-386.0226	4276.4451	-3.2489	10.555**	0.2219
B. sowerbyi	Temp.	5031.4911	-76.1799	397.6737	-0.7882	0.6209	0.0165
	pH	-5074.7871	1130.8292	700.1074	1.4127	1.995	0.0511
	DO	1126.5924	287.0632	938.4608	1.9358	3.747	0.0919
	CO_2	3673.3163	-72.1123	378.6829	-0.752	0.565	0.015
	N	3815.6965	-686.7235	774.1636	-1.5716	2.4699	0.0625
	PO_4	2720.5932	6218.8533	421.249	0.836	0.698	0.0185
	Ca	8783.8645	-308.8694	794.827	-1.616	2.613	0.0659
	OC	15287.6940	-138.9929	1542.1049	-3.4962	12.223**	0.248

* at 5% level of significance

** at 1% level of significance

Table 51 : Simple regression coefficient (B), of organisms (Y) on physico-chemical factors of water (Temp., pH, DO, CO_2, N, PO_4, Ca, OC) with the corresponding intercept (A) standard error and coefficient of multiple correlation at depth B of SB pond.

Y	X	A	B	SE(B)	t	$F_{1,37}$	R^2
	Temp.	20090.4020	-372.6310	1748.8347	-1.120	1.254	0.0327
	pH	-46118.6530	8269.0600	4594.5953	3.290	10.824**	0.2263
	DO	6464.0410	829.0034	2775.3905	1.825	3.331	0.0825
	CO_2	15766.4880	-461.4680	2715.266	-1.782	3.175	0.0790
Total fauna	N	21502.2500	-10523.4890	3828.9240	-2.6269	6.9006*	0.1571
	PO_4	7975.9320	34808.4970	1759.2112	1.1269	1.269	0.0331
	Ca	29828.5040	-928.1651	1900.1568	-1.2206	1.489	0.0387
	OC	53134.4040	-477.5649	8020.5300	-9.0696	82.246**	0.689
	Temp.	17367.1660	-347.9771	1633.1280	-1.214	1.473	0.0383
	pH	-47227.5180	8119.092	4511.267	3.908	15.277**	0.292
	DO	4346.2794	823.045	2755.445	2.1278	4.527*	0.1090
	CO_2	13641.9430	-464.664	2734.0744	-2.1093	4.448**	0.1073
Oligochaetes	N	18404.2350	-9529.2792	3467.185	-2.778	7.717**	0.1726
	PO_4	3752.848	55185.588	2789.0635	2.157	4.652*	0.117
	Ca	22742.520	-677.3874	1411.1459	-1.0436	1.089	0.028
	OC	47511.477	-437.765	7352.105	-11.327	128.301**	0.776
	Temp.	801.1174	-15.291	71.611	-0.436	0.190	0.005
	pH	-3748.485	602.2918	334.655	2.1523	4.632*	0.111
	DO	169.7236	45.8836	153.575	0.942	0.888	0.023
	CO_2	421.148	3.0225	16.783	0.1078	0.012	0.0003
B. semperi	N	874.7582	-448.3816	163.141	-1.002	1.005	0.026
	PO_4	-717.248	11486.0320	580.501	4.315	18.623**	0.334
	Ca	-702.7914	58.3615	119.461	0.7296	0.532	0.0141
	OC	2405.045	-22.4419	376.5313	-2.465	6.080*	0.141
	Temp.	501.858	-14.444	67.625	-1.3619	1.855	0.0477
	pH	-602.0908	110.6826	61.4968	1.2302	1.513	0.0392
	DO	167.0444	0.3675	3.1134	0.024	0.0005	0.0000
	CO_2	209.5928	-4.3706	25.034	-0.5059	0.2559	0.0068
D. digitata	N	295.1324	-132.545	48.224	-0.957	0.916	0.0241
	PO_4	181.4337	-94.0307	17.4259	-0.342	0.1176	0.0031
	Ca	732.7308	-28.5494	58.411	-1.1668	1.361	0.0354
	OC	424.7020	-2.9305	46.2627	-0.977	0.955	0.025
	Temp.	8123.1932	-80.3609	385.8032	-0.3666	0.1343	0.0036
	pH	-30802.949	5322.8808	2957.5892	3.1616	9.995**	0.2127
	DO	2074.447	561.6704	1880.394	1.8656	3.480	0.085
	CO_2	9447.9161	-346.8416	2014.0146	-2.0121	4.048	0.0986
L. hoffmeisteri	N	12538.2470	-6577.036	2393.0249	-2.4465	5.985*	0.1392
	PO_4	2611.5377	36261.1190	1832.6263	1.8139	3.290	0.0816
	Ca	22162.1160	-804.0516	1646.0691	-1.6154	2.609	0.0658
	OC	35075.4560	-330.2244	5545.9851	-10.4775	109.767**	0.7479
	Temp.	4206.7682	-97.5044	468.1186	-1.5584	2.427	0.0615
	pH	-10791.0740	1827.3996	969.19701	3.6431	13.271**	0.2640
	DO	832.5561	189.5969	634.7363	2.1737	4.7249*	0.1132
	CO_2	2677.6845	-74.9227	440.8051	-1.4621	2.1377	0.0546
B. sowerbyi	N	3887.3240	-2001.772	728.3358	-2.5462	6.482*	0.1490
	PO_4	1447.1724	5273.2522	271.7925	0.8857	0.7832	0.0207
	Ca	1151.469	42.3186	86.611	0.2796	0.078	0.0021
	OC	7802.4313	-66.7259	1120.5146	-4.4927	20.184**	0.3529

* at 5% level of significance

** at 1% level of significance

b) The number of total fauna increased with the increase of pH. However, at depth A of SB pond pH showed a negative relation.

The relationships were noted to be at 1% level significance at depth A of SH pond (t = 2.93) and at depth B of SB pond (t = 3.29).

c) The density of total fauna increased with the increase of DO content. The relationship between DO and total fauna was noted to be at 1% level of significance at the depth A of SH pond (t = 2.98) and at depth B of PG pond (t = 3.22).

d) The abundance of total fauna decreased with the increase of CO_2 content.

e) The abundance of total fauna decreased with the increase of total nitrogen content. The relationship was noted to be at 5% level of significance at depth B of SB pond (t =-2.63).

f) PO_4 did not show any definite relationship.

g) The density of total fauna decreased with the increase of Ca content and the relationship was recorded to be at 1% level of significance at depth A of SH pond (t =-2.915) and SB pond (t =-2.912).

h) The number of total fauna decreased with the increase of organic carbon content and a highly significant relation was found at A of SH (t =-3.45) and A (t =-3.64) and B (t =-9.06) of SB ponds.

(2) <u>Oligochaetes and Physico-chemical parameters of water</u>

a) The density of oligochates increased with the decrease of temperature in all depths of the three ponds except at B of SH and PG ponds. A highly significant relation was found at A of SH pond (t =-3.79).

b) The abundance of oligochaetes increased with the increase in pH in all depths of the three ponds except at B of PG pond. The coefficient is noted to be at 1% level of significance at B of SB pond (t = 3.908).

c) The density of oligochaetes increased of DO content. The relationship was observed to be significant at 5% level at depth B of SB pond (t = 2.127).

d) The number of organisms decreased with the increase of CO_2 content and the relationship was recorded to be significant at 5% level at depth A of PG pond (t = -2.38) and at depth B of SB pond (t = -2.11).

e) The faunal abundance decreased with the increase of total nitrogen content. The coefficients were highly significant at depth A (t = -2.59) and at depth B (t = -2.78) in SB pond.

f) Phosphate did not show any specific relationship.

g) The number of organisms decreased with the increase of Ca content.

h) The density of oligochaetes decreased with the increase of organic carbon content. The relationship was noted tc be at 5% level of significance at depth B of PG pong (t = -2.46). It was highly significant at depth A of SH (t = -4.01) and at depth A (t = -4.47) and B (t = -11.32) of SB ponds.

(3) *Branchiodrilus semperi* and physico-chemical parameters of water

a) The abundance of the species decreased with the increase of temperature. However, at depth A of PG pond the faunal density increased with the increase of temperature.

b) The density of the species increased with the increase of pH value. The relationship was noted to be at 5% level of significance at depth B of SB pond (t = 2.15).

c) The number of the species increased with the increase of DO content in all depths of the ponds except at depth A of SB pond.

d) CO_2 did not show any specific relationship.

e) Total nitrogen content did not exhibit any specific relationship.

f) PO_4 did not show any specific relationship. It recorded a negative relationship at 5% level of significance at depth A of SH pond (t = -2.24), whereas a positive relationship at 1% level of significance at depth B of SB pond (t = 4.31).

g) No specific relationship was found between Ca and the density of the species.

h) The density of the species decreased with the increase of organic carbon content. The relationship was noted to be at 5% level of significance at depth B in SB pond (t = -2.46).

(4) *Dero digitata* and physico-chemical parameters of water

a) No specific relationship was found between temperature and the species. A positive relationship was noted to be at 5% level of significance at depth B of PG pond ($t = 2.34$) whereas a negative relationship was observed to be at 5% level of significance at depth A of SB pond ($t = -2.23$).

b) The density of the species increased with the increase of pH in all depths of the three ponds except at depth B of PG pond.

c) DO did not show any specific relationship.

d) The number of species decreased with the increase of CO_2 content in most cases except at depth B of SH pond.

e) Total nitrogen did not exhibit any specific relationship.

f) PO_4 did not show any specific relationship.

g) The density of the species decreased with the increase of calcium content in most cases except at depth B of PG pond. A highly significant relationship was observed at depth A of SB pond ($t = -2.95$).

h) No specific relationship was found between organic carbon and abundance of *D. digitata*. A positive relationship was observed to be at 5% level of significance at depth B of SH pond ($t = 2.36$), whereas a negative relationship was recorded to be at 1% level of significance at depth A of SB pond (t = -3.03).

(5) *Limnodrilus hoffmeisteri* and physico-chemical parameters of water

a) The density of the species decreased with the increase of temperature. The relationship was found to be at 5% level of significance at depth A of PG pond (t = -2.25) and it was at 1% level of significance at depth A of SH pond (t = -3.82).

b) The number of the species increased with the increase of pH. The relationship was noted to be at 1% level of significance at depth A of SH pond (t = 3.82) and depth B of SB pond (t = 3.16).

c) The abundance of the species increased with the increase of DO content in most cases except at depth B of SH pond. The relationship was found to be at 5% level of significance at depth A of SH pond (t = 2.52) and it was noted to be at 1% level of significance at depth B of PG pond (t = 4.01).

d) The abundance of *L. hoffmeisteri* decreased with the increase of CO_2 content.

e) The number of the species decreased with the increase of total nitrogen content. The relationship was noted to be at 1% level of significance at depth A (t = -2.05) and B (t = -2.4) in SB pond.

f) PO_4 did not exhibit any specific relationship.

g) The density of the species decreased with the increase of Ca content. The relationship was noted to be at 1% level of significance at depth A in SB pond (t = -2.64).

h) The faunal abundance of the species decreased with the increase of organic carbon content. The relationship was noted to be at 5% level of significance at depth B of SH (t = -2.22) and PG (t = -2.20) ponds whereas it was at 1% level of significance at A (t = -3.25) and B (t = -10.48) of SB pond.

(6) *Branchiura sowerbyi* and physico-chemical parameters of water

Correlation coefficients between the density of *B. sowerbyi* and physico-chemical parameters of water were calculated in SB pond only as the species was found to be one of the dominant species in this pond.

a) The number of the species decreased with the increase of temperature.

b) The density of the species increased with the increase of pH. The relationship was noted to be at 1% level of significance at depth B in SB pond ($t = 3.64$).

c) The number of the species increased with the increase of DO content. The relationship was found to be at 5% level of significance at depth B of SB pond ($t = 2.17$).

d) The density of the species decreased with the increase of Ca content.

e) The number of the species decreased as a total nitrogen content increased. The coefficient was noted to be at 5% level of significance at depth B of SB pond ($t = -2.54$).

f) PO_4 exhibited a positive relationship.

g) Ca did not show any specific relationship.

h) Highly negative relationships were observed between organic carbon and the density of species at depth A ($t = -3.49$) and B ($t = -4.49$) in SB pond.

(B) Multiple Regression

The multiple regression coefficients of abundance of total fauna, total oligochaetes and dominant oligochaete species with temperature, pH, dissolved oxygen, carbondioxides, total nitrogen, phosphates, calcium and organic carbon were calculated. These are shown in details in Tables 52 - 57 and also discussed below:

a) Total fauna.

A significant value of multiple correlation and coefficient between total fauna and water parameters was noted at depth A (F = 4.445) in SB pond. A highly significant value was recorded at depth A of SH (F = 5.6), at B of PG (F = 6.23) and at B of SB pond (F = 9.47).

b) Oligochates.

A highly significant value was noted at depth A of SH (F = 5.60), at depth B of PG (F = 6.92) and SB (F = 21.05) ponds.

c) *Branchiodrilus semperi*.

A significant multiple correlation coefficient value was recorded at depth B of SB pond (F = 4.73).

Table 52 : Showing the multiple regression coefficients of different organisms (Y) on the physico-chemical factors of water with the corresponding standard errors and multiple correlation coefficients at depth A of SM pond.

Y		X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	A	R^2	$F_{8,29}$
No. of Total fauna	B	-96.221	1853.434	-78.701	133.008	184.883	-2604.389	320.574	-97.782			
	SE	121.290	918.517	153.664	148.133	627.245	10875.721	320.047	36.114	-3788.083	0.782	5.696**
	t	-0.793	2.017	-0.512	0.897	0.294	-2.394	1.001	-2.707			
No. of Oligochaetes	B	1637.708	264.369	1615.137	469.485	362.693	-6378.355	331.66	-156.337			
	SE	207.507	1505.348	264.738	247.905	6793.891	18583.593	563.197	61.966	-1485.608	0.779	5.604**
	t	1.187	1.087	1.773	1.463	0.237	-3.432	-0.588	-2.522			
No. of *B. sowerbi*	B	-2.888	76.360	-31.854	-13.559	217.497	-2904.523	-59.312	1.530			
	SE	23.200	156.224	30.045	27.325	764.164	1971.151	62.028	5.177	662.921	0.433	0.834
	t	-0.124	0.488	-1.060	-0.496	0.234	-1.473	-0.956	0.295			
No. of *D. digitata*	B	9.277	66.302	-47.112	-20.105	1236.408	-4398.439	18.325	-5.935			
	SE	33.553	236.732	37.025	38.095	1186.677	2986.631	93.449	7.803	125.806	0.361	0.539
	t	0.279	0.280	-1.272	-0.527	1.041	-1.472	-0.196	-0.760			
No. of *L. hoffmeisteri*	B	-100.191	1101.972	83.039	208.973	4647.047	-15948.574	46.000	-101.724			
	SE	96.965	704.603	123.609	114.810	3067.978	8444.260	157.737	27.847	-727.47	0.813	7.089**
	t	-1.039	1.563	.671	1.820	1.514	-1.888	0.291	-3.652			

where X_1= Temp., X_2= pH, X_3= DO, X_4= CO_2, X_5= Nitrogen, X_6= PO_4, X_7= Ca, X_8= OC

** at 1% level of significance

Table 53 : Showing the multiple regression coefficients of different organisms (Y) on the physico-chemical factors of water with the corresponding standard errors and multiple correlation coefficients at depth B of SH pond.

Y		X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	A	R^2	$F_{8,29}$
	B	-122.346	-750.604	235.353	-3.557	669.466	25334.956	-329.542	-73.617			
No. of Total fauna	SE	104.125	1066.599	289.247	125.323	2755.609	13135.497	349.468	58.550	17473.420	0.485	1.114
	t	-1.174	-0.703	0.813	-0.028	0.242	1.928	-0.942	-1.257			
	B	317.977	157.6	182.619	-36.172	618.642	9812.335	-524.904	-73.200			
No. of Oligochaetes	SE	121.845	927.552	215.550	100.465	404.083	10866.609	266.844	47.299	5513.527	0.619	2.253
	t	2.608	-0.170	0.847	-0.360	-1.530	0.902	-1.967	-1.548			
	B	4.807	-52.255	28.515	14.362	-14.261	3452.109	-82.629	7.512			
No. of *D. digitata*	SE	14.006	100.210	25.300	11.742	52.032	1315.572	31.715	3.573	383.594	0.629	2.378
	t	0.341	-0.521	1.127	1.223	0.274	2.624	-2.605	2.102			
	B	267.081	-384.623	-27.301	-77.755	-810.813	13.510	-256.375	-78.062			
No. of *L. hoffmeisteri*	SE	108.933	862.649	224.616	97.598	2151.308	23.968	293.688	44.860	7331.977	0.554	1.602
	t	2.451	-0.445	-0.121	-0.796	-0.376	0.563	-0.872	-1.740			

where X_1= Temp., X_2= pH, X_3=DO, X_4= CO_2, X_5= Nitrogen, X_6= PO_4, X_7= Ca, X_8= OC

Table 54 : Showing the multiple regression coefficients of different organisms (Y) on the physico-chemical factors of water with the corresponding standard errors and multiple correlation coefficients at depth A of PG pond.

Y		X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	A	R^2	$F_{8,32}$
No. of Total fauna	B	-943.915	10713.571	-734.680	-548.743	6084.958	23099.302	2291.319	115.109			
	SE	517.907	5892.523	708.872	583.024	7915.415	35884.841	1320.125	68.595	68410.304	0.545	1.678
	t	-1.822	1.818	-1.036	-0.941	0.768	0.643	1.735	1.678			
No. of Oligochaetes	B	-390.093	9511.513	-865.187	-652.279	6215.91	22632.215	567.464	-19.308			
	SE	438.407	5132.89	663.747	641.57	5570.327	34087.033	1083.500	166.757	45725.67	0.26	1.445
	t	-0.889	1.853	-1.303	-1.016	1.115	0.663	0.523	-0.115			
No. of *B. [illegible]*	B	63.890	212.985	97.93	5.083	-909.95	17270.422	228.556	-4.712			
	SE	129.059	355.267	173.615	189.071	1823.31	9361.56	314.396	47.909	648.610	0.485	1.228
	t	0.495	0.599	0.564	0.026	-0.499	1.844	-0.726	-0.098			
No. of *D. digitata*	B	6.911	2495.12	-83.79	31.431	2125.62	-17.36	196.907	-0.814			
	SE	80.408	983.480	120.486	118.352	1244.35	599.565	211.086	29.656	20067.02	0.454	1.036
	t	0.085	2.537	-0.695	0.265	1.708	-0.002	0.932	-0.027			
No. of *L. hoffmeisteri*	B	-369.365	3641.305	-305.781	-134.278	1248.38	12892.89	286.44	-1.419			
	SE	269.763	3280.808	394.819	394.95	4170.71	20003.6	704.935	102.493	12791.085	0.436	0.937
	t	-1.369	1.109	-0.774	-0.339	0.299	0.644	0.406	-0.013			

where X_1= Temp., X_2= pH, X_3= DO, X_4= CO_2, X_5= Nitrogen, X_6= PO_4, X_7= Ca, X_8= OC

Table 55 : Showing the multiple regression coefficients of different organisms (Y) on the physico-chemical factors of water with the corresponding standard errors and multiple correlation coefficients at depth B of PG pond.

Y		X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	A	R^2	$F_{8,32}$
	B	884.971	4137.088	39.344	-242.369	-1311.423	-34519.115	-1274.823	-94.349			
No. of Total fauna	SE	187.721	2931.407	42.309	149.075	1953.044	14403.460	374.683	25.906	11738.823	0.7803	6.230**
	t	4.714	1.411	0.929	-1.625	-0.671	-2.396	-3.402	-3.641			
	B	451.740	1979.052	35.119	57.228	422.786	189.319	-1304.560	151.848			
No. of Oligochaetes	SE	162.420	2985.545	88.055	188.739	480.023	1909.434	335.486	34.086	10843.345	0.796	6.925**
	t	2.781	0.662	0.398	0.303	0.880	0.099	-3.888	-4.454			
	B	34.853	-1032.891	3.076	-72.181	122.313	2055.394	-74.451	-3.156			
No. of *D. digitata*	SE	17.022	390.381	33.507	18.275	252.534	1672.800	42.899	4.455	8061.015	0.591	5.845**
	t	2.047	-2.645	0.091	-3.949	0.484	1.228	-1.735	-0.708			
	B	283.591	-1717.134	727.328	35.971	18.746	-401.657	-459.037	-113.737			
No. of *L. hoffmeisteri*	SE	132.352	2416.018	211.016	117.736	240.930	204.307	275.436	26.120	21397.408	0.798	7.027**
	t	2.142	-0.710	3.446	0.305	0.077	-1.965	-1.666	-4.354			

Where X_1= Temp., X_2= pH, X_3=DO, X_4= CO_2, X_5= Nitrogen, X_6= PO_4, X_7= Ca, X_8= OC

** at 1% level of significance

Table 56 : Showing the multiple regression coefficients of different organisms (Y) on the physico-chemical factors of water with the corresponding standard errors and multiple correlation coefficients at depth A of SB pond.

Y		X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	A	R^2	$F_{8,30}$
No. of Total fauna	B	764.512	-5427.586	-624.749	214.301	5961.712	27189.153	-2390.757	-1134.894			
	SE	619.217	5843.671	1006.599	694.670	2067.908	40480.424	1325.093	333.300	196103.371	0.738	4.475*
	t	1.234	-0.928	-0.062	0.308	2.882	-0.671	-1.804	-3.405			
No. of Oligochaetes	B	-201.159	-1821.538	-548.880	-178.682	102.377	31130.400	62.406	-861.011			
	SE	514.524	5889.809	842.007	667.532	264.276	73783.502	612.138	256.240	115300.16	0.623	2.382
	t	-0.390	-0.309	-0.651	-0.267	0.387	0.421	0.101	-3.360			
No. of *B. semperi*	B	-79.333	1029.69	-483.967	-201.219	5837.015	22168.78	425.455	-213.49			
	SE	132.943	1267.369	215.021	179.738	3616.97	13312.93	273.538	79.615	6936.93	0.568	1.788
	t	-0.596	0.812	-2.25	-1.178	1.613	1.665	1.555	-2.681			
No. of *D. digitata*	B	-70.439	11.397	-127.757	-68.371	2519.371	6281.552	-130.738	-83.263			
	SE	53.271	21.187	88.128	61.882	1497.152	5456.565	112.249	32.953	11651.171	0.626	2.424
	t	-1.322	0.537	-1.449	-1.099	1.682	1.151	-1.164	-2.526			
No. of *L. hoffmeisteri*	B	-54.772	-3589.592	495.796	63.195	-595.085	399.111	645.994	-289.083			
	SE	329.931	2966.359	543.298	137.222	7448.616	31958.347	705.141	209.816	71172.209	0.557	1.686
	t	-0.166	-1.210	0.912	0.460	-0.079	0.012	-0.916	-1.377			
No. of *B. sowerbyi*	B	68.488	918.969	108.996	163.351	-338.581	-209.618	-20.052	-146.404			
	SE	123.688	1031.544	184.236	121.239	501.716	206.506	260.036	59.607	6444.572	.584	1.942
	t	0.553	0.890	0.591	1.347	-0.674	-1.005	-0.077	-2.456			

where X_1= Temp., X_2= pH, X_3= DO, X_4= CO_2, X_5= Nitrogen, X_6= PO_4, X_7= Ca, X_8= OC

* at 5% level of significance

Table 57 : Showing the multiple regression coefficients of different organisms (Y) on the physico-chemical factors of water with the corresponding standard errors and multiple correlation coefficients at depth B of SB pond.

Y		X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	A	R^2	$F_{8,30}$
	B	-165.554	2277.224	24.927	66.275	1312.183	-1061.487	115.087	-446.735			
No. of Total fauna	SE	241.403	2626.672	334.557	205.047	3208.675	21928.604	544.955	81.832	35805.380	0.846	9.469**
	t	-0.685	0.866	0.074	0.323	0.408	-0.048	0.211	-5.679			
	B	-306.948	71.388	-42.572	-159.906	-73.708	34373.471	236.023	-393.372			
No. of Oligochaetes	SE	141.360	59.484	216.353	120.812	140.511	14807.981	415.635	43.524	43848.798	0.922	21.053**
	t	-2.171	1.200	-0.196	-1.323	-0.524	2.439	0.567	-9.037			
	B	-39.026	727.521	-67.468	19.954	707.653	3651.662	433.020	34.545			
No. of B. sammari	SE	43.842	479.275	62.642	40.257	590.248	4031.026	100.218	15.019	9903.420	0.7469	4.733*
	t	-0.890	1.517	-1.077	0.495	1.198	0.905	4.320	-2.300			
	B	-15.675	98.185	-11.641	2.381	-114.572	18.918	38.842	1.219			
No. of D. digitata	SE	12.931	142.283	19.283	11.827	178.161	304.434	29.132	4.350	653.329	0.379	0.631
	t	-1.212	0.690	-0.603	0.201	-0.643	0.062	-1.333	-0.280			
	B	-95.811	-116.374	214.927	-89.912	806.518	12738.669	-113.807	-312.400			
No. of L. hoffmeisteri	SE	127.179	1498.338	248.470	123.143	1854.867	13202.420	312.621	47.292	36295.174	0.886	13.778**
	t	-0.753	-0.077	0.865	-0.730	0.434	0.964	-0.364	-6.605			
	B	-72.628	1093.465	43.906	44.204	-549.249	2279.518	6.450	-46.172			
No. of B. sowerbyi	SE	55.943	714.419	89.601	59.518	803.850	5388.888	69.657	18.857	491.049	0.700	3.610*
	t	-1.298	1.530	0.490	0.742	-0.683	0.423	0.092	-2.448			

where X_1 = Temp., X_2 = pH, X_3 = DO, X_4 = CO_2, X_5 = Nitrogen, X_6 = PO_4, X_7 = Ca, X_8 = OC

* at 5% level of significance

d) *Dero digitata*.

A highly significant value was found at depth B of PG pond (F = 5.84).

e) *Limnodrilus hoffmeisteri*.

A highly significant multiple correlation coefficient value was noted at depth A of SH (F = 7.09), B of PG (F = 7.03) and B of SB ponds (F = 13.78).

f) *Branchiura sowerbyi*.

A significant value was recorded at B of SB pond (F = 3.61).

The calculated values of simple correlation coefficients between the faunal abundance and eight physico-chemical parameters of water; thus reveals, that the DO content and pH value showed a positive relationship with faunal abundance whereas temperature, CO_2, total nitrogen, calcium content and organic carbon content showed a negative relationship. The phosphate content did not exhibit any specific relationship with faunal abundance.

In the present investigation a significant multiple correlation and coefficients between faunal abundance and the above eight factors of water was found only at A and B of SB pond.

(vi) Population of Benthic Macroinvertebrates a and some Chemical Parameters of Soils

The relationship between density of macrobenthos, total oligochaetes and pH, total nitrogen, and organic carbon content of soils at the two depths (where the populations were mostly resticted) of the ponds were calculated for the year 1976 and 1977 and the results are shown in details in Tables 58, 59. Some highlights of the results are stated as follows:

(A) Density of total organisms and chemical parameters of soils

a) Total fauna and pH of soils.

The abundance of total organisms increased with the increase of soil pH in all the depths of three ponds except at depth A of SB pond. The relationship was noted to be at 5% level of significance at depth B in SB pond during 1976 ($t = 2.29$).

b) Total fauna and total nitrogen content.

No specific relationship between the density of total organisms and total nitrogen content of soil was found.

c) Total fauna and organic carbon content of soils.

The number of total fauna decreased with the increase of organic carbon content of soil at depth A in all the three

Table 58: Showing correlation coefficients between total fauna, oligochaetes and pH, N/T and OC of soil in SH and PG ponds at depths A and B

Pond				Depth	r	t
SH	Total fauna	S	pH	A	+0.0026	+0.012
	"	S	N/T	"	-0.039	-0.1829
	"	S	OC	"	- .0091	-0.042
	Oligochaetes	S	pH	"	+0.003	+0.015
	"	S	N/T	"	-0.011	-0.052
	"	S	OC	"	-0.011	-0.052
	Total fauna	S	pH	B	+0.272	+1.325
	"	S	N/T	"	+1.458	+1.458
	"	S	OC	"	+0.057	+0.268
	Oligochaetes	S	pH	"	+0.399	+2.015*
	"	S	N/T	"	+0.838	+7.261**
	"	S	OC	"	+0.281	+1.368
PG	Total fauna	S	pH	A	+0.386	+1.987
	"	S	N/T	"	-0.097	-0.461
	"	S	OC	"	-0.352	-1.75
	Oligochaetes	S	pH	"	+0.228	+1.109
	"	S	N/T	"	-0.116	-0.567
	"	S	OC	"	-0.141	-0.663
	Total fauna	S	pH	B	+0.301	+1.475
	"	S	N/T	"	+0.061	+0.282
	"	S	OC	"	+0.161	+0.762
	Oligochaetes	S	pH	"	- .001	-0.006
	"	S	N/T	"	+0.032	+0.147
	"	S	OC	"	+0.152	+0.712

* Significant at 5% level ** Significant at 1% level

Table 59: Showing correlation coefficient between total fauna, oligochaetes and pH, N/T and OC of soil at depths A and B

Pond				Depth	r	t
	Total fauna	S	pH	A	-0.052	-0.235
	"	S	N/T	"	-0.501	-2.708*
	"	S	OC	"	-0.432	-2.233*
	Oligochaetes	S	pH	"	+0.021	+0.094
	"	S	N/T	"	-0.111	-0.510
	"	S	OC	"	-0.002	-0.009
SB						
	Total fauna	S	pH	B	+0.44	+2.294*
	"	S	N/T	"	-0.301	-1.475
	"	S	OC	"	+0.223	+1.06
	Oligochaetes	S	pH	"	+0.292	+1.421
	"	S	N/T	"	+0.911	+10.295**
	"	S	OC	"	+0.112	+0.519

* Significant at 5% level

** Significant at 1% level

ponds, whereas a reverse relationship was found at depth B of these ponds. The relationship was noted to be significant at 5% level at depth A in SB pond during 1976 (t = -2.23).

(B) Density of Oligochaetes and Chemical Parameters of Soils

a) Oligochaetes and pH of soils.

In most cases the number of organisms increased with the increase of soil pH. The coefficient was found to be at 5% level of significance at depth A in SH pond during 1977 (t = 2.015).

b) Oligochaetes and total nitrogen content.

The density of oligochaetes decreased with the increase of total nitrogen content of soil at depth A in all the three ponds, whereas the number increased with increase of total nitrogen content at depth B in these ponds. The relationships was recorded to be at 1% level of significance at depth B in SH (t = 7.261) and SB ponds (t = 10.29) during 1977.

c) Oligochaetes and organic carbon content of soils.

The density of oligochaetes decreased with the increase of organic carbon content at depth A in all the three ponds but a reverse relationship was noticed at depth B in these ponds.

Thus, the nitrogen and organic content of soil showed a negative relationship with the faunal abundance at A and a positive relationship at B in all the three ponds.

CHAPTER VI

DISCUSSION

During the present investigation the maximum abundance and their diversification were found in SB pond and the lowest in SH pond, whereas, the PG pond stood in between these two (Fig. 16). The gentle and gradual slope with rich populations of macrophytes was possibly one of the reason for the maximum number and forms of macrobenthos in SB pond. The bottom contour of PG pond was characterized by sharp slope at the margin which gradually became less steep downward. A fairly good growth of macrophytes was witnessed in the pond.

These factors helped to abode a large number of macrobenthos in PG pond. On the other hand the slope of SH pond was sharp and a poor density of macrophytes was recorded at the margin (Figs. 2, 4, 6). Thus, the number of benthic organisms was the lowest in SH pond.

The above finding agrees well with those of Adamstone (1924), Rawson (1930), Dun (1961), Grimas (1965), Krishnamurthy (1966) and Macan & Kitching (1972).

The average bacterial cell count revealed the SB pond has the highest number of bacterial cells in its sediment (Table 6). Harrel (1973) noted that the population of bacterial cell in a water body influenced the abundance of macroinvertebrates since some macroinvertebrates feed on bacteria. The highest bacterial populations in the sediment of SB pond possibly enriched the faunal abundance of the pond.

In the present studies it was found that the oligochaetes was the major group determining the total bulk of the macrobenthos. Among these worms, *Limnodrilus hoffmeisteri* was the abundant species in all the three ponds (Figs. 25, 26, 28, 29, 31, 32, 34 - 39). *L. hoffmeisteri* is a pollution tolerant species and it thrives in water receiving sewage effluents (Thut, 1969; Harrel and Duplechin, 1976; Ali and Rashiduzzaman,1976). *L. hoffmeisteri* was thus noted to abound in SB pond which receives sewage inflow and domestic wastes.

The abundance of most taxa and diversification of organisms were recorded to vary inversely with depth in all the three ponds. The highest number of macroinvertebrates with great diversification of forms was noted at depth A (0.2 m) in all the three ponds. The number and variety of organisms decreased as the higher depth was attained, and at the deepest area (3 m) the faunal abundance was found to be exceptionally poor (Fig. 16, Appendices 1 - 6). Juday (1922), Rawson (1930), Humphries (1936), Eggleton (1937), Berg (1938), Deevey (1941), Losos (1952), Dunn (1961), Sivertsen (1973), Solem (1973), Ali *et al.* (1978), and Ali *et al,* (1979) also observed that the abundance of macrobenthos correlated inversely with depth. It appears that, fresh supply of organic nutrients, high DO values, low CO_2 tension, low organic carbon content in sediment and water, and presence of rich macroflora population all possibly contributed to the maximum abundance and variety of benthic invertebrates at depth A (0.2 m). On the contrary Paterson and Fernando (1969a) found that the average number of organisms and the depth was insignificant for all groups than some of the chironomids in temperate water. They also noted that the oligochaetes and mites wer most abundant in a grass substrate regardless of depth. Juget and Giani (1974) also did not observe any relation between distribution of oligochaetes and depth of water bodies. In temperate region the particulate organic matter undergoes decomposition in summer, when water temperature is more suitable for bacterial activity. The water turn over brings DO to the bottom in autumn and spring. So depletion of DO takes place in winter due to crust formation. In winter DO requirement of benthos was minimum due to reduced physiological activities of the organisms. In the tropics, however, one may expect continuous decomposition of organic matters throughout the year and it gets accelerated during summer. As the over turn in tropical ponds is negligible, the bottom water more or less shows the accumulation of high CO_2, H_2S, and low DO content. The conditions of bottom become more deplorable in ponds, as seen in the present study, where accumulation of organic matters exceeds decomposition. Thus the faunal abundance decreased drastically at the greater depths (3 m) in all the three ponds.

In the present study it was noted that rainfall influenced the distribution of oligochaete worms at depth A (0.2 m) and B (1 m) in all the three ponds (Figs. 18 - 21). During summer and monsoon oligochaete worms were found to decrease in number at depth A of these ponds with simultaneous increase at depth B (Figs. 18 - 21). The above observation corroborates with the earlier investigations by Goodbody (1961), Paterson and Fernando (1969a), Harrel (1969), and Gupta (1976). During rain the run-off water carried organic nutrients from the pond margins and adjacent areas to the deeper water resulting in an increase in bacterial populations. This attracted the worms to the deeper depth. Some of the organisms were also carried from the pond margins to the deeper region by rain water. This was clearly demonstrated by *L. hoffmeisteri* in SH and PG ponds (Table 42). These ponds have sharp slope at the margin and a sudden drop in population of *L. hoffmeisteri* at depth A occurred during summer and monsoon with a simultaneous increase in population at depth B in most cases (Figs. 44 - 47). However, the populations of oligochaetes did never increase at depth C as compared to A and B at any stage during the investigation.

An inverse relationship was observed occasionally between the populations of chironomids and oligochaetes (Fig. 20). Similar inverse relationship was also reported by Srivastava (1959), Brinkhurst and Kennedy (1965), Harrel and Dorris (1968), Hruska (1973), and Ali *et al.* (1978). It has been noted that midge larvae and oligochaetes feed on silt particles, bacteria, and detritus (Hruska, 1973; Hynes, 1974; Harrel and Duplechin, 1976) living in the same habitat. Harrel and Duplechin (1976) further recorded that larvae of some chironomid species feed on oligochaetes. These factors might cause the inverse relationship between the populations of midge larvae and oligochaetes in the present investigation. However, Gaini and Lucas (1974) did not find any competition between the populations of chironomid larvae and oligochaetes in Lake Port-Bielh.

The population freshwater mussel, *Lamellidens marginalis* was recorded only from SH pond (Fig.27). This filter feeding species prefers pollution free water. The SH pond showed less contamination in comparison to PG and SB ponds as indicated from chloride values of water (Thresh *et al.*, 1944 *c.f.*: Munawar, 1970, Sreenivasan, 1967) and percentage of oligochaete worms in the population (Goodnight, 1973). This possibly explains the presence of *L. marginalis* at SH pond.

The larvae of *Chaoborus* sp. were found to be restricted at C (3 m) in all the three ponds (Figs. 17 - 19 and Table 19). Stahl (1966) indicated that larvae of *Chaoborus* to be benthic during day time, and they migrate vertically during night. Hamilton (1971) noted that larvae of *Chaoborus* live in deep and deoxygenated water. Similar observations were also made by Deevey (1941), Northcote and Clarotto (1975), Harrel *et al.* (1976), and Darlington (1977).

While conducting the investigation it was noticed that the oligochaete worms did not show any specific pattern in seasonal abundance. The peak growth period of these worms fell widely between September and July (Table 22). On the contrary, Michael (1968b) noted the maximum density of oligochaetes between January and April in a pond near Calcutta, India. *Limnodrilus hoffmeisteri*, the most common species, showed the highest occurrence between December and June. *Branchiodrilus semperi* exhibited maximum growth between April and December, whereas, *Branchiura sowerbyi* recorded the highest number between April and September (Table 22). The above observation is possibly due to the fact that these ponds were mostly subjected to human interference which disturbs the natural reproductive and nutritive behaviour of the organisms.

The molluscs, on the other hand, showed a more or less specific pattern in seasonal abundance. The highest number of the organisms occurred between June and October with the exception in SB pond during 1976 when two peaks, the first in January and the second in October, were recorded (Fig. 23). *Digoniostoma pulchella* showed the peak occurrence between May and October. *Alocinma orcula*, the most common molluscs of SB pond, exhibited the peak between June and October. However, in 1976 excluding the October peak *A. orcula* also recorded a peak in January but its populations declined sharply in February and March. *Viviparus bengalensis*, the most abundant snail of SH and PG pond, was found to have the peak between August and September and the lowest number was noted between November and April (Table 23). A large number of dead shells of *V. bengalensis* was noted to float in these ponds from January to March. From the above observation it is presumed that the ring snail, *V. bengalensis* has one year life span. Further studies in the regard may be undertaken in future. Michael (1968b) also recorded the highest number of *V. bengalensis* between April and October and the lowest between December and February.

In course of the investigation a minimum occurrence of molluscan species, *Viviparus bengalensis*, *Digoniestoma pulchella* in PG and SH ponds and *Alocinma orcula* in SB pond was recorded during winter and summer (Table 23). During the period a dense algal bloom was also witnessed. The coincidence of the small number of these species with algal bloom is an interesting phenomenon. A detailed study may be carried out to ascertain any possible relationship between algal bloom and the reduced snail populations.

In the present study dry weight of macroinvertebrates, preserved in 4% formalin for nearly a year, was done. Howmiller (1972) noted that the dry weight of oligochaete and chironomid larvae after preserving in formalin 1½ and 2 months decreased by 20 to 30% of its calculated initial weight. The weight of different groups of animals might also be affected differently by preservation. Thus the biomass in terms of formalin dry weight as noted in the present observation is an undervalue of the actual dry weight by an unknown amount. The data may be used for inter groups and inter-ponds comparison only.

During the first and second year in SB pond the biomass of oligochaete worms formed 77.8% and 68.2% of total standing crops at depth A and 84% and 91% of standing crops at depth B respectively. In PG pond nearly 85% of standing crops composed of molluscan species in two depths, whereas the molluscs constituted more than 95% of standing crops at depth A and B in SH pond during the period of study (Figs. 42, 43).

Though the bulk of benthos in all these ponds comprised of oligochaetes worms, yet the biomass of total organisms mainly composed of molluscan fauna (Figs. 17 - 19 and 42). The value of molluscs as fish food organisms is to be established firmly with regards to common fishes cultured in Bangladesh. Thus excluding the biomass of molluscan fauna it was found that SB pond was most productive than the other two (Fig. 41).

Kennedy (1966) observed that *L. hoffmeisteri* has no specific breeding season. He further noted that depending on the productivity of habitat breeding may take place throughout the year or be strictly seasonal or show seasonal peaks in activity. Young (1974) found that breeding of *L. hoffmeisteri* took place at low level for most of the year and it intensified from March to July. In the present study *L. hoffmeisteri* showed breeding season throughout the year as revealed from the appearance of individuals belonging to small size group in all the three ponds. The peak breeding period ~~in case~~ was encountered between March and July (Table 42, Figs. 44 - 49). *Branchiura sowerbyi* also showed the breeding activity throughout the year with some gaps. The peak was recorded between September and October (Table 42). The irregular breeding pattern of these species was presumably due to the reason that these organisms bred intensively in suitable condition which was depended to a great extent on the external interferences.

In the first year mutual association between *Branchiodrilus semperi* and *Dero digitata* as reflected by rank correlation test was recorded to be at 5% level of significance at A and B of SB and at A of SH ponds. In the second year the association among these two species was noted to be at 1% level of significance at both depths of SB pond, at depth A of PG pond, and at B of SH pond (Tables 43 - 45). From the above observation it appeared that significant mutual association exists between the two species, *B. semperi* and *D. digitata*. Other species did not, however, exhibit any definite association among them (Tables 43 - 44).

Physico-chemical parameters of water and abundance of benthic macroinvertebrates.

The different physico-chemical parameters of water of the three ponds were studied and described in Chapter III. The correlation coefficients between physico-chemical parameters of water and the faunal abundance are noted in Chapter V and these relationships are discussed in the following paragraphs.

Cook and Jahnson (1974) found that temperature of water has a fundamental contributing influence on turn over ratio, as it affects the metabolism of individual annuals. Macan (1961, '63) indicated a number of ways in which temperature can affect the growth and life cycle, and limit the distributional range of fresh water animals. Berg (1938) noted that migration of bottom fauna in lakes greatly depended on temperature. Paterson and Fernando (1969a) observed colonization of bottom macroinvertebrates in small impoundment was accelerated by temperature. All the above observations were made in temperate zone. But in tropical region, the picture is just the reverse. Srivastava (1956) noted that large scale mortality of bottom organisms occurred in summer due to excessive heat. In the present study a negative correlation between temperature of water and density of total fauna, and oligochaetes were recorded at depth **A** of all the three ponds and a good negative correlation was noted at **A** in SH pond (total fauna t = -3.271, oligochaetes, t = -3.798) (Tables 46 - 51). Hall *et al.* (1970) while working in temperate environment also observed a steep reduction in average standing drops as water temperature increased. It was observed in the present study that the increased temperature resulted the formation of high amount of CO_2, depletion in DO, and the presence of H_2S (Table 4, Figs. 7 - 15). These factors were possibly the reasons for the negative relationship between temperature and the faunal density. However, negative relation of temperature with faunal density was not observed at B in PG and SH ponds. This was possibly due to the fact that rains drove downward a large number of organisms from the steep margins of these ponds and that the temperature during monsoon was fairly high. However, Krishnamurthy (1971) could not get a clear relationship between temperature and distribution of animals while studying the bottom biota of Pulicat Lake.

In the present study the number of *Branchiura sowerbyi* decreased with the increase of temperature and the species was found to thrive mostly in autumn and winter when the temperature ranged between 15^{o}

and 25°C. Brinkhurst (1965), on the other hand, observed that *B. sowerbyi* is a thermophilic species in North America. Harrel (1969) also noted the maximum density of *B. sowerbyi* during months when water temperature was high. The above observation is logical since water temperature in summer months of temperate region is nearly equal that of the winter in tropical region. Thus thermophilic species on North America becomes thermophobic in Bangladesh condition.

Mathew (1975) observed that water pH at 8.0 is favourable for high rate of production. Hora and Pillay (1962) have shown that pH range 7.0 - 8.0 is characteristic of good water suitable for fish cultivation. In the present investigation a positive relation of pH with the abundance of total fauna and oligochaete worms was also noted in all the depths of the three ponds except at depth A of SB pond where a negative relationship occurred. The positive relationship was noted to be at 1% level of significance at A (total fauna $t = 2.937$, oligochaete $t = 3.77$) of SH pond and at B (total fauna $t = 3.29$, oligochaete $t = 3.91$) of SB pond (Tables 46 - 51). Despite the above observation a negative relationship of pH with faunal abundance at A of SB pond indicates that the effect of pH on the animal was likely to be indirect one.

The importance of DO in the biology, physiology and abundance of bottom organisms has been recognized by different workers (Brundin, 1950; Jonasson, 1969; Harrel, 1973; Hruska, 1973; Solem, 1973; Cook and

Johnson, 1974; Giani and Lucas, 1974; Lang, 1978). Deevey (1941) recorded that shallow lakes with eutrophic oxygen curve are more productive of bottom fauna than other types. In the present observation a positive correlation of dissolved oxygen with the abundance of total fauna and oligochaete worms was noted in all the three ponds. The relationship was noted to be at 1% level of significance between DO and total fauna at A (t = 2.98) of SH pond, and it was at 1% level of significance between DO and total fauna (t = 3.23) and between DO & oligochaete worms (t = 3.54) at B of PG pond (Tables 48, 49). However, *Limnodrilus hoffmeisteri* did not show the positive relation with DO at depth B of SH pond (Table 42) possibly owing to poor occurrence of the species at depth B.

The carbondioxide and organic carbon content of water showed negative relationships with the total density of all the organisms (Tables 46 - 51). For example, a highly negative relationship at 1% level of significance was encountered between organic carbon and density of macroinvertebrates, oligochaetes, and the dominant species of oligochaetes at depth A and B of SB pond and at A of SH pond (Tables 46, 50, 51). The negative values at 5% level of significance were also noted between oligochaete worms and *Limnodrilus hoffmeisteri* and organic carbon at depth B of SH and PG ponds (Tables 47 and 49). All these results showed that the faunal abundances studied were greatly minimised as the organic carbon content of water increased. The total nitrogen and calcium content of water also showed a negative relationship with the density of total organisms as these were found to be related directedly to the amount of organic matters present.

The significant values of multiple correlation coefficient for total organisms were calculated at depth A and B of SB pond (Tables 56 and 57). It seems that the physico-chemical parameters of water at SB pond were favourable for the high production of benthic organisms.

Soil characteristic and abundance of macroinvertebrates.

Some physico-chemical aspects of soils of these three ponds and their relationships with the faunal abundance were studied in Chapter IV & V. In the investigation the higher density of organisms was recorded at depth A in sediment with fine grains.

The number of macroinvertebrates was noted to decrease at areas with coarse-grained mud. On the other hand, Cook (1975) noted that coarse grained glaciolacustrine sediments were capable of supporting higher benthic stocks than more flocculent, fine-grained muds. However, Giani and Lucas (1974) did not find clear relationship of faunal abundance to grain size of the sediment.

The growth of high benthic populations was observed at depth A and B of SB pond with the soil pH ranged between 5.9 and 6.9. The depth A of SH pond, however, did not support rich populations of macroinvertebrates under almost similar condition. The abundance of oligochaetes as well as other macroinvertebrates was noted to decrease as the soil pH turned more acidic. At depth C the soil pH was highly acidic in all the three ponds (Tables 10, 13, 16). Benthic population at this area, therefore, was negligible (Fig. 16). Banerjea (1967) in his studies considered both highly acidic and alkaline conditions of soil undesirable for fish growth. Schaeperclaus (1933) reported that the slightly alkaline pH of soil and water in a fish pond was favourable for high productivity. On the contrary, Khalaf and Ghabbour (1963) observed that soil pH has no relation to the distribution of megadriline oligochaetes in Egypt.

The nitrogen is present in pond sediment mostly in organic forms such as aminoacids, peptides, and easily decomposable protein called available protein and may be regarded as an indicator of productivity of the water body (Banerjea, 1967). Mortimer (1938) stated that the lakes in English Lake District could be arranged in order of their organic productivity perhaps best represented in the nitrogen content of their mud. But Stangenberg (1949) could not corroborate the above statement of Mortimer (1938) when dealing with lakes and ponds of Poland. Lellak (1966) and Sumitra (1973) did not find any correlation between nitrogen content and productivity of water bodies. In the present investigation the nitrogen content and the faunal abundance did not show any specific relationship. The nitrogen content was noted to be high and nearly equal in the sediment of PG and SB ponds (Tables 11 - 16). But faunal abundance was observed to be higher in SB pond than that of PG pond (Fig. 16). On the other hand the nitrogen content of SH pond was found to be the lowest among the three ponds and the pond supported the minimum number of organisms (Tables 8 - 10, Fig. 16). It was noted further that the nitrogen content was the highest at depth C in all the three ponds where the populations of benthos were negligible. And the nitrogen content showed a negative relationship with the faunal density at depth A, whereas a positive relationship was noted at depth B in the three ponds.

It was observed that SB pond contained the highest amount of available phosphorus in its sediment than the other two ponds. The number of benthic populations were also the greatest in SB pond. Banerjea (1967) in his study observed "In the range of 3 - 6 available phosphorus (expressed as mg P_2O_5/100 g of soil), out of 27 ponds, 26 were of average production, in the range of 6 - 12, out of 18 ponds, 14 were productive, 2 average and only 1 unproductive, whereas ponds with available phosphorus above 12 were all productive." The available phosphorus content of SB pond ranged between 7 and 17 (expressed as mg P_2O_5/100 g of soil) and the pond (SB) found to be highly productive among the three ponds.

Similar to Cook's (1975) observation, a negative correlation between organic carbon in the sediment and faunal abundance was obtained at depth A of the three ponds (Tables 58, 59). But a positive correlation between organic carbon with total fauna and oligochaete fauna was observed at depth B. This may be attributed to the fact that during monsoon water current washed organic matter from depth A and adjacent areas and accumulated below at the region of depth B which is less steep. The fresh supply of organic matter at B increased the bacterial population which attracted the oligochaete worms at this area and thus their number was increased. Some macrofauna were driven to deeper areas by water current which further increased their number. But conversely organic carbon content of water recorded a negative relationship (Tables 46 - 51) with oligochaete fauna and total fauna at B. This was possibly due to the fact that the organic carbon content of water at B decreased during rainy season as rainfall cut down the temperature which retarded the bacterial activity. The increased oligochaete population also minimised the size of bacterial populations thus the bacterial activity was further reduced. Nevertheless, the annual average content of organic carbon in the sediment showed a negative relationship with faunal abundance in all depths of three ponds. On the other hand McLachlan and McLachlan (1971) while working on a newly created tropical lake in Africa did not find any correlation between chironomid biomass and percentage of organic carbon in littoral area whereas they observed a positive correlation in profundal zone during winter. Lellak (1966) also could not observe any correlation between the organic matter of mud and biological production of pond in temperate zone. However, a considerable area at greater depth of these ponds thus remained almost barren possibly due to deficiency of dissolved oxygen, abundance of carbodioxide, and presence of hydrogen sulphide gas caused by bacterial breakdown of the huge organic matter accumulated over a long period of time.

LITERATURE CITED

Adamstone, F.B. 1924. The distribution of economic importance of bottom fauna of Lake Nipigon with an appendix on the bottom fauna of Lake Qutario. University of Toronto Studies, Biological series, Pb. Ontario Fisheries Research Laboratory, 24:35-100.

Ali, S. 1973. Aquatic Oligochaetes of Dacca city (Bangladesh) with short notes on their ecology. Dacca Univ. Studies Pt. B., 21:9-14.

Ali, S. and A.H.M. Issaque. 1975. A systematic study of freshwater oligochaetes from Dacca city, Bangladesh. Bangladesh J. Zool., 3:55-61.

Ali, S. and A.K.M. Rashiduzzaman. 1976. The oligochaete fauna of Dhanmondi Lake, Dacca, Bangladesh. Dacca Univ. Studies Pt. B., 24:89-95.

Ali, S. and M. Begum. 1976. Freshwater Molluscs of Dacca (Bangladesh) with notes on their ecology. J. Asiatic Soc. Bangladesh (Sc.), 2(II):29-36.

Ali, S., A.Q. Chowdhury, and N. Mazumder. 1977. Studies on the population dynamics of benthic macroinvertebrates of a fish pond at Chandpur, Bangladesh. Dacca Univ. Studies. Pt. B., 26:131-137.

Ali, S., A.S.M. Haque, J.R. Oppenheimer, and K.M.S. Aziz. 1978. Studies on the bottom fauna of three fish ponds in Dacca city, Bangladesh. Bangladesh J. Zool., 6(1):43-55.

Ali, S., M.A. Rouf, and A.K.M. Ashraf-ul-Alam. 1979. Studies on the benthic macroinvertebrates in a pond. J. of Bangladesh Academy of Sciences, 3(182):109-112.

American Public Health Association. 1971. *Standard methods for the examination of water and waste water.* 13th Ed. Amer. Pbl. Health Assoc. New York, 874 pp.

Anderson, R.O. and F.F. Hooper. 1956. Seasonal abundance and production of Littoral bottom fauna in a Southrern Michigan Lake. Trans. Amer. Micros. Soc., 75(3):259-270.

Ashahina, E. 1942. Bottom fauna of Lake Beppi of Shumushu Island, the Kuriles. Zool. Mag. (Tokyo), 54:371-372.

Ashahina, E. 1943. Bottom fauna in the coastal lakes of Takachi. I. Zool. Mag. (Tokyo), 55:137-154.

Ball, R.C. 1948. Relationship between available fish food, feeding habits of fish and total fish production in Michigan Lake. Michigan State Coll. Agri. Exp. Sta. Tech. Bill., 206:259 pp.

Banerjea, S.M. 1967. Water quality and soil condition of fish ponds in some states of India in relation to fish production. Indian J. Fish., 14:115-144.

Banu, N. 1976. The biology and control of reproduction in the bull-head *Cottus gobio* (L.). Ph.D. Thesis, The University of Liverpool, U.K., 240 pp.

Berg, K. 1938. Studies on the bottom animals of Esrom Lake. Mem. Acad. Roy. Sci. Lett. Denmark Sect. Sci. Ser., 8-9:1-255.

Bouyoucos, G.J. 1928. The hydriometer method for making a very detailed mechanical analysis of soils. Soil Sci., 26:233-238.

Brinkhurst, R.O. 1965. Studies on the North American aquatic oligochaeta II : Tubificidae, Proc. Acad. Nat. Sci. Philad, 117:117-172.

Brinkhurst, R.O. and C.R. Kennedy. 1965. Studies on the biology of the Tubificidae (Annelida, Oligochaeta) in a polluted stream. J. Anim. Ecol., 34:429-443.

Brinkhurst, R.O. and B.G.M. Jamieson. 1971. *Aquatic Oligochaetes of the world*. Oliver and Boyd. Edinburgh, 860 pp.

Brundin, L. 1950. The relation of O_2 microstratification at the mud surface to the ecology of profundal fauna. Ref. Inst. Fresh. Res. Drott., 31:32-42.

Buscemi, P.A. 1961. Ecology of the Bottom fauna of Parvin Lake, Colorado. Trans. Amer. Microsc. Soc., 80(3):266-307.

Chowdhury, M.S., M.N. Khan, and S.A. Malek. 1969. Manual of elementary soil experiments. Published by Md. Nuruzzaman Khan. Dacca. 103 pp.

Clampitt, P.T., E.L. Waffle, and R.V. Bovjerg. 1960. An ecological reconnaissance of the bottom fauna, Miller's Bay, Lake West Okoboji. Proc. Iowa Acad. Sci., 67:553-568.

Cook, D.G. 1971. The Tubificidae (Annelida, Oligochaeta) of cape Cod. Bay II Ecology and systematics, with distribution of *Phallodrilus parviatriatus* Nov. sp. the Biol. Bull., 141(2): 203-221.

Cook, D.G. 1975. A preliminary report of the benthic macroinvertebrates of Lake Superior. Tech. Report No. 572. Fisheries and Marine Service. Canada. 44 pp.

Cook, D.G. and M.G. Johnson. 1974. Benthic macroinvertebrates of St. Lawrence Great Lakes. J. Fish Res. Board. Can., 31:763-782.

Craven, R.E. and B.E. Brown. 1969. Benthic macroinvertebrates of Boomer Lakes, Payne Counte, Oklahome. Southwest. Natur., 14(22):221-230.

Daniel, P.M. 1972. Acton Lake : Biology of its benthos and notes on its physical limnology. 1956-1970. Ohio. J. Sci., 72(5):241-253.

Darlington, J.P.E.C. 1977. Temporal and Spatial variation in the benthic invertebrate fauna of Lake George. J. Zool. Lond., 181:95-111.

Deevey, E.S. 1941. Limnological studies in Connecticut. VI. The quantity and composition of the bottom fauna of thirty six Connecticut and New York Lakes. Ecol. Mongr., 11(14):415-455.

Dejoux, C., L. Lauzanne and C. Leveque. 1971. Nature des fords et repatition des organisms benthiques dans la region De Bol (Achipal est due lac Techad) Cah. O.R.S.T.M., Ser Hydrobiol. 3(4):213-223. (In French)

De'Smet, W.H.O. 1978. The influence of water aeration by the phallus process on the macrobenthic fauna (Preliminary report). Hydrobiologia, 61(1):39-47.

Dewan, S. 1973. Investigations into the ecology of fishes in a Mymensingh Lake. Ph.D. Thesis. Bangladesh Agri. Univ. Mymensingh, 335 pp.

Dunn, D.R. 1961. The bottom fauna of Llyn Tegid (Lake Bela), Mreionethshire. J. Anim. Ecd., 30:267-281.

Eggleton, F.E. 1931. A limnological study of the profundal bottom fauna of certain freshwater Lakes. Ecol. Mogr. 1:231-232.

Eggleton, F.E. 1937. Productivity of the profundal benthic zone in Lake Michigan. Michigan Acad. Sci. Arts lett., 22:593-611.

Efford, I.E. and K.J. Hall. 1975. *Energy flow its biological dimension.* The Royal Society of Canada, Ottawa, 319 pp.

Einsele, W. 1936. Ueber die Bezeichungen des Eisenkreislaufs zum Phosphatkreislauf in Eutrophen Sec. Arch. Hydrobiol., 29: 664-686. (In Germany)

Fogg, G.E. 1960. The extracellular products of algae. Proc. Symposium on Algology : New Delhi, India. 138-143.

Freshwater Research Centre, Chandpur. 1974. Abstracts of Fisheries Research Report 1963-1972. Series 1, Govt. of Bangladesh, Directorate of Fisheries, 221 pp.

Ganapati, S.U. 1940. The ecology of a temple tank containing a permanent bloom of *Microcystis aeruginosa* (Kutz) Heufr. J. Bombay Nat. Hist. Soc., 42(1):65-77.

Ganapati, S.U. 1941. Seasonal changes in the physical and chemical conditions of garden pond containing abundant aquatic vegetation. J. Madras Univ., 13:55-69.

Ganapati, S.U. 1943. An ecological study of a garden pond containing abundant zooplankton. Proc. India Acad. Sci. B., 17:41-58.

Gaini, N. and C. Lucas. 1974. Les Qediments Dun lac de haute montagne : structure et peuplement. Annls. Limnol., 10(3):223-244. (In French)

Gaini, N. and P. Lavandier. 1977. Les dgochaetes du torrent d'estaragne (Pyrenees centrales). Extrait du bulletin de la societe d'historie naturalle de Toulouse, 113, Fesc. 1-2:234-243. (In French)

Gaufin, A.R. 1968. The effects of pollutions on a midwestern stream. Amor. Midl. Natur., 78:428-436.

George, M.G. 1962. Diurnal variation in two shallow ponds in Delhi, India. Hydrobiologia, 18(3):265-273.

Ghabbour, S.I. 1966. The importance of oligochaetes in fish culture: A review with special reference to Lake Nasser. The progressive Fish-Culturist, 28(4):206-215.

Ghosh, A., L.H. Rao, and S.C. Benerjee. 1974. Studies on the hydrobiological conditions of a sewage fed pond with a note on their role in fish culture. J. Inland Fish. Soc. India, 6:51-61.

Golterman, H.L. 1971. *Methods for chemical analysis of freshwater.* International Biological Programme. Blackwell Scientific Publications. Oxford and Edinburgh, 166 pp.

Gonzalves, E.A. and D.B. Joshi. 1946. Freshwater algae near Bombay. J. Bombay Nat. Hist. Soc., 46(1):154-176.

Goodbody, I. 1961. Mass mortality of marine fauna following tropical rains. Ecology, 42:150-155.

Goodnight, C.J. 1973. The use of aquatic macroinvertebrates as indicators of stream pollution. Trans. Amer. Micros. Soc., 92(1):1-14.

Grimas, U. 1965. Inlet impoundments. An attempt to preserve littoral animals in regulated Subacctic Lakes. Inst. Freshw. Res. Drottingholm. Report No. 46:22-30.

Grimas, U. 1967. On the fauna in the lower reaches of River Viskan, Southern Sweden. Rep. Inst. Freshw. Res. Drottingholm. Report No. 47:87-97.

Grimas, U. 1968. Stora sjoar i blick punkten. Fauna Och. Flora: 46-49.

Grimas, U. 1969. The bottom fauna of Lake Vattern, Central Sweden, and some effects of entrophication. Rep. Inst. Freshw. Res. Drottingholm. Report No. 49:49-62.

Gupta, S.D. 1976. Macrobenthic fauna of Loni Reservoir. J. Inland Fish. Soc. India, 8:49-59.

Hall, K.J. and K.D. Hyatt. 1974. Marion Lake (IBP) from bacteria to fish. J. Fish. Res. Can., 31:839-911.

Hall, D.J., W.E. Cooper, and E.E. Werner. 1970. An experimental approach to the production dynamics and structure of freshwater animal communities. Limnol. Oceanogr., 15:839-928.

Hamilton, A.L. 1971. Zoobenthos of fifteen lakes in the experimental lakes area, North Western Ontario. J. Fish. Res. Board Can., 28:257-263.

Harrel, C.R. 1969. Benthic macroinvertebrates of the Otter Greek Drainage Basin, North Oklahoma. The Southwestern Naturalist, 14(2):231-248.

Harrel, C.R. 1973. Limnological studies on a southwest Texas Meander Scar Lake. The Texas J. of Sci., 24(4):517-533.

Harrel, C.R. and T.C. Dorris. 1968. Stream Order, Morphometry, physico-chemical conditions, and community structure of benthic macroinvertebrates in an intermitten stream system. Amer. Midl. Natur., 80:220-251.

Harrel, C.R. and J.L. Duplechin. 1976. Stream bottom organisms as indicators of ecological change. Research Project completion report. Project No. B189 Tex. Texas Water Resources Institute, Texas A & M University. 49 pp.

Harrel, C.R., J. Ashcraft, R. Howardm and L. Patterson. 1976. Stress and community structure of macrobenthos in a gulfcoast riverine estuary. Marine Science, 20:69-81.

Hora, S.L. and T.V.R. Pillay. 1962. *Handbook of fish culture in Indopacific regions.* FAO. Biol. Tech. Pap., 14. 32 pp.

Howmiller, R.P. 1972. Effects of preservation on weights of some common macrobenthic invertebrates. Trans. A. Fish. Soc., 4: 743-746.

Hruska, V. 1973. The changes in benthos in slapy Reservoir in the years 1960-1961. Hydrobiol. Stud., 2:213-247.

Huet, M. 1950. Limnological outline of the inland waters of Belgium. Trav. Sta. Rech. Groenendaal., Ser. D., 2:29-40.

Humphries, C.F. 1936. An investigation of the profundal and sub-littoral fauna of Windermere. J. Animal Ecol., 5:29-52.

Hutchinson, G.E. 1957. *A treatise on Limnology.* Vol. I. Geography, Physics, and Chemistry. John Wiley and Sons., Inc., New York, 1015 pp.

Hynes, H.B.N. 1974. *The Biology of Polluted waters.* University of Toronto Press, Buffalo, New York, 202 pp.

Islam, A.K.M.N., A.K.Y. Haroon, and K.M. Zaman. 1974. Limnological studies of River Buriganga. I. Physical and chemical aspects. Dacca Univ. Studies. Pt. B., 22(2):99-113.

Islam, A.K.M.N. and J.K. Saha. 1975. Limnological studies of Ramna Lake at Dacca. Dacca Univ. Studies. Pt. B., 23(2):39-46.

Islam, A.K.M.N. and P. Sarma. 1976. Freshwater algae of Bangladesh. V. Genus *Oedogonium*. Nova Hedwigia, 27(1 & 2):425-454.

Islam, A.K.M.N. and F. Mendes. 1976. Limnological studies of Jheel in Sher-E-Bangla Nagar, Dacca. Dacca Univ. Studies. Pt. B., 24(2):63-71.

Islam, A.K.M.N. and S.N. Paul. 1977. Limnological studies on *Wolffia arhiza* (L.) Wimm. J. Asiatic Soc. Bangladesh (Sc.), 3(1): 111-123.

Islam, A.K.M.N. and N. Paul. 1978. Hydrobiological study of the haor Hakaluri in Sylhet. J. Asiatic Soc. Bangladesh (Sc.), 4(1):83-91.

Iyengar, M.O.P. 1940. On the algal flora of some muddy rain water pools. Proc. 27th Ind. Sc. Congr., 3:128.

Jackson, M.L. 1958. *Soil chemical analysis*. Prentice-Hall Inc., Englewood Cliffs, N.J., 498 pp.

Jana, B.B. 1973. Seasonal periodicity of plankton in a freshwater pond in West Bengal, India. Int. Revve ges. Hydrobiol., 58(1):127-143.

Jonasson, P.M. 1948. Quantitative studies of the bottom fauna (Biological studies on the River Susaa). Folia Limnol. Second, 4:204-284.

Jonasson, P.M. 1964. The relationship between primary production and production of profunelal bottom in vertebrates in a Danish eutrophic lakes. Verh. Internal. Verin Limnol, 14:471-479.

Jonasson, P.M. 1969. Bottom fauna and entrophicati on Eutroplucation causes, consequenses, correlatives. Natural Academy of science. Washington, D.C.:274-305.

Jonasson, P.M. 1970. Population studies on *Chironomus anthrocinus*. Proc. Adv. Study Inst. Dynamics Number Pop., 220-231.

Jonasson, P.M. 1975. Population, ecology, and production of benthic detrivores. Verh. Internat. Verien Limnol., 19:1066-1078.

Jonasson, P.M., and J. Kristiansen. 1967. Primary and secondary production in Lake Estrom. Growth of *Chironomus anthrocinus* in relation to seasonal cycle of phytoplankton and dissolved oxygen. Int. Revne. Ges. Hydrobiol., 52(2):163-217.

Johasson, P.M., and F. Thorhange. 1976. Population dynamics of *Potamothrix hammoniesis* in the profundal of lake Esrom with special reference to environmental and competitive factors. Okios, 27:193-203.

Juday, D. 1922. Quantitative studies of the bottom fauna in the water of Lake Mendota. Trans. Wis. Acad. Sci. Arts. and Lett., 20:461-493.

Juget, J. and N. Giani. 1974. Repartition des oligochaetes lacustres du massif de neoavielle (Hautes. Pyreness) avec la description. De *Peloscolex pyrenaicus* n. sp. Annals. Limnol., 10(1):33-53.

Kennedy, C.R. 1966. The life history of *Limnodrilus hoffmeisteri* Clap. (Oligochaetes: Tubificidae) and its adaptive significance. Oikos, 17:58-168.

Khalf El-Duweine, A. and S.I. Ghabbour. 1963. A study of the specific distribution of Mehadriline Oligochaetes in Egypt and its dependence on soil properties. Bull. Zool. Soc. Egypt, 18:21-30.

Khalilov, A.P. and E.A. Ahmedov. 1972. Studies on Zooplankton and Zoobenthos of Mingechawiskii Reservoir. 12V Akad nauk az SSRSER Biol. nank., 9:91-96. (In Russian)

Khan, A.A., A.Q. Siddiqui, and M. Ali. 1977. Relationship between electrical conductivity and total dissolved solids in two ponds at Aligarh. J. Asiatic Soc. Bangladesh (Sc.), 3(1):73-76.

Kharitonova, N.N. 1962. Food and food interrelationship of carp and gold fish in ponds. Trudy Ukrainskogo Nauchno - Issledovated skogo Institat Rybnog Khziaystva., 15:7-25. (In Russian)

Kitagawa, N. 1972. Studies on the bottom fauna od lakes Mizakiko, Aokiko, Nakatsunako, Nojiri-ka, and Sura-ko. Jap. J. Limnol., 34:12-23.

Krishnamurthy, K.N. 1966. Preliminary studies on the bottom macrofauna of Tungabhodra Reservoir. Proc. Indian Acad. Sci., 63:96-103.

Krishnamurthy, K.N. 1971. Preliminary studies on the bottom biota of Pulicat Lake. J. Mar. Biol. Ass. India, 13(2):1-5.

Krisnamurthy, K.P. and G. Visweswara. 1965. Hydrobiological studies in Gandhi Sagar (Jumma Tank). Diurnal variations in plankton. Hydrobiologia, 25:99-118.

Krzyzanek, E. 1973. Bottom macrofauna in Geoczalkawice dam reservoir in the years 1965-1969. Acta Hydrobiol., 15(2):189-196.

Lang, C. 1978. Factorial correspondence of analysis of oligochaeta communities according to eutrophication level. Hydrobiologia. 57:241-248.

Lellak, J. 1965. The food supply as a factor regulating the population dynamics of bottom animals. Mitt. Internat. Verein Limnol., 13:128-138.

Lellak, J. 1966. Nitrogen and hydrolysable carbohydrates in the bottom deposits of some back waters and fish ponds. Acta Universitatis Carolinae Biologia., 1:51-82.

Lellak, J. 1969. The regeneration-rate of bottom fauna populations of the fish ponds after wintering or summering. Internat. Verein. Limnol., 17:560-569.

Lenz, F. 1955. Der lago Maggiore und die. Kennziechnende Bedentung seiner boden fauna Ist. Ital. Idrobiol. Doff. Marco de Marchi., 8:183-203.

Losos, B. 1952. Contribution to hydrobiological investigations of Kniniky Dam near Brono (Moravia) Acta Academiae Scientiarum Naturatium, Moravia. 24:379-425.

Loveriolge, C.C. and D.G. Cook. 1976. A preliminary report on the benthic macroinvertebrates of Georgian Bay and North Channel. Fisheries and Marine Service. Tech. Report No. 610. 45 pp.

Macan, T.T. 1961. Factors that limit the range of fresh water animals. Biol. Rev., 36:151-198.

Macan, T.T. 1963. *Freshwater ecology*. Longrans Green & Co. Ltd., London, 338 + 10 pp.

Macan, T.T. 1964. *A Guide to Freshwater Invertebrates*. Longrans Green & Co. Ltd., London, 118 pp.

Macan, T.T. 1965. The fauna in the vegetation of a moorland fish pond. Arch. Hydrobiol., 61:273-310.

Macan, T.T. and R. Maudsley. 1966. The temperature of a moorland fish pond. Hydrobiol., 27:(1-2):1-22.

Macan, T.T. and A. Kitching. 1972. Some experiments with artificial substrata. Verh. Internat. Verein. Limnol., 18:213-220.

Mandal, B.N. and S.K. Moitra. 1975. Studies on the bottom fauna of a freshwater fish pond at Burdwan. J. Int. Fish. Soc. India, 7:43-48.

Mathew, P.M. 1975. Limnology and productivity of Govindgarh Lake, Rewa, Madha Pradesh. J. Inland Fish. Soc., India, 16-24.

Mayer, K. 1934. Die Nahrung der Ceratopogoniden larven (Dipt.) Arch. Hydrobiol., 27:564-570.

McLachlan, A.J. and S.M. McLachlan. 1971. Benthic fauna and sediments in the newly created Lake Karibal Central Africa. Ecology, 52(5):800-809.

Mellanby, H. 1963. *Animal life in Freshwater.* 6th ed. Cox & Wyman Ltd., Fakenham, 308 pp.

Michael, R.G. 1968a. Seasonal trends in Physico-chemical factor and their role in fish culture. Hydrobiologia, 13:144-160.

Michael, R.G. 1968b. Studies on the bottom fauna in a tropical freshwater fish pond. Hydrobiologia, 13:203-230.

Moffet, J.W. 1943. Limnological investigation of the dynamics of a sandy wave swept shool in Doughas Lake, Michigan. Trans. Amer. Microsp. Soc. 62:1-23.

Moore, G.M. 1950. Limnological studies of Louisiana Lake. I. Lake Providence. Ecol., 31:86-99.

Mortimer, B. 1938. The nitrogen balance of large quantities of water. Publ. Health Congress and exhibition, 1-10.

Mortimer, C.H. 1941. The exchange of dissolved substances between mud and water in lakes. J. Ecol., 30:280-329.

Munawar, M. 1970. Limnological studies on freshwater ponds of Hyderabad, India. I. The biotope. Hydrobiologia, 35(1):127-162.

Mundie, J.H. 1959. The diurnal activity of the larger invertebrate at the surface of lac La Ronge, Saskatchewan. Canadian J. Sool., 37:945-956.

Muttowski, R.A. 1918. The bottom fauna of lake Mendota - a qualitative and quantitative survey with special reference of insects. Tran. Wis. Acad. Sci. Arts. and Lett., 19:374-482.

Naidu, K.V. 1962. Studies on the freshwater oligochaetes of South India. I. Aelosomatidae and Naididae port 2-4. J. Bombay Nat. Hist. Soc., 59:131-145, 520-546, 897-921.

Naidu, K.V. 1965. Studies on the freshwater oligochaete of South India. II. Tubificidae. Hydrobiologia, 26:463-483.

Nelder, K.H. and R.W. Pennak. 1955. Seasonal faunal variations in a Colorado alpine pond. Amer. Midl. Nat., 53:419-430.

Northcote, T.G. and P.A. Larkin. 1956. Indices of productivity in British Columbia Lakes. J. Fish Res. Board. Can., 13(4):515-540.

Northcote, T.G. and R. Clarotto. 1975. Limnotic macrozooplankton and fish predation in some coastal British Columbia Lakes. Verh. Internat. Verein. Limnol., 19:2378-2393.

Ohle, W. 1938. Die Bedentung cler Austrauschrorgange Schlamn und Wasser fur den Stoffkeislaef der Gerwasser. Vom Wasser., 13:87-97. (In German)

Oppenhiemer, J.R., M.G. Ahmed, A. Haque, K.A. Haque, A.K.M. Ashraf-ul Alam, K.M.S. Aziz, S. Ali, and M. Haque. 1978. Limnological studies of three ponds in Dacca Bangladesh. J. Fisheries, Bangladesh, 1:1-20.

Parshad, B. 1961. The seasonal conditions governing the pond life in the Punjab. J. Asiatic Soc. Beng., 12:142-145.

Paterson, C.G. and C.H. Fernando. 1969a. The macroinvertebrate colonization of a small reservoir in Eastern Canada. Verh. Internat. Verein Limnol., 17:126-136.

Paterson, C.G. and C.H. Fernando. 1969b. Macroinvertebrate colonization of the marginal zone of a small impoundment in Eastern Canada. Can. J. Zool., 47:1229-1238.

Patnaik, S. 1971. Seasonal abundance and distribution of bottom fauna of Chilka Lake. J. Mar. Biol. Ass. India, 13:(1):106-125.

Pearsall, W.H. 1923. A theory of diatom periodicity. J. Ecol., 11-12:165-183.

Pearsall, W.H. 1930. Phytoplankton in the English Lakes. I. The proportion in the water of some dissolved substances of biological importance. J. Ecol., 18:306-320.

Pearson, E.S. and H.O. Heartley. 1958. *Biometrika Table for Statisticians*. Vol. I, 2nd ed. Cambridge University Press, 240 pp.

Petersen, W. 1926. Seasonal succession of animals in a Characattail pond. Ecol., 7:371-377.

Philipose, M.T. 1940. The ecology and seasonal succession of algae in a permanent pool at Madras. M.Sc. Thesis. Madras Univ., 220 pp.

Poddubanaya, T.L. 1962. Consumption of Tubificidae by fish. Problems of Ichthyology. 2:560-562.

Pruthi, H.S. 1933. Studies on the bionomics of freshwater of India. I. Seasonal changes in the physical and chemical conditions of water of the tank in the Indian Museum compounel. Int. Rev. Hydrobiol., 28:46-67.

Pupkov, V.A.K. 1972. Kharakteristike sezonnoi dinaniki chislennostii. Vestn. Zool., 6(3):82-85. (In Russian)

Raman, K., R.R. Ghosh, and D.K. Chatterjee. 1975. Studies on the ecology of fish ponds with special reference to bottom fauna. J. Inland Fish. Soc. India, 3:79-102.

Rao, C.B. 1955. On the distribution of algae in a group of six ponds. II. Algal periodicity. J. Ecol., 41:291-308.

Rao, V.S. 1971. An ecological study of the three fish ponds of Hyderabad, India. I. The environment. Hydrobiologia, 36:213-223.

Rawson, D.S. 1930. The bottom fauna of Lake Simcoe and its note in the ecology of the Lake. Univ. Toronto Stud. Pub. Ont. Fish Res. Lab., 40:1-183.

Ricker, W.E. 1952. The benthos of cultus lake. J. Fish. Res. Board Can., 9(4):204-212.

Ruttner, F. 1952. Plankton studien der Dentschen Limnologischen Simoa Expedition. Arch. Hydrobiol. Suppl. 21):161 pp. (In German)

Ruttner, F. 1953. *Fundamentals of Limnology*. University of Toronto Press. Toronto, 242 pp.

Saha, G.N., K.L. Sehgal, E. Mitra, and A.C. Nandy. 1971. Studies on the seasonal and diurnal variations in physico-chemical and biological conditions of a perennial freshwater pond. J. Inland Fish. Soc. India, 3:79-102.

Sarker, H.L., and H. Rai. 1964. The limnology of Suraj Kund, India. I. Physico-chemical condition and plankton. Trans. Amer. Microsc. Soc., 83:260-266.

Satyamurti, S.T. 1960. *The Land and Freshwater Mollusca.* Bull. of the Madras Government Museum. Govt. of Madras, 174 pp.

Schaeperclaus, W. 1933. *Text Book of Pond culture.* U.S. Fish Wildl. Serv. New York, 261 pp.

Seenayya, G. 1971. Ecological studies in the plankton of certain freshwater ponds of Hyderabad, India. I. Physico-chemical complexes. Hydrobiologia, 35(1):7-31.

Sepers, A.B.J. 1977. The utilization of dissolved organic compound in aquatic environments. *Ibid.*:52(1):39-54.

Sewell, R.B.S. 1934. Studies on the bionomics of fresh waters in India. II. Int. Rev. Geg. Hydrobiol. V. Hydrogr., 31:203-238.

Singh, V.P. 1960. Phytoplankton ecology of the inland waters of Uttar Pradesh. Proc. Symp. Algol. ICAR. New Delhi, 243-271.

Sitaramaiah, P. 1966. Studies on the ecology of fresh water pond community. Hydrobiologia, 27:523-547.

Sivertsen, B. 1973. Bottom fauna of Lake Huddingsvatn, based on quantitative sampling. Norw. J. Zool., 21:303-327.

Solem, J.O. 1973. The bottom fauna of Lake Little Jonsvann Trondelag, Norway. J. Zool., 21:227-261.

Sreenivasan, A. 1967. Application of limnology and primary productivity studies in fish culture. FAO Fish Report, 44(3):103-113.

Sreenivasan, A. 1968. The limnology of and fish production in two ponds in Chingle pat (Madras). Hydrobiologia, 32:131-144.

Srivastava, V.K. 1956. Benthic organisms of a freshwater fish tank. Curr. Sci., 5:158-159.

Srivastava, V.K. 1959. Studies of freshwater bottom fauna II, Qualitative composition and variation of the available food supply for fishes. Proc. Acad. Sci. India, 29:207-216.

Stahl, J.B. 1966. Coexistence of *Chaoborus* and its ecological significance. Invt. Indiana Lakes and Streams, 7:99-113.

Stangenberg, M. 1949. Nitrogen and carbon in the bottom deposits of lakes and in the soils under carp. ponds. Verh. Internal. Verein Limnol., 10:422;437.

Stephenson, W. 1951. Preliminary observation upon the release of phosphate from estuarine mud. Proc. Indo-Poc. Fish. Coun., Sect. 3:184-189.

Sumitra, V. 1973. A comparative account of the soil-water relationship in three tropical ponds. Indian J. Fish., 20(2):617-623.

Taeesh, M.R.A. 1910. Tawarikh - i - Dhaka. Dacca 302 pp.

Tebo, L.B. 1955. Bottom fauna of a shallow entrophic lake, Lizard Lake, Pocahwtas Country. Iowa Amer. Midl. Nat., 54:89-103.

Thienemann, A. 1954a. Tropical freshwater plankton. Symposium on Marine and Freshwater plankton in Indo-Pacific. Indo-Pac. Fish. Com. Bangkok, 85-86.

Tienemann, A. 1954b. Chironomus Laben, Verbreitung und Wirtschftliche Bedntung der Chironomiden. Die Binnenge Waasser., 20:1-834.(In German)

Thorup, J. 1966. Substrate type and its value as a basic for the determination of bottom fauna community in running waters. Special publication No. 4. Pymatuning Laboratory of Ecology, Univ. Pittsburg:59-74.

Thorup, J. 1970. The influence of a short termed flood on a spring-book community. Arch. Hydrobiol., 66(4):447-457.

Thut, R.N. 1969. A systematic study of the profundal bottom fauna of Lake Washington. Ecol. Monogr., 39(1):79-100.

Timms, B.V. 1974. Morphology and benthos of three volvanic lakes in the Mt. Gambier District, South Australia. Aust. J. Mar. Freshwater Res., 25:287-297.

Tressler, W.L., L.R. Tiffany and W.P. Spencer. 1940. Limnological studies of Buckeye Lake, Ohio. Ohio. J. Sci., 40:261-290.

Truog, E. 1930. The determination of readily available phosphorus of soils. J. Amer. Soc. Agron., 23:874-882.

Vaas, K.F. and A. Vaas-van-Ovan. 1959. Studies on the production of natural food in Indonesian carp ponds. Hydrobiologia, 12: 308-392.

Vallentyne, J.R. 1957. The molecular nature of organic in lakes and oceans with lesser reference to sewage and terrestrail soils. J. Fish. Res. Board Can., 14:33-82.

Walshe, B.M. 1947. Feeding habits of certain chironomid larvae (Sub-family Tendipedinae) Proc. Zool. Soc. Lond., 121(1):63-79.

Ward, H.B. and G.C. Whipple. 1963. *Freshwater Biology*. 2nd ed. John Wiley & Sons, Inc., New York, London, 1248 pp.

Webb, D.W. 1965. Limnological features of Cedar Lake, Manitoba J. Fish. Res. Board Can., 5:1123-1136.

Welch, P.S. 1952. *Limnology*. McGraw-Hill Book Co. Inc., New York, 538 pp.

Wojcik, S. 1970. An attempt at a quantitative evaluation of Chironomidae larvae in lake Warniak. Acta Hydrobiol., 12(2-3):309-323.

Young, J.O. 1974. Life cycles of some invertebrate taxa in a small pond together with change in their numbers over a period of three years. Hydrobiologia, 45(1):63-90.

Young, J.O. 1975. Laboratory study using 45 Ca tracer, on the source of calcium during growth in two freshwater species in gastropoda. Proc. Malac. Soc. Law, 41:439-445.

Zafar, A.R. 1964. On the ecology of algae in certain fish pond of Hyderabad, India I. Physico-chemical complex. Hydrobiologia, 23:179-195.

Zafar, A.R. 1966. Limnology of Hussain Sugar Lake, Hyderabad, India. Phykos., 5(1-2):115-216.

Appendix 1 : Showing the abundance per meter square of different groups of benthic macroinvertebrates at three depths in SH pond for the year 1976.

Dates	A								B					C					Grand Total
	Oligo.-	Chiro-.	Molluscs	Mites	Ostra-.	Leech	Other	Total	Oligo-.	Chiro-.	Molluscs	Other	Total	Oligo-.	Chiro-.	Chao-.	Other	Total	
13.1.76	5462	220	88	-	-	44	88	5902	44	88	132	44	308	-	44	220	88	352	6562
10.2.76	4444	6590	308	-	1300	-	616	13558	220	88	396	-	704	-	88	132	-	220	14482
9.3.76	1320	9780	396	-	880	44	220	12640	308	-	484	-	792	-	-	-	-	-	13212
5.4.76	3562	4970	484	-	308	-	132	9456	880	-	-	-	880	-	-	-	-	-	10336
7.5.76	1584	880	618	-	-	-	176	3258	484	-	-	-	484	132	-	44	-	176	3918
26.5.76	44	-	484	44	-	-	-	572	3608	88	1936	44	5676	22	-	-	-	22	6270
15.6.76	88	-	704	-	-	-	-	792	176	-	1056	-	1232	88	-	-	-	88	2112
25.6.76	1936	132	44	-	-	-	308	2420	264	88	1496	-	1848	88	-	132	-	220	4488
12.7.76	616	44	792	-	-	-	132	1584	440	-	1232	-	1672	264	-	176	-	440	3696
26.7.76	1232	484	1012	-	-	-	220	2948	4752	44	2904	-	7700	-	-	44	-	44	10692
10.8.76	1364	88	44	-	-	-	88	1584	13772	-	396	-	14168	44	-	308	-	352	16104
25.8.76	88	176	1276	-	-	-	-	1540	792	-	1276	-	2068	264	88	88	-	440	4048
10.9.76	220	-	308	-	-	-	44	572	2508	44	1628	44	4224	-	-	88	-	88	4884
25.9.76	528	-	835	-	-	-	44	1408	4620	-	3520	-	8140	44	-	44	-	88	9636
10.10.76	3256	44	440	-	-	-	-	3740	2904	-	2288	-	5192	-	-	88	-	88	9020
25.10.76	484	-	528	-	-	-	-	1012	2728	88	1276	-	4092	88	-	352	-	440	5544
24.11.76	9372	528	308	-	-	-	-	10208	1944	352	482	-	1758	-	-	308	-	308	12274
11.12.76	5016	1144	176	-	-	-	132	6468	1320	792	308	88	2464	1144	88	924	-	2156	11088
27.12.76	8492	5256	1144	-	-	-	44	14936	1234	700	132	-	1976	352	172	704	-	1228	1814[illegible]

Appendix 2 : Showing the abundance per meter square of different groups of benthic macroinvertebrates at three depths in SH pond for the year 1977.

Dates	A								B					C					Grand Total
	Oligo-.	Chiro-.	Molluscs	Ostra-.	Mites	Leech	Other	Total	Oligo-.	Chiro-.	Molluscs	Other	Total	Oligo-.	Chiro-.	Chao-.	Other	Total	
31.1.77	7744	4356	1584	-	-	-	132	13816	528	618	132	-	1278	132	-	-	-	132	15226
10.2.77	3129	9812	264	924	-	-	662	14789	396	1936	220	44	2596	176	484	132	-	792	18128
23.2.77	3476	9416	528	308	88	-	836	14652	308	1584	176	-	2068	44	308	308	-	660	17480
14.3.77	2772	6468	220	-	-	44	88	9592	748	924	396	44	2112	-	-	-	-	-	11704
25.3.77	6072	4972	968	44	268	-	132	12456	440	968	484	-	1892	-	-	176	-	176	14524
4.4.77	7876	4972	1056	-	44	44	132	14124	748	1100	352	-	2200	88	-	-	-	88	15412
28.4.77	4444	3960	2552	220	572	-	88	11836	1584	1012	1452	44	4092	44	-	176	-	220	16148
7.5.77	3564	792	1082	-	-	-	-	5438	3124	308	880	44	4356	-	-	528	-	528	10322
28.5.77	572	132	1848	88	-	-	220	2760	3740	484	2024	-	6248	-	-	44	-	44	9052
29.6.77	88	44	1232	-	-	-	44	1408	7084	264	2024	88	9372	-	-	88	-	88	10868
6.7.77	4356	88	3960	-	-	-	44	8448	4796	-	2156	44	6996	-	-	220	-	220	15664
26.7.77	8008	176	1408	-	-	-	-	9592	3608	-	1804	-	5412	-	-	-	-	-	15004
12.8.77	6204	132	3080	-	-	-	88	9504	5324	88	264	-	5676	-	-	264	-	264	15444
5.9.77	2596	-	1364	-	-	-	-	3960	2552	88	2288	-	4928	-	-	132	-	132	9020
26.9.77	1144	-	2772	-	-	-	-	3916	3872	-	2200	-	6028	-	-	264	-	264	10208
11.10.77	1408	44	3300	-	-	-	-	4752	2904	-	1300	-	4224	-	-	394	-	394	9370
25.10.77	6952	880	924	-	-	-	-	8756	4180	-	660	-	4840	-	-	968	-	968	14574
14.11.77	5588	132	660	176	-	-	44	6600	3256	88	396	44	3784	-	-	264	-	264	10648
12.12.77	5676	396	1100	-	-	44	176	7392	1716	836	440	-	2992	88	44	792	-	924	11308

Appendix 3 : Showing the abundance per meter square of different groups of benthic macroinvertebrates at three depths in PG pond for the year 1976.

Dates	A										B					C					Grand Total
	Oligo-.	Chiro-.	Mollu-.	Mites	Ostra-.	Leech	Plano-.	Odona-.	Other	Total	Oligo-.	Chiro-.	Mollu-.	Other	Total	Oligo-.	Chiro-.	Chao-.	Other	Total	
4.1.76	10076	5896	308	-	-	-	-	-	-	16280	2244	748	-	44	3036	440	308	-	88	836	20152
24.1.76	7652	7348	220	528	1760	-	176	44	616	18344	572	484	-	132	1188	308	132	-	44	484	20014
7.2.76	6890	9580	134	1780	2500	-	-	88	220	21192	220	3720	-	220	4160	-	-	-	-	-	25350
12.3.76	8520	12080	88	968	572	44	-	44	88	22404	1408	1672	-	88	3168	220	88	-	-	308	25880
7.4.76	5676	1936	220	-	-	-	-	-	88	7920	1848	962	-	-	2810	-	-	-	-	-	10730
30.4.76	7744	-	308	-	-	-	-	-	88	8140	2466	-	-	-	2466	-	-	-	44	44	10610
15.5.76	2552	660	308	220	-	44	-	-	88	3872	1936	-	-	44	1980	-	-	-	-	-	5392
24.5.76	4796	1496	44	176	-	-	-	132	968	7612	4312	-	-	-	4312	-	-	132	-	132	12056
10.6.76	352	44	-	-	-	132	-	176	396	1100	5720	6160	44	88	12012	88	88	-	-	176	13288
22.6.76	572	-	132	132	-	-	-	88	-	924	8316	264	176	-	8756	88	88	176	-	352	10032
7.7.76	9108	308	1408	-	-	44	132	176	-	11176	9100	264	440	88	9892	44	-	176	-	220	21288
22.7.76	18128	132	2684	-	-	-	-	44	88	21076	9020	220	264	-	9504	-	-	1100	-	1100	31680
5.8.76	9196	308	1936	-	-	-	-	-	88	11528	4092	44	660	-	4796	-	-	44	-	44	16368
22.8.76	6116	572	2508	-	-	-	220	484	-	9900	11748	220	1672	220	13860	-	-	572	-	572	24332
7.9.76	19536	176	2816	-	-	-	44	308	-	22880	6776	132	1980	88	8976	-	-	264	-	264	32164
22.9.76	19184	-	528	-	-	-	-	44	-	19756	6864	-	1452	-	8316	-	-	308	-	308	28380
7.10.76	4790	-	1452	-	-	-	-	44	-	6286	9020	-	1144	-	10164	-	-	308	-	308	16820
22.10.76	4092	-	968	-	-	-	-	44	-	5104	13684	-	1804	-	15488	-	-	440	-	440	21032
7.11.76	4576	-	1232	-	1892	-	968	176	44	8888	15444	-	880	-	16324	-	-	352	-	352	25564
9.12.76	15180	-	1012	-	-	-	-	44	-	16236	4356	-	-	-	4356	-	-	352	-	352	20944
22.12.76	32516	44	1188	-	-	-	-	176	-	33924	9944	-	-	-	9944	-	-	2024	-	2024	45892

Appendix 4 : Showing the abundance per meter square of different groups of benthic macroinvertebrates at three depths in PG pond for the year 1977.

Dates	A										B					C					G.Total
	Oligo-.	Chiro-.	Mollu-.	Mites	Ostra-.	Leech	Planor-.	Odona-.	Other	Total	Oligo-.	Chiro-.	Mollu-.	Other	Total	Oligo-.	Chiro-.	Chao-.	Other	Total	
10.1.77	23760	176	1408	-	-	-	-	44	-	25388	14652	-	132	-	14784	-	-	1672	-	1672	41844
7.2.77	22836	1980	572	-	-	-	-	88	88	25564	7128	-	-	-	7128	-	-	1012	-	1012	33704
17.2.77	19580	484	1100	-	-	-	-	44	44	21252	4090	220	-	44	4354	-	-	308	-	308	25906
1.3.77	9240	704	132	-	-	-	-	-	44	10120	10516	-	-	-	10516	-	-	44	-	44	20680
13.3.77	7568	15752	478	308	-	88	-	44	44	24552	7128	132	-	44	7304	-	-	44	-	44	31900
2.4.77	31384 (21384)	3256	176	44	-	-	-	44	-	24904	12760	4796	-	88	17644	-	-	-	-	-	42548
16.4.77	13860	172	88	-	-	44	-	-	-	14164	7120	2816	44	-	9980	-	-	-	-	-	24144
6.5.77	20988	1364	4180	-	-	352	-	-	-	26884	12496	176	396	44	13112	-	-	396	-	396	40392
26.5.77	12408	176	2288	-	-	352	-	44	-	15268	16144 (16148)	396	1276	88	17908	88	-	616	-	704	33880
25.6.78	13420	-	5984	-	-	88	-	-	-	19492	16632	-	484	44	17160	-	-	1012	-	1012	37664
5.7.77	20944	-	5720	-	-	-	44	-	-	26708	8888	44	1056	-	9988	-	-	-	-	-	36652
28.7.77	4224	-	5324	-	-	-	-	-	-	9548	11660	44	1408	88	13200	-	-	44	-	44	22792
10.8.77	9504	-	2772	-	-	-	-	220	44	12540	13992	-	1144	-	15136	-	-	88	-	88	27764
20.8.77	8052	-	4752	-	-	44	-	44	-	12892	12188	-	1672	-	13860	-	-	88	-	88	26840
8.9.77	13112	-	4756	-	-	-	-	-	-	17688	1804	-	1672	-	3476	-	-	44	-	44	21208
28.9.77	15312	176	11616	1848	-	-	-	-	-	28952	3432	-	7480	264	11176	-	-	-	-	-	40128
6.10.77	1804	-	10076	528	968	-	-	-	-	13376	5940	88	2596	-	8624	-	-	-	-	-	22000
29.10.77	6512	88	3256	660	44	-	-	44	-	10604	12188	88	836	-	13112	-	-	-	-	-	23672
10.11.77	880	544	220	528	-	44	-	44	-	2260	8008	-	176	132	8316	-	-	-	-	-	10576
14.1277	1188	880	660	44	924	-	44	528	44	4312	9196	-	528	44	9768	88	-	88	-	176	14256

Appendix 5 : Showing the abundance per meter square of different groups of benthic macroinvertebrates at three depths in SB pond for the year 1976.

Dates	A										B					C					Grand
	Oligo-.	Chiro-.	Mollu-.	Mites	Planor-.	Odona-.	Ostra-.	Leech	Other	Total	Oligo-.	Chiro-.	Mollu-.	Other	Total	Oligo-.	Chiro-.	Chao-.	Other	Total	Total
15.1.76	39462	-	1364	15400	-	-	1364	44	-	57634	1188	220	220	440	2068	220	-	88	220	528	60230
30.1.76	36722	1672	3432	2860	-	-	2640	-	-	47326	836	132	-	176	1144	264	132	-	44	440	48910
15.2.76	50560	1850	-	5920	-	220	5240	-	220	64010	5980	850	-	-	6830	440	-	-	-	440	71280
15.3.76	31230	8920	-	10920	-	360	8790	-	440	60660	2120	1720	-	-	3840	-	-	-	-	-	64500
15.4.76	24816	10164	352	22440	-	44	14950	-	-	72766	-	-	-	968	968	-	-	-	132	132	73866
30.4.76	27804	12462	880	19890	-	-	12980	-	-	74016	660	854	44	-	1558	88	88	264	-	440	76014
18.5.76	23232	9064	176	14300	3168	264	1276	-	176	51656	264	-	-	308	572	88	-	-	-	88	52316
30.5.76	10340	264	88	3212	1144	-	3608	44	44	18744	836	132	88	88	1444	-	-	-	-	-	19888
16.6.76	1144	44	-	88	-	-	1056	-	88	2420	18260	572	220	1212	20284	88	-	-	-	88	22792
30.6.76	6512	2420	308	308	1804	-	1012	44	44	12452	10824	11267	1452	2200	25738	-	-	-	-	-	38188
15.7.76	32560	264	352	264	264	-	3344	-	-	37048	14124	1056	1364	44	16588	-	-	-	-	-	53636
31.7.76	220	6996	176	1892	44	220	880	-	-	10428	1012	44	132	-	1188	-	-	44	-	44	11660
16.8.76	3344	44	-	220	-	132	880	-	-	4620	4664	3168	132	264	8228	-	-	-	-	-	12848
31.8.76	14476	13112	1276	352	6368	-	792	44	-	36420	11396	396	528	44	12364	-	-	-	-	-	48784
15.9.76	4488	27016	968	528	44	-	-	-	-	33044	19712	220	924	748	21604	-	-	132	-	132	54780
30.9.76	616	1364	132	704	836	308	2200	-	308	6468	8272	-	176	308	8756	-	-	88	-	88	15312
30.10.76	17248	396	3168	220	1100	-	748	132	132	23144	2068	-	132	-	2200	-	-	-	-	-	25344
30.11.76	25872	396	220	-	-	-	704	-	-	27192	23320	-	440	-	2772	-	-	-	-	-	44176
17.12.76	27456	5806	1012	1540	-	-	-	-	-	35816	8096	44	220	-	8360	-	-	-	-	-	44176
28.12.76	15048	12848	44	3124	-	-	308	-	-	31372	21384	1980	1628	-	24992	-	-	-	-	-	56364

Appendix 6 : Showing the abundance per meter square of different groups of benthic macroinvertebrates at three depths in SB pond for the year 1977.

Dates	A										B					C					
	Oligo-.	Chiro-	Mollu-.	Mites	Plano-.	Odona-	Ostracoda	Leech	Others	Total	Oligo-.	Chiro-.	Mollu-.	Others	Total	Oligo-.	Chiro-.	Chao-	Other	Total	G.Total
19.1.77	13216	19976	-	1320	-	-	572	-	132	35212	16104	6028	616	44	22792	-	-	-	-	-	58004
14.2.77	20970	44748	-	528	-	-	264	196	572	67258	16500	8316	-	44	24860	-	-	-	-	-	92118
28.2.77	10912	32912	44	704	-	-	352	-	-	44924	11352	3520	-	-	14872	-	-	-	-	-	59796
15.3.77	15310	55000	-	6028	-	-	704	264	44	77352	1408	-	-	44	1452	-	-	-	-	-	78804
30.3.77	4840	31196	-	6820	-	-	660	-	264	43780	220	-	-	-	220	-	-	-	-	-	44000
8.4.77	5588	34540	88	23980	-	-	-	88	-	64284	8360	17292	-	132	25784	-	-	-	-	-	90068
29.4.77	43032	264	176	11484	-	4.4	4840	-	-	59840	132	-	-	484	616	-	-	-	-	-	60456
9.5.77	31768	308	358	358	-	-	2728	-	-	35520	-	-	-	-	-	-	-	-	-	-	35520
31.5.77	31460	-	440	792	396	-	704	132	44	33968	968	-	44	-	1012	-	-	44	-	44	35014
22.6.77	35376	1232	792	1056	44	-	2200	44	-	40744	9416	616	88	44	10164	44	-	-	-	44	50952
7.7.77	24464	132	1892	2156	44	88	1364	132	-	30272	19536	-	572	-	20108	-	-	-	-	-	50380
30.7.77	352	44	4752	176	-	-	88	-	-	5412	17204	-	44	132	17380	-	-	-	-	-	22792
18.8.77	8492	-	6600	8932	88	88	5148	-	44	29392	21516	-	968	44	22528	-	-	44	44	88	52008
9.9.77	25652	88	1408	176	264	88	1672	-	-	29348	23012	-	660	44	23716	-	-	352	352	704	53396
30.9.77	42328	-	1672	264	176	-	836	-	-	45276	23936	44	88	-	24068	-	-	-	-	-	69344
14.10.77	24205	44	132	-	-	44	44	-	-	24464	21824	44	-	88	21956	-	-	-	-	-	46420
31.10.77	46464	308	396	-	220	-	528	-	-	47916	20504	220	132	-	20856	-	-	264	264	528	69036
15.11.77	26972	396	924	44	-	88	44	44	44	28556	12188	308	693	44	13233	-	-	44	44	88	41833
22.12.77	1012	10296	440	308	-	-	-	132	-	12188	6688	5412	-	-	12100	88	-	1320	4452	1452	25740

Appendix 7 : Showing the weight of different groups of macroinvertebrates in g/m^2 at depths A, B and C of SH pond for the year 1976.

Dates	A										B					C				Grand Total
	Oligo-.	Chiro-.	Mollu-.	Mites	Ostra-.	Plano-.	Leech	Odona-.	Others	Total	Oligo-.	Chiro-.	Mollu-.	Others	Total	Oligo-.	Chiro-.	Chao-.	Total	
10.1.76	7.123	.13	2.02	-	-	-	.09	-	.082	9.45	.008	.006	1.27	.05	1.33	.68	.026	.064	.777	11.56
10.2.76	7.71	2.07	2.38	-	.009	-	-	-	.23	12.39	.008	.004	4.36	-	4.36	-	.053	.03	.08	16.84
9.3.76	1.75	2.56	42.19	-	.007	-	.069	-	.13	46.706	.01	-	3.92	-	3.93	-	-	-	-	50.64
5.4.76	2.42	1.69	6.47	-	.002	-	-	.3	.106	10.99	.12	-	-	-	0.12	-	-	-	-	11.11
7.5.76	1.21	.19	4.998	-	-	-	-	.47	-	6.868	.0193	-	-	-	.0193	.0299	-	.012	.042	6.93
26.5.76	.01	-	21.47	.0007	-	-	-	-	-	21.48	1.82	3.52	292.51	.132	297.98	.0001	-	-	.0001	319.46
15.6.76	.02	-	91.67	-	-	-	-	-	-	91.69	.08	-	513.26	-	513.34	.053	-	-	.053	605.08
25.6.76	1.12	.07	.42	-	-	-	-	.46	-	2.07	.12	.04	425.09	-	425.25	.05	-	.03	.08	427.40
12.7.76	.24	.09	37.71	-	-	-	-	.73	.001	38.77	.02	-	62.96	-	62.98	.05	-	.04	.09	101.84
26.7.76	.10	.13	40.20	-	-	-	-	.43	.46	41.32	6.17	.25	410.8	-	417.22	-	-	.02	.02	458.56
10.8.76	.28	.03	4.97	-	-	-	-	-	.38	5.66	8.38	-	48.05	-	56.43	.008	-	.07	.08	62.17
25.8.76	.005	.106	88.96	-	-	-	-	-	-	89.07	.32	-	154.96	-	155.28	.05	.05	.019	.12	244.47
10.9.76	.01	-	43.12	-	-	-	-	.09	-	43.22	2.96	.09	319.74	.08	322.87	-	-	.02	.02	366.11
25.9.76	.07	-	24.09	-	-	-	-	.33	-	24.49	6.58	-	319.77	-	326.35	.008	-	.01	.018	350.86
10.10.76	.98	.21	149.75	-	-	-	-	-	-	150.94	1.81	-	210.1	-	211.91	-	-	.01	.01	362.86
25.10.76	.08	-	17.98	-	-	-	-	-	-	18.06	2.93	.17	274.67	-	277.77	.01	-	.08	.09	295.92
24.11.76	13.08	.36	14.29	-	-	-	-	-	-	27.73	1.81	.27	80.44	-	82.52	-	-	.08	.08	110.33
11.12.76	5.61	52	3.85	-	-	-	-	-	-	10.45	.89	.50	37.58	.02	38.99	.55	.17	.36	1.08	50.52
27.12.76	11.75	1.63	48.92	-	-	-	-	-	.16	62.46	.3	.24	23.39	-	23.93	.04	.1	.36	.51	86.89

Appendix 8 : Showing the weight of different groups of macroinvertebrates in g/m^2 at depths A, B and C of SH pond for the year 1977.

Dates	A										B					C				Grand Total
	Oligo-.	Chiro-.	Mollu-.	Mites	Ostraco-.	Plano-.	Leech	Odonata	Others	Total	Oligo-.	Chiro-.	Mollu-.	Others	Total	Oligo-.	Chiro-.	Chao-.	Total	
13.1.77	10.14	2.61	46.00	-	-	-	-	-	.49	59.24	.54	.37	2.11	-	3.02	.05	-	-	.05	62.31
10.2.77	7.30	5.98	12.95	-	.01	-	-	.42	2.52	29.18	.05	1.38	40.30	.09	41.82	.05	.29	.04	.38	71.38
23.2.77	6.70	5.55	150.31	.00005	.005	-	-	-	2.97	165.65	.4	.85	63.00	-	64.25	.001	.18	.08	.26	230.16
14.3.77	1.55	1.62	2.33	-	-	-	.09	-	.39	5.98	2.49	.40	150.48	.13	153.5	-	-	-	-	159.48
25.3.77	3.05	1.09	16.45	.009	.0005	-	-	-	.21	20.81	.39	.25	46.92	-	47.56	-	-	.04	.04	68.41
4.4.77	10.13	1.09	17.95	.0002	-	-	.07	-	.29	29.53	.30	.32	19.53	-	20.15	.02	-	-	.02	49.70
28.4.77	1.45	.87	105.66	.02	.002	-	-	.46	-	108.46	1.29	.34	68.97	.06	70.66	.08	-	.04	.12	179.24
7.5.77	2.50	.32	192.41	-	-	-	-	-	-	195.23	1.82	.10	46.77	.06	48.75	-	-	.14	.14	244.12
28.5.77	.04	.08	37.97	-	.0007	-	-	1.47	-	39.56	2.39	.116	22.51	.04	25.05	-	-	.01	.01	64.63
29.6.77	.02	.01	46.06	-	-	-	-	.44	-	46.53	3.92	.08	193.17	.02	197.19	-	-	.03	.03	243.75
6.7.77	7.30	.10	376.87	-	-	-	-	.25	-	384.52	7.80	-	240.26	.0009	248.06	-	-	.05	.05	632.63
26.7.77	3.05	.05	177.64	-	-	-	-	-	-	180.74	2.66	-	225.90	-	228.56	-	-	-	-	409.30
12.8.77	5.00	.14	152.18	-	-	-	-	.85	-	158.17	2.27	.08	34.14	-	41.49	-	-	.068	.068	199.73
5.9.77	3.63	-	235.13	-	-	-	-	-	-	238.76	1.84	.03	535.52	-	537.39	-	-	.034	.034	776.184
26.9.77	2.56	-	468.64	-	-	-	-	-	-	471.20	3.75	-	414.74	-	418.49	-	-	.068	.068	889.76
11.10.77	.99	.03	1898.06	-	-	-	-	-	-	1899.08	5.81	-	732.99	-	738.80	-	-	-	-	2637.88
25.10.77	6.81	.24	553.74	-	-	-	-	-	-	560.78	6.57	-	365.94	-	372.52	-	-	.25	.25	933.55
14.11.77	3.70	.05	341.35	-	.002	-	-	.35	-	345.45	6.29	.01	266.11	.08	272.49	-	-	.07	.07	618.01
12.12.77	7.45	.2	77.61	-	-	-	.09	1.39	-	86.73	1.46	.5	127.6	-	129.56	-	-	.24	.24	216.53

Appendix 9 : Showing the weight of different groups of macroinvertebrates in g/m^2 at depths A, B and C of PG pond for the year 1976.

Dates	A										B					C					Grand
	Oligo-.	Chiro-.	Mollu-.	Mites	Ostraco-.	Plano-.	Leech	Odonata	Others	Total	Oligo-.	Chiro-.	Mollu-.	Others	Total	Oligo-.	Chiri-.	Chao-	Other	Total	Total
4.1.76	5.47	1.17	36.63	-	-	-	-	-	-	42.27	1.03	.149	-	.013	1.19	.026	.06	-	2.11	2.2	46.66
24.1.76	9.18	1.47	17.71	.00095	.228	.0017	-	.066	.067	28.72	.034	.096	-	.0017	.1317	.0184	.026	-	.0057	.050	28.90
7.2.76	14.30	2.20	3.43	.0040	.0243	-	.048	.8184	.042	20.91	.0462	.78	-	.0017	.827	-	-	-	-	-	21.73
13.3.76	5.92	2.65	2.28	.00096	.0004	-	-	.27	.20	11.32	1.23	..51	-	.176	1.916	.0088	.026	-	-	.034	13.27
7.4.76	9.08	-	7.92	-	-	-	-	-	.264	17.264	.8873	-	-	-	.548	-					18.70
30.4.76	10.84	-	8.50	-	-	-	-	-	.029	19.369	.63	-	-	-	.63	-	-	-	.072	.072	20.07
15.5.76	.4732	.1386	9.17	.0035	-	-	.06	-	.126	9.97	.78	-	-	.0101	.7901	-	-	-	-	-	10.76
24.5.76	1.178	.3142	.275	.0031	-	-	-	.2508	1.936	3.95	3.62	-	-	-	3.6231	-	-	.03	-	.03	7.60
10.6.76	.0211	.0083	-	-	-	-	.264	1.0032	.79	2.08	9.01	1.29	.156	.017	10.47	.0035	.0228	-	-	.026	12.57
22.6.76	.449	-	1.86	.0032	-	-	-	.396	-	2.70	5.70	.182	6.696	-	12.57	.0037	.037	.0405	-	.091	15.35
7.7.76	1.60	.08	21.39	-	-	.039	.069	-	-	23.17	9.05	.1082	11.99	.23	21.37	.0083	-	.042	-	.05	44.59
22.7.76	11.91	.27	62.43	-	-	-	-	.39	.17	75.17	5.49	.1496	10.20	-	15.839	-	-	.286	-	.28	91.29
5.8.76	6.70	.15	57.45	-	-	-	-	-	.19	64.45	2.70	.057	20.95	-	23.70	-	-	.014	-	.014	88.16
22.8.76	1.24	.22	59.13	-	-	.066	-	2.88	-	63.53	3.34	.132	57.01	.843	61.32	-	-	.154	-	.154	125.00
7.9.76	8.10	.2752	103.31	-	-	.0132	-	-	-	111.70	4.92	.30	77.57	1.45	84.24	-	-	.06	-	.06	196.01
22.9.76	3.29	-	17.67	-	-	-	-	.38	-	21.34	4.06	-	99.52	-	103.58	-	-	.08	-	.08	125.01
7.10.76	1.17	-	170.54	-	-	-	-	.40	-	172.11	2.62	-	124.99	-	127.61	-	-	.08	-	.08	299.80
22.10.76	2.05	-	131.45	-	-	-	-	.39	-	133.89	11.70	-	179.53	-	191.23	-	-	.12	-	.12	325.24
7.11.76	5.49	-	133.44	-	.013	.34	-	1.37	.09	140.74	11.79	-	67.78	-	79.57	-	-	.08	-	.08	220.39
9.12.76	12.39	-	169.92	-	-	-	-	.41	-	182.72	1.289	-	-	-	1.289	-	-	.088	-	.088	184.10
22.12.76	32.67	.0101	101.87	-	-	-	-	2.64	-	137.19	7.87	-	-	-	7.87	-	-	.425	-	.425	145.49

Appendix 12 : Showing the weight of different groups of macroinvertebrates in g/m^2 at depths A, B and O of SB pond for the year 1977.

Dates	A										B					C					Grand Total
	Oligo-.	Chiro-.	Mollu-.	Mites	Ostra-.	Plano-.	Leech	Odon-.	Other	Total	Oligo-.	Chiro-.	Mollu-.	Other	Total	Oligo-.	Chiro-.	Chao-.	Other	Total	
19.1.77	92.8	9.98	-	-	.009	-	-	-	.54	103.33	41.68	3.01	2.52	.0004	47.21	-	-	-	-	-	150.54
14.2.77	35.7	23.71	-	.006	.005	-	.02	-	2.05	61.49	52.92	3.4	-	.03	56.35	-	-	-	-	-	117.84
28.2.77	20.25	19.74	.17	.009	.004	-	-	-	-	40.17	27.34	2.11	-	-	29.45	-	-	-	-	-	69.62
15.3.77	29.85	25.3	-	.05	.09	-	.25	-	.5	56.04	.16	-	-	.01	.17	-	-	-	-	-	56.21
30.3.77	7.72	12.16	-	.05	.05	-	-	-	.55	20.53	.01	-	-	-	.01	-	-	-	-	-	20.54
8.4.77	4.02	14.5	2.28	.05	-	-	.13	-	-	20.98	13.57	3.63	-	.47	17.67	-	-	-	-	-	38.65
29.4.77	70.2	.10	1.88	.02	.04	-	-	.41	-	72.65	.01	-	-	.009	.02	-	-	-	-	-	72.67
9.5.77	8.96	.16	4.15	.00007	.02	-	-	-	-	13.29	-	-	-	-	-	-	-	-	-	-	13.29
31.5.77	24.52	-	2.64	.001	.006	.12	.09	-	.13	27.51	1.95	-	.24	-	2.19	-	-	.009	-	.009	29.71
22.6.77	37.42	.32	3.88	.002	.01	.01	.06	.8	-	42.50	23.31	-	.49	-	23.80	.01	-	-	-	.01	66.31
7.7.77	54.11	.03	11.69	.02	.01	.01	.25	.81	-	66.93	52.53	-	3.71	-	56.24	-	-	-	-	-	123.17
30.7.77	.02	.02	26.55	.0003	.0007	-	-	-	-	26.60	35.46	-	.25	.138	35.85	-	-	-	-	-	62.45
18.8.77	9.44	-	52.71	.01	.04	.02	-	.66	.15	63.07	46.71	-	6.11	.39	53.21	-	-	.01	-	.01	116.29
9.9.77	15.29	.05	7.46	.0002	.01	.06	-	.73	-	23.60	53.68	-	3.06	.1	56.84	-	-	.08	-	.08	80.52
30.9.77	26.9	-	7.68	.0004	.007	.04	-	-	-	34.63	66.52	.01	.40	-	66.94	-	-	-	-	-	101.56
14.10.77	50.82	.01	4.77	-	.0003	-	-	.34	-	55.94	45.78	.01	-	.01	45.80	-	-	-	-	-	101.74
31.10.77	22.7	.14	4.02	-	.005	.05	-	-	-	26.92	34.66	.09	.71	-	35.46	-	-	.06	-	.06	62.44
15.11.77	41.89	.16	5.02	.00008	-	-	.07	.69	-	47.83	31.11	.13	1.98	.08	33.30	-	-	.01	-	.01	81.14
22.12.77	1.25	3.18	2.98	.002	-	-	.19	-	-	7.60	16.2	1.56	-	-	17.77	.008	.02	.34	-	.37	25.74