J. Indian bot. Soc. Vol. 69 (1990) 153-158

# A COMPARATIVE STUDY OF THE PHYTOPLANKTON OF THE RIVER GANGA AND POND OF PATNA (BIHAR), INDIA

A.K. SINGH AND S.H. AHMAD[2]

*Freshwater Biology Laboratory, B.D.E.College, Patna - 800 001 (Bihar)..*

Comparative studies on the seasonal variations of the phytoplankton in relation to the physico-chemical condition was carried out in a pond and river water at Patna (Bihar), India, at 25°31'N Lat.; 85°21'E Long. from October, 1986 to September, 1987. The phytoplanktons were mainly represented by the families Bacillariophyceae, Chlorophyceae, Cyanophyceae and Euglenineae. The pattern of seasonal variations in both water bodies were found to be bimodal, the primary peak was in summer and the secondary in winter. All together 26 and 42 species of phytoplankton were collected from the pond and river. The qualitative and quantitative differences observed in phytoplankton seem to reflect their response to the physico-chemical conditions of water. The co-efficient of similarity index values indicate that though the two types of water bodies lie adjacent to each other but they differ considerably in phytoplankton species composition.

Key words : Phytoplankton, pond, Ganga river.

## INTRODUCTION

Phytoplankton are ecologically significant as they trap the energy of sunlight to metabolize inorganic materials. Many herbivores mostly zooplankton graze upon the phytoplankton and in turn are preyed upon by other organisms, thus passing the stored energy along to larger organisms which may be benthic macroinvertebrates or fish. Studies on the phytoplankton of Indian ponds in relation to their environmental conditions have been made by Ganapati (1941), Dutta *et al.* (1954), Das and Srivastava (1956), George (1962), Zafar (1964), Munawar (1970), Khan and Siddiqui (1974), Jana (1973), Hosmani and Bharati (1980). Similar investigations on Indian running water habitats are comparatively few. The publications of Lakshminaryana (1965), Pahwa and Mehrotra (1966), Rai (1978), Prasad and Saxena (1980), Venkateshwarlu *et al.* (1981), Nandan and Patel (1984) are noteworthy. Literature pertaining to the comparative study of phytoplankton of pond and river water are rather scanty.

The neighbouring water bodies situated on the same geological substratum harbours different algal flora (Rao, 1955). In view of this, the present investigation was undertaken to study the seasonal periodicity and abundance of phytoplankton of a perennial river of north India and to compare it with that of an adjoining pond.

## MATERIALS AND METHODS

The present investigation was conducted in a freshwater pond of 0.25 hectare, with an average depth of 2.4 meter, situated near the Patna Dental Hospital, and a stretch along the southern bank of the River Ganga which is located about 4 km away from the pond. Water samples and phytoplanktons were collected at fortnightly intervals continuously for 12 months from October, 1986 to September, 1987. The physico-chemical analysis of pond and river water were done following APHA (1985). For phytoplankton analysis one litre of water samples from both the habitats were taken and treated with 10 ml of Lugol's solution. Out of which 100 ml of the sample water was allowed to settle for 48 hr in a measuring cylinder. The identification and counting of phytoplankton were made from 1 ml of settled concentrate using a Sedgwick Rafter Plankton counting cell.

Co-efficient of similarity and dissimilarity of the total phytoplankton and their groups found in the pond and river was analyzed by the following equations:

$$\text{Similarity Index (s)} = \frac{2C}{a+b}$$

where, a + b, is the number of species found in pond and river, c, is the number of species common in both the water bodies. Index of dissimilarity = 1 - s.

## OBSERVATIONS

Seasonal variations of the physico-chemical factors of water are presented in Fig. 1.

*Physical characteristics:* The surface water temperature of pond and river varied from 18.7 to 31.9°C and 20.2 to 32.1°C during the study period. The

2. Present address - College of Fisheries, Rajendra Agricultural University, Dholi - 843 121 (Bihar).

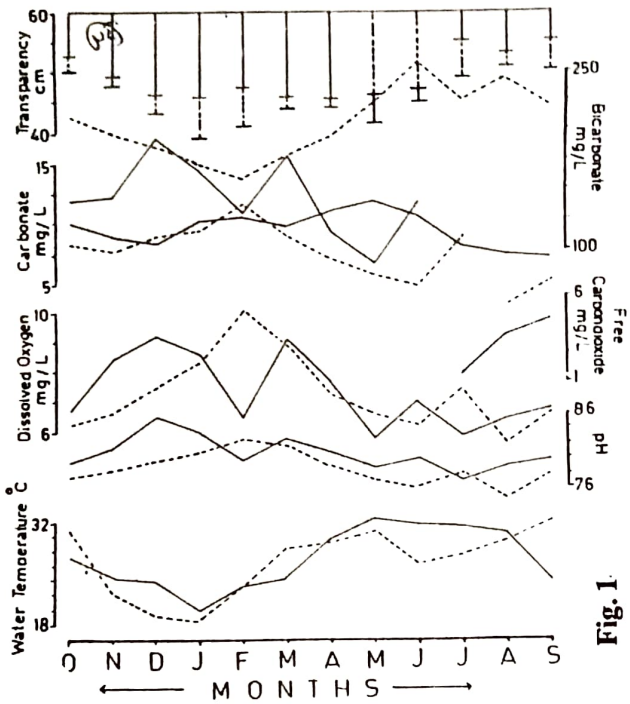


Fig. 1

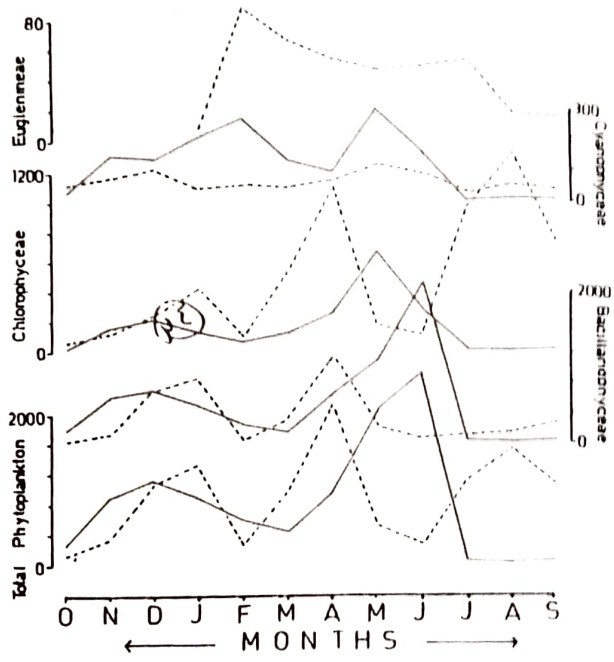


Fig. 2

tempera-ture was found to be higher in river as compared to pond. The Secchi disc visibility, ranged from 18.1 to 37.6 cm and 9.9 to 37.4 cm in both pond and river respectively. In pond the transmittance of light was quite different from that of the river.

*Chemical characteristics:* The pH of pond ranged from 7.5 to 8.3 while in river the values were higher where it fluctuated from 7.7 to 8.6. The pH of surface water of both the habitats were found to be alkaline during the entire study period. The dissolved oxygen concentration of pond fluctuated from 5.51 to 10.11 mg/L, while it was slightly higher in river and varied from 5.67 to 9.21 mg/L. Free carbon dioxide was only detected during the monsoon months in both types of waterbodies. The carbonate alkalinity of pond and river varied from 4.9 to 11.9 mg/L and 6.6 to 17.5 mg/L respectively. The bicarbonate alkalinity was present in appreciable quantities in the pond which varied from 163.9 to 258.8 mg/L, while a fall was noticed in river where it fluctuated from 97.6 to 143.9 mg/L.

*Phytoplankton periodicity:* Table-1 is a complete compilation of the 26 and 42 species collected from pond and river water samples. The seasonal distribution of major groups of phytoplankton are shown in Fig. 2.

Three groups of algae viz., Bacillariophyceae, Chlorophyceae and Cyanophyceae contributed substantially to the phytoplankton abundance of both the habitats. Some forms of Euglenineae though present in pond, contributed to a neglegible extent to the abundance.

In the present study, the population of phytoplankton exhibited two peaks in pond, the first in January (1308 org./L) and the other in August (1546 org./L). In the river it showed a minor peak in December (1072 org./L) and a major peak in June (2534 org./L). In pond Bacillariophyceae showed a secondary maxima in January (840 org./L) and a primary maxima in April (1154 org./L), while in river it showed single major peak with 2114 org./L in June. The dominant species were *Synedra ulna, Navicula* spp., *Fragilaria* spp. and *Cymbella* sp. present in both the environments. In the river *Cyclotella* sp. were abundant during the post-monsoon and early winter. Other species of Bacillariophyceae did not depict any seasonal periodicity. Bacillariophyceae was found to be more in pond than in river. Chloro- phyceae formed a large group in both pond and running water habitats. In pond the total number of Chlorophyceae showed a minor peak in April with 1094 org./L and a major peak with 1308 org./L in August. It also showed two peaks in river, the first in December (214 org./L) and the other in May (652 org./L). It was observed that the group Chlorophyceae present in the river contains the highest number of species although they were

numerically less as compared to pond. *Pediastrum simples*, *Tetradon* spp. and *Actinastrum* spp. develop profusely in pond, while the river harbours a large number of *Coelastrum* sp., *Pediastrum simples*, *Cladophora* sp. and *Scenedesmus* spp., which form the major bulk of the Chlorophyceae population. Cyanophyceae have always been observed to be more in river samples as compared to pond. It showed two peaks of growth in both the habitats during December and February (102 and 266 org./L) and May (112 and 298 org./L) respectively. In pond Cyanophyceae population was largely composed of *Oscillatoria* spp. and *Arthrospira* sp., while in river water *Anabaena* spp., *Nostoc spp.* and *Merismopoedia* spp. occurred in large number. A few species of Euglenineae were collected throughout the study period from pond without depicting any seasonal trend.

## DISCUSSION

Ruttner (1952) stated that the tropical and subtropical waters contain more rich phytoplankton communities. In the present study the pond and river harbours 26 and 42 species of phytoplankton respectively. From the other part of India, George (1962) reported 81 species from some freshwater ponds of Delhi. Pahwa and Mehrotra (1966) collected 46 species from the river Ganga. Govindan and Sundaresan (1979) reported 100 species from the Adyar river. Pant *et al.* (1983) observed that the Phytoplankton community of a static waterbody of Nainital is composed of 55 species. Pant *et al.* (1985) reported 42 species of phytoplankton from a freshwater lentic habitat. Nandan and Patel (1984) observed nearly 85 species of phytoplankton from the river Vishwamitri. From the present data (Table-1), it apparent that the running water habitat harbours more species of phytoplankton than the still waterbody. Obviously this is due to the differences in the physico-chemical nature of their water. The present data revealed that certain species of phytoplankton disappeared at certain periods only to reappear later. This corroborates the view of Phillipose (1960) that in certain seasons phytoplankton usually tide over the adverse conditions of weather by remaining in the bottom soil, either in the form of resting spores or in some other dormant condition. When the conditions become favourable again, these flora change from resting or dormant state to the active vegetative state. Fig. 2 depicts the seasonal fluctuations of phytoplankton in

Table 1. List of phytoplankton collected from the pond water and river Ganga.

| Phytoplankton | Lentic environment (Pond) | Lotic environment (River Ganga) |
|---|---|---|
| BACILLARIOPHYCEAE | | |
| *Cyclotella Sp.* | + | + |
| *Synedra ulna* | + | + |
| *Fraqilaria* spp. | + | + |
| *Nitzschia* spp. | + | + |
| *Navicula* spp. | + | + |
| *Rhapalodia* sp. | + | - |
| *Gomphonema* sp. | + | - |
| *Cymbella* sp. | + | + |
| *Gyrosigma* sp. | - | + |
| *Pleurosigma* sp. | - | + |
| *Pinnularia* sp. | - | + |
| *Tabellaria* sp. | - | + |
| *Melosira granulata* | - | + |
| *Cocconeis* sp. | - | + |
| CHLOROPHYCEAE | | |
| *Closteridium* sp. | + | - |
| *Tetraedron* spp. | + | - |
| *Nephrocytium* sp. | + | - |
| *Actinastrum* spp. | + | - |
| *Pediastrum simplex* | + | + |
| *Coelastrum* sp. | + | + |
| *Sorastrum* sp. | + | - |
| *Crucigenia* sp. | + | - |
| *Scenedesmus* spp. | + | + |
| *Ulothrix* sp. | - | + |
| *Chaetophora* sp. | - | + |
| *Oedogonium* sp. | - | + |
| *Cladophora* sp. | - | + |
| *Pithophora* sp. | - | + |
| *Rhizochonium* sp. | - | + |
| *Chlorella* sp. | - | + |
| *zygnema* sp. | - | + |
| *Spirogyra* spp. | + | + |
| *Cosmarium* sp. | - | + |
| *Phaws* sp. | - | + |
| *Chara* sp. | - | + |
| *Nitella* sp. | - | + |
| *Oocystis* sp. | - | + |
| *Dictyosphaerium* sp. | - | + |
| *Pandorina* sp. | - | + |
| *Denticula* sp. | - | + |
| *Desmidium* sp. | - | + |
| CYANOPHYCEAE | - | + |
| *Acrocystis* sp. | + | - |
| *Gloeotrichia* sp. | + | + |
| *Oscillatoria* spp. | + | - |
| *Arthrospira* sp. | + | - |
| *Spirulina* sp. | + | + |
| *Phormidium* sp. | - | + |
| *Lyngbya* spp. | - | + |
| *Anabaena* spp. | - | + |
| *Nostoc* spp. | - | + |
| *Rivularia* spp. | - | + |
| *Merismopoedia* spp. | - | + |
| *Microcystis aeoginosa* | - | + |
| EUGLENINEAE | | |
| *Euglena* sp. | + | - |
| *Phacus* sp. | + | - |
| *Trachelomonas* sp. | + | - |
| Number of species | 26 | 42 |

+, Present; -,Absent.

pond and river. It showed a bimodal pattern of variations, the first peak in winter and the other in summer season. In the Indian freshwater ponds, similar peaks have been observed by George (1962) and Jana (1973). From the different stretches of the river Ganga, Pahwa and Mehrotra (1966) also recorded two peaks in the same month.

The causative factors for variations in phytoplankton abundance are not clearly understood. In the present study some species of phytoplankton although present in both the waterbodies develop profusely in one but not in the other waterbody.

It is generally believed that temperature is one of the most important factors in an aquatic ecosystem, but Hutchinson (1967) suggested that it was never a critical factor for considerable variation in the growth of phytoplankton. This appears to be more appropriate that in both habitats, high temperature were found to be more conducive to the increase of phytoplankton. On the other hand, the low temperature also favoured the growth of certain phytoplankton as the minor peak was always observed in winter. A few earlier workers correlated high temperature with denser phytoplankton (Moitra and Bhattacharya, 1965).

It is interesting to note that the pond and river water harbour considerable number of *Bacillariophyceae* in winter but their peak was observed in summer. This is in conformity with Pahwa and Mehrotra (1966), Khan and Siddiqui (1974) who reported similar summer dominance of diatoms (Bacillariophyceae). However, Dutta *et al*. (1954) and Ramakrishnaiah and Sarkar (1982) noticed the maximum yield of diatoms in winter. The growth of Chlorophycea was found to be luxuriant with great variety and abundance in both pond and river. They were more abundant in summer, which is in agreement with the findings of Phillipose (1956), Pahwa and Mehrotra (1966). Although, Rao (1955) and Pant *et al*. (1983) reported the maximum growth of Chlorophyceae during monsoon. Many workers while studying the periodicity of Cyanophyceae have given much stress on water temperature (Gonzalves and Joshi, 1946; Rai, 1978). During the present study, the growth of Cyanophyceae was found to increase in summer, confirming the observation of George (1962), Khan and Siddiqui (1974) and Rai (1978). Several publications are available on the distribution of Euglenineae in the various types of freshwater environments (Gonzalves and Joshi, 1946; Phillipose, 1960; Zafar, 1964; Pahwa and Mehrotra, 1966; Munawar, 1970). In the present study species of Euglenineae grow profusely only in the pond water and never present in the river samples.

The importance of pH in the distribution of phytoplankton in freshwater has been emphasized by Das and Srivastava (1956), Pahwa and Mehrotra (1966) and Jana (1973). The pond and river water have an average pH of 7.9 and 8.1, which were more favouable for the development of phytoplankton. Gonzalves and Joshi (1946) observed that the higher pH values of water is responsible for the growth of Chlorophyceae. In the present study moderately high pH during summer may perhaps be responsible for diversity of Chlorophyceae in both the habitats.

One of the most important sources of dissolved oxygen in water are released from the photosynthetic activities of phytoplanktons. It is most probable that the dissolved oxygen content in water is directly dependent on the density of the phytoplankton. Similar conclusion has been drawn by Das and Srivastava (1956) and Jana (1973) that an increase of phytoplankton causes increase in the dissolved oxygen content of water. Munawar (1970) established a relationship between diatoms and dissolved oxygen. Zafar (1964) and Munawar (1970) attributed the higher percentages of Chlorophyceae to high values of dissolved oxygen. On the contrary, in the present study the phytoplankton and their different group seems to grow in large numbers in summer when the concentration of dissolved oxygen was moderately high in water in both the habitats.

In the present study no relationship could be established between free carbon dioxide and phytoplankton. However, Munawar (1970) suggested that Euglenineae prefer higher concentration of free carbon dioxide for their growth. This view did not find favour from the present investigations as free carbon dioxide was often observed in the monsoon.

The co-efficient of similarity and dissimilarity data are basically an approach to biological quality through the structure of the community. It is evident from Table 2 that the phytoplankton population of two adjacent aquatic habitats differ considerably in their species composition. In the present data, Bacillariophyceae exhibited greater percentage of similarity (60%). There is possibility that amongst the Bacillariophyceae there are species which can grow

profusely in pond and may also occur in river water with low density. On the other hand, the species of Chlorophyceae and Cyanophyceae present in the pond differ markedly from the river thus showing high percentage of dissimilarity (Table 2). In the present data, Euglinineae reflect 100% of dissimilarity because they were collected from the pond only.

Table 2. The percentages of similarity and dissimilarity co-efficient of the different groups of phytoplankton found between the pond and river.

| Group of organisms | Similarity co-efficient (%) | Dissimilarity co-efficient (%) |
|---|---|---|
| Bacillariophyceae | 60.0 | 40.0 |
| Chlorophyceae | 25.8 | 74.2 |
| Cyanophyceae | 28.6 | 71.4 |
| Euglenineae | -- | 100 |
| Total Phytoplankton | 35.1 | 64.9 |

## REFERENCES


APHA AWWA & WPCF 1985 Standard methods for the examination of water and waste water. 16the Ed. American Public Health Association New York.

Das S M & V K Srivastava 1956 Quantitative studies on freshwater plankton correlation between plankton and hydrobiological factors. *Proc Nat Acad Sci India* **27** 243-254.

Dutta N J C Malhotra & B B Bose 1954 Hydrology and seasonal fluctuations of the plankton in the Hooghly estuary Symp Mar & Freshw. Plankton in the Indo-Pacific Bangkok 35-44.

Ganapati S V 1941 Studies on the chemistry and biology of ponds in the Madras City. Seasonal changes in the physical and chemical conditions of a garden pond containing aquatic vegetation. *J Madras Univ* **13** 55-59.

George M G 1962 Occurrence of a permanent algal bloom in a fish tank at Delhi with a special reference to factors responsible for its production. *Proc Nat Acad Sci India* **56** 354-362.

Gonzalves E A & D B Joshi 1946 Freshwater algae near Bombay. *J Bombay nat Soc* **46** 154-176.

Govindan V S & B B Sundaresan 1979 Seasonal succession of algal flora in polluted region of Adyar river. *Indian J Environ Hlth* **21** 131-142.

Hosmani S P & S G Bharati 1980 Limnological studies in ponds and lakes of Dharwad comparative phytoplankton ecology of four water bodies *Phykos* **19** 27-43.

Hutchinson G E 1967 A treatise on Limnology Vol II Introduction to lake biology and limnoplankton. John Wiley & Sons Inc New York.

Jana B B 1973 Seasonal periodicity of plankton in a freshwater pond in West Bengal. *India Int Rev Ges Hydrobiol* **58** 127-143.

Khan A A & A Q Siddiqui 1974 Seasonal changes in the limnology of a perennial fish pond at Aligarh. *Indian J Fish* **12** 453-478.

Lakshminarayana J S S 1965 Studies on the phytoplankton of the lriver Ganga Varanasi Part II Seasonal growth and succession of the plankton algae in river Ganga. *Hydrobiologia* **25** 138-165.

Moitra S K & B K Bhattacharya 1965 Some hydrological factors affecting plankton production in a fish pond in Kalyani West Bengal. India *Ichthyologia* **4** 8-12.

Munawar M 1970 Limnological studies on freshwater ponds of Hyderabad India II The biocenose Distribution of unicellular and colonial phytoplankton in polluted and unpolluted environments. *Hydrobiologia* **36** 105-128.

Nandan S N & R J Patel 1984 Ecological studies on blue-green algae of polluted habitats of Gujarat state fertilizer company Baroda Proc V Indian Geophytol. Conf Lucknow (1983) Spl Publ 1984 226-231.

Pahwa D V & S N Mehrotra 1966 Observations on fluctuations in the abundance of plankton in relation to certain hydrological conditions of river Ganga. *Proc Nat Acad Sci India* **36** 157-189.

Pant M C A P Sharma & D P Chaturvedi 1983 Phytoplankton population and dual variation in a subtropical lake. *J Envirom Biol* **4** 15-25.

Pant M C S Jaiswal & A P Sharma 1985 A compositional and structural analysis of phytoplankton in lake Khurpatal (U.P.). *India Int Rev Ges Hydrobiol* **70** 269-280.

Philipose M T 1960 Freshwater phytoplankton of inland fisheries *Proc Sym Algology ICAR* New Delhi 272-291.

Prasad B N & M Saxena 1980 Ecological study of blue green algae in river Gomati. *Indian J Environ, Hlth* **22** 151-168.

Rai L C 1978 Ecological studies of algal communities of the Ganges river at Varanasi. *Indian J Ecol* **5** 1-6.

Rao C B 1955 On the distribution of algae in a group of six small ponds. *J Ecol* **43** 291-308.

Ramakrishnaiah M & S K Sarkar 1982 Plankton productivity in relation to certain hydrological factorsin Konar reservoir (Bihar). *J Inland Fish Soc India* **14** 58-68.

Ruttner F 1952 Plankton studien der Deutscheu Limnologischen Sunda-Expedition Arch Fur. *Hydrobiol* **21** 1-274.

Venkateshwarlu V C J Rao & A N Rao 1981 A comparative study of algae blooms. *Indian J Bot* **4** 31-36.

Zafar A R1964 On the ecology of algae in certain fish ponds of Hyderabad India. II. Distribution of unicellular & colonial forms. *Hydrobiologia* **24** 556-566.