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BULLETIN NO. 21
AUGUST, 1976

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BARRACKPORE • WEST BENGAL • INDIA

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ABSTRACT

The algal and animal organisms which get attached to glass slides fixed at three levels in a perennial fish pond at Cuttack were studied at fortnightly intervals for two years in relation to the prevailing meteorological conditions and physico-chemical features of water. The study revealed a rich and distinct periphyton community, both algal and animal, with maximum development of algae during January-May, 1966 and November-December 1965 and 1966 and of animalcules during July-September and January-March. Algae generally decreased from surface to bottom whereas animalcules were more at the bottom or middle than at surface except during October-December when they decreased gradually from surface to bottom. A number of algal and animal genera were indicative of mild pollution, as also borne out by the water conditions. There was no clear-cut stratification in physico-chemical factors at 09.30 hrs, the time of collection, except in oxygen which decreased markedly from surface to bottom during April-June and sometimes January-March. It is suggested that provision of suitable attaching surface might help in the utilization of the rich periphyton in such water bodies by browsing types of fish.

The study is the first of its kind in India.

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INTRODUCTION

Young (1945) described periphyton as an assemblage of organisms growing upon the free surfaces of submerged objects in water and covering them with a slimy coating. Hunt (1952) defined it as an assemblage of algae and minute animals covering submerged objects with a slimy coating. Neel's (1953) definition of periphyton as an assemblage of mainly microscopic organisms that form or live in coatings upon rocks and other submerged objects has been regarded by Gumtow (1955) to correspond closely to Ruttner's (1953) "Aufwuchs". Like Hunt (l.c.), Gumtow (l.c.) considered all organisms forming or living within the mat as part of the periphyton complex. Thus, not only the minute sessile organisms living within a slimy matrix on submerged objects but also the free living organisms associated with this matrix have been generally treated as periphyton.

Willer (1919) studied the effect of light on the vertical distribution of periphytion ("Aufwuchs") on the stems of aquatic plants in several lakes of East Germany. In subsequent years a number of studies on the seasonal succession and vertical distribution of periphyton of inland waters were made mostly in Europe, N. America and Egypt. The investigations were conducted in different types of water like lakes (Duplakov, 1925; Thomasson, 1925; Brehm and Ruttner, 1926; Cholnoky, 1929; Budde, 1935; Godward, 1937; Newcombe, 1950), reservoirs (Abdin, 1947, 1954; Flint, 1950; Sladeckova, 1960; Sladecek and Sladeckova, 1963), streams and rivers (Butcher, 1944; Neel, 1953; Gumtow, 1955), ponds (Ivlev, 1929; Duplakov, 1930; Hammann, 1952) and on slow sand filter beds (Brook, 1955). Of the more important studies mentioned that of Sladeckova (1960) has been one of the most exhaustive. She (1962) has also reviewed the investigation methods used in periphyton studies. The submerged objects examined generally included water plants, shells of molluscs, boulders, stones, and even sand particles (Meadows and Anderson, 1966). According to Sladeckova (1960) Hentschel (1916) was the first to use artificial substrata like glass

slides, celluloid plates, slates, etc., to study the periphyton community of rivers *in situ* in connection with detection of pollution. This method was later used effectively in a number of limnological investigations referred to above and in river pollution studies in England (Butcher, 1932, 1946) and other countries. Beers and Neubald (1968) used paraffin - coated objects in their studies on stream periphyton.

Though considerable information on the ecology of algae and other organisms of Indian inland waters is available, practically nothing is known on the periphyton community, no exclusive study of these organisms having been undertaken so far. The only studies made hitherto are with reference to the taxonomy, life history and, rarely, ecology of isolated attached forms. In connection with studies on the ecology and seasonal succession of algae in a pond at Madras, Philipose (1940) made some observations on the forms attached to marginal grasses, stones and shells of molluscs in the pond and on the surface of glass jars or slides in laboratory cultures of mud and water from the pond. Quite recently, Singh (1970) recorded the diatoms which attached themselves to slides in mud-water cultures from a pond at Barang, Orissa.

The present investigation was carried out in a perennial pond at Cuttack city for a period of two years (1965 and 1966) to find out whether there is a regular periphyton community, both plant and animal, in such waters, and to observe their seasonal changes and vertical distribution in relation to meteorological conditions and the physico-chemical features of water

MATERIAL AND METHODS

The pond investigated is approximately square, about 0.25 ha in area with an average depth of 2.6 metres in September-October and 1.4 metres in May-June. It is surrounded on three sides by small trees and bushes, with a big mango tree, on the southern side and a large banyan tree at the North-East corner. Eastern side has a low embankment separating another ponds with which it become contiguous during monsoon. The bottom is slightly silted with a good proportion of sand.

Except for stray duck weeds and *Pistia* which appeared on the water surface mostly during the rainy season, the pond was devoid of any macrovegetation either on the margins or in the body of water

throughout the period of investigation. The source of water in the pond was only from rain or domestic drainage at its western & northern side, the pond served mostly as a water shed for domestic purposes. Decomposition of leaves falling in the pond and the domestic washings probably caused a mild pollution. The pond was free from permanent algae blooms. However, chlanydomonads occurred in short spurts during June & sometimes in January.

Fortnightly collections were made from three levels in the pond, viz., a little below the water surface, in the middle of the water column and a little above the bottom mud. The distance between the adjacent sampling level ranged from 0.4 to 0.8 metre depending on the prevailing depth of water. Sampling was done everytime between 9.00 & 10 A.M. The periphyton were collected by fixing glass slides at the three levels adopting the Cork stopper method employed by Kuznecov (1952), as cited by Sladeckova (1960). Glass slides of 75 x 25 mm were used.

The slides when immersed occupied a vertical position with reference to the water surface. To enable regular fortnightly samplings, two sets of strings with Corks and slides were used, each set being fixed in the pond a fortnight before the sampling date.

For sampling the string with the three Cork was lifted slowly from a boat and transferred to an enamel bucket containing clean pond water so that any debris or plankters which might have loosely attached themselves to the slides were washed off. Later the corks belonging to different levels were separated in enamel trays with tap water to avoid mixing. Both sides of one slide from each cork were then scraped throughly with a sharp blade and the material preserved in 4 percent formalin in separate tubes for further investigation. The organisms on the remaining slides of a cork were studied in the fresh condition both qualitatively and quantitatively. One side of each of these slides was wiped clean but on the reverse side a square cover slip (18 x 18 mm) was dropped at random after adding a few drops of tap water. The organisms covered by one such square each on two slides and by two squares on the third slide were counted, making a total of four squares, and the average number of organisms per square calculated. This was subsequently converted to units (organisms) per sq. cm. They were also identified as far as possible in the fresh condition.

Periodic qualitative examination of the plankton of the pond was made to obtain an idea of the truly planktonic forms in the ecosystem

and relevant physico-chemical factors of water were studied every fortnight by collecting water samples from the three levels under reference. Transparency of water was determined with a half metre scale having a bright pin fixed at one end. Chemical analyses were done as per standard methods given by the American Health Association (1955).

Air temperatures were recorded on the spot at the time of sampling and data on rainfall and daily hours of bright sunshine obtained from the Central Rice Research Institute, Cuttack, situated at a distance of about 10 km from the pond site.

RESULTS

A. Meteorological conditions :

Air temperature :

Air temperature during 1965 ranged from 24.5 to 33.9°C with the minimum in December and maximum in June. In 1966, the minimum (23.2°C) was in January and the maximum (35.8°C) in May. In the first year higher temperatures of 32.6-33.9°C were recorded during June, September and October compared to April-June in the second year (33.2-35.8°C). During both years air temperatures were considerably low (24.7-25.9°C) during January-February (See Table 1).

TABLE 1

Ranges and averages (the latter within brackets) of air temperature, sunshine and total rainfall during the various quarters and the whole year at Cuttack during 1965 and 1966.

Year	1965				
Months	Jan.-March	April-June	July-Sept.	Oct.-Dec.	Whole year
Mean Air Temp. (°C)	24.7-30.7 (26.9)	29.5-33.9 (31.0)	28.2-32.6 (30.8)	24.5-33.5 (28.4)	24.5-33.9 (29.3)
Daily Sunshine (hrs)	7.9-8.2 (8.1)	6.5-9.0 (7.9)	2.8-5.0 (3.5)	7.1-8.8 (8.3)	2.8-9.0 (6.9)
Total Rainfall (mm)	186.9	229.5	921.6	99.0	1437.0
Year	1966				
Mean Air Temp. (°C)	23.2-31.0 (26.9)	33.2-35.8 (34.5)	31.9-33.0 (32.6)	27.0-29.7 (28.1)	23.2-35.8 (30.5)
Daily sunshine (hrs)	9.0-10.2 (9.5)	6.6-9.2 (8.0)	3.3-4.4 (3.9)	6.1-10.1 (7.9)	3.3-10.2 (7.3)
Total Rainfall (mm)	1.5	308.1	781.5	464.1	1555.2

Rain fall :

The main period of rains at Cuttack is during the South-West monsoon season of July to September when maximum precipitation usually occurs. There is, however, some amount of rainfall during the North-East monsoon period of October-November also. In 1965 maximum rainfall was recorded in July (455.7 mm) as against October (462.7 mm) in 1966. The unusually higher rainfall in the first quarter of 1965 (186.9 mm) than in 1966 (1.5 mm) and the higher rainfall in the third quarter of 1966 (464.1 mm) than in 1966 (99.0 mm) brought the annual figures to nearly the same level (See Table 1).

Sunshine :

The quarterly ranges and averages in daily hours of bright sunshine during the two years are given in Table 1. As may be expected, longer hours of sunshine were recorded during periods of least rainfall and vice versa.

B. Water conditions in time and space :

Average water conditions obtaining at three levels in the pond during the four quarters and for the whole year in 1965 and 1966 are given in Table 2.

Water temperature

Water temperature ranged from 22.4-32.7°C and 24.5-33.6°C at the surface, from 24.8-33.3°C and 24-35.2°C in the middle and from 24.2-33.1°C and 22.5-34.7°C at the bottom in 1965 and 1966 respectively. Maxima were generally recorded at all levels in May, rarely in June, and minima during December-January. There was no appreciable stratification from surface to bottom, the maximum difference of 2.5°C between surface and middle (higher temperature at the latter level) being recorded in June, 1965, and a slightly lower figure of 2.0°C in January 1966 (highest temperature at surface and lowest at bottom).

Transparency :

The water of the pond was fairly clear for the major part of the year, there being not much of plankton in the general body of water. However, following the first heavy rains or in summer the water became somewhat turbid. Transparency ranged from 10.5-19.5 cm (average 15.2 cm) in 1965 and from 13.2-36.4 cm (average 18.8 cm) in

TABLE -2

Ranges and Averages of physico-chemical conditions of water at different levels during the four quarters of the year and the whole year in 1965(Averages within parenthesis) in the C.I.F.R. Substation pond, Cuttack.

Items analysed	Levels in the pond	1965 Jan.-Mar.	April-June	July-Sept.	Oct.-Dec.	Whole year
Water temperature (°C)	Surface	22.5-31.3 (26.5)	30.8-32.7 (31.7)	29.5-30.7 (30.0)	22.4-30.8 (26.4)	22.4-32.7 (28.7)
	Middle	25.6-29.0 (27.1)	30.7-33.3 (32.0)	29.1-31.6 (30.1)	24.8-31.1 (27.4)	24.8-33.3 (29.1)
	Bottom	24.2-29.1 (26.8)	30.5-33.1 (31.7)	28.8-30.5 (29.6)	24.2-30.7 (26.8)	24.2-33.1 (28.7)
Transparency (cm)		14.1-16.0 (15.8)	10.7-15.1 (12.3)	10.5-19.5 (15.0)	14.7-19.4 (14.4)	10.5-19.5 (15.2)
pH	Surface	8.0-8.1 (8.06)	8.5-8.6 (8.53)	8.0-8.6 (8.20)	8.1-8.4 (8.23)	8.4-8.6 (8.26)
	Middle	8.0-8.2 (8.06)	8.3-8.6 (8.43)	8.0-8.5 (8.20)	8.2-8.2 (8.20)	8.0-8.6 (8.22)
	Bottom	7.9-8.1 (8.03)	8.0-8.4 (8.23)	8.0-8.6 (8.20)	8.0-8.1 (8.06)	7.9-8.6 (8.13)
Free CO_2 (ppm)	Surface	1.84-3.80 (2.69)	Nil	Nil-5.04 (2.10)	1.78-3.06 (2.33)	Nil-5.04 (1.78)
	Middle	1.84-4.75 (3.15)	Nil-1.84 (0.61)	Nil-5.10 (2.56)	1.28-2.55 (2.04)	Nil-5.10 (2.09)
	Bottom	1.38-3.80 (2.54)	1.84-4.62 (3.69)	Nil-4.72 (2.51)	2.25-4.05 (2.86)	Nil-4.72 (2.90)
T.A. (ppm)	Surface	66.9-88.0 (77.6)	73.4-91.1 (83.6)	32.7-53.0 (40.0)	36.3-51.4 (42.9)	32.7-91.1 (61.6)
	Middle	68.0-88.0 (77.9)	76.6-91.1 (85.4)	32.7-53.0 (40.0)	36.3-51.4 (42.9)	32.7-91.1 (61.6)
	Bottom	68.0-88.0 (77.9)	77.6-91.1 (85.7)	32.7-53.0 (40.0)	36.3-51.4 (42.9)	32.7-91.1 (61.6)
D.O. (ppm)	Surface	5.83-6.80 (6.36)	8.76-16.42 (12.34)	4.48-8.08 (6.48)	6.66-12.00 (8.63)	4.48-16.42 (8.45)
	Middle	4.54-9.90 (7.69)	4.74-14.64 (9.45)	5.73-9.98 (7.32)	6.44-18.38 (10.56)	4.54-18.38 (8.75)
	Bottom	4.20-11.57 (6.88)	4.14-7.10 (5.48)	4.23-6.25 (5.29)	5.65-9.88 (7.28)	4.14-11.57 (6.23)

Contd...

Items analysed	Levels in the pond	1965 Jan.-March	April - June	July - September	October-December	Whole year
Ox. org. Matter (ppm)	Surface	14.2-17.8 (16.27)	20.0-17.7 (14.17)	6.6-9.0 (7.87)	6.5-7.0 (6.80)	6.5-17.8 (11.28)
	Middle	15.5-18.9 (17.33)	15.0-16.6 (15.7)	7.5-8.5 (7.87)	5.6-7.8 (6.77)	5.6-18.9 (11.92)
	Bottom	15.5-20.0 (18.23)	16.2-18.6 (17.4)	6.9-9.6 (8.03)	5.8-8.0 (7.03)	5.8-20.0 (12.68)
Free NH_3 (ppm)	Surface	0.02-0.06 (0.04)	0.17-0.27 (0.23)	0.04-0.15 (0.09)	0.06-0.44 (0.19)	0.02-0.44 (0.14)
	Middle	0.02-0.07 (0.05)	0.05-0.16 (0.12)	0.04-0.13 (0.09)	0.04-0.17 (0.10)	0.02-0.17 (0.09)
	Bottom	0.01-0.05 (0.03)	0.11-0.16 (0.13)	0.05-0.12 (0.09)	0.03-0.13 (0.08)	0.01-0.16 (0.08)
NO_3 (ppm)	Surface	0.04-0.16 (0.12)	0.10-0.15 (0.13)	0.10-0.12 (0.11)	0.08-0.17 (0.12)	0.04-0.17 (0.12)
	Middle	0.06-0.19 (0.12)	0.10-0.16 (0.13)	0.11-0.12 (0.12)	0.10-0.12 (0.11)	0.06-0.16 (0.12)
	Bottom	0.04-0.15 (0.10)	0.10-0.18 (0.14)	0.09-0.22 (0.14)	0.11-0.11 (0.11)	0.04-0.22 (0.12)
PO_4 (ppm)	Surface	1.4-1.5 (1.43)	0.75-1.7 (1.32)	1.8-4.7 (3.03)	3.9-4.3 (4.13)	0.75-4.7 (2.48)
	Middle	1.6-1.8 (1.67)	0.79-1.5 (1.13)	1.7-4.7 (3.00)	3.1-4.3 (3.73)	0.79-4.7 (2.38)
	Bottom	1.4-2.0 (1.73)	0.85-1.7 (1.25)	1.8-4.3 (2.83)	3.2-3.7 (3.47)	0.85-4.3 (2.32)
CL (ppm)	Surface	18.1-23.1 (20.40)	23.8-27.2 (25.83)	15.7-23.1 (18.23)	17.2-22.6 (19.40)	15.7-27.2 (21.38)
	Middle	17.6-22.1 (19.77)	23.0-27.2 (25.57)	16.1-22.2 (18.13)	16.9-22.6 (19.17)	16.1-27.2 (20.66)
	Bottom	18.5-23.1 (20.53)	23.8-26.5 (25.47)	15.6-19.2 (16.97)	16.1-21.6 (19.73)	15.6-26.5 (20.68)
Ca (ppm)	Surface	17.2-26.0 (21.53)	25.0-29.0 (27.33)	16.0-22.0 (18.33)	14.0-21.6 (17.13)	14.0-29.0 (21.06)
	Middle	20.8-28.0 (23.60)	25.0-27.0 (26.00)	16.0-22.0 (18.33)	15.0-21.2 (17.47)	15.0-28.0 (21.35)
	Bottom	17.2-22.0 (19.73)	23.6-30.0 (26.53)	16.0-22.0 (18.33)	15.0-21.6 (17.73)	15.0-30.0 (20.58)

Contd...

Items analysed	Levels in the pond	1966 January-March	April-June	July-September	October-December	Whole year
Water temperature (°C)	Surface	24.5-30.0 (27.7)	31.0-33.6 (32.5)	30.7-32.7 (31.4)	24.9-31.7 (28.4)	24.5-33.6 (30.0)
	Middle	24.0-30.2 (27.5)	32.9-35.2 (33.9)	31.0-32.2 (31.7)	24.7-31.5 (28.2)	24.0-35.2 (30.3)
	Bottom	22.5-29.9 (26.7)	31.5-34.7 (32.7)	30.7-31.4 (31.1)	24.5-30.7 (27.6)	22.5-34.7 (29.5)
Transparency (cm)		14.3-18.6 (16.8)	13.2-14.6 (14.0)	13.9-23.2 (18.3)	19.9-36.4 (26.3)	13.2-36.4 (18.8)
pH	Surface	8.8-9.0 (8.86)	8.4-8.9 (8.73)	8.3-8.6 (8.46)	8.0-8.1 (8.06)	8.0-9.0 (8.73)
	Middle	8.5-8.9 (8.70)	8.4-8.9 (8.66)	8.2-8.6 (8.40)	8.0-8.1 (8.06)	8.0-8.9 (8.46)
	Bottom	8.3-8.8 (8.60)	8.5-8.6 (8.53)	8.2-8.4 (8.33)	7.9-8.2 (8.03)	7.9-8.8 (8.37)
Free CO_2 (ppm)	Surface	Nil-2.04 (0.68)	Nil	Nil-1.58 (0.53)	1.58-1.78 (1.65)	Nil-2.04 (0.85)
	Middle	Nil-0.51 (0.17)	Nil	Nil-2.37 (0.79)	0.79-2.17 (1.64)	Nil-2.37 (0.83)
	Bottom	1.02-4.18 (1.73)	Nil	Nil-1.57 (0.52)	0.79-1.57 (1.18)	Nil-4.18 (0.99)
T.A. (ppm)	Surface	50.4-74.5 (62.7)	59.0-84.4 (70.2)	45.3-59.9 (52.0)	56.1-66.9 (60.4)	45.3-84.4 (61.3)
	Middle	50.4-74.5 (62.7)	59.0-84.4 (70.2)	45.3-59.9 (52.0)	56.1-66.9 (60.4)	45.3-84.4 (61.3)
	Bottom	50.4-74.5 (62.7)	59.0-84.4 (70.2)	45.3-59.9 (52.0)	56.1-66.9 (60.4)	45.3-84.4 (61.3)
D.O. (ppm)	Surface	12.01-17.50 (15.28)	10.60-13.90 (12.80)	4.14-13.90 (8.03)	5.00-7.50 (6.30)	4.14-17.50 (10.60)
	Middle	18.14-17.16 (13.21)	9.11-12.00 (10.90)	7.30-11.10 (8.97)	4.19-6.50 (5.46)	4.19-17.16 (9.63)
	Bottom	3.10-16.31 (10.56)	4.60-8.52 (6.61)	5.60-9.90 (7.40)	3.49-5.25 (4.48)	3.10-16.31 (7.26)
Ox. org. Matter (ppm)	Surface	6.1-6.7 (6.37)	4.9-5.5 (5.13)	5.4-6.1 (5.70)	5.7-6.2 (5.97)	4.9-6.7 (5.79)
	Middle	6.0-6.5 (6.33)	4.9-5.3 (5.13)	5.3-6.2 (5.77)	5.8-6.7 (6.17)	4.9-6.7 (5.85)
	Bottom	5.8-7.1 (6.53)	4.9-5.3 (5.13)	5.2-6.0 (5.60)	6.2-6.7 (6.43)	4.9-7.1 (5.91)

Contd....

ems alysed	Levels in the ponds	1966 January-March	April-June	July - September	October-December	Whole year
ee NH_3 (ppm)	Surface	0.04-0.05 (0.04)	0.01-0.06 (0.03)	traces-0.07 (0.03)	0.02-0.05 (0.04)	traces-0.07 (0.04)
	Middle	0.03-0.03 (0.03)	traces-0.08 (0.03)	traces-0.05 (0.02)	traces-0.03 (0.02)	traces-0.08 (0.02)
	Bottom	0.01-0.04 (0.02)	traces-0.02 (0.01)	traces-0.04 (0.01)	traces-traces (traces)	traces-0.04 (0.01)
3 ppm)	Surface	0.11-0.15 (0.13)	0.11-0.15 (0.13)	0.09-0.11 (0.10)	0.11-0.12 (0.12)	0.09-0.15 (0.12)
	Middle	0.09-0.12 (0.11)	0.12-0.14 (0.13)	0.10-0.12 (0.11)	0.12-0.13 (0.12)	0.09-0.14 (0.12)
	Bottom	0.09-0.14 (0.12)	0.10-0.11 (0.11)	0.10-0.11 (0.10)	0.12-0.14 (0.13)	0.09-0.14 (0.11)
4 ppm)	Surface	2.7-3.1 (2.93)	3.1-3.4 (3.23)	2.2-3.5 (3.07)	2.2-3.0 (2.53)	2.2-3.5 (2.94)
	Middle	2.7-3.2 (2.90)	3.0-3.2 (3.10)	2.2-3.4 (2.97)	2.1-3.0 (2.57)	2.1-3.4 (2.88)
	Bottom	2.5-2.9 (2.73)	2.6-2.9 (2.77)	2.1-3.3 (2.77)	1.9-3.1 (2.50)	1.9-3.1 (2.69)
. ppm)	Surface	23.6-27.7 (24.97)	28.7-33.9 (30.77)	20.5-25.7 (22.93)	12.7-16.4 (14.83)	12.7-33.9 (23.38)
	Middle	21.6-27.7 (23.97)	28.7-33.9 (30.77)	21.6-24.6 (22.77)	12.7-16.4 (14.83)	12.7-33.9 (23.08)
	Bottom	21.6-27.7 (23.97)	28.7-33.9 (30.77)	20.6-23.6 (22.27)	12.7-16.4 (14.83)	12.7-33.9 (22.91)
. ppm)	Surface	14.4-26.0 (19.20)	28.0-68.0 (45.33)	21.0-58.0 (34.33)	26.0-33.0 (30.00)	14.4-68.0 (32.22)
	Middle	14.5-27.0 (19.53)	27.0-68.0 (45.00)	22.0-58.0 (35.00)	27.0-31.0 (29.67)	14.5-68.0 (32.30)
	Bottom	14.4-27.0 (19.77)	31.0-68.0 (45.67)	21.0-58.0 (34.33)	28.0-32.0 (30.33)	14.4-68.0 (32.69)

1966 with minima in April 1965 and July 1966 and maxima in September 1965 were recorded during March-August and December and of 13.2-14.6 cm in 1966 during January and April-July.

The clarity of the water had some bearing on the development of periphyton at various levels (see under discussion).

Hydrogen- ion concentration:

pH value did not show any marked variation during both the years. At the surface it ranged between 8.0 and 8.6 in 1965 and between 8.0 and 9.0 in 1966 with averages of 8.26 and 8.73 respectively. Maximum of 9.0 was recorded in February, 1966, and the minimum of 8.0 in February and August, 1965, and December, 1966.

In the middle it ranged between 8.0 and 8.6 in 1965 with minimum in January, March and August and maximum in April, and between 8.0 and 8.9 in 1966 with minimum in December and maximum in February and June.

At the bottom the pH ranged from 7.9 to 8.6 in 1965 and 7.9 to 8.8 in 1966 with averages of 8.13 and 8.37 respectively. Maximum difference of 0.5 between the surface and bottom was in May, 1965 and March, 1966. As may be expected the pH at the bottom was generally slightly lower than at the surface.

Free carbon dioxide :

Free carbon dioxide ranged from nil to 5.10 ppm in 1965 and from nil to 4.18 ppm in 1966 at the three levels in the pond with maximum of 5.10 ppm in the middle in August 1965 and of 4.18 ppm at the bottom in March 1966 and minimum on several occasions during both the years. On the average, carbon dioxide was higher at the bottom than at the surface by 1.12 ppm in 1965 and by 0.14 ppm in 1966.

Total alkalinity :

Total alkalinity of the pond water ranged from 32.7 to 91.1 ppm during the period of study. Maxima of 91.1 ppm in 1965 and 84.4 ppm in 1966 were recorded in June and minima of 32.7 and 50.4 ppm in August, 1965 and January, 1966, respectively. In September 1966 also the value was fairly low (50.9 ppm). The sharp fall from 53 ppm in July to 32.7 ppm in August 1965 was probably due to dilution of the water as a result of heavy rainfall. Thereafter it rose gradually to 51.4 ppm by December, 1965.

There was no appreciable difference in this factor between various levels in the pond, the difference between averages of the three levels for the whole year being only 0.6 ppm in 1965 and nil in 1966.

Dissolved oxygen :

Dissolved oxygen at the surface ranged from 4.48 to 16.42 ppm in 1965 (average 8.45) and from 4.14 to 17.50 in 1966 (average 10.6) with minima in September, 1965 and August, 1966, and maxima in May 1965 and February, 1966. At the bottom it varied in 1965 from 4.14 ppm in April to 11.57 ppm in February (average 6.23) and in 1966 from 3.10 ppm in March to 16.31 ppm in February (average 7.26). In the middle the concentration was usually midway between the surface and bottom values except in January, September and October, 1965, when they were higher than both at the surface and bottom.

Maximum stratification was observed during April-May, 1965, March-April, 1966 and September 1966 when the values were higher at the surface than at the bottom by 7.2 to 9.32 ppm. In February 1965, on the other hand, bottom value was higher than that of the surface by 4.77 ppm and in October 1965 the maximum value was in the middle being higher than at the surface and bottom by 6.38 and 8.50 ppm respectively.

Average values for the three levels together were generally lower during November-December and July-August and sometimes in March, and higher during January-February, April-May and September-October.

Organic matter:

In 1965, organic matter ranged from 6.5 to 17.8 ppm at the surface, 8.6 to 18.9 ppm in the middle and 5.8-20.0 ppm at the bottom with averages of 11.28, 11.92 and 12.68 ppm respectively. Corresponding values at the three levels in 1966 were 4.9 to 6.7, 4.9 to 6.7 and 4.9 to 7.1 ppm with averages of 5.79, 5.85 and 5.91 ppm respectively. The maximum of 20 ppm of the bottom was noted in March, 1965 and the minimum of 4.9 at the surface and middle in June, 1966 and at the bottom in April 1966. The much lower organic content at all levels in the second year could not be explained.

Free ammonia :

Free ammonia at the surface ranged from 0.02 to 0.44 ppm in 1965 and traces to 0.07 ppm in 1966 with averages of 0.14 and 0.04

ppm respectively; in the middle from 0.04 to 0.17 ppm in 1965 and traces to 0.08 ppm in 1966 with averages of 0.09 ppm and 0.02 ppm in respectively; and at the bottom from 0.01 to 0.16 ppm in 1965 and traces to 0.04 ppm in 1966 with averages of 0.08 and 0.01 respectively.

As with organic matter, the concentration of free ammonia at the three levels was much less in 1966 than in 1965. On most occasions higher values were recorded at the surface than at the bottom.

Nitrates :

Nitrate values did not show any appreciable variation during both the years. Nor was there any marked difference in this factor at the various levels. At the surface it ranged from 0.04 to 0.17 ppm with an average of 0.12 ppm during 1965, and from 0.09 to 0.15 ppm with an average of 0.12 ppm in 1966. The maximum of 0.19 ppm in 1965 was recorded in the middle in January and of 0.15 ppm in 1966 at the surface in February and April. The minimum of 0.04 ppm in 1965 was at the surface and bottom in March and of 0.09 ppm in 1966 at the middle and bottom in March and at the surface in September.

Phosphates :

Phosphates ranged from 0.75 to 4.7 ppm in 1965 with the minimum at the surface in June and the maximum at the surface and middle in September. In 1966 they ranged from 1.9 to 3.5 ppm with the minimum at the bottom in November and the maximum at the surface during July-August. The difference in values between surface and bottom ranged only from 0.1 to 1.0 ppm, the maximum difference (higher value at surface) being in November, 1965, and the minimum in June, 1965, September 1966 and December, 1966 (higher value at surface or bottom). The values in the middle were generally midway between those at the surface and bottom except in January and November, 1965 and March and October, 1966, when they were slightly higher or lower than both at surface and bottom.

On the whole, the pond was fairly rich in this nutrient salt with its value gradually increasing from bottom to surface.

Chlorides :

Chloride concentrations ranged from 15.6 to 27.2 ppm in 1965 and from 12.7 to 33.9 ppm in 1966. Maxima during both the

years were recorded in June and minima in August and December respectively.

Chloride values were lower during August-October, 1965 (15.6-18.4 ppm) and October-December, 1966 (12.7-16.4 ppm) than during the remaining periods of the two years. There was also no appreciable difference in this factor from one level to the other.

Calcium

Values of calcium ranged from 14.0 to 29.0 ppm at the surface with an average of 21.1 ppm in 1965 compared to a bigger range and average of 14.4-68.0 ppm and 32.2 ppm respectively in 1966. The maxima were recorded in June during both the years and the minima in October, 1965 and January, 1966.

As with chlorides, there was very little difference in its values from one level to the other on a given date.

C. Micro-organisms recorded and their periodicity and vertical distribution.

Microflora :

A list of the algal flora encountered on the slides together with their months of maximum frequency and their percentage constancy in the samples collected are given in Table 3.

TABLE -3

List of algae encountered on slides at 3 levels in the C.I.F.R. Substation Office pond, Cuttack, with months of maxima and % constency in samples

(N.B. Arbitrary numerical values for symbols: i 1-3; vr 4-10; r 11-25; rc 26-50; c 51-100; vc 101-250; a 251-750; va 751-1500 (rarely more) per sq. cm; m-mass growth)

Sl. No.	Name of alga	Maxima with months within brackets			% Constancy in samples		
		Surface	Middle	Bottom	Surface	Middle	Bottom
1	2	3	4	5	6	7	8
	CHLOROPHYCEAE						
1.	Chlamydomonas conferta Korsh.	m (1)	rc (1)	rc (2)	8.3	8.3	4.2

Contd..Table 3

1	2	3	4	5	6	7	8
2.	Eudorina elegans Ehr.	i (5)			4.2		
3.	Characium sp.	m (1,2,4,5, 11,12)	a (12)	c (2)	41.6	8.3	4.2
4.	Pediastrum tetras(Ehr.) Ralfs	vr (1)	i (1,2)	i (2)	20.8	25.0	16.7
5.	Ankistrodesmus falcatus (Corda) Ralfs	r (3)	vr (1,3)	rc (3)	8.3	16.7	16.7
6.	Selenastrum gracile Reinsch	i (2)	vr (2,4)	i (4)	4.2	8.3	4.2
7.	Scenedesmus spp. S. acuminatus (Lagerh.)Chod.; S.dimorphus(Turp.)Kuetz.; S.quadricauda(Turp.)Breb.	rc (9)	rc (2,9)	c (6)	83.3	87.5	87.5
8.	Ulothrix tenerrima Kuetz.	i (2,12)	-	-	8.3	-	-
9.	Chaetophora sp.	vr (1)			4.2		
10.	Stigeoclonium spp. S. tenue (Ag.) Kuetz.; S. farctum Berth.	vc (5)	c (10)	-	95.8	37.5	-
11.	Coleochaete sp.	vr (12)	-	-	4.2	-	-
12.	Oedogonium sp.	c (3-5,12)	rc (10)	vr (11)	79.2	50.0	8.3
13.	Closterium ehrenbergianum Menegh. & Closterium sp.	r (11)	i (12)	-	8.3	4.2	-
14.	Cosmarium sp.	a (12)	rc (9)	rc (7-9)	58.4	62.5	62.5
15.	Cyclotella operculata(Ag) Kuetz.	-	-	i (8)	-	-	4.2

Contd..Table 3

1	2	3	4	5	6	7	8
16.	Melosira granulata (Ehr.) Ralfs	r (1)	r (1)	r (1)	70.8	66.7	70.8
17.	Fragilaria intermedia Grun	rc (12)	Vr (3,4)	-	25.0	16.7	-
18.	Synedra ulna (nitz.)Ehr.	c (12)	r (12)	vr (12)	50.0	62.5	62.5
19.	Navicula spp. N. cryptocephala ktz.; N. simplex krasske; N. rhyncocephala ktz.; N. Lanceolalta (Ag.) ktz.	vc (12)	c (9)	r (6)	95.8	91.6	100.0
20.	Pinnularia spp. P. gibba Ehr.; P. viridis(Nitz.)Ehr. P. acrosphaeria Breb.;	rc (12)	vr (9,12)	r (1)	54.2	50.0	45.8
21.	Amphara ovalis ktz.	r (12)	vr (9,12)	vr (12)	37.5	50.0	45.8
22.	Cymbella turgida(Greg.) Cleve	vr (3 , 4)	i (1)	vr (7)	25.0	29.2	16.7
23.	Gomphonema spp. G. augur Ehr.; G. Gracile Ehr.; G. constrictum Ehr.; G. olivaceum (Lyngb.) ktz.	a-va (11,12)	vc (12)	rc (12)	54.2	54.2	58.4
24.	Nitzschia spp. N. palea (ktz.) W. Smith; Nitzschia spp.	a (12)	r (12)	vr (1-3,5-6)	66.7	70.8	58.4
25.	Surirella robusta Ehr.	i (9,12)	i (9,12)	vr (12)	8.3	8.3	4.2
	EUGLENINEAE						
26.	Euglena spp. E. tuba H.J. Carter; E. viridis Ehr.; E. acus Ehr.	i (1,10)	vr (1)	i (1,6)	8.3	8.3	20.8

Contd..Table - 3

1	2	3	4	5	6	7	8
27.	Phacus sp.	vr (1)	vr (7)	vr (6,8)	29.2	12.5	8.3
28.	Trachelomonas spp. T. armata (Ehr.)Stein; T. caudata (Ehr.) Stein	r (12)	rc (12)	c (1)	20.8	16.7	25.0
	MYXOPHYCEAE						
29.	Oscillatoria spp. O. tenuis Ag.; Oscillatoria sp.	c (2)	vr (5,9)	r (5)	62.5	29.2	33.3
30.	Spirulina major Kuetz.	i (1)	-	-	4.2	-	-
31.	Anabaena sp.	vr (6)	i (2-5,7)	vr (6,11)	12.5	20.8	25.0
32.	Rivularia sp.	m (3)	-	i (12)	4.2	-	4.2

From Table 3 it may be seen that the algae belonged to four major classes with the Bacillariophyceae having the maximum representation in terms of species (20), closely followed by the Chlorophyceae (18 species) and the Euglenineae and Myxophyceae with the least representation (6 and 5 species respectively). In terms of number/sq. cm (see Table 5) green algae were the most important but were closely followed by diatoms. Blue-greens came next and euglenoids last.

In terms of habit, the following chief categories could be distinguished: 1) filamentous green algae (e.g. Oedogonium) and diatoms (e.g. Melosira); 2) prostrate or heterotrichous green algae (e.g. Coleochaete and Stigeoclonium); 3) unicellular stalked (regular stalk or gelatinous stalk) algae (e.g. Characium and Gomphonema); 4) Unicellular algae, mostly diatoms, attached by general mucilage (e.g. Cymbella, Amphora); 5) unicellular forms, mostly planktonic but loosely attached with or without mucilage (e.g. Chlamydomonas, Navicula, Surirella, Euglena, Trachelomonas); 6) small colonial algae loosely or firmly attached by mucilage (e.g. Scenedesmus, Rivularia).

TABLE - 4

Seasonal vertical distribution of the more important algal genera in the C.I.F.R.Substation Pond during 1965 and 1966 (Av. No. per sq. cm of slide surface).

Algal genera and vertical levels	1965					1966				
	Jan-March	Apr.-June	July-Sept.	Oct.-Dec.	Whole year	Jan-Mar.	Apr.-June	July-Sept.	Oct.-Dec.	Whole year
Chlamydomonas										
S	-	-	-	-	-	m	-	-	-	m/4
M	-	-	-	-	-	20	-	-	-	5
B	-	-	-	-	-	7	-	-	-	2
Characium										
S	-	-	-	m	m/4	m+22	m+83	-	543	m/2+162
M	-	-	-	102	26	6	-	-	-	2
B	-	-	-	-	-	22	-	-	-	6
Scenedesmus										
S	1	1	10	10	6	11	5	9	1	7
M	2	1	11	3	4	13	6	8	1	7
B	2	-	5	4	3	9	25	8	3	11
Stigeoclonium										
S	10	46	9	56	30	15	75	9	53	38
M	4	10	1	23	10	-	1	-	-	1
B	-	-	-	-	-	-	-	-	-	-
Oedogonium										
S	48	53	16	1	30	11	15	1	30	14
M	4	3	1	9	4	-	1	-	5	2
B	-	1	-	-	1	-	-	-	1	1
Cosmarium										
S	-	-	10	5	4	4	1	1	123	32
M	-	-	17	6	6	4	1	1	1	2
B	-	-	36	5	10	4	6	1	2	3
Melosira										
S	5	5	1	2	3	4	1	1	1	2
M	9	2	2	1	5	4	2	1	-	2
B	7	4	2	1	4	3	2	1	1	2

Contd..Table 4

Algal genera and vertical levels	1965					1966				
	Jan - March	Apr.- June	July- Sept.	Oct.- Dec.	Whole year.	Jan- March	Apr.- June	July- Sept.	Oct.- Dec.	Whole year
Synedra										
S	2	4	2	19	7	14	1	-	6	5
M	2	2	5	2	3	3	1	-	6	3
B	2	1	2	1	2	3	1	-	4	2
Navicula										
S	5	4	25	42	19	57	12	9	58	34
M	4	1	23	16	11	13	10	3	5	8
B	2	2	7	4	4	7	8	3	5	6
Gomphonema										
S	48	43	1	116	52	25	54	-	958	259
M	14	17	6	1	10	1	1	-	76	20
B	3	1	1	1	2	1	1	-	16	5
Nitzschia										
S	1	-	1	91	23	39	4	2	2	16
M	1	-	4	5	3	5	3	2	1	3
B	1	-	1	1	1	6	3	1	1	3
Oscillatoria										
S	9	23	1	-	8	23	3	1	2	7
M	1	2	2	-	1	-	1	-	1	1
B	1	4	1	1	1	-	-	-	1	1
Rivularia										
S	-	-	-	-	-	m	-	-	-	m/4
M	-	-	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-	-	1

S = Surface; M = Middle; B = Bottom; M = mass growth

From Tables 3 and 4 is is also seen that (1) Chlamydomonas conferta, Characium sp., Gomphonema spp. and Rivularia were the most abundant organisms during certain periods at the surface while Stigeoclonium spp., Oedogonium, Cosmarium, Navicula and Nitzschia were also important, again at the surface; (2) in terms of percentage constancy at the three levels, Navicula occupied the topmost position (95.8%) followed by Scenedesmus (86.1%), Melosira (69.4%), Nitzschia (65.3%), Cosmarium (61.1%), Synedra (58.3%), Gomphonema (55.6%) and Pinnularia (50%). Though Oedogonium and Stigeoclonium showed averages of only 45.8 and 44.4 per cent respectively for the three levels, their percentage constancies at the surface were 79.2 and 95.8; (3) maximum stratification was exhibited by Chlamydomonas, Characium Stigeoclonium, Oedogonium, Navicula, Nitzschia, Gomphonema and Rivularia and in a lesser degree by Synedra and Oscillatoria, their greatest frequencies being at the surface and the least at the bottom; and (4) Scenedesmus, Melosira, Pinnularia and Amphora did not show any clear stratification even though their percentage constancies in the samples were fairly high. Cosmarium was more at the bottom in 1965 but in 1966 it was more at the surface.

The monthly averages of algae encountered on the slides, excluding mass growth of Chlamydomonas, Characium and Rivularia during short periods, ranged at the surface from 20 to 941/sq.cm in 1965 and 12-3966 in 1966; in the middle from 13 to 380 in 1965 and from 3 to 266 in 1966; and at the bottom from 6 to 83 in 1965 and 6-133 in 1966. However, when mass growth of Chlamydomonas, Characium and Rivularia were taken into account the figures for the surface were much higher during the period November 1965 to March 1966.

Taking into account quarterly figures excluding mass growth of Chlamydomonas, Characium and Rivularia (see Table 5) maximum incidence of algae at the surface and middle was in the last quarter of both years whereas at the bottom it was highest in the third quarter of 1965 and in the first quarter of 1966. When mass growth of the three algae mentioned was taken into account maximum growth at the surface was, however, during the third and fourth quarters of 1965 and in the first and second quarters of 1966. There was a gradual decrease in the total organisms from the surface to the bottom. This was all the more marked in yearly averages.

TABLE - 5

Seasonal vertical distribution of major classes of algae in C.I.F.R. Substation Office Pond, Cuttack during 1965 and 1966 (Av. No. per sq. cm of slide surface) in relation to sunshine hours and transparency of water.

Class of Algae and vertical levels	1965					1966				
	Jan.-Mar.	Apr.-June	July-Sept.	Oct.-Dec.	Whole year	Jan.-Mar.	Apr.-June	July-Sept.	Oct.-Dec.	Whole year
1	2	3	4	5	6	7	8	9	10	11
Chlorophyceae										
S	61	99	45	75+m	70+m	74+m	179*+m	19	754*	257*+m
M	10	14	30	146	50	55	11	9	9	21
B	2	1	41	9	13	57	33	9	7	26
Bacillariophyceae										
S	70	65	34	305	119	142	72	13	1043	318
M	33	26	46	26	33	29	18	5	96	37
B	17	9	15	10	13	24	17	6	31	20
Euglenineae										
S	1	-	1	2	1	2	1	1	5	2
M	3	-	2	-	1	3	1	-	10	4
B	1	1	2	-	1	22	3	-	1	7
Myxophyceae										
S	9	25	1	1	9	23+m	3	1	2	7+m
M	1	2	3	-	2	1	2	-	1	1
B	1	4	2	2	2	1	1	1	2	1
Total										
S	141	189	81	383+m	199+m	241+m	255*+m	34	1804*	584*+m
M	47	42	81	172	86	88	32	14	116	63
B	21	15	60	21	30	104	54	16	41	54
Daily sunshine (hrs.)	8.1	7.9	3.5	8.3	6.9	9.5	8.0	3.9	7.9	7.3
Transparency of water (cm)	15.8	12.3	15.0	14.4	15.2	16.8	14.0	18.3	26.3	18.8

* Includes Characium; S - surface; M - middle; B - bottom
m - mass growth of Chlamydomonas, Characium or Rivularia

Microfauna

A list of the micro-fauna encountered on the slides together with the months of their maximum frequency and percentage constancy in the samples collected are given in Table 6.

TABLE -6

List of animalcules encountered on slides at 3 levels in the C.I.F.R. Substation Pond, Cuttack, with months of maxima and percentage constancy in samples.

N.B. - Numerical values for symbols same as in Table 3

Sl. No.	Name of organism	Maxima with months within brackets			% constancy in samples		
		Surface	Middle	Bottom	Surface	Middle	Bottom
1	2	3	4	5	6	7	8
	PROTOZOA						
1) i)	Rhizopoda						
	Amoeba proteus Pallas	i (5)	i (5,7)	vr (10,12)	33.3	50.0	54.2
2.	Arcella vulgaria Ehr. & A. dentata Ehr.	vr (2,6)	i (2,3)	c (2)	25.0	8.3	29.2
3.	Centropyxis sp.	i (5,6)	-	-	8.3	-	-
4.	Difflugia corona Wallich	i (1,8,11)	i (1,4,5,8, 11)	i (8-10)	12.5	20.8	45.8
ii)	Actinopoda						
5.	Acanthocystis sp.	r (9)	vr (9)	i (6,8,9,12)	16.7	16.7	16.7
6.	Actinophrys sol Ehr.	-	i (6-8)	i (11,12)	-	12.5	8.3
7.	Actinosphaerium sp.	vr (12)	vr (12)	vr (8)	12.5	16.7	25.0
8.	Heterophyrys sp.	vr (9)	a (3)	vc (1)	58.4	70.8	62.5

1	2	3	4	5	6	7	8
iii)	Ciliata						
9.	Actinobolina sp.	vr (1)	i (1,8,12)	i (1,8,12)	8.3	12.5	12.5
10.	Bursaria sp.	rc (1)	vc (9)	rc (6)	75.0	70.8	66.7
11.	Campanella sp.	vc (2)	c (2)	c (2)	45.8	45.8	37.5
12.	Epistylis sp.	a (8)	vc (2,6,7)	vc (3,6,7)	100.0	9.6	100.0
13.	Euplotes sp.	vr (8)	i (1,7,12)	i (5,7,8)	16.7	12.5	12.5
14.	Lacrymaria sp.	i (1,11)	vr (9)	i (1,2,6,12)	45.8	45.8	45.8
15.	Loxodes sp.	rc (3,4)	c (4)	rc (3)	62.5	66.7	66.7
16.	Oxytricha sp.	vr (1,3,4,9-12)	rc (9)	rc (3)	70.8	58.4	58.4
17.	Paramecium sp.	i (1-5,6-10,12)	vr (6)	i (9)	45.8	45.8	25.0
18.	Stentor sp.	vr (8, 9)	r (4)	r (4)	41.6	50.0	54.2
19.	Vorticella campanula Ehr.	vr (7)	vr (2)	a (7)	91.6	87.5	91.6
20.	Other ciliates	vr (8)	vr (2,12)	vr (3,5)	66.7	66.7	75.0
iv)	Suctoria						
21.	Acineta sp.	vr (3)	vr (7)	vr (3)	4.2	8.3	4.2
22.	Podophrya sp.	r (1,3)	r (1,7,10,12)	vc (7)	66.7	75.0	87.5

1	2	3	4	5	6	7	8
23.	Tokophrya sp.	c (9,10)	c (8)	vc (5)	62.5	87.5	91.6
24.	Trichophrya rotunda Lachmann	a (1)	a (6)	vc (5)	87.5	87.5	79.2
	ROTATORIA						
25.	Brachionus sp.	vr (1,3,8)	vr (3,7)	i (2,8)	54.2	50.0	41.6
26.	Conochilus sp.	r (7)	r (7)	vr (6,7)	58.4	58.4	25.0
27.	Lecane sp.	i (1,3,7,12)	-	i (6)	16.7	-	4.2
28.	Monostyla sp.	i (6)	vr (5,6,8)	i (6)	41.6	41.6	45.8
29.	Rotaria sp.	vr (1)	vr (4,6-10)	r (5)	83.3	70.8	75.0
30.	Collotheca sp.	-	-	i (5)	-	-	4.2
31.	Other rotifers	vr (3)	vr (3,8)	vr (3-5)	8.3	29.2	12.5
32.	TURBELLARIA	i (6)	i (9)	i (9)	16.7	16.7	16.7
33.	NEMATA	i (1,2,6,9)	i (1,6,7,9)	i (6,7)	16.7	16.7	8.3
	GASTROTRICHA						
34.	Chaetonotus sp.	i (1,6)	i (12)	i (9,12)	20.8	20.8	8.3
35.	OLIGOCHAETA	i (11,12)	-	-	8.3	-	-

It may be seen that the fauna belonged to six major phyla of which the phylum Protozoa was most abundant and having the maximum representation in terms of genera (about 24). This was followed by the phylum Rotatoria (7 genera) and the phyla Turbellaria, Gastrotricha, Nemata and Oligochaeta with the least representation (One genus each). Among the Protozoa, actinopods, ciliates and suctoria were the most dominant.

In terms of habit, the following chief categories could be distinguished; 1) unicellular with unbranched stalk (e.g. Vorticella, Acineta, Podophrya, Tokophrya); 2) colonial with individuals at the ends of branched stalks (e.g. Epistylis, Campanella); 3) Unicellular fauna, mostly protozoans firmly or loosely attached by mucilage or by chitinous or siliceous spicules (e.g. Trichophrya, Heterophrys, Acanthocystis); 4) Unicellular or colonial free-living ones found among the real periphyton organisms (e.g. rotifers like Conochilus, Brachionus, Monostyla and Rotaria, ciliates like Bursaria and the gastrotrich Chaetonotus).

From Table 6 it is also seen that (1) while Epistylis sp., Trichophrya rotunda and Heterophrys sp. were the most dominant organisms during certain periods at all levels, Vorticella, Bursaria, Campanella, Podophrya and Tokophrya were also important; (2) in terms of percentage constancy at various levels Epistylis led the rest (an average of 97.2% for the three levels) followed by Vorticella (90.2%), Trichophrya (84.7%), Tokophrya (80.5%), Podophrya and Rotaria (76.4%), Bursaria (70.8%), Loxodes (65.3%), Heterophrys (63.9%), Oxytricha (62.5%), Stentor and Brachionus (48.6%), Conochilus (47.3%), Lacrymaria (45.8%), Monostyla (43%) and Campanella(41.4%); (3) Distinct stratification (see Tables 6 & 7) was exhibited by a number of genera like Heterophrys, Bursaria, Epistylis, Vorticella, Podophrya, Tokophrya and Trichophrya during certain months though the pattern of stratification varied. From the yearly averages it seemed that in Epistylis and Trichophrya there was a somewhat gradual decrease from surface to bottom whereas the reverse was probably true of Vorticella, Podophrya and Tokophrya. With Heterophrys, Bursaria and probably Loxodes there was greater aggregation-in the middle layer; (4) A number of genera like Lacrymaria, Stentor, Oxytricha, Conochilus and Rotaria did not show marked stratification even though their percentage constancies in the samples were relatively high.

TABLE - 7

Seasonal vertical distribution of the more important genera of animalcules in the C.I.F.R. Substation Pond during 1965 and 1966 (Av. No. per sq. cm of slide surface)

Animal genus & vertical levels	1965					1966				
	Jan.-March	Apr.-June	July-Sept.	Oct.-Dec.	Whole year	Jan.-March	Apr.-June	July-Sept.	Oct.-Dec.	Whole year
Heterophrys										
S	48	1	15	14	20	9	1	83	2	24
M	140	3	43	74	65	255	1	50	5	78
B	169	22	8	61	65	15	-	17	15	12
Bursaria										
S	-	13	6	8	7	13	11	3	1	7
M	1	4	52	9	17	14	52	7	-	18
B	-	19	3	6	7	12	13	4	3	8
Epistylis										
S	40	19	98	58	54	41	39	190	38	77
M	29	14	48	39	33	61	74	110	7	63
B	82	57	45	13	49	30	62	73	24	47
Loxodes										
S	1	12	1	7	5	17	9	-	-	7
M	2	2	8	8	5	14	28	3	-	11
B	-	3	1	6	3	11	13	3	1	7
Oxytricha										
S	3	3	3	8	4	5	2	1	-	2
M	3	3	15	11	8	4	1	-	-	1
B	1	2	2	6	3	13	2	1	-	4
Vorticella										
S	15	3	54	2	19	7	20	2	4	8
M	52	4	17	2	19	9	6	1	13	7
B	27	2	137	4	43	30	9	2	8	12

Contd....

Contd...Table 7

nimal genus & ertical levels	1965 Jan.-March	1965 Apr.-June	1965 July-Sept.	1965 Oct.-Dec.	1965 Whole year	1966 Jan.-March	1966 Apr.-June	1966 July-Sept.	1966 Oct.-Dec.	1966 Whole year
odophrya										
S	7	2	3	3	4	5	2	4	1	3
M	8	3	9	7	7	3	5	9	6	6
B	3	3	115	3	31	7	14	19	4	11
okophrya										
S	2	1	21	26	13	1	1	16	21	10
M	2	3	8	12	6	2	2	22	13	10
B	2	15	229	7	63	78	102	9	6	49
richophrya										
S	1	80	43	133	64	48	62	71	26	52
M	1	120	86	19	57	25	88	64	10	47
B	-	28	8	1	9	31	48	20	2	25
onochilus										
S	3	1	5	1	3	1	1	1	-	1
M	1	3	7	1	4	1	5	1	-	2
B	1	1	2	1	1	-	-	-	-	-
otaria										
S	2	1	10	2	4	1	3	3	1	2
M	-	1	7	4	3	1	5	3	1	3
B	-	3	3	3	3	1	6	2	1	3

S = surface; M = middle; B = bottom

Monthly averages of microfauna ranged at the surface from 60 to 505/sq. m in 1965 and 19-467/sq.cm in 1966; in the middle from 33 to 451 in 1965 and 6-795 in 1966; and at the bottom from 66 to 1271 in 1965 and from 67 to 462 n 1966. Taking into account only quarterly figures (see Table 8) maximum auna at the surface were in the third and fourth quarters of 1965 and the third uarter of 1966 while in the middle they were highest in the third quarter in 965 and the first quarter in 1966, and at the bottom highest figures were in he third quarter of 1965 and the first and second quarters of 1966. In terms f yearly averages the middle and sometimes bottom layers recorded a slightly arger number of organisms than the surface layer.

TABLE - 8

Seasonal vertical distribution of major groups of animalcules and total plant and animal organisms in C.I.F.R. Substation Pond, Cuttack, during 1965 and 1966 (Av. No. per sq. cm of slide surface).

Groups of Organisms & vertical levels	1965					1966				
	Jan-Mar.	Apr.-June	July-Sept.	Oct.-Dec.	Whole year	Jan.-Mar.	Apr.-June	July-Sept.	Oct.-Dec.	Whole year
1	2	3	4	5	6	7	8	9	10	11
Zoo-organisms										
Rhizophoda										
S	1	1	-	1	1	4	2	4	1	3
M	1	-	1	2	1	3	2	1	-	2
B	1	1	2	7	3	23	1	4	9	9
Actinopoda										
S	48	1	15	17	20	9	1	88	3	25
M	140	3	43	74	65	255	1	53	7	79
B	169	22	8	62	65	16	1	20	17	14
Ciliata										
S	63	60	172	90	96	131	87	200	50	117
M	94	31	152	76	88	136	176	125	25	115
B	115	85	199	47	111	131	118	89	40	95
Suctoria										
S	14	83	67	162	82	55	64	90	49	65
M	11	125	105	37	70	29	95	94	29	62
B	7	45	352	11	104	115	164	48	12	85
Rotatoria										
S	11	3	19	4	9	4	5	4	2	4
M	5	5	19	6	9	4	15	8	1	7
B	4	9	8	5	6	3	6	2	2	3
Residual										
S	1	2	1	2	2	1	1	-	-	1
M	1	1	2	2	2	1	-	-	-	1
B	-	1	1	1	1	-	-	-	-	-

Contd..

Contd...Table 8

1	2	3	4	5	6	7	8	9	10	11
Total										
S	138	150	274	276	210	204	160	386	105	215
M	252	165	322	197	234	428	289	281	62	266
B	295	163	570	133	290	288	290	163	83	206
Total phyto- & Zoo-organisms										
Surface	279	339	355	659+m	409+m	445+m	415+m	420	1909	799+m
Middle	299	207	403	369	320	516	321	295	178	329
Bottom	316	178	630	154	320	392	344	179	121	260

S = Surface; M = Middle; B = Bottom; M - mass growth

Ciliates were the most important major group of fauna followed by suctoria, actinopoda, rotatoria and rhizopoda in the order mentioned, at all levels.

When the phyto- and zoo-organisms were considered together (see Table - 8) maximum number of organisms was at the surface except in the first and third quarters of 1965 when it increased gradually towards the bottom. However, on the basis of yearly averages the surface recorded the maximum and the bottom usually the least.

D. Periodicity and stratification of important genera :

Algal organisms :

1. Chlamydomonas

This genus showed mass development at the surface during the cool dry month of January 1966 when it constituted about 75 per cent of all algae, even Characium occupying only second place (25%). By February it had almost disappeared (5 units/sq.cm). In the middle and bottom layers it was negligible (22-39/sq.cm) during January-February, 1966.

2. Characium

It showed mass growth at the surface from November 1965 to February 1966 and again during April-May 1966, which corresponded to rainless periods. In March and June 1966 it was only 66 and 249/sq.cm respectively. It occurred again only in October (5/sq. cm) and November (1623/sq.cm) 1966. In the middle layer it was noticed in December 1965 (305/sq.cm) and February 1966 (22/sq.cm) and at the bottom only in February 1966 (65/sq.cm).

3. Scenedesmus

Species of this genus occurred at all levels almost throughout the two years though in small numbers. Maxima of 28/sq.cm at surface, 25-26/sq.cm at middle and 63/sq.cm at bottom were recorded in September 1965, September 1965 and February 1966, and June 1966 respectively.

4. Stigeoclonium

The genus was present at the surface throughout the two years except in July 1965, ranging from 1-126/sq.cm. with maxima of 99 in November 1965 and 126 in May 1966. Generally, growth was greatest during the second and last quarters of both years. In the middle layer it was less frequent. In 1965 it was 13-14/sq. cm in March-April, 16/sq.cm in June and 5-55/sq.cm during October-December with maximum in October. It was absent or stray during the rest of the period, especially in 1966. It did not occur in the bottom layer.

5. Oedogonium

In 1965 this genus was present at the surface in fairly large numbers (40-71/sq.cm) during January, March to June and September, and in 1966 in April (40/sq.cm) and December (73/sq.cm). At other times it was much less (2-13/sq.cm) or absent altogether. In the middle layer it was more frequent in 1965 than in 1966, maxima of 36/sq.cm and 12/sq.cm being in October and December 1965 respectively. At the bottom stray filaments were noticed only in June 1965 and November, 1966.

6. Cosmarium

It occurred at the surface layer from July to December 1965 (1-23 sq. cm), January-March (1-8/sq.cm) 1966, July-August 1966 (1/sq.cm) and November-December 1966 (1-368/sq.cm), the maximum being in December. In the middle layer it was noted during July-December 1965 (2-44/sq.cm) with maximum in September, and in smaller numbers (1-8/sq.cm) in 1966 except in March and September-October when it was absent. In the bottom layer also, the trend was the same with 3-49/sq.cm during July-December, 1965 (maximum in July) and 1-15/sq.cm in 1966 except in March and September-October.

7. Melosira

This diatom ranged from 1-11/sq.cm at the surface, 1-19/sq.cm in the middle and 1-11/sq.cm at the bottom with maxima in January in all the layers.

8. Synedra

It occurred only in small numbers with maxima of 56/sq.cm at the surface in December 1965 and 36/sq.cm in March 1966. In December 1966 also it was fairly high (19/sq.cm). Otherwise it was scarce (1-7/sq.cm) or absent, particularly in 1966. In the middle it ranged only from 1-9/sq.cm in 1965 and 1-16/sq.cm in 1966 with maxima in September and December respectively. At the bottom it was even less (1-4/sq.cm in 1965 and 1-10/sq.cm in 1966).

9. Navicula

Species of this genus were present at all levels almost throughout 1965 and 1966. At the surface, maximum incidence of 62,111, 100, 62 and 168/sq.cm was observed in September and December, 1965 and January, March and December 1966 respectively. In the middle the genus was less (20-58/sq.cm in 1965 and 2-24/sq.cm in 1966) with maxima of 58 and 40 in September and December 1965 and 24 in January, 1966. At the bottom it ranged only from 1-9/sq.cm in 1965 and 1-14/sq.cm in 1966 with maxima in July and June respectively.

10. Gomphonema

Species of this genus were very common at the surface layer during January, March-June and December 1965 (31-346/sq.cm with

maximum in December)and during January, March, June and November-December 1966 (17-2244/sq.cm with maximum in November). At other times they were scarce or absent. In the middle they were common in March-April 1965 (31-50/sq.cm), September 1965 (17/sq.cm) and during November-December 1966 (55 and 177/sq.cm). At other times they were scarce (1-7/sq.cm) or absent. At the bottom they ranged from 1-6/sq.cm in 1965 and 1-48/sq.cm in 1966 with maximum in December 1966.

11. Nitzschia

At the surface it was scarce (1-3/sq.cm) or absent till November 1965 but became abundant (273/sq.cm) in December. By January 1966 it decreased to 89/sq.cm. Thereafter it ranged from nil-20/sq.cm only. In the middle it was absent during February-June 1965, August 1965 and November, 1966, but ranged from 1-10/sq.cm at other times. At the bottom it was even less (nil-3/sq.cm) in 1965 and nil-7/sq.cm in 1966.

12. Oscillatoria :

It occurred at the surface from January to July 1965 (2-42/sq.cm. with maximum in April), in February 1966 (70/sq.cm) and during April-June and September-December 1966 (1-4/sq.cm). In the middle it was either absent or scarce (1-7/sq.cm). At the bottom it ranged from nil-12/sq.cm in 1965 whereas it was absent in 1966 except in December (1/sq.cm).

13. Rivularia

It showed mass growth at the surface during the warm dry month of March 1966. Otherwise it was absent at all levels except at the bottom in December 1966 (1/sq.cm).

Animalcules :

14. Heterophrys :

This actinoped genus was observed at the surface off and on both in 1965 and 1966. It occurred in large numbers during January-March 1965 (25-73/sq.cm), August 1965 (35), December 1965 (42), January 1966 (25) and October 1966 (249/sq.cm, which was the maximum). At other times it ranged from 1-9/sq.cm or was absent. It was more frequent in the middle with incidence of 269, 144 and 34-111/sq.cm in January, March and August-December in 1965 and 115, 650 and 147 in January, March and October 1966 respectively. Otherwise it ranged

from 1-9/sq.cm or was absent. At the bottom also it was present in fairly large numbers during January-March (88-242/sq.cm), May (65) and September-December (20-113) in 1965 and January (44), August-September (23-28) and November (43) in 1966.

15. Bursaria

This ciliate occurred at the surface except during January-March 1965 and August, October and December 1966 and ranged from 1- 23/sq.cm in 1965 and 1-27/sq.cm in 1966 with maxima in June and January respectively. In the middle it was present in January (1/sq.cm), April-May (3-10) and July-December (1-138) in 1965 with maximum in September, and during January-June (9-130) and September (4) in 1966 with maximum in April. At the bottom it was less than in the middle (nil-33 in 1965 and nil-22 in 1966) with maxima in June and May respectively.

16. Epistylis

It was present at the surface throughout the two years ranging from 2-163/sq.cm in 1965 and 10-345/sq.cm in 1966 with maxima in August in both the years. In May-June and December there was the least growth (2-33/sq.cm). In the middle it was observed throughout except in June 1965 and December 1966, ranging from 1-83/sq.cm in 1966 (max. in December) and 1-191/sq.cm in 1966 (max. in July). Its incidence in February, June and August 1966 was also fairly high (109-138/sq.cm). At the bottom it was present throughout ranging from 3-222/sq.cm in 1965 and 6-127/sq.cm in 1966. Maximum in 1965 was in March and in 1966 in July. In June 1965 also it was in large numbers (133/sq.cm).

17. Loxodes

This genus was much less than Epistylis ranging at the surface from nil-33/sq.cm in 1965 (max. in April) and nil-49/sq.cm in 1966 (max. in March). During July-December 1966 it was not observed. In the middle it ranged from nil-14/sq.cm in 1965 (max. in Sept.) and nil-81/sq.cm in 1966 (max. in April). At the bottom it ranged from nil-8/sq.cm in 1965 and nil-31/sq.cm in 1966 (max. in March 1966).

18. Oxytricha

It ranged from nil-10/sq.cm at the surface in 1965 and nil-7/sq.cm in 1966. It was absent during February-March 1965 and

August-December 1966. In the middle it was more (nil-38/sq.cm with max. in Sept.) in 1965 and nil-10/sq.cm in 1966. It was absent during February-March 1965, February 1966 and June-December 1966. At the bottom it ranged from nil-13/sq.cm in 1965 and nil-32/sq.cm in 1966 with maxima in November and March respectively.

19. Vorticella

This was another important ciliate present at the surface throughout except in June 1965 and August 1966, ranging from 1-148/sq. cm in 1965 (max. in July) and 1-49/sq.cm in 1966 (max. in April). In the middle it was present throughout except in June and November 1965 and August 1966 ranging from 1-109/sq.cm. in 1965 (max. in Feb.) and 1-29/sq.cm in 1966 (max. in Oct.). At the bottom it was absent in May 1965 and October 1966. Otherwise it ranged from 1-377/sq.cm in 1965 (max. in July) and 1-60/sq.cm in 1966 (max. in February).

20. Podophrya

This suctorian genus occurred off and on at the surface ranging from 1-21/sq.cm in 1965 and 2-12/sq.cm in 1966 when present. In the middle it ranged from nil-24/sq. cm in 1965 and nil-23/sq.cm in 1966. At the bottom it was absent during March and May-June 1965. Otherwise it ranged from 1-250/sq.cm in 1965 and 1-46/sq.cm in 1966. Maximum of 250 was recorded in July 1965, other large numbers of 94, 30 and 46 being in September 1965 and April and August 1966 respectively.

21. Tokophrya

It ranged from nil-66/sq.cm at the surface in 1965 and from nil-43/sq.cm in 1966 with maximum development of 62-66 during September-October 1965 and 39-43 during the same period in 1966. In the middle it ranged from nil-28/sq.cm in 1965 with maximum in October and 1-59/sq.cm in 1966 with maximum in August. At the bottom it was more profuse ranging from nil-582/sq.cm in 1965 with maximum in July and secondary maximum (104) in September, and from 3-180 sq. cm in 1966 with maximum of 180 in May and secondary maximum of 163 in March.

22. Trichophrya

It was common at all levels. At the surface it ranged from

nil-317/sq.cm in 1965 (max. in Oct. and absence during February-March) and nil-132/sq.cm in 1966 with maximum in June and absence only in December. In the middle it was absent only during February-March 1965 and October 1966. The range in 1965 was nil-310/sq.cm with maximum in June and secondary maximum (188) in July, and in 1966 from nil-182/sq.cm with maximum again in June. At the bottom it ranged from nil-67/sq.cm in 1965 (max. in Juhe) and nil-112/sq.cm in 1966 (max. in May).

23. Conochilus

This rotifer occurred off and on at all levels but only in small numbers. At the surface it ranged from nil-12/sq. cm in 1965 (max. in July) and nil-2/sq.cm in 1966, in the middle from nil-16/sq.cm in 1965 (max. in July) and nil-7/sq.cm in 1966. At the bottom it ranged from nil-4 in 1965 but was not noticed in 1966.

24. Rotaria

This genus occurred at the surface throughout except during February-May 1965. Otherwise it ranged from 1-22/sq.cm in 1965 (max. in July) and 1-4/sq.cm in 1966. In the middle it was not observed up to May 1965 and in October and December 1966. During the rest of the period it ranged from 1-10/sq.cm. At the bottom also it was absent till May 1965 and in November 1966, but ranged from 1-13/sq.cm at other times.

E Plankton of the pond

Though no regular studies of the plankton were made, occasional collections revealed that the plankton of the pond was fairly rich in Chlamydomonas spp., Chlorogonium sp., Eudorina elegans, several Chlorococcales (Pediastrum, Ankistrodesmus, Scenedesmus), a number of Euglenineae (Euglena acus, E. proxima, E. oxyuris, Phacus spp. and Trachelomonas spp.) some diatoms (Cyclotella, Nitzschia, Cymbella, Surirella) and blue-greens like Anabaena during the rainy season (late June to September), in Euglena viridis, E. tuba, E. oxyuris, Phacus and Trachelomonas, the cryptomonad Cryptomonas, a number of diatoms (Melosira, Synedra, Navicula, Pinnularia, Nitzschia, Gomphonema) and some species of Chlamydomonas, Chlorococcales like Ankistrodesmus and desmids like Closterium and

Cosmarium during October-February and in E. tuba, Phacus spp., Trachelomonas spp., several Chlorococcales (Pediastrum, Scenedemus) and diatoms (Navicula, Pinnularia) and some filamentous blue-green algae (Oscillatoria, Spirulina and Anabaena) during summer. Characuim sp. which was predominant on the slides during November 1965 to June 1966 and Rivularia which was abundant in March were not observed in these collections.

Animal organisms common in the plankton consisted mostly of rhizopods like Difflugia, Arcella, Centropyxis, ciliates like Bursaria, and rarely Vorticella, the rotifers Brachionus, Cephalodella (Furcularia) Rotaria, Testudinella (Pterodina) and Lecane, the copepods Cyclops and Diaptomus including their nauplii, the cladocerans Moina, Ceriodaphnia and Diaphanosoma, and a few ostracods. Most of these organisms were found in fairly large numbers during the rainy season and part of summer but some of the rotifers, Cladocera (esp. Diaphanosoma), the copepods Cyclops and Diaptomus and the rhizopod Arcella were quite common during the winter months as well.

DISCUSSION

From the meteorological data and water temperature presented in the foregoing pages it is seen that the maximum differences in air and water temperature at the surface in the course of 1965 and 1966 were 9.4-10.3 and 9.1-12.6°C respectively and that the maximum difference in water temperature between the bottom and surface or between the surface and middle during the sampling hour (about 09.30 hrs) was only 2-2.5°C. Rainfall was highest during July-September/ October with sunshine hours least during the same period. Thus, while all the three factors were important in the seasonal changes in water conditions and periphyton organisms, the sunshine hours taken in conjunction with transparency (10.5-36.4 cms) and depth (1.4-2.6 m on the average) appeared to be the only factor which could affect the vertical distribution of the plant organisms during different seasons to any appreciable extent (see Table 5). This is all the more so since in shallow Indian ponds (1-3 m.) the slight stratification in water temperature and a few other water qualities built up during the day time with maximum difference between bottom and surface at about 14.00 hrs is broken up at night by convection currents (Philipose, 1940). Even in slightly deeper ponds (See Saha et al., 1971) the maximum difference in temperature between surface and bottom during peak stratification in summer was only 4.1°C.

The pH of 7.9-9.0, total alkalinity 32.7-91.1 ppm, organic matter 4.9-20.0 ppm, nitrates 0.04-0.22 ppm, phosphates 0.75-4.7 ppm, chlorides 12.7-33.9 ppm, calcium 14-68 ppm and sufficient ammoniacal nitrogen, carbon dioxide and oxygen were indicative of a fairly productive pond (also see Philipose, 1959). Seasonal variations were not marked in any of these except to some extent in transparency, total alkalinity, dissolved oxygen, chlorides and calcium. Transparency was usually lower in the summer months of April-June when the water level was lowest and during July-August when there were frequent heavy rains bringing in washing from the sides and through the main drain. Total alkalinity was generally lower during the second half of the year than the first. This could probably be due to the dilution of the water during the monsoons extending from July to November. As may be expected, dissolved oxygen showed a somewhat direct correlation with the average hours of daily sunshine. Chlorides were maximum during April-June and least during the monsoon months, obviously due to the lower water level during the former period than the latter. Calcium showed more or less the same trend. Seasonal changes in pH and nitrates were not marked while carbon dioxide, free ammonia and phosphates were variable. The fairly high level of nitrates and phosphates almost throughout the year both in 1965 and 1966 appeared to be due to mild pollution. It was not clear why organic matter was higher (12-20 ppm) during the first half of 1965 alone compared to the second half of the same year (6.5-9.6 ppm) and the whole of 1966 (4.9-7.1 ppm). Similarly, values of carbon dioxide and free ammonia were also higher in the first year whereas calcium showed the reverse trend.

Differences in values of physico-chemical factors other than temperature between the various levels were least in pH, total alkalinity, nitrates, phosphates, chlorides, calcium and, to some extent, in organic matter. Free carbon dioxide was variable though on the average its values increased slightly towards the bottom, as one would naturally expect. Free ammonia was also variable. Dissolved oxygen generally increased towards the surface, obviously due to greater photosynthesis there. Saha et al. (1971) also noted somewhat similar trends. The absence of distinct stratification in most factors was evidently due to the sampling hour.

From the large number of organisms recorded on the slides almost throughout the period of investigation it is clear that the pond is quite rich in periphyton which might have been missed but for the suspended slides since there is practically no macroflora or large stones in the margin or elsewhere on which they could

be detected. Among the plant prganisms Chlamydomonas and Characium occurred in such profusion at the surface, the former in January 1966 and the latter during November 1965 to February 1966 and April to May 1966, as to mask all other organisms. The same was the case with Rivularia in March 1966. Among the animalcules, the ciliates Vorticella and Epistylis were present at all levels almost throughout the two years.

Characium, young stages of Ulothrix tenerrima, Stigeoclonium spp., Chaetophora, Coleochaete, Amphora ovalis, Cymbella turgida, Gomphonema spp. and Rivularia were truely attached forms whereas Eudorina elegans, Pediastrum tetras, Ankistrodesmus falcatus, Selenastrum gracile, Scenedesmus spp., Melosira granulata, Nitzschia spp., Surirella robusta, Euglena acus, Trachelomonas spp. and Spirulina were truly planktonic. Though Chlamydomonas appeared abundantly in the plankton, in its initial palmelloid stages it could appear in large numbers on the slides also. Others which could attach themselves to the slide for shorter or longer periods were Closterium spp., Cosmarium, Cyclotella operculata, Synedra, Fragilaria, Pinnularia spp., Navicula spp., Euglena viridis, E. tuba, Oscillatoria and Anabaena, all by means of their mucilaginous coats or sheaths.

Philipose (1940) observed that, like the phytoplankters in the pond he investigated, a number of algae attached to various marginal objects or those which were loosely associated with them showed a definite periodicity. Thus, during the cool dry sunny months of January to March, when the water level was high and the water clear, there was an Oedogonium-Ulothrix-desmids- Cladophora-Chaetophorales - diatom community followed by a Spirogyra - Pithophora - Cylindrocapsopsis - blue-green community during the hot, dry, bright months of April to June when the water level was low and water more concentrated. During the sultry South West monsoon period when the water level was still low and the concentration of dissolved salts maximum, the summer forms continued intermittently, but with the heavy rains of October-November Cladophora, Oedogonium, various Chaetophorales, desmids and diatoms again came up. In pond water-silt cultures also there was a more or less similar succession but completed within 6-8 weeks. These cultures proved that many of the attached and planktonic forms including palmelloid ones passed their resting stages in the pond silt, and provision of an attaching surface made it easy to detect most of the former. However, he did not study the vertical distribution of the attached forms. Singh (1970) also did not study the vertical stratification of the diatoms he

recorded. In studies by Gonzalves and Joshi (1946) and Krishnamurthy (1954), attached forms have not been studied exclusively. Attached animal organisms have not been taken into account in any of these studies. Thus, the present investigation is the only exclusive one made so far in India.

In the pond under present observation only some of the algal genera like Chlamydomonas, Characium, Oscillatoria and Rivularia showed distinct periodicity while others, especially the filamentous and heterotrichous green algae, Scenedesmus, Cosmarium and diatoms were present in fairly large numbers almost throughout the year. There was a general decrease in the number of algae from the surface to the bottom. This was particularly true of most green algae (except Scenedesmus and Cosmarium), the diatoms and the few blue-greens present. Though the present pond is not comparable to lake Windermere (See Pearsall et al., 1946) and Sedlice Reservoir (See Sladeckova, 1960), the effect of sunlight on the stratification of producers as well as consumers (see below) noticed by these authors was apparent even in this small pond.

Among the animal organisms, the ciliates Vorticella, Epistylis, Stentor and Campanula, the suctoria Acineta, Podophrya, Tokophrya and Trichophrya, the gastrotrich Chaetonotus, the rotifer Collotheca and the stray nematode and oligochaete worms were predominantly attached forms not seen in the plankton. Most of the Protozoa, the ciliates Lacrymaria, Loxodes, Bursaria, Oxytricha and Euplotes and all the Rotatoria, on the other hand, seemed to be truly planktonic, though Amoeba, Difflugia, Arcella, Actinosphaerium, Heterophrys, Paramecium and a few others were found more or less constantly among the attached forms, Heterophrys being the most noteworthy in this respect. None of the free-living Protozoa and ciliates except Arcella, Difflugia, Actinosphaerium and Bursaria could, however, be detected in occasional plankton collections.

The more important animal organisms were present almost throughout the year. No clear-cut vertical stratification, as in the case of plant organisms, could be observed among the animal organisms, though on the basis of yearly averages some genera seemed to be more at the surface, middle or bottom.

The lower average of plant organisms (70/sq.cm for the three levels) in the first quarter of 1965 compared to the same quarter of 1966 (144 + M/sq.cm) appeared to be due to higher rainfall during the former period. Anumalcules also showed a similar trend during the same periods (228/sq.cm in 1965 and 307/sq.cm in 1966 for the three levels).

Though a number of periphyton genera recorded in the present study are the same as those recorded by Sladeckova (1960), there are obvious differences both with regard to species (whenever available) and the seasonal succession and vertical distribution, on account of the different habitats, viz. a small shallow tropical pond and a large deep temperate reservoir respectively. However, as noted by Sladeckova, vertical distribution of the algae followed a similar pattern in both bodies of water. It also showed the richness of periphyton fauna and flora in a typical Indian fish pond with average nutrient level almost throughout the year. The present pond would, thus, seem to be capable of supporting a stock of fish, especially of the browsing type, which could feed on these organisms if suitable substrate are provided for their development. In this connection it is noteworthy that at the Oceanic Institute, Waimanalo, Hawaii (See Shehadeh, 1970), the possibility of increasing pond productivity by providing plastic sheets for attachment of diatoms and other algae which serve as the food of mullets has been investigated and found promising.

Sladeckova (1960) reported that glass slides fixed vertically in relation to the water surface gave a better growth of periphyton than those slides fixed in a horizontal position though the latter collected sediments also. In the present study, where slides were fixed only vertically, algal and faunal growth was very rich almost throughout the year.

It is also interesting to note that a number of organisms recorded in the present study, viz. Chlamydomonas conferta, Stigeoclonium spp., Closterium spp., Gomphonema spp., Navicula spp., Cymbella turgida, Euglena spp., Phacus, Trachelomonas, Oscillatoria, Spirulina, most of the Protozoa (especially the ciliates and suctoria) and Rotifera are indicative of mild pollution as also borne out by the chemical analyses of water which indicated fairly high organic matter, nitrogen and phosphorus. Sladeckova (1960) also recorded a number of these organisms and suggested that they were indicative of the degree of pollution from starch factories, etc. (Also see Butcher, 1946; Motwani et al., 1956; Philipose, 1959). Sladeckova (1966) has also discussed the significance of periphyton of reservoirs for theoretical and applied limnology. In some of the alpine lakes he investigated, Rabe (1965) observed that periphyton weights increased up to eight times or more when the lakes were fertilized than when left untreated. Excessive development of nannoplankton could, however, reduce periphyton growth. In the present pond the fairly clear water almost throughout the year and absence of any permanent algal bloom helped in the good growth of periphyton almost throughout the year.

ACKNOWLEDGEMENTS

The authors wish to express their gratitude to (1) Dr. V.G. Jhingran, Director of the institute, for his keen interest in this study; (2) the Director, Central Rice Research Institute, Cuttack, for kindly making available their meteorological records for the years 1965 and 1966.

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