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TEMPORAL AND SPATIAL DISTRIBUTION OF PHYTOPLANKTON WITH EMPHASIS ON *SKELETONEMA COSTATUM* IN THE MATHAMUHURI RIVER - ESTUARY (CHAKARIA MANGROVE ECOSYSTEM), BANGLADESH

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ABSTRACT: A total of 91 species under 44 genera were identified among the phytoplankton community during the course of one year's investigation between May 1982 and April 1983. Bacillariophyta was the most dominant group with 72 species, Chlorophyta 11 spp, Cyanophyta 6 spp and Pyrrophyta was represented by 2 species. The yearly percentage composition of 4 groups of phytoplankton in order of abundance were Bacillariophyta 50.77%, Cyanophyta 47.70%, Chlorophyta 1.5% and Pyrrophyta 0.02%. The highest densities of phytoplankton were recorded in monsoon months (June - July) with a peak in July (31550 cells/l) and the minimum in February (770 cells/l). Higher concentration of phytoplankton was recorded at station 2, nearer to the Chakaria Sundarbans (mangroves), but abundance of phytoplankton showed no significant difference in the two stations (Mann Whitney U test, P=0.64, Z=-0.642, U=64). Phytoplankton populaton in this area were positively correlated with rainfall (r=0.655, P=<0.5, df.22) and water temperature (r=0.523, P=<0.05). *Skeletonema costatum* was the dominant member of phytoplankton and occupied 35.23% of the annual population and occurred throughout the period of study except in September and January. Its abundance was recorded during the monsoon months (April - July) with a maximum density (24185 cels/1) in July. No significant correlation was found between abundance of *S. costatum* and the hydro-meteorological parameters recorded in the Chakaria mangrove area.

KEY WORDS: Phytoplankton, *Skeletonema costatum,* Mathamuhuri estuary, mangrove ecosystem, Bangladesh.

INTRODUCTION

Phytoplankton containing chlorophyll are able to utilize dissolved carbon dioxide, nutrient salts and the solar energy to produce carbohydrates, proteins and oils, the basic food materials. Estuaries are frequently the areas of high fertility and large phytoplankton populations. The high primary production is reflected in presence of dense population of zooplankton and may be an advantage to the many marine species, which breed in the estuaries, and their larvae have a plentiful supply of food at a critical period (Ketchum, 1967). At present many species of phytoplankton are used in rearing of penaeid shrimp larvae. *Skeletonema costatum* has been widely used both in extensive and intensive hatchery systems of *Penaeus japonicus* (Hudinaga, 1942 and 1969) and *P. monodon* (Su *et al.,* 1990). Informations on the temporal and spatial distribution of phytoplankton in the estuarine and marine environment of Bangladesh is scarce. Only Islam and Aziz (1975 and 1977) worked on taxonomy of phytoplankton in the north-eastern part of the Bay of Bengal. The present work adds further to this knowledge.

MATERIALS AND METHODS

Phytoplankton samples were collected (May, 1982 - April, 1983) fortnightly at high tide during new moon and full moon by a plastic container from the surface water of two stations in the Mathamuhuri river estuary (Fig. 1). Two litres of water were taken and immediately presreved in 5% neutralized formalin and stored for analysis in the laboratory. Concurrently atmospheric temperature, water temperature, dissolved oxygen, salinity, transparency of water and hydrogen ion concentration were recorded. Data on monthly rainfall were obtained through the courtesy of Meterological Department.

After allowing 16-20 hours to settle, each of the phytoplankton sample was concentrated to 10ml by careful filtration and decantation as mentioned by Boyd (1979). For quantitative study, the number of cells per litre of water were counted on a Sedgwick Rafter-cell under a compound microscope. For identification of phytoplankton Davis (1955), Islam and Aziz (1975) and Newell and Newell (1979) were followed.

RESULTS

Hydrometeorological Parameters:

Hydrometeorological parameters of the studied area (Table 1) varied as follows, maximum air and water temperature were 29.5°C and 31.2.°C respectively, lowest temperature was recorded in January and the highest in May. The concentration of dissolved oxygen varied through a range of 3.96 ml/1 to 6.76 ml/1, maximum was recorded in November and the minimum in May. Salinity ranged between 2.01‰ and 32.61‰, highest value was recorded in March and the lowest in September. Secchi-depth varied between 21.5cm (August) and 77.5cm (December). The hydrogen ion concentration (pH) varied through a narrow range (7.1 and 7.6). The effective rainfall

Table 1. Hydro-meteorological parameters of the Mathamuhuri river-estuary, Chakaria mangrove area, Bangladesh (May 1982 - April 1983)

Months	Air temperature (average) (°C)	Water temperature (°C)	Dissolved oxygen (ml/1)	Salinity (‰)	Secchidepth (cm)	Hydrogen ion concentration (pH)	Rainfall (mm)
May	29.44	31.23	3.96	30.42	42.0	7.1	157
June	27.48	29.48	4.56	17.29	38.0	7.5	1164
July	27.88	28.49	5.49	8.68	32.0	7.5	886
August	26.85	28.43	5.90	2.63	21.5	7.1	850
September	27.62	29.78	5.96	2.01	25.5	7.5	483
October	27.95	28.91	5.89	6.64	25.0	7.5	03
November	23.20	28.04	6.75	19.87	35.0	7.5	119
December	21.08	22.49	6.71	24.04	77.5	7.5	00
January	20.42	21.50	5.65	28.17	35.5	7.2	08
February	22.60	23.50	5.85	31.78	36.0	7.6	47
March	25.63	26.29	5.15	32.61	75.0	7.4	19
April	27.73	28.50	4.15	24.08	33.5	7.3	113

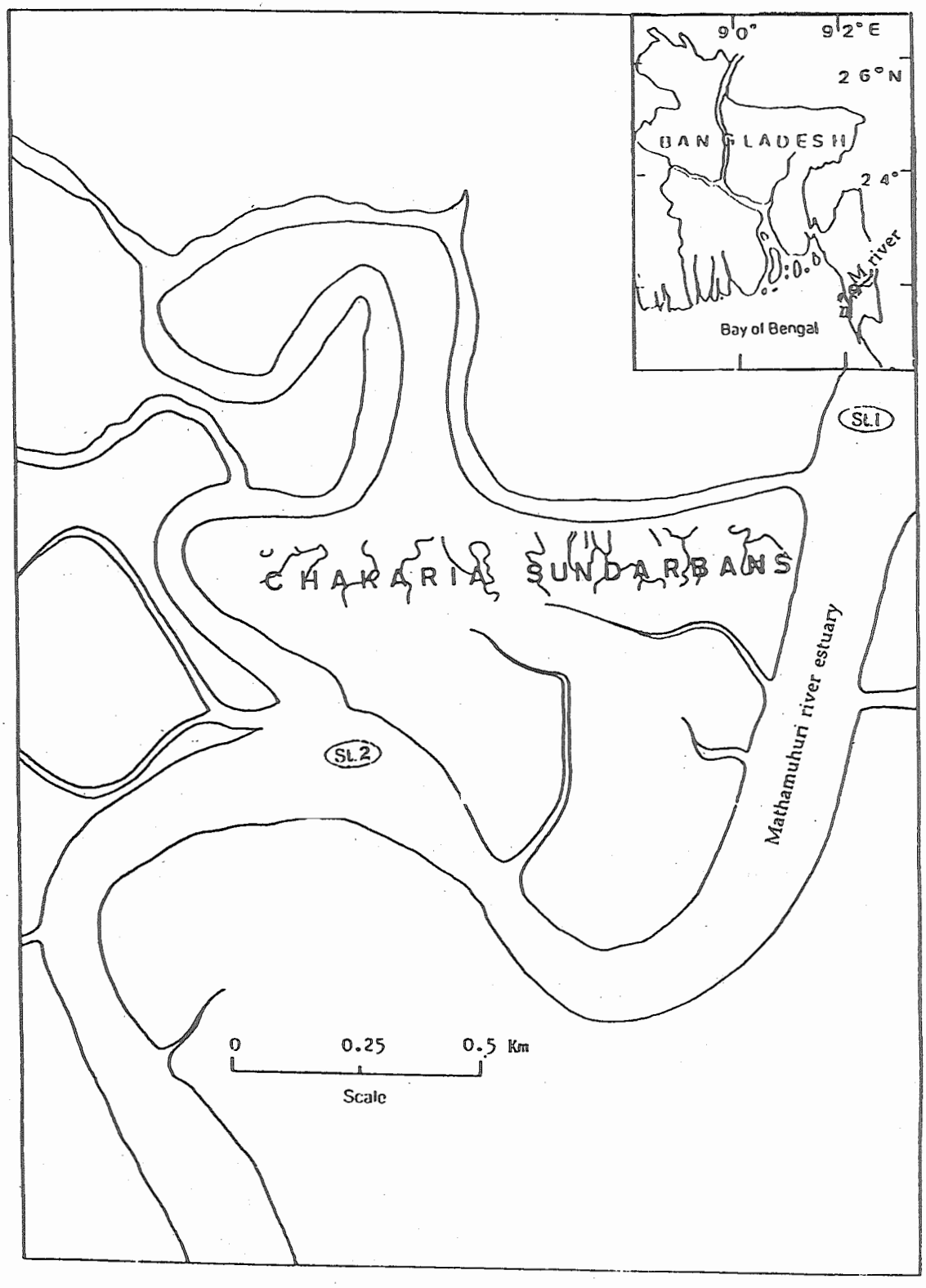

Fig. 1. Map showing location of sampling stations (1 and 2) in the Mathamuhuri river-estuary of the Chakaria sundarban, location of which has been pointed in the map of Bangladesh (inset).

was confined in the monsoon season between June and September, with the maximum (1164mm) in July.

Occurrence and Abundance of Phytoplanktom:

A total of 91 species under 44 genera were recorded from the Mathamuhuri river-estuary of Chakaria Sundarban area (Fig. 2-92). Bacillariophyta was the most dominant group with 72 species; 11 spp. under Chlorophyta, 6 spp under Cyanophyta and 2 spp. under Pyrrophyta. The average percentage composition of these groups in order of abundance were Bacillariophyta 50.77%, Cyanophyta 47.70%, Chlorophyta 1.5% and Pyrrophyta 0.02% (Table 2). The fluctuations in average total number of phytoplankton and the observed hydrological factors showed strong seasonal variation. Generally higher densities of phytoplankton were recorded at station 2, but the abundance of phytoplankton indicates no significant difference between the two stations of the Mathamuhuri river-estuary of Chakaria Sundarban (Mann Whitney U test P=0.64, Z=-0.642, U=64). The highest number of the phytoplankton was recorded in early monsoon months (April-July) and minimum in late winter (February and March). The peak in occurrence of phytoplankton was recorded in July (31550 cells/1) and the minimum in February (770 cells/1). Phytoplankton densities of this area were positively correlated with rainfall (r=0.655, P<0.05, df.=22) and water temperature (r=0.523, P=<0.05).

Abundance of four groups of Phytoplankton:

The highest density of Chlorophyta was recorded in October (1145 cells/1), being absent in September, February and March. Cyanophyta was the second dominant group and the highest densities occurred during monsoon season with a peak in June (25090 cells/1) and it was totally absent during the winter months (December through April). A significant positive correlation was found between the Cyanophyta abundance and rainfall (P=0.038, r=0.425). Pyrrophyta was poorly represented group among the phytoplankters. It occurred only in December (20 cells/1). Bacillariophyta was the most dominant group in the phytoplankton population (Table 2). It was present throughout the period of investigation. The maximum was recorded in July (27220 cells/1) and minimum in January (740 cells/1).

Skeletonema costatum:

No significant correlation was found between abundance of *Skeletonema costatum* and hydrological parameters. During the year long investigation the maximum densities of *S. costatum* were recorded when range of different parameters were as follows: water temperature (28~31°C), salinity (9~30‰), dissolved oxygen (4~5.5ml/1), Secchi-depth (32~42cm) and pH (7~7.5). *Skeletonema costatum* occupied 69.40% of the Bacillariophyta population. The Bacillariophyta as a whole represented 50.77% of the total phytoplankton population (Fig. 93) in the Mathamuhuri river estuary of Chakaria sundarban area. It was recorded throughout the period of investigation except in September and January, and higher densities occurred during the monsoon months (April-July) with a peak (24185 cell/1) in July (Fig. 94).

Table 2. Seasonal variation in distribution of four major groups of Phytoplankton (cells/l) in the Mathamuhuri river estuary of the Chakaria mangrove ecosystem, Bangladesh.

Major groups	1982								1983				Yearly	Percentage
	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Average ($\bar{X}$)	composition (%)
Chlorophyta	20	40	80	50	0	1145	40	20	450	0	0	4	154	1.51%
Bacillariophyta	3090	3400	27220	870	410	16270	2380	1340	740	770	890	4606	5166	50.77%
Cyanophyta	1900	25090	4250	0	20500	2300	4200	0	0	0	0	0	4853	47.70%
Pyrrophyta	0	0	0	0	0	0	0	20	0	0	0	0	2	0.02%
Monthly total of Phytoplankton	5010	28530	31550	920	20910	19715	6620	1380	1190	770	890	4610	10175	100.00%

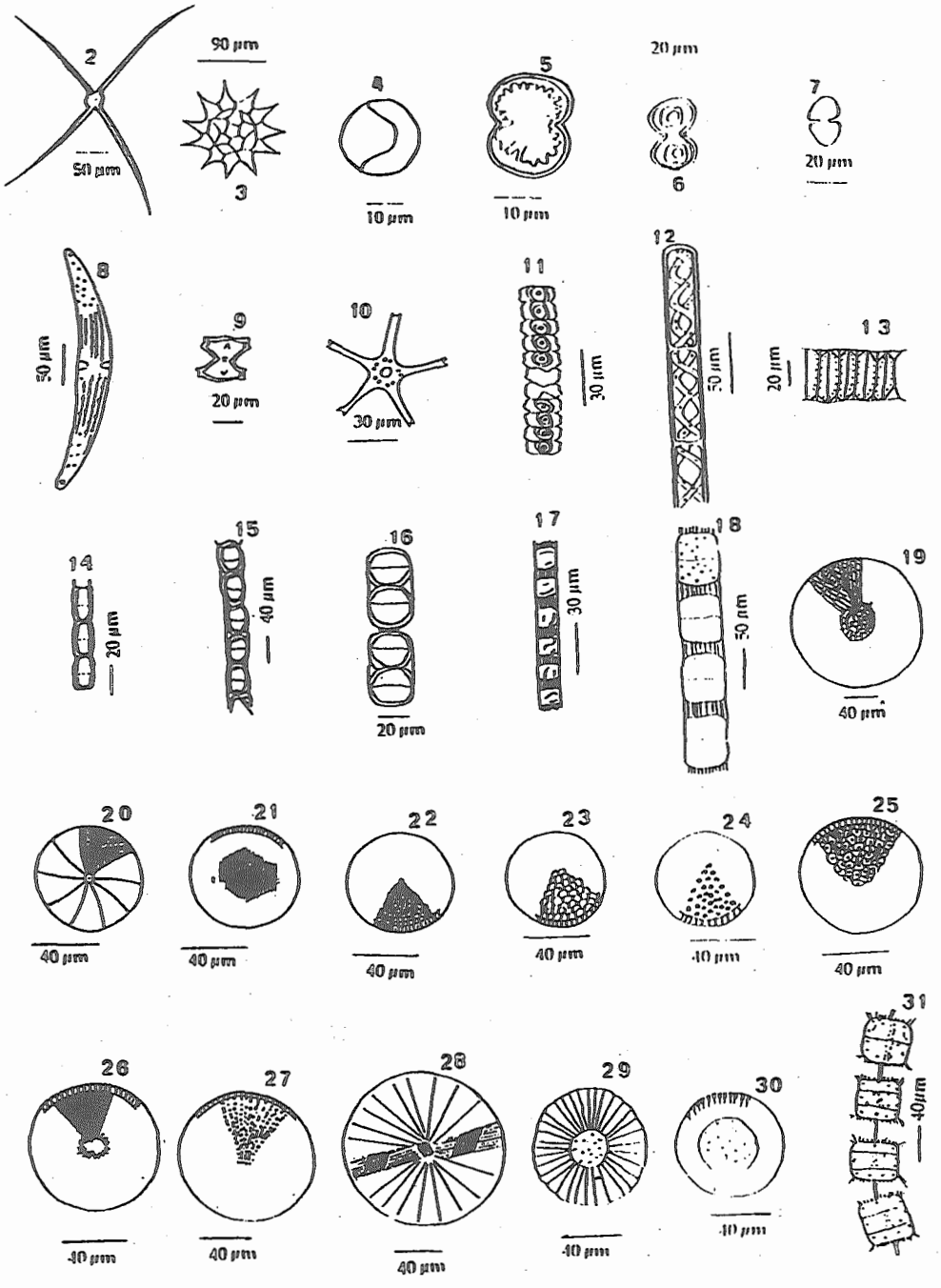

Fig. 2. *Legerheimia* sp; 3. *Pediastrum simplex*; 4. *Chlorella variegatus*; 5. Cosmarium globosum; 6. *C. moniliforme*; 7. *C. granatum*; 8. *Closterium* sp; 9. *Staurestrum aversum*; 10. *Staurestrum* sp; 11. *Desmidium swartzii*; 12. *Spirogyra* sp; 13. *Melosirasulcata*; 14. *M. varians*; 15. *M. nummuloides*; 16. *M. moniliformis*; 17. *Skeletonema costatum*; 18. *Stephenopyxis palmeriana*; 19. *Coscinodiscus centrales*; 20. *C. curvatulus*; 21. *C. lineatus*; 22. *C. excentricus*; 23. *C. nitidus*; 24. *C. radiatus*; 25. *C. marginatus*; 26. *C. gigas*; 27. *C. perforatus*; 28. *C. granii*; 29. *Planktoniellasol*; 30. *Cyclotellacomta*; 31. *Thalassiosiragravida*.

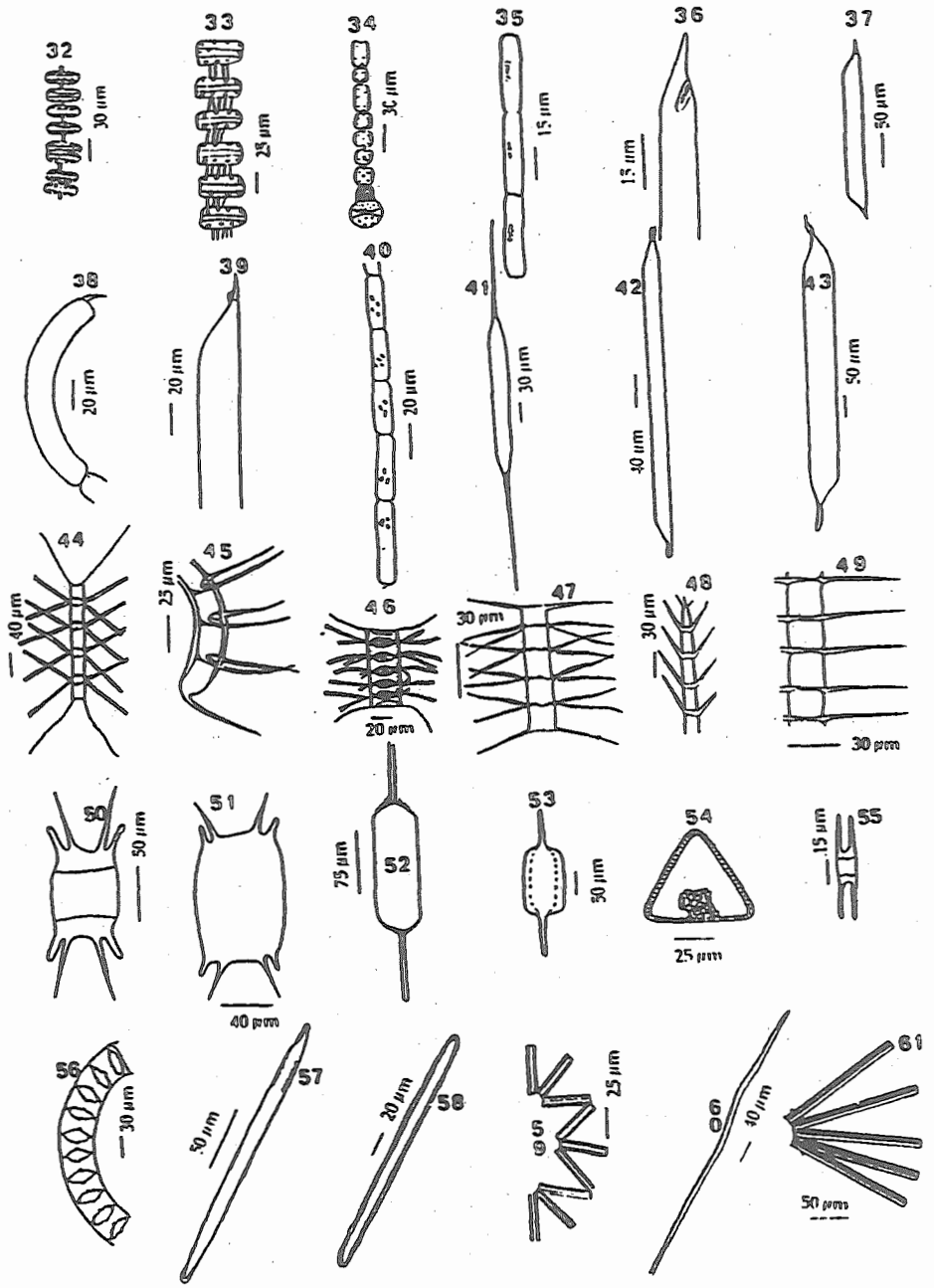

Fig. 32. *T. rutula*; 33. *Coscinosira polychorda*; 34. *Schroderelladelicatula*; 35. *Leptocylindrus danicus*; 36. *Rhizosolenia alata*; 38. *R. stolterforthii*; 39. *R. styliformis*; 40. *R. delicatula*; 41. *R. setigera*; 42. *R. hebetata*; 43. *R. calcaravis*; 44. *Chaetoceros atlanticus*; 45. *C. curvisetus*; 46. *C. costatus*; 47. *Chaetoceros* sp 1; 48. *Chaetoceros* sp 2; 49. *Chaetoceros* sp 3; 50. *Biddulphia granulata*; 51. *B. mobiliensis*; 52. *Ditylum brightwellii*; 53. *D. sol*; 54. *Triceratium distinctum*; 55. *Hemiaulus hauckii*; 56. *Eucampia zoodiacus*; 57. *Synedra ulna*; 58. *Synedra* sp; 59. *Thalassionema nitzschioides*; 60. *Thalassiothrix longissima*; 61. *T. frauenfeldi*;

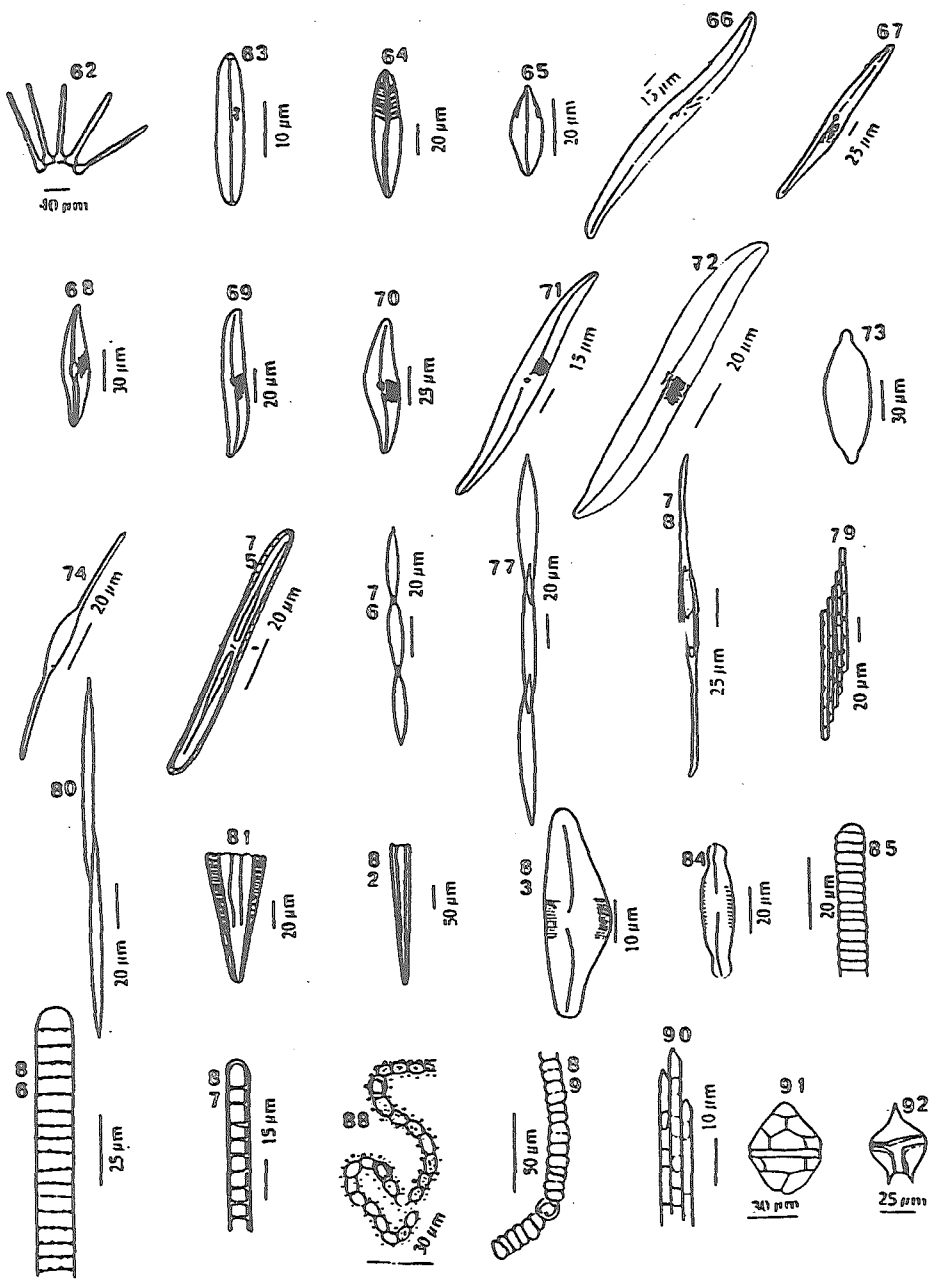

Fig. 62. *Asterionella japonica*; 63. *Grammatophora angulosa*; 64. *Navicula distans*; 65. *N. salinarum*; 66. *Pleurosigma intermedium*; 67. *P. elongatum*; 68. *P. normanii*; 69. *P. affine*; 70. *P. rigidum*; 71. *Gyrosigma spencerii*; 72. *G. balticum*; 73. *Amphora hyalina*; 74. *Nitzschia closterium*; 75. *N. sigma*; 76. *N. pacifica*; 77. *N. seriata*; 78. *N. longissima*; 79. *N. paradoxa*; 80. *N. pungens*; 81. *Licmophora abbreviata*; 82. *Climacosphenia moniligera*; 83. *Cymbella stuxbergii*; 84. *Cymbella* sp; 85. *Oscillatorea tenuis*; 86. *O. limosa*; 87. *Trichodesmium thiebauti*; 88. *Nostoc* sp; 89. *Anabaena circinalis*; 90. *Aphanizomenon flosague*; 91. *Peridinium thorianum*; 92. *Peridinium* sp.

DISCUSSION

Subrahmanyan (1958) worked in the Arabian sea off the west coast of India and reported 336 species of phytoplankton with Bacillariophyta being the dominant flora. Islam and Aziz (1975) worked on phytoplankton from the northeastern part of the Bay of Bengal and found a total of 76 species in which diatoms formed the dominant flora. In the Chakaria mangrove area 91 species of phytoplankton were recorded and where also the diatoms constituted the most dominant flora. Gopinathan (1972) in Cochin Back-water found two peak periods of phytoplankton occurance during May to June and October to November. He also reported that during January - February phytoplankton production was insignificant and during March through April phytoplankton production was at a moderate level. This view is similar to the present findings. Carpentar (1971) reported that phytoplankton was dominated by the diatom *Skeletonema costatum* in the Cape Fear river estuary. Hulburt and Guillard (1968) expressed that *Skeletonema costatum* was an abundant and ubiquitous neritic diatom species and Lloyed (1925) stated that its occurrence was higher in the month of May. Su *et al.* (1990) reported optimum range of temperature for this species being 20~30°C, and salinity 15~30ppt. Chandran and Ramamoorthi (1984) stated that during monsoon season, the estuary was enriched with nutrients due to heavy rainfall, and the consequent land run-off resulted in bloom formations (Chandran, 1985). Similar may be the situation in Mathamuhuri river estuary of Chakaria mangrove area where maximum occurrence of *S. costatum* was recorded during monsoon period. Pati (1980) also mentioned that the coastal water was found to be rich in nutrients, with peak values of phytoplankton during southwest monsoon. Thus, the abundance of *Skeletonema costatum* during monsoon as recorded by this investigation is more or less similar with other works stated above.

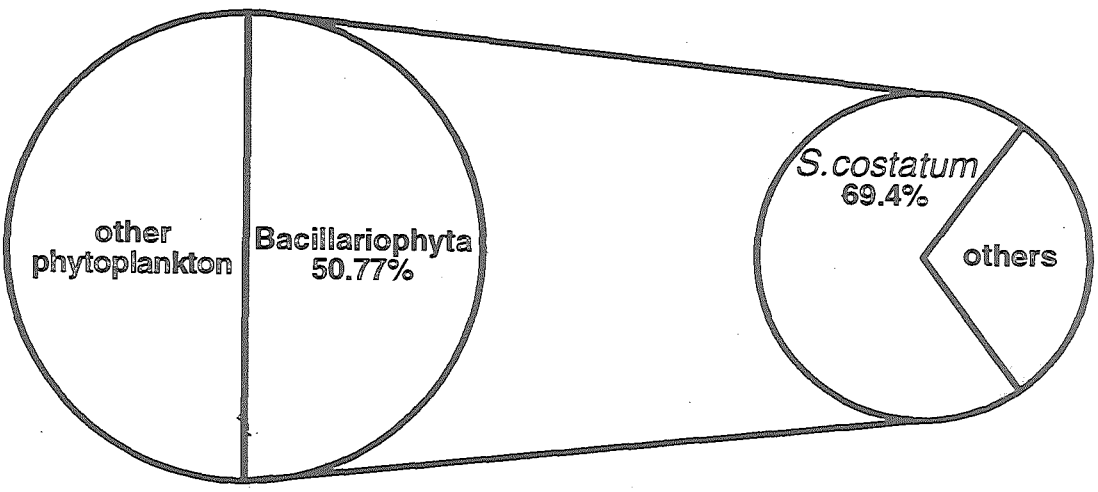

Fig. 93. Percentage composition of *Skeletonema costatum* in the total annual population of phytoplankton of the Mathamuhuri river-estuary.

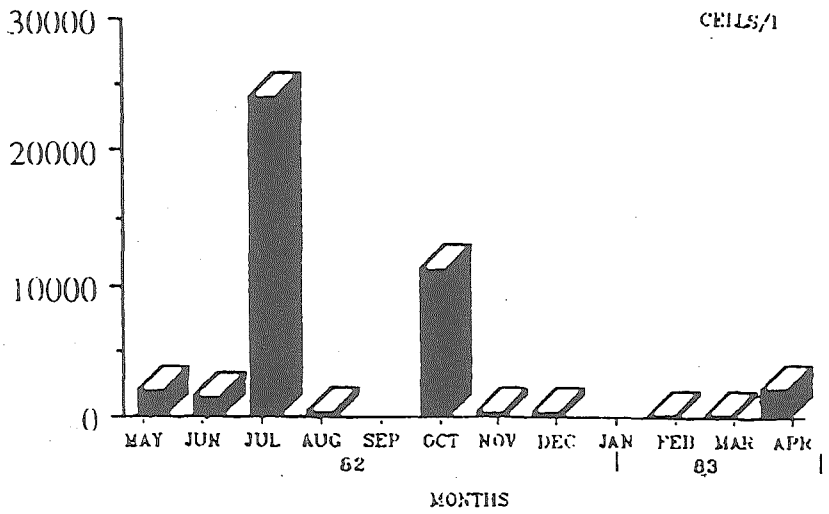

Fig. 94. Monthly occurrence and abundance of *Skeletonema costatum* in the Mathamuhuri river-estuary of Chakaria sundarban, Bangladesh.

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