Species Composition, Abundance and Distribution of Phytoplankton in the Bay of Bengal

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Abstract

Species composition, abundance and distribution of phytoplankton were studied from water samples collected at surface layer of 24 stations in 3 areas (north, west and east) in the Bay of Bengal in November 2007. A total of 135 phytoplankton species belonging to 2 species of cyanobacteria, 78 species of diatoms, 53 species of dinoflagellates and 1 species of silicoflagellate were identified. The occurrence of species in each area was recorded. *Oscillatoria erythraea* and *Proboscia alata* were the dominant species in all areas. *Pseudo-nitzschia pseudodelicatissima* presented with high densities causing the blooms in the Northern Bay. The highest phytoplankton density was 133,790 cells/L. Dinoflagellate did not dominate phytoplankton population during this survey.

Key words : phytoplankton, Bay of Bengal, species composition, abundance, distribution

Introduction

This study is a part of the project on "The Ecosystem-Based Fishery Management in the Bay of Bengal" which is a collaborative survey project of the BIMSTEC member countries.

The Bay of Bengal is characterized as a large marine ecosystem bounded by territory of many countries. It is a semi-enclosed tropical ocean basin under strong influence of tropical monsoons and receives large volume of freshwater from both river discharge and rainfall (Vinayachandran and Mathew, 2003).The northern part of the Bay of Bengal is an area where storm surges and cyclones frequently occur. These cyclones cause turbulence in coastal and nearshore areas (Dwivedi and Choubey, 1998).

The information on phytoplankton in the offshore waters of the Bay of Bengal is scanty and inadequate for understanding the dynamics of the Bay ecosystem. Most studies have been carried out in the coastal areas. The International Indian Ocean Expedition was the prominent survey conducted both in the coastal areas and open sea of the Indian Ocean including the Bay of Bengal in 1963. Dinoflagellate species collected during this survey were recorded by Taylor (1974). Except for this expedition, the present study is the first investigation of phytoplankton in the offshore areas around the Bay. The purpose of this study is to describe species composition, abundance and distribution in the surface layer in the Bay of Bengal. The results will benefit for marine fishery studies of the BIMSTEC member countries.

Materials and Methods

Phytoplankton sampling was carried out on board M.V.SEAFDEC at 24 stations during November 2007. The study area was divided into three areas: area A or the Northern Bay, area B or the Western Bay and area C locates in the Eastern Bay of Bengal (Fig. 1). Seawater samples were collected by Van Dorn water sampler at 2-4 m below the sea surface. Forty to sixty liters of the water samples were filtered onto a 20 µm mesh phytoplankton net and preserved with 2% formalin/seawater mixture immediately. The samples were concentrated by sedimentation. Phytoplankton in the concentrated samples was count and identified by using a 0.5 ml counting slide, compound microscope fitted with a phase contrast device. Filamentous cyanobacteria was counted as one unit or filament.

Results

Identification

A total of 58 genera with 135 species were identified from the samples collected in the surface layer during this survey. The identified phytoplankton consisted of 2 genera with 2 species of cyanobacteria, 36 genera with 78 species of diatoms, 19 genera with 53 species of dinoflagellates and 1genus with 1 species of silicoflagellate. There were 52 genera with 103 species, 29 genera with 46 species and 48 genera with 95 species observed in the area A,B, and C, respectively. A taxonomic list and occurrence were recorded in Table1.

Phytoplankton Abundance

Phytoplankton densities in 3 areas of the Bay of Bengal are shown in Fig.2 and Table 2. The cell densities in the area A, B and C were in the range of 261-133,790, 509-722 and 171-11,178 cells/L, respectively. The maximum cell count was found at station 23 which is located in the northwestern part of the Bay. The cell densities examined from 3 stations in the area B were rather low similar to most stations in the area C but high cell densities were observed near coastal area of Myanmar.

Species Composition and Distribution

One species of cyanobacteria and 5 species of diatoms dominated phytoplankton population in the surface layer during the survey period in the Bay of Bengal. The composition of 6 dominant species and 15 associated species are shown in Table 2. *Oscillatoria erythraea* and *Proboscia alata* occurred as dominant species distributed in all areas (area A, B and C).

Phytoplankton population at 6 western stations of the area A were dominated by *Pseudo-nitzscia pseudodelicatissima* (Fig.3) and presented with highest percentage of abundance (68.12%) at station 20. The massive blooms of *Pseudo-nitzsci pseudodelicatissima* as dominant species and *Chaetoceros messanensis* as associated species, with of 27.67 % and 20.62 % contribution to total phytoplankton density, respectively, led to distinct phytoplankton bloom at station 23 in which total phytoplankton density reached 133,790 cells/l. Phytoplankton communities in 4 stations in area A were distinguished from other areas due to their lower abundance and the dominance (in term of percentage of abundance) of a cyanobacteria, *Oscillatoria erythraea*. There was no distinct bloom of phytoplankton in the area B and C. The dominant species and associated species of 3 stations in the area B occurred with low percentage of abundance of low total phytoplankton densities.

High percentage of abundance of dominant species were observed with low densities in some stations in the area C, and on the contrary, very low percentage of abundance of *Chaetoceros compressus* which presented as dominant species was found from high total phytoplankton density in station 10 (Table 2).

Discussion and Conclusion

Phytoplankton species of the present survey were mostly similar to those recorded from the Andaman Sea in November 2004 (Boonyapiwat, 2006) and Myanmar waters in February 2007 (Boonyapiwat, in press) but the species number was lower than other studies. This might due to the differences in sampling depths since only surface phytoplankton samples were reported in this study while other studies covered both surface and sub-surface samples. It is also widely recognized that phytoplankton species in the surface layer and deeper layer are different (Boonyapiwat, 1999, 2000; Furuya and Marumo,1983).

From this study, it is obvious that the Northern Bay of Bengal were productive with high phytoplankton densities during the northeast monsoon. Naik *et al.* (2006) noted that surface phytoplankton population in the Bay of Bengal showed seasonal variations and the abundance peaked during the beginning of northeast monsoon (November). However, Paul *et al.* (2007) collected sample during southwest monsoon and revealed that microphytoplankton were abundant in the Northern Bay. Then this area might be the most productive area compared to the other areas in the Bay of Bengal during both northeast and southwest monsoons. The present study showed the abundance at the western part of the Northern Bay that might be resulted from the nutrient-rich water discharge from the rivers at the west coast of India to the Bay of Bengal. The great bloom occurred at station 23 where Prommas *et al.* (in press) also found highest phosphate and nitrite+ nitrate concentrations.

Thallassionema frauenfeldii and *Thalassiothrix longissima* were the dominant species recorded by Paul *et al.* (2007) and they were abundant as associated species in the Northern and Western Bay of Bengal. *Oscillatoria erythraea* was dominant in the Eastern Bay which closed to Myanmar waters where Boonyapiwat (2006) and Boonyapiwat (in press) reported that this species also dominate phytoplankton population.

It is concluded that the Northern Bay of Bengal was productive during the survey period. *Psuedo-nitzscia pseudodelicatissima* occurred as bloom throughout the western part of the Northern Bay. *Oscillatoria erythrare* and *Proboscia alta* were the major dominant species in the Bay because they distributed predominantly in all areas of the Bay.

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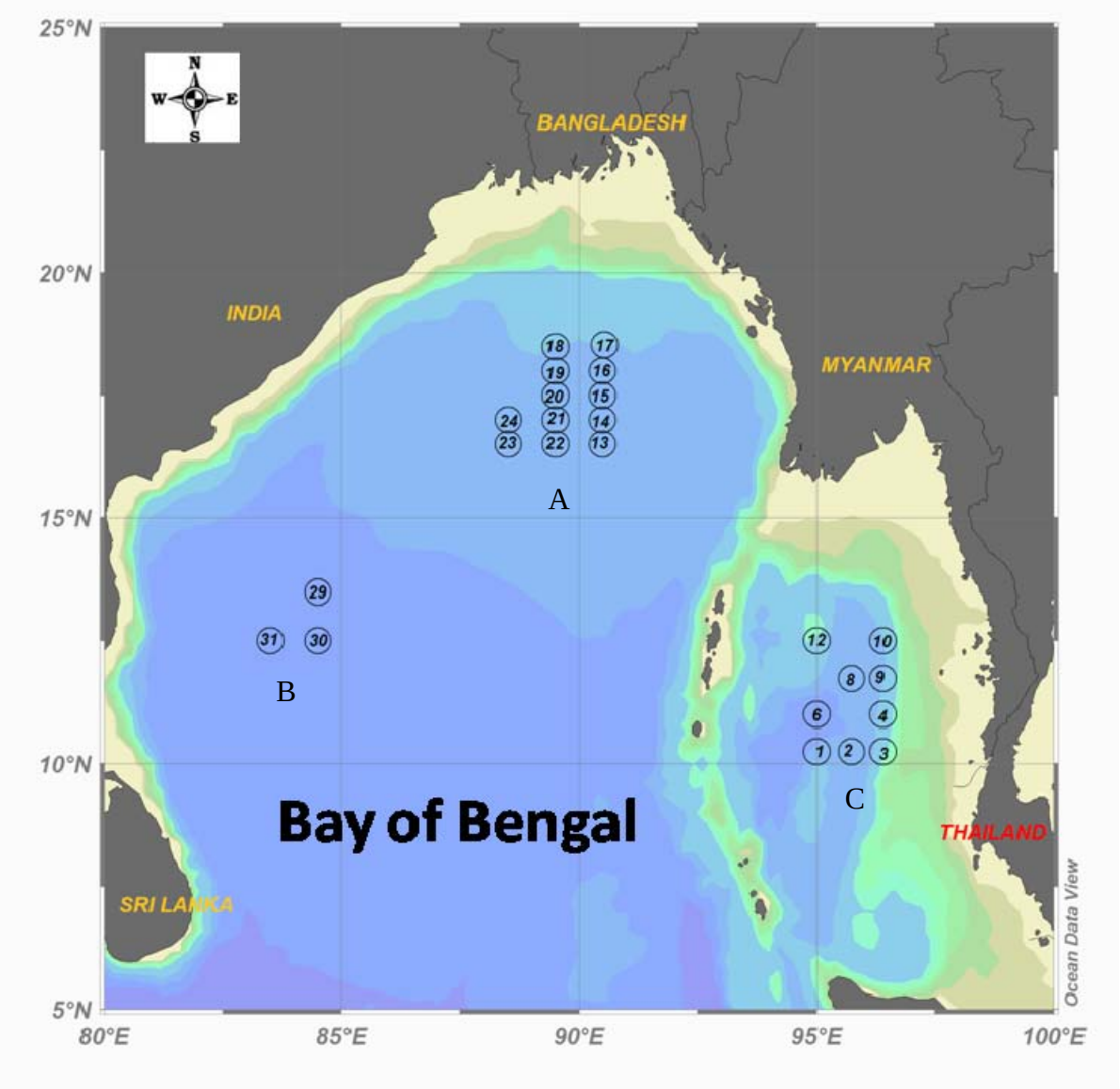

Figure 1 Sampling station of Phytoplankton in the Bay of Bengal.

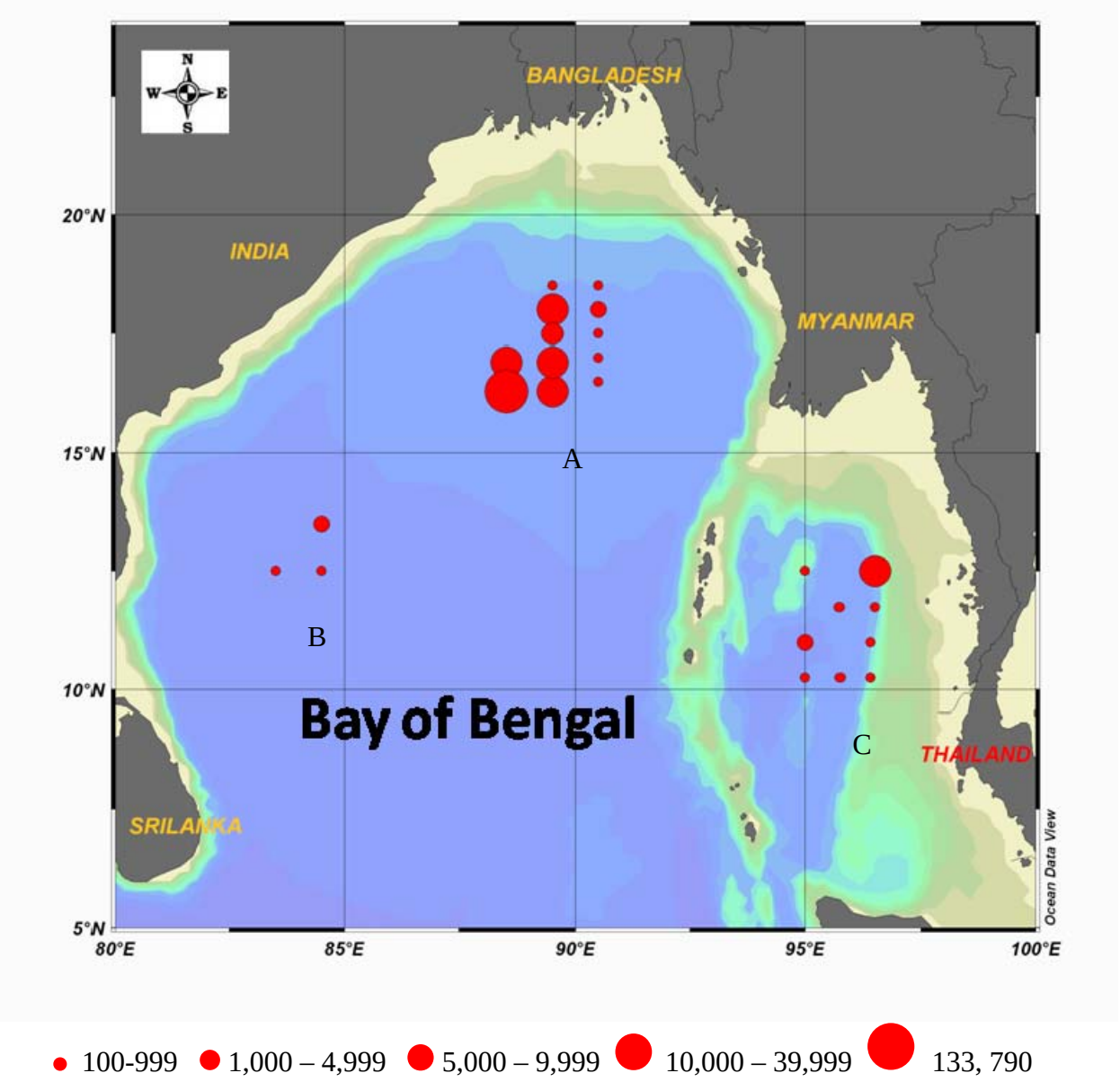

Figure 2 Phytoplankton density (cells/liter) in the surface layer.

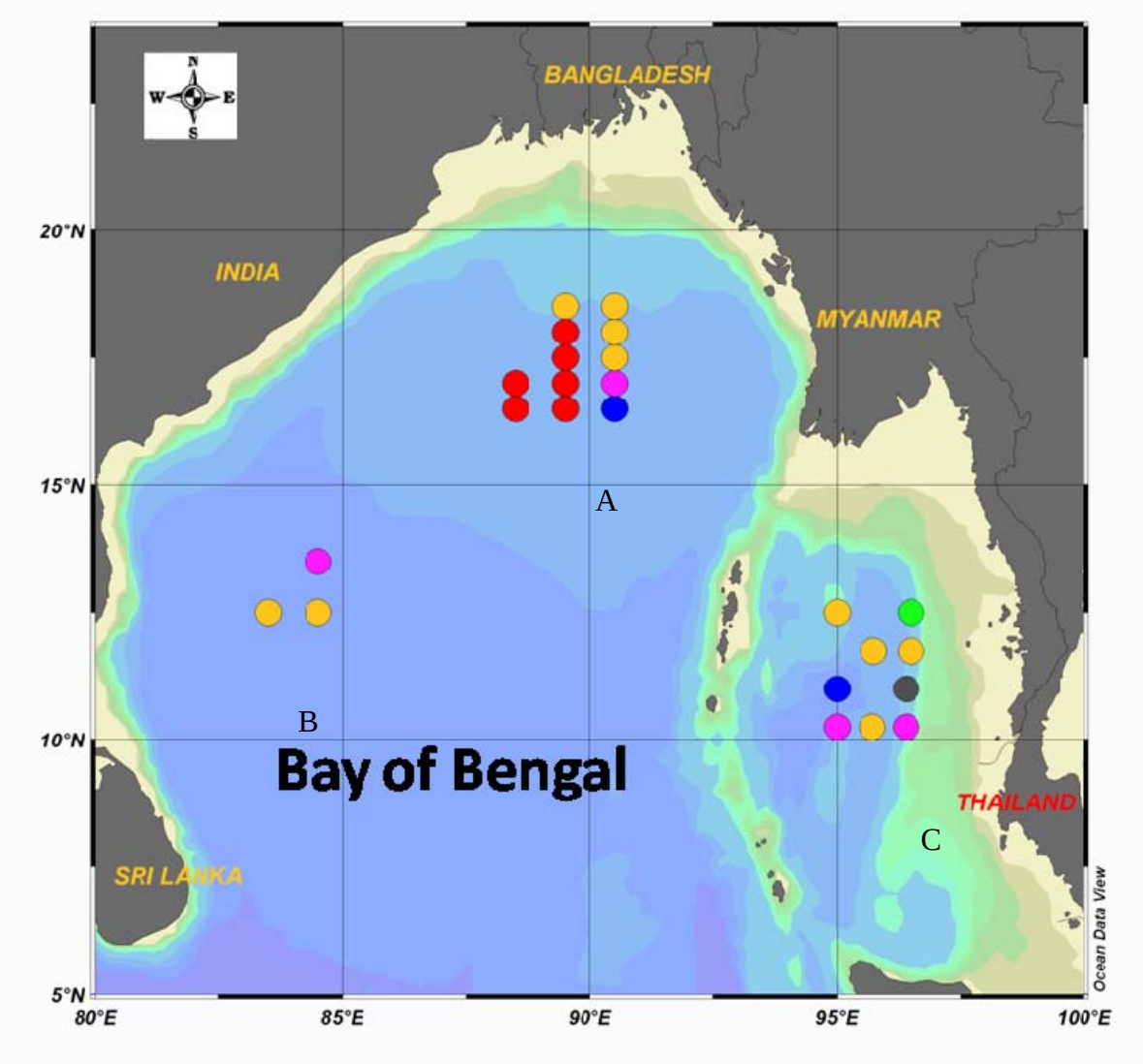

Figure 3 Dominant phytoplankton species in the Bay of Bengal.

Table 1 List of species occurred in 3 areas and range of their densities (cells/l).

Taxa	Area A	Area B	Area C
Division Cyanophyta			
Class Cyanophyceae (Cyanobacteria or Blue-green algae)			
Calothrix crustacea Schousboe & Thuret	0-416	3-26	0-5
Oscillatoria erythraea (Ehrenberg) Geitler	0-1,109	69-131	0-555
Division Chromophyta			
Class Bacillariophyceae (Diatom)			
Actinocyclus spp.	0-35	0	0-5
Asterolampra marylandica Ehrenberg	0-35	0	0
Asteromphalus flabellatus (Bre'bisson) Greville	0	0-1	0-17
A. roperianus (Greville)	0	0	0-5
A. sarcophagus Wallich	0	0	0-3
Asteromphalus spp.	0	0	0-2
Azpeitia nodulifera (A. Schmidt) G. Fryxell & P.A. Sims	0-4	0-26	0-35
Bacteriastrum comosum (O.F. Muller) Hendey	0-416	0	0-381
B. delicatulum Cleve	0-5,963	0-26	0-589
B. elongatum Cleve	0--607	0	0-18
B. minus Karsten	0	0	0-26
Bacteriastrum sp.	0-21	0	0-11
Cerataulina bicornis (Ehrenberg) Hasle	3-1,109	0	0-399
C. pelagica (Cleve) Hendey	0-5,963	0	0-36
Chaetoceros aequatorialis Cleve	0-104	0-7	0
C. affinis Lauder	0-2,496	0-113	0-849
C. atlanticus Cleve	0-8,736	0-26	0
C. borealis Bailey	0-320	0	0
C. brevis Schütt	0-503	0	0
C. coarctatus Lauder	0-1,127	0-165	0-121
C. compressus Lauder	0-27	0	0-1,30
C. curvisetus Cleve	0-3,328	0	0
C. dadayi Pavillard	0-815	0-24	0
C. densus (Cleve) Cleve	0-867	0	0-26
C. denticulatus Lauder	0-1387	0	0
C. diadema (Ehrenberg) Gran	0-32	0	0
C. didymus Ehrenberg	0	0	0-243
C. diversus Cleve	0-17	0-61	0-260
C. laevis Leuduger-Fortmorel	0	0	0-919
C. lauderii Ralfs in Lander	0-1,803	0	0
C. lorenzianus Grunow	0-2,635	0-113	0-1,109
C. messanensis Castracane	0-27,595	0	0-96
C. peruvianus Brightwell	0-1,803	0-61	0-86
C. pseudodichaeta Ikari	0	0	0-19
C. rostratus Lauder	0-2,912	0	0
C. socialis Lauder	0-589	0	0-399

0 = not found

Table 1 (Cont.)

Taxa	Area A	Area B	Area C
Chaetoceros subtilis Cleve	0	0	0-36
C. tetrastichon Cleve	0-225	0	0-5
Chaetoceros spp.	0-1,560	17-61	0-27
Climacodium biconcavum Cleve	0-156	0	0-108
C. frauenfeldianum Grunow	0-520	17-65	0-243
Corethron criophilum Castracane	0	0	0-35
Coscinodiscus asteromphalus Ehrenberg	0	0	0-4
C. radiatus Ehrenberg	0-3	0	0
Coscinodiscus spp.	0-4	0-4	0-3
Cylindrotheca closterium (Ehrenberg) Reimann & Lewin	0-104	0	0
Dactyliosolen blavyanus (H. Peragallo) Hasle	0-1	0	0
D. fragilissima (Bergon) Hasle	0-1	0	0-2
D. phuketensis (Sundstrom) Hasle	0-87	0	0-8
Detonula pumila (Castracane) Gran	0	0	0-1,179
Ditylum sol Grunow	0	0	35
Ethmodiscus spp.	0-2	0	0
Eucampia cornuta (Cleve) Grunow	0-1,248	0	2
Fragilariopsis doliolus (Wallich) Medlin & Sims	0-329	0	0-329
Fragillaria spp.	0-139	0	0-13
Guinardia cylindrus (Cleve) Hasle	0-87	0	0-2
G. flaccida (Castracane) H. Peragallo	0	0	0-17
G. striata (Stolterfoth) Hasle	0-52	0-26	0-64
Halicotheca thamensis (Shrubsole) Ricard	0-13	0	0
Haslea gigantea (Hustedt) Simonsen	0-1,109	0-19	0-11
H. wawrikae (Hustedt) Simonsen	0-35	0-26	0-8
Hemiaulus hauckii Grunow	0	0	0-66
H. membranacea Cleve	0	0	0-29
H. sinensis Greville	0-156	0-26	0-503
Lauderia annulata Gran	0-1	0	0-104
Leptocylindrus danicus Cleve	0-416	0	0-225
L. mediterraneus (H. Peragallo) Hasle	0-416	0-9	0-30
Lioloma delicatulum (Cupp) Hasle	0-69	0	0-17
Meuniera membranacea (Cleve) P. C. Silva	0-52	0-17	0-2
Navicula spp.	0-3	0	0-2
Nitzschia spp.	0-5	0	0
Planktoniella sol (Wallich) Schütt	0-832	0	0
Proboscia alata (Brightwell) Sundstrom	0-3,883	44-243	0-192
Pseudo-nitzchia pseudodelicatissima (Hasle) Hasle	0-37,024	0	0-68
P. pungens (Grunow&Cleve) Hasle	0-17,472	0	0
Pseudo-nitzschia spp.	0-65	0	0-96
Pseudosolenia calcar-avis (Chultz) Sundstrom	0-1,803	49-116	0-8
Rhizosolenia bergonii H. Peragallo	0-9	0-832	0

0 = not found

Table 1 (Cont.)

Taxa	Area A	Area B	Area C
Rhizosolenia clevei Ostenfeld	0-17	0-5	0-6
R. formosa H. Peragallo	0	0-4	0-8
R. hyalina Ostenfeld	0-10	0	0-2
R. imbricata Brightwell	0-173	0	0-52
R. robusta Norman	0	0	0-2
R. setigera Brightwell	0-35	0	0-329
R. styliformis Brightwell	0-139	0-9	0
Thalassionema frauenfeldii (Grunow) Hallegraeff	0-1,109	0-17	0-329
Thalassionema nitzschioides (Grunow) Mereschkowski	0	0	0-32
Thalassiosira eccentrica (Ehrenberg) Cleve	0-17	0	0-6
Thalassiosira spp.	0-953	0-12	0-8
Thalassiothrix longissima Cleve Grunow	0-1,248	0-52	0-1
Class Dinophyceae (Dinoflagellate)			
Alexandrium spp.	0-17	3-17	0
Amphisolenia bidentata Schroder	0-17	0-9	0-3
Ceratium azorium Cleve	0-17	0	0
C. biceps Claparede Lachmann	0	0	2
C. bilone Cleve	0	0-9	0
C. carriense Gourret	0-17	0	0-2
C. contortum Gourret	0-1	0	0
C. declinatum (Karsten) Jörgensen	0-87	0-3	0
C. deflexum (Kofoid) Jörgensen	0-1	0-1	0-1
C. dens Ostenfeld & Schmidt	0-35	0	0-1
C. furca (Ehrenberg) Claparede Lachmann	0-416	0-9	0-17
C. fusus (Ehrenberg) Dujardin	1-81	0-9	0-5
C. gravidum Gourret	0	0	0-2
C. gibberum Gourret	0-3	0	0
C. hexacanthum Gourret	0	0-1	0
C. horridum (Cleve) Hran	0	0-1	0
C. kofoidii Jörgensen	0-17	0	0-17
C. massiliense (Gouttet) Karsten	0-17	0	0
C. praelongum (Lemmermann) Kofoid	0-17	0	0
C. pulchellum Schroder	0-1	0	0
C. teres Kofoid	0-139	0-4	0-8
C. trichoceros (Ehrenberg) Kofdoid	0-17	0-1	0-2
C. tripos (O.F. Muller) Nitzsch	0-139	0-1	0-2
Ceratium spp.	0	0	0-2
Ceratocorys horrida Stein	0-17	0	0
Dinophysis acuminata Claparede & Lachmann	0	0	0-35
Dinophysis spp.	0-1	0	0
Diplopsalis lenticulata Berg	0-17	0	0-2
Goniodoma polyedricum (Pouchet) Jörgensen	0-139	0	0-2

0 = not found

Table 1 (Cont.)

Taxa	Area A	Area B	Area C
Gonyaulax glyptorhynchus Murry & Whitting	0	0	0-2
G. spinifera (Claparede & Lachmann) Diesing	0-17	0	0-6
Gonyaulax spp.	0	0-4	0
Gymnodinium sanguineum Hirasaka	0	0	0-4
Gymnodinium spp.	0-13	0	0-8
Ornithocercus magnificus Stein	0-1	0	0-35
O. thumii (A. Schmidt) Kofoid & Skogsberg	0-1	0	0-35
Oxytoxum scolopax Stein	0-7	0	0
Phalacroma doryphorum Stein	0-1	0	0-2
P. rotundatum (Claparede & Lachmann) Kofoid & Michener	0-1	0	0-5
Podolampas palmipes Stein	0-3	0-3	0-2
P. spinifera Okamura	0	0-1	0-1
Pronoctiluca spp.	0	0	0-2
Prorocentrum compressum (Bailey) Abe' & Dodge	0-1	0-1	0-1
P. graclie Schütt	0	0	0-1
P. mexicanum Tafall	0-1	0	0
P. micans Ehrenberg	0	0	0-5
Protoperidinium angustum (Dangeard) Balech	0-17	0	0
P. conicum (Gran) Balech	0-277	0	0-2
P. crassipes (Kofoid) Balech	0-1	0-1	0
P. divergens (Ehrenberg) Balech	0-2	0	0
P. grande (Kofoid) Balech	0	0	0-2
P. latispinum (Mangin) Balech	0-3	0-1	0
P. oceanicum (Vanhoff) Balech	0-17	0	0-17
P. pacificum Kofoid & Michener	0-2	0	0-17
P. pallidum (Ostenfeld) Balech	0-1	0	0
Protoperidinium spp.	0-35	0-1	0-10
Pyrocystis hamulus Cleve	0-1	0	0
P. lunula species complex	0-69	0-1	2
P. noctiluca Murray ex Haeckel	0-17	0	0
Pyrophacus horologium Stein	0	0	0-17
Scripsiella spp.	0-3	0-5	0-5
Class Dictyochophyceae			
(Silicoflagelate)			
Dictyocha speculum Ehrenberg	0-35	0	0
Dictyocha sp.	0	0	0-1

0 = not found

Table 2 Percentage of abundance of phytoplankton species in the Bay of Bengal.

Area	Station	Total (cells/l)	Dominant species	%	Associated species	%
	1	171	*Proboscia alata*	40.94	*Climacodium frauenfeldianum*	12.28
	2	191	*Oscillatoria erythraea*	26.70	*Climacodium frauenfeldianum*	10.99
	3	649	*Proboscia alata*	29.58	*Oscillatoria erythraea*	14.79
	4	564	*Climacodium frauenfeldianum*	19.15	*Chaetoceros peruvianus*	15.25
C	6	1,266	*Chaetoceros lorenzianus*	14.06	*Chaetoceros socialis*	12.12
	8	730	*Oscillatoria erythraea*	65.07	*Proboscia alata*	10.68
	9	328	*Oscillatoria erythraea*	62.80	*Chaetoceros lorenzianus*	5.79
	10	11,178	*Chaetoceros compressus*	12.41	*Detonula pumila*	10.55
	12	299	*Oscillatoria erythraea*	48.83	*Proboscia alata*	8.36
	13	473	*Chaetoceros lorenzianus*	13.95	*Chaetoceros peruvianus*	9.72
	14	429	*Proboscia alata*	24.48	*Oscillatoria erythraea*	5.83
	15	716	*Oscillatoria erythraea*	21.23	*Thalassionema frauenfeldii*	17.18
	16	1,321	*Oscillatoria erythraea*	16.65	*Thalassionema frauenfeldii*	13.63
	17	661	*Oscillatoria erythraea*	18.00	*Thalassionema frauenfeldii*	16.79
A	18	261	*Oscillatoria erythraea*	14.17	*Chaetoceros lorenzianus*	4.21
	19	11,691	*Pseudo-nitzschia pseudodelicatissima*	30.83	*Cerataulina bicornis*	7.26
	20	8,767	*Pseudo-nitzschia pseudodelicatissima*	68.12	*Cerataulina bicornis*	10.48
	21	14,613	*Pseudo-nitzschia pseudodelicatissima*	22.18	*Pseudo-nitzschia pungens*	13.52
	22	21,153	*Pseudo-nitzschia pseudodelicatissima*	14.5	*Chaetoceros messanensis*	10.82
	23	133,790	*Pseudo-nitzschia pseudodelicatissima*	27.67	*Chaetoceros messanensis*	20.62
	24	33,573	*Pseudo-nitzschia pseudodelicatissima*	33.04	*Pseudo-nitzschia pungens*	15.23
	29	1,497	*Proboscia alata*	16.23	*Chaetoceros coarctatus*	11.02
B	30	509	*Oscillatoria erythraea*	24.50	*Thalassiothrix longissima*	10.22
	31	722	*Oscillatoria erythraea*	18.14	*Pseudosolenia calcar-avis*	16.07

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