Distribution of Chlorophyll-a in the Bay of Bengal

Ritthirong Prommas[1], Pirote Naimee[2], Penchan Laongmanee[1], Natinee Sukramongkol[1] and Nawinee Khumthong[1]

[1] Southeast Asian Fisheries Development Center, Training Department
P.O.Box 97, Phrasamutchedi, Samutprakarn 10290, THAILAND
[2] Deep Sea Fishery Technology Research and Development Institute,
Department of Fisheries, Sumutprakarn 10270, THAILAND

Abstract

The distribution of chlorophyll in the Bay of Bengal was determined between 25 October to 21 December 2007, during the joint research survey on the Ecosystem-Based Fishery Management in the Bay of Bengal by the M.V. SEAFDEC. Chlorophyll-a from twenty-four stations in the study area were investigated using spectrophotometer. Results showed that the concentrations of chlorophyll-a in the eastern Bay of Bengal was 0.0375-0.5207 mg m^{-3}. In the northern Bay of Bengal it was 0.0365-1.1162 mg m^{-3}. While in the western Bay of Bengal the range was 0.0357-0.1839 mg m^{-3}. The spatial distribution of chlorophyll-a was similar pattern to the salinity and the highest concentration mostly confined at 10 m. The surface layer taken at the low latitude stations had higher concentrations than at the high latitude stations. Furthermore, river discharge with high turbidity may impede photosynthesis activity of phytoplankton in this area.

Key words: chlorophyll-a, primary productivity, Bay of Bengal

Introduction

Phytoplankton is a primary producer which converts inorganic matters into organic compounds through photosynthesis, enabling the transfer of energy and nutrients to the zooplankton. Considering that plankton organisms have short life cycles and can quickly respond to changing environments such as in the case of water pollution, some phytoplankton species can thus be used as index for monitoring water quality.

Chlorophyll is a principal pigment which phytoplankton use in photosynthesis to convert nutrients and carbon dioxide, which are dissolved in sea water into plant materials. Chlorophyll-a,b,c and Phaeophytin are the most commonly occurring pigment in seawater. Their concentrations showed wide fluctuation. Chlorophyll-a is the major photosynthetic pigment of marine phytoplankton that has been used as an indicator of biomass or primary productivity in the oceans (Beebe, 2008). The aim of this study is to collect information on the distribution of chlorophyll-a in the Bay of Bengal as they reflect the primary productivity.

Materials and Methods

Site Location

From the 42 oceanographic observation stations, station 25-28, 32-33, 35-45 were cancelled because of the influence of the northeast monsoon and rough sea conditions. Furthermore, the samples extracted from station 1, 2, 3 and 31 had decomposed before these could be analyzed due to the repair of the spectrophotometer. In this study, the water samples were collected from 24 stations in the Bay of Bengal covering three areas, namely: in the

northern Bay of Bengal (area A: latitude 16°N-19°N, longitude 88°E-91°E); in the western Bay of Bengal (area B: latitude 09°N-14°N, longitude 82°E-85°E); and in the eastern Bay of Bengal (area C: latitude 10°N-12°N, longitude 95°E-97°E) from 25 October to 21 December 2007 using the M.V. SEAFDEC. The map of the sampling locations is shown in fig. 1.

Sample Collection

Most of the water samples were collected using the 10 l Vandorn water sampler. The 12 fold rosette with 2.5 l Niskin bottle was used when the sea condition was rough. Water samples were taken from four depths: 2 m, 10 m, 100-150 m and 200-300 m. Four to twelve liters of water samples were vacuum filtered onboard through the Whatman GF/F (pore size *ca.* 0.45 µ, diameter 47 mm) in the dark laboratory. Then the filters were dropped with suspension of magnesium carbonate and stored in desiccant bottle at -20°C until extraction.

Sample Extraction and Analysis

The filters were cut into small pieces and placed in a 50 ml centrifuge tube, then 15 ml of 90% acetone was added and allowed to stand overnight in a refrigerator. Then, these were centrifuged at room temperature for 10 min at 3000 RPM. The supernatants were decanted into a 50 mm path length spectrophotometer cuvette. The methods employed for algal absorption measurements and calculations are described in detail by Parsons *et al.*, (1984). The horizontal profile of chlorophyll and salinity were analyzed using the Ocean Data View (ODV) software (Schlitzer, 2006).

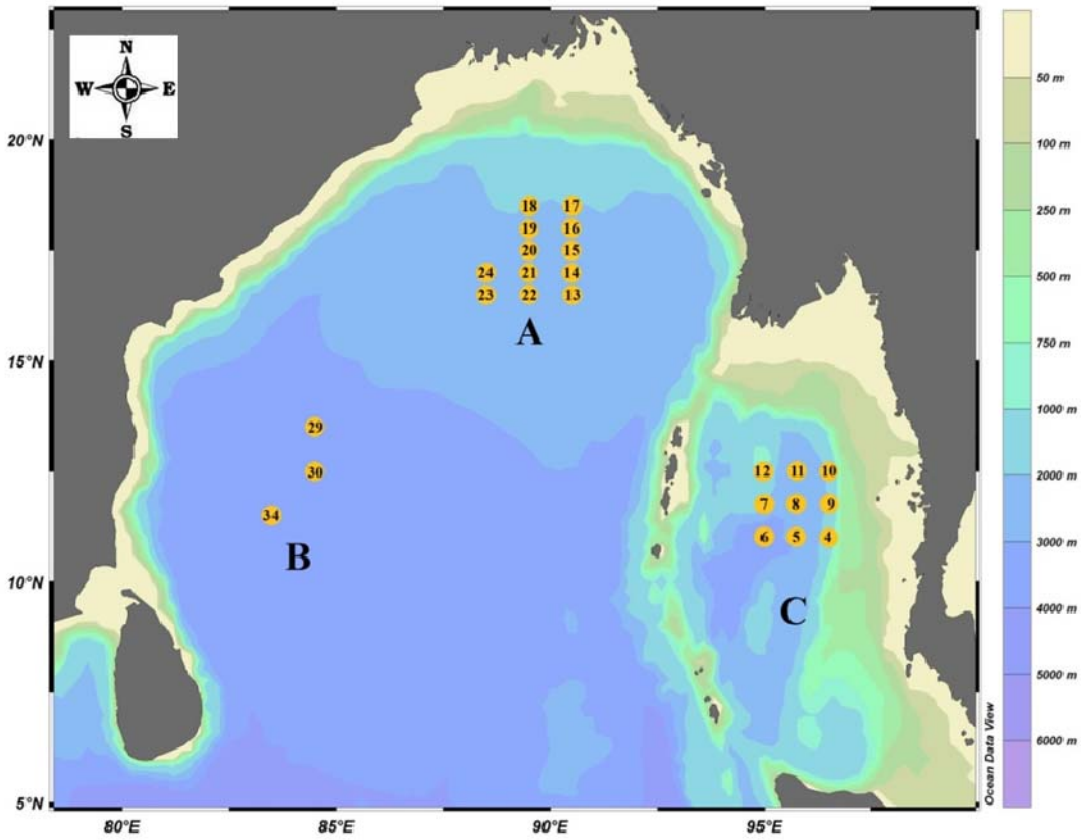

Figure 1 Chlorophyll sampling stations in the Bay of Bengal.

Table 1 Bottom depths and sampling depth (m) of chlorophyll samples.

Area	Station	Bottom depth	1st depth	2nd depth	3rd depth	4th depth
A	13	2,430	2	10	125	250
	14	2,353	2	10	125	200
	15	2,231	2	10	125	250
	16	2,136	2	10	125	250
	17	2,005	2	10	125	200
	18	2,012	2	10	150	250
	19	2,146	2	10	125	200
	20	2,249	2	10	125	250
	21	2,402	2	10	125	200
	22	2,511	2	10	125	200
	23	2,633	2	10	125	200
	24	2,530	2	10	125	200
B	29	3,412	2	10	125	200
	30	3,329	2	10	125	250
	34	3,470	2	-	-	-
C	4	890	2	10	115	215
	5	513	2	10	125	250
	6	3,526	2	10	125	200
	7	2,841	2	10	100	200
	8	2,556	2	10	125	300
	9	883	2	10	125	200
	10	1,128	2	10	125	200
	11	2,551	2	10	150	250
	12	1,418	2	10	125	250

"-"= samples were not collected

Results and Discussions

The bottom depth and sampling depth of the stations where chlorophyll samples were collected are shown in table 1. The concentrations of chlorophyll-a at various depths in the Bay of Bengal observed from this study are shown in table 2 and illustrated in figs. 2 and 4.

Table 2 Concentrations of chlorophyll-a (mg m^{-3}) observed at various depths.

Area	Station	Chlorophyll-a			
		1st depth	2nd depth	3rd depth	4th depth
A	13	0.4229	0.3951	0.1346	0.0415
	14	0.2224	0.2700	0.2562	0.0610
	15	0.1113	0.1388	0.0704	0.0856
	16	0.2314	0.2360	0.3184	0.0813
	17	0.1790	0.2045	0.1939	0.0851
	18	0.3130	0.3539	0.0618	0.0560
	19	0.4032	0.3560	0.0527	0.0365
	20	0.5074	0.6084	0.0686	0.0597
	21	0.2965	0.3737	0.0886	0.3003
	22	0.7147	0.7475	0.1061	0.0725
	23	0.7902	1.1162	0.0967	0.0538
	24	0.2742	0.2904	0.2100	0.0502
B	29	0.1397	0.1839	0.0502	0.0517
	30	0.1223	0.1319	0.0645	0.0357
	34	0.1533	-	-	0.0390
C	4	0.5207	0.2143	0.0830	0.0375
	5	0.1674	0.1519	0.1291	0.0458
	6	0.4738	0.2498	0.0898	0.0574
	7	0.2704	N.D.	N.D.	-
	8	0.1599	0.1852	0.1031	0.0414
	9	0.2187	0.2142	0.0817	0.0418
	10	0.2544	0.3218	0.0974	0.0522
	11	0.0433	0.1943	0.0453	0.1812
	12	0.1604	0.1812	0.0799	0.0422

"-"=samples not collected, "N.D." = not detected

Chlorophyll in area A: the northern Bay of Bengal (Fig. 2)

Distribution of chlorophyll-a at 2 m and 10 m are similar that low latitude stations had higher chlorophyll-a concentration than in the high latitude stations. The plume of chlorophyll-a distribution seemed to come from the Southeast. The surface chlorophyll-a concentration at the Southwest was higher than that in the northeast area by 0.5-0.7 mg m^{-3}. The chlorophyll-a concentrations at 2 m and 10 m ranged from 0.1113 to 0.7902, and 0.1388 to 1.1162 mg m^{-3}, respectively. Most of stations had higher concentration at 10 m more than at 2 m depth. Almost all stations that deeper than 100 m had lower concentration of chlorophyll-a.

In this study, the southwest of area A had the highest concentration of chlorophyll-a, which perhaps could be assumed, as influenced by the nutrients from deeper water lead by cold-core eddy which was consistently reported by Kumar *et al.* (2004). Distribution of chlorophyll-a was similar pattern to the salinity (Fig.3). Therefore, river discharge with high turbidity may impede photosynthesis activity of phytoplankton in the high latitude of this area.

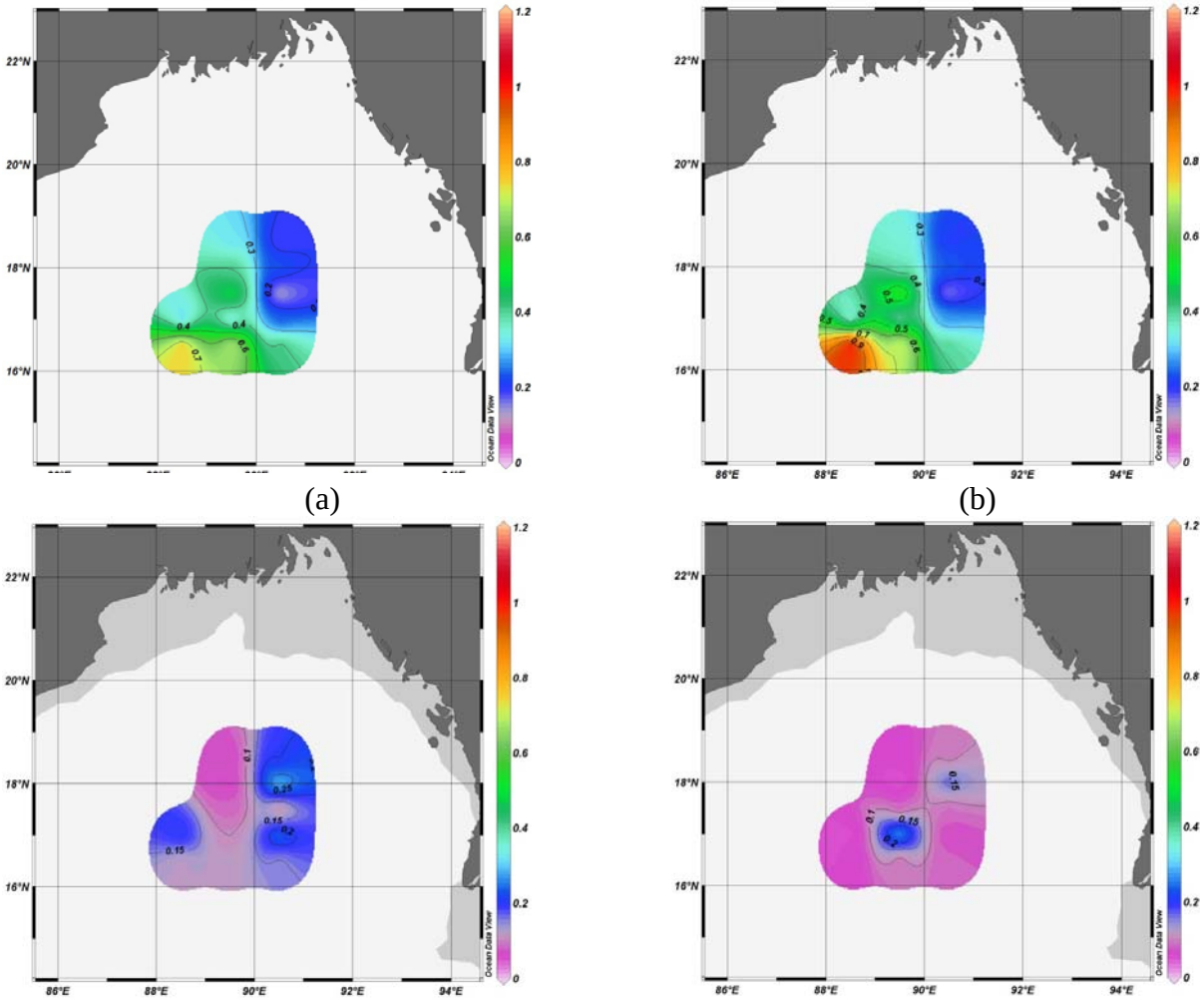

Figure 2 Concentration of chlorophyll-a (mg m^{-3}) in area A of the Bay of Bengal.
(a) 1st depth (b) 2nd depth (c) 3rd depth (d) 4th depth

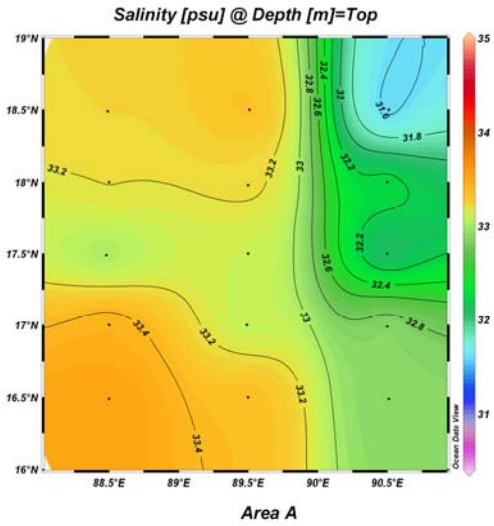

Figure 3 Horizontal plots of salinity (psu) at surface layer in area A.
(Dots indicate data location)

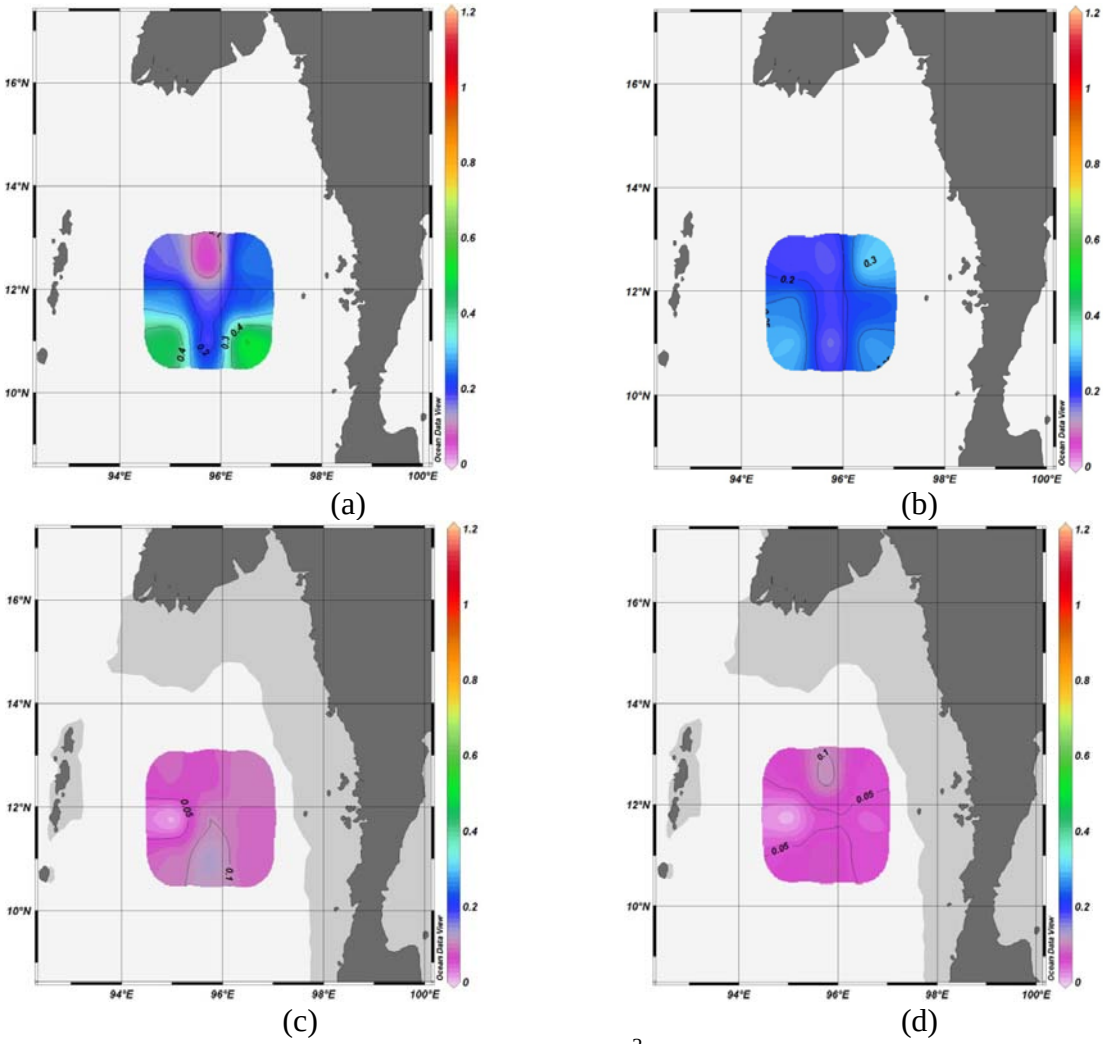

Figure 4 Concentration of chlorophyll-a (mg m^{-3}) in area C of the Bay of Bengal.
(a) 1st depth (b) 2nd depth (c) 3rd depth (d) 4th depth

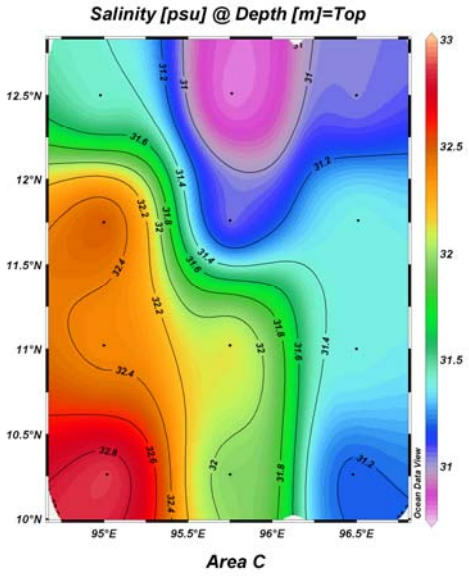

Figure 5 Horizontal plots of salinity (psu) at surface layer in area C.
(Dots indicate data location)

Chlorophyll in Area B: the Western Bay of Bengal

During the period when area B was surveyed, many of the survey stations were canceled because of the Northeast Monsoon and rough sea conditions. The data in area B were therefore not enough to make a conclusion. However, the chlorophyll-a concentrations observed from this area are indicated in table 2.

Chlorophyll in Area C: the Eastern Bay of Bengal (Fig. 4)

Spatial distribution of chlorophyll-a is shown in fig. 4. The chlorophyll-a concentrations at 2 m and 10 m ranged from 0.0433-0.5207 mg m^{-3} and 0.1519 to 0.3218 mg m^{-3}, respectively. The distributions of chlorophyll-a at 2 m and 10 m are same pattern. It was also observed that the low latitude stations had higher chlorophyll-a than the high latitude stations, similar to that in area A. Distribution of chlorophyll-a was also similar pattern to the salinity (Fig.5). Especially at surface layer of station 11, the salinity was low, because influence of the Irrawadee river discharge with high turbidity may effect to decreasing of chlorophyll-a concentration. At deeper than 100 m, chlorophyll-a concentrations were lower than above and homogeneous.

The observed range of chlorophyll-a at 2 m ranged between 0.04-0.52 mg m^{-3}, which were higher than in earlier reports by Wisespongpand *et al.* (2006) that the concentrations of chlorophyll-a in the Andaman Sea covering the waters of Thailand and Myanmar between 06° 45´N, 096° 15´E and 12° 45´N, 096° 45´E, were 0.03-0.11 mg m^{-3} . In this study, the highest concentrations of chlorophyll-a in several stations were observed at 10 m depth similar to area A.

Conclusions

It was observed during the survey that most of the low latitude stations in the Bay of Bengal exhibited somewhat higher chlorophyll-a concentrations than in the high latitude stations. The highest chlorophyll concentration was mostly confined at 10 m of most of the survey stations. Distribution of chlorophyll-a was similar pattern to the salinity. Furthermore, river discharge with high turbidity may impede photosynthesis activity of phytoplankton.

Acknowledgements

The authors wish to express their sincere thanks to all the scientists from Bangladesh, India, Myanmar, Sri Lanka, Nepal and Thailand for their cooperation during the BIMSTEC project survey, 75-1/2007 cruise of the M.V. SEAFDEC. The successful completion of this project would have not also been possible without the dedication of the officers from the Department of Fisheries of Thailand as well as the captain, officers and crew of the M.V. SEAFDEC. Our special thanks are also extended to Ms. Suree Satapoomin (Phuket Marine Biological Center), Ms. Puntip Wisespongpand (Department of Marine Science, Kasetsart University) and Ms. Virgilia T. Sulit (SEAFDEC) for their constructive and critical comments and suggestions.

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