Phytoplankton Community and Abudance in Some Estuaries of the Northern Coast of Java

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INTRODUCTION

Most of the big rivers in Java flow northwards into the shallow Java Sea. The northern coast of Java, is therefore, flat and the coastal waters have estuarine characteristics. During the last three decades industrial development in Java has progressed very rapidly, and with the increase of population, have caused environmental changes in the quality of estuarine waters.

The northern coast of Java is also used as sites for fish and shrimp culture. The brackish water ponds use river water and seawater to rear fish and shrimp. The water quality, both river water and sea water, will play an important role in the success of fish/shrimp culture.

The changes in water quality also affect the phytoplanton community and abundance. Some phytoplankton species are nuisance organisms, such as *Noctiluca scititillans*, which has impacts on coastal fisheries and recreational sites. Other phytoplankters may produce toxins harmful for other marine fauna and human health. The change in water quality may induce blooming of these unwanted phytoplankters, which may also affect fish and shrimp reared in fish ponds or in cages placed in coastal areas.

A study on phyloplankton community and abundance was made using data collected in the 1970's, 1980's and 1990's from several estuaries in the northern coast of Java. This paper reports condition, quality and changes of phytoplankton community at these estuaries.

MATERIAL AND METHODS

The data used for the study are historical data collected in the past by several research activities conducted by the Research and Development Centre for Oceanology of the Indonesian Institute of Sciences. Research activities conducted in estuarine waters were primarily done in connection with primary productivity, seawater quality, pollution studies, and study on the Red Tide phenomenon.

The Banten Bay in West Java (Figure 1) was covered 6 times, in November 1980 (Praseno, 1981a), February 1981 (Praseno, 198lb), June 1981 (Praseno, 1982a), March 1982 (Praseno, 1982b), December 1985 (Adnan, 1994), and November 1995 (Sutomo et. al., 1996) respectively. Phytoplankton sampling in the Jakarta Bay were conducted 6 times, November 1975 (Praseno, 1976a), May 1976 (Praseno, 1976b), August 1977 (Praseno, 1977a), January 1978 (Praseno, 1978), January 1979 (Praseno, 1979), and June 1980 (Praseno, 1980) respectively, while in sections of the bay phyloplankton samplings were made in July 1993 (Sutomo et. al., 1995), and August 1995 (Adnan, unpublished) in the Sampur Section, while in Angke Section samplings were conducted in November 1980 (Praseno, 1981c), February 1981 (Praseno, 1981d), June 1981 (Praseno, 1982c), July 1993 (Sutomo et. al., 1995), and August 1995 (Adrian, unpublished). Phytoplankton data from East Java were made in the Porong River estuary and Solo River estuary. In the Porong River estuary samplings were conducted in May 1993, September 1993 (Adrian, 1995a), and October 1993 (Adnan, 1995b). Samplings in the Solo River estuary were made in May 1993, September 1993, and October 1993 (Adnan, 1993).

Research in the Cilacap and Segara Anakan were made at 3 sections, namely Kembang Kuning River, Donan River, and Segara Anakan estuarine waters. Phytoplankton samples were collected in May 1980, July 1980, and October 1980 (Praseno, 1983). Other phytoplankton data were obtained from Tanjung Karang, Tanjung Indramayu, Tegal, Semarang, Lasem, and Surabaya estuaries (Praseno, 1980).

Samplings of phytoplankton were conducted using a modified Kitahara plankton net with a mouth diameter of 31 cm, 120 cm length and 0.11 mm mesh. The net was lowered until close to the bottom of the sea and hauled up vertically to the surface. Phytoplankton samples were preserved in 3% neutralized formaline. The samples were then analyzed under a microscope to determine species abundance. For identification several literature's were used, such as Lebour, 1925; Lebour, 1930; Allen & Cupp, 1935; Cupp 1943; Davis 1955; Wood et. al 1959; Hasle, 1965; Yamaji, 1966; Saunders & Glenn, 1969, Steidinger & Williams, 1970; Simonsen 1974; Taylor 1976; Balech 1985; Balech 188; Fukuyo 1985; Fukuyo et. al. 1990; and Kim et. al. 1990.

RESULTS AND DISCUSSION

The Phytoplankton community

Phytoplankton in tropical estuarine waters usually is composed of 2 major groups, the diatoms and the dinoflagellates. Sometimes a third group appeared in abundance belonging to the cyano-bacteria. Other phytoplankters appear in very small numbers. Due to the capability of mitosis, the diatoms are able to reproduce 3 times, within 24 hours. The dinoflagellates are only able to reproduce once in 24 hours. So whenever nutrient inputs from land through river discharge occurred, the diatoms have a better chance to reproduce, especially those adapted to law salinities. The composition of phytoplankters in estuarine waters is, therefore, dominated by diatoms.

During the observations made at estuaries on the coastal waters of Java, it is apparent that diatoms are nearly always dominating (Table 1). Only on two occasions dinoflagellates dominated the phytoplankton community, which occurred in Banten Bay on February 1981 and in the Jakarta Bay/Muara Angke waters also in February 1981.

The dominant genera were nearly always *Chaetoceros*, *Skeletonema*, or *Thalassiothrix*. Only on some occasions other genera, like *Bacterastrum* and *Nitzschia* formed the dominant genera. Whenever *Skeletonema* is dominating the phytoplanklon community, it could be concluded that the salinity of seawater was low. This genus is very tolerant to low salinities and will bloom whenever nutrient input is high. During rainy seasons usually this species, *Skeletonema costatum*, will always bloom first, and will later on succeeded by other phytoplankters, such as *Chaetoceros* or *Noctiluca*.

The genus *Chaetoceros* is a very common phytoplankter and is usually the most important member of phyloplankton community. Whenever this genus dominates the phytoplankton community, it is expected that the sea water condition is normal. With high concentrations of *Chaetoceros*, primary productivity is also expected to be high. However, one of its species, *C. concavicornis*, is harmful for fish. The setae of this species has small sharp horns, which may harm the gills of fishes causing mass mortality of fish.

On two occasions dinoflagellates were dominating, on February 1981 at Banten Bay the dominant genus was *Ceratium* (Praseno 1981d) and in a section of the Jakarta Bay it was *Noctiluca*. This proves that dinoflagellates sometimes may bloom in estuarine waters, despite the fact that it grows slower than diatoms.

Many species of dinoflagellates are known to have potentials for producing toxins. These toxins may be harmful for other marine biota, causing fish or shrimp kills. It might also be harmful for human health. One of the most harmful species identified in Indonesian waters is the dinoflagellate *Pyrodinium bahamense var. compressum*, which has caused problems in Kao Bay, Halmahera (Wiadnyana et. al. 1994). This species produces PSP (Paralytic Shellfish Poisoning) and can cause death to people consuming shellfish. The cyst of this species was also identified in the Jakarta Bay sediments (Matsuoka et. al. - manuscript). Many other toxic species have been identified in Indonesian estuarine waters, but so far there is no strong evident of toxin impact on marine biota or human health. This does not mean that the Indonesian coastal waters are free from Harmful Algal Bloom (HAB) organisms. Continuous monitoring should be conducted in fishing areas to prevent unpleasant incidents due to the consumption of toxins in fish, shellfish or other marine products.

Abundance.

The estuarine water is very complex. Changes in water quality and conditions occur frequently and very rapid. The changes will affect marine life, including the phytoplankters. During the rainy season, which last from December and February, river water enters the estuary carrying nutrients. The condition of seawater will be less saline, but rich in nutrients. This condition favors the blooming of diatoms tolerant to low salinities, such as *Skeletonema costatum*. When salinity increases other diatoms may have the chance to bloom, such as species of the genera *Chaetoceros*, *Bacteriastrum*, *Coscinodiscus*, *Thalassiothrix* and many other species.

On certain cases dinotlagellates may bloom. The most common dinoflagellate that bloom is the non- photosynthetic *Noctiluca scintillans*. This species feed on diatoms and usually will bloom after a diatom bloom. *Noctiluca scintillans* is thought to be the cause

Table 1. Phytoplankton abundance (mil. cells/m3) and dominant genera in some estuaries of Jawa.

#	Date	Phytoplankton			Dominant genera	Source
		Total	Diatoms	Dinoflagellates		
Banten Bay						
1	Nov. '80	4.1	4.1	-	Bacteriastrum	Praseno '81a
2	Feb. '81	0.2	0.09	0.11	Ceratium	Praseno '81b
3	Jun. '81	0.9	0.89	0.01	Nitzchia	Praseno '82a
4	Mar. '82	0.4	0.4	-	Chaetoceros Thalassiothrix	Praseno '82b
5	Dec. '85	14	13.9	0.01	Thalassiothrix	Adnan '94
6	Nov. '95	3.3	3.2	0.01	Chaetoceros	Sutomo *et al.* '94
Jakarta Bay						
7	Nov. '75	1.4	1.2	0.2	Chaetoceros	Praseno '76a
8	May. '76	22.8	22.6	0.2	Chaetoceros	Praseno '76b
9	Aug. '77	17	16.8	0.2	Skeletonema	Praseno '77a
10	Jan. '78	4.4	4	0.4	Skeletonema	Praseno '78
11	Jan. '79	6.2	5.9	0.3	Chaetoceros	Praseno '79
12	Jun. '80	2.8	2.8	-	Chaetoceros	Praseno '80b
13	Jul. '93	41.3	41.2	0.1	Skeletonema	Sutomo et al. '94
14	Nov. '80	3.5	3.5	-	Skeletonema	Praseno '81a
15	Feb. '81	1	-		Noctiluca	Praseno '81b
16	Jun. '81	0.3	0.2	0.1	Chaetoceros	Praseno '82a
17	Jul. '93	18.6	18.5	0.1	Chaetoceros	Sutomo et al. '94
Porong River, East Jawa						
18	May. '93	3.9	3.9	-	Skeletonema	Adnan '95
19	Sep. '93	0.8	0.8	-	Skeletonema	Adnan '95

of mass fish mortality in the Jakarta Bay, which occurred on 8 December 1993 (Praseno, 1995). This incident may also occur in other estuaries and can cause serious problems for

Table 1 (continued).

#	Date	Phytoplankton			Dominant genera	Source
		Total	Diatoms	Dinoflagellates		
21	Oct. '93	0.5	0.5	-	Chaetoceros	Adnan '95
Solo River, East Jawa						
22	May '93	1.4	1.4	-	Skeletonema	Adnan '95
23	Sep. '93	1.7	1.7	-	Skeletonema	Adnan '95
24	Oct. '93	1.6	1.6	-	Skeletonema	Adnan '95
Kembang Kuning River, Cilacap, Center Jawa						
25	May '80	8.4	8.1	0.3	Skeletonema	Praseno '83
26	Jul. '80	14.1	13.8	0.3	Thalassiothrix	Praseno '83
27	Oct. '80	11.8	10.7	1.1	Thalassiothrix	Praseno '83
Donan River, Cilacap, Center Jawa						
28	May '80	122.9	122	0.9	Skeletonema	Praseno '83
29	Jul. '80	10.9	10.6	0.3	Thalassiothrix	Praseno '83
30	Oct. '80	34.6	32.1	4.5	Thalassiothrix	Praseno '83
Segara Anakan, Cilacap, Center Jawa						
31	May '80	38	38	-	Skeletonema	Praseno '83
32	Jul. '80	0.2	0.2	-	Skeletonema	Praseno '83
33	Oct. '80	3.7	3.7	-	Skeletonema	Praseno '83
Banten Bay (34,35), Tanjung Karawang (36,37), Indramayu (38, 39), Tegal (40, 41), Semarang (42, 43), Lasem (44, 45), Surabaya (46, 47).						
34	Dec. '79	1.5	1.2	0.3	Chaetoceros	Praseno '80a
35	Jun. '80	0.2	0.2	-	Chaetoceros	Praseno '80b
36	Dec. '79	44	44	-	Skeletonema	Praseno '80a
37	Jun. '80	0.5	0.5	-	Chaetoceros	Praseno '80b
38	Dec. '79	9.9	9.9	-	Thalassiothrix Chaetoceros	Praseno '80a
39	Jun. '80	0.1	0.1	-	Chaetoceros	Praseno '80a
40	Dec. '79	3.9	3.9	-	Chaetoceros	Praseno '80a

Table 1 (continued).

#	Date	Phytoplankton			Dominant genera	Source
		Total	Diatoms	Dinoflagellates		
41	Jun. '80	0.3	0.3	-	Chaetoceros	Praseno '80b
42	Dec. '79	3.9	3.7	0.2	Chaetoceros, Noctiluca	Praseno '80a
43	Jun. '80	13.2	12.2	1	Skeletonema	Praseno '80b
44	Dec. '79	7.7	7.7	-	Chaetoceros, Bacteriastrum	Praseno '80a
45	Jun. '80	0.1	0.1	-	Rhizosolenia	Praseno '80b
46	Dec. '79	4.9	4.8	0.1	Bacteriastrum	Praseno '80a
47	Jun. '80	0.8	0.8	-	Skeletonema	Praseno '80b

fisheries and aquaculture. Table 1 shows two occasions where *Noctiluca* had bloom, which was during the month of February 1981 in the Jakarta Bay, and during December 1979 in Semarang estuary. What really triggers dinoflagellates to bloom is still being studied, especially blooms of toxic dinoflagellates. It is, therefore, important to monitor seawater conditions continuously to design models of phytoplankton blooms, which in turn can provide an early warning system.

The complexity of estuarine water conditions is reflected in the great variety of phytoplankton abundance in estuarine waters. In the Banten Bay phytoplankton densities may vary between 0.1 to 14 million cells m^{-3} (Table l). In the Jakarta Bay it vary between 0.3 to 4l.3 million cells m^{-3}. For the Banten Bay both phytoplanklon cell density values were obtained from samples taken during the rainy season (February and December). Data of December 1979 (Table 1, # 34) and June 1980 (Table 1, # 35) from Banten Bay showed clear affects of the seasons. Phytoplankton densities were 1.5 and 0.2 million cells m^{-3} for the rainy and dry seasons respectively. This was also true for other locations, such as Tanjung Karawang, Indramayu, Tegal, Lasem and Surabaya estuaries. An exception was for the Semarang waters, where a higher value was obtained during the dry season (Table 1, # 45) compared to value obtained during rainy season (Table 1, # 44). During the rainy season Noctiluca scintillans was amongst the phytoplankters that dominated the phytoplankton community. The diatoms may than be consumed by

Noctiluca, which explains the low cell count. In the Jakarta Bay high values were obtained during the dry season (June and July).

The study on phytoplankton should be linked with physical and chemical conditions of sea water. Furthermore, it should also be linked with meteorological conditions to come up with a better understanding of processes in the estuarine waters. A continuous recorder may supply the necessary data for this purpose.

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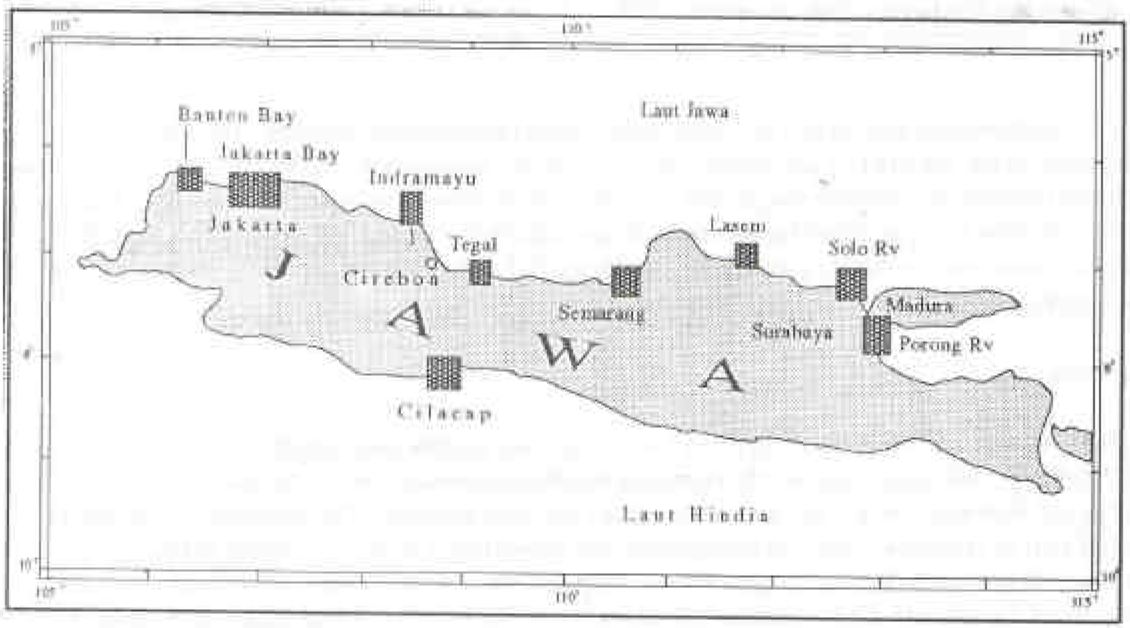

Figure 1. Estuaries on the northern coas of Jawa and Cilacap area

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