HORIZONTAL DISTRIBUTION OF DINOFLAGELLATE CYSTS IN SURFACE SEDIMENTS OF JAKARTA BAY: SOME PRELIMINARY RESULTS

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ABSTRACT

Ten surface sediment samples were collected from Jakarta Bay to study the horizontal distribution of dinoflagellate resting cysts in this area. Overall results had shown unique species composition and diversity of dinoflagellate cyst assemblages. However, dinoflagellate cysts found in this preliminary research were sparse and relatively low in term of species number and concentrations. Twenty cyst morphophites were identified in this research, within which ten cysts belong to autotrophic and another ten belong to heterotrophic species. *Protoperidinium* cysts were the most diversified group, predominating in almost the sampling locations. The cysts identified were generally characterized by species belonged to three orders namely Gonyaulacales, Gymnodiniales, and Peridiniales. Only one dinoflagellate cyst found that was belonged to the toxic and harmful algal bloom (HAB) member species, i.e. *Gymnodinium catenatum*.

Keywords: Dinoflagellate cysts, Jakarta Bay, Harmful Algal Bloom (HAB)

INTRODUCTION

Dinoflagellate is considered as a few member of marine phytoplankton to be able to produce dormant cysts or resting spores in their life cycle (Anderson *et al.*, 1995). Among living dinoflagellate, it was predicted that about 13-16% (Head, 1996) or 80 species (Matsuoka and Fukuyo, 2000) of its member has an ability to form cysts.

Cyst formation for dinoflagellate was basically related to a variety of ecological functions such as: "seed" population to initiate red tides or Harmful Algal Bloom (HAB), survival strategy due to environmental adverse conditions, agents for special dispersal, means for genetic recombination, direct sources of toxicity, and factor in bloom termination (Anderson, 1984). Dinoflagellate cysts found in the sediment may indicate which species of motile stages (vegetative cells) were present in the water column and thus it means that cysts were regarded as "seed bed" or "inoculum" for HAB outbreak in an area (Dale, 1983). Hence, analysis of dinoflagellate cysts can provide information about the mechanisms of spreading and recurrence of HAB (Furio *et al.*, 2006).

HAB in Indonesian waters were increasing in term of numbers and frequencies in the last decade (Sidharta, 2004) and the same phenomenon was observed in Jakarta Bay (Damar, 2003). One of the important things to monitor for HAB outbreak in Jakarta Bay was through dinoflagellate cyst study. Such study has been used to define the bloom dynamic of a particular harmful algal species that may occur and it will also give chance to prevent HAB outbreak. In addition, dinoflagellate cyst study might be helpful for determining the non-native occurrence of HAB organisms that may invasive into an area through ship's ballast water (Hallegraeff, 1995).

Cyst study in Indonesia, however, was rarely done (Wiadnyana, 1996), therefore data of dinoflagellate cyst assemblage and distribution in

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the country are still dearth, hence, such study is worth to be done. Furthermore, cyst study can be considered as giving a more integrated record of the phytoplanktonic population found in the water column (Wang *et al.*, 2004). The objectives of this research are: 1) to study the diversity of dinoflagellate cyst assemblage in Jakarta Bay and 2) to reveal the horizontal distribution of dinoflagellate cyst in the area.

MATERIALS AND METHODS

Ten surface sediment samples were taken from some locations in Jakarta Bay (Fig. 1) on 29 July 2006. The upper 2 cm surface sediment core samples were collected by a TFO gravity corer from each location for palynological processes (Matsuoka and Fukuyo, 2000). Sediment samples were divided into two parts. The first part was oven-dried at 70 °C for 24 hours to measure the dry weight (DW) and to calculate the water content. The second part was treated with HCl (10%) and HF (~40%) solutions in order to remove calcium carbonate and silicate materials. The samples were washed repeatedly with distilled water to remove the acids until the pH reached 7.0. The latter samples were sonicated for 30 seconds and then sieved successively through 125 and 20 µm mesh-size screens to remove coarse and fine materials. The samples retained in the 20 µm screen were transferred into a plastic tube and suspended in 10 ml distilled water.

Observation was done utilising light microscope at magnifications of 100-450 x and equipped with digital camera for taking the cyst's picture. A 0.1-0.5 ml aliquot of the processed samples was placed on a 1 ml counting slide. Samples were counted until either 200 dinoflagellate cysts were found or each Sedgewick-Rafter counting slide with specimen had been completely analysed to provide relative abundance of dinoflagellate cysts taxa. Both biological and paleontological nomenclatures were utilized in order to identify and describe the dinoflagellate cysts (Fensome *et al.*, 1993).

RESULTS

Twenty cyst morphophytes were found in ten locations (Table 1). The 20 cyst species were divided into three orders such as Gonyaulacales, Gymnodiniales, and Peridiniales (Table 2). There were four species found in the order Gonyaulacales namely *Gonyaulax scrippsae*, *G. spinifera*, *Lingulodinium polyedrum*, and *Protoceratium reticulatum*. Order Gymnodiniales represented by five species, namely *Cocholodinium* sp cf. *polykrikoides*, *Gymnodinium catenatum*, *Phaeopolykrikos harmanii*, *Polykrikos kofoidii*, and *P. schwartzii*. Order Peridiniales was the highest in term of number of species found in the whole sampling stations, i.e. 11 cyst species. Cyst concentrations calculated from the 10

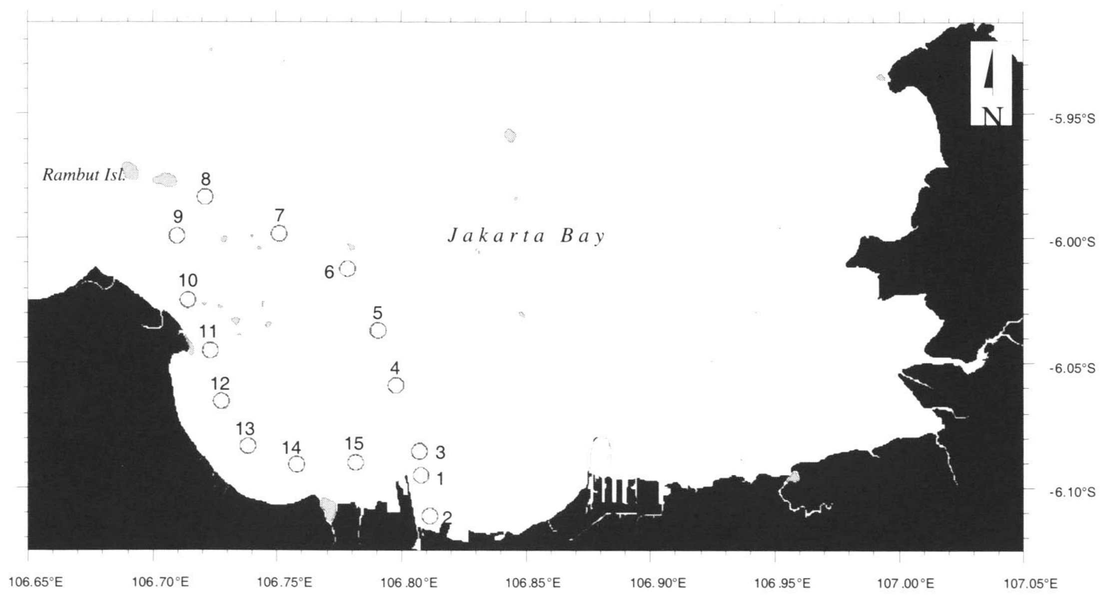

Figure 1. Map of sampling location

Table 1. Location, water depth, water temperature, salinity, and transparency

Loc. No.	Latitude (S)	Longitude (E)	Water depth (m)	Salinity (ppt)	Transparency (m)	Temperature (°C)
1	-6°09'50"	106°80'78"	9	31.92	2.26	29.47
3	-6°08'54"	106°80'72"	11	32.01	2.29	29.26
4	-6°05'90"	106°79'78"	15	32.14	3.33	28.92
5	-6°03'70"	106°79'05"	18	32.40	5.38	28.60
7	-5°99'81"	106°75'10"	26	32.17	4.00	28.91
8	-5°98'33"	106°72'12"	16	32.31	4.51	28.81
9	-5°99'89"	106°70'99"	19	32.14	2.85	29.05
12	-6°06'54"	106 °72'76"	11	29.79	2.10	30.11
13	-6°08'32"	106 °73'83"	8	29.49	1.81	30.37
14	-6°09'06"	106 °75'80"	10	31.25	1.86	30.14

Table 2. Horizontal distribution of dinoflagellate cysts in the research area
+ : cyst present, - : cyst absent, na : not available

Biological name	Paleontological name	Location									
		1	3	4	5	7	8	9	12	13	14
Order Gonyaulacales											
Gonyaulax scrippsae	*Spiniferites bulloideus*	+	-	-	-	-	-	-	-	-	-
Gonyaulax spinifera	*Spiniferites mirabilies*	+	+	-	-	-	-	-	-	+	-
Lingulodinium polyedrum	*Lingulodinium machaerophorum*	+	+	-	-	-	+	+	-	-	+
Protoceratium reticulatum	*Operculodinium centrocarpum*	-	-	+	+	-	+	+	+	+	+
Order Gymnodiniales											
Cochlodinium sp cf. *polykrikoides*	*na*	-	-	-	-	-	-	-	+	-	-
Gymnodinium catenatum	*na*	-	+	-	-	+	-	-	+	-	-
Phaeopolykrikos harmanii	*Phaeopolykrikos harmanii*	+	+	-	-	-	+	+	-	-	+
Polykrikos kofoidii	*na*	-	-	-	-	-	-	+	-	-	-
Polykrikos schwartzii	*na*	+	+	-	-	-	-	-	-	-	-
Order Peridiniales											
Protoperidinium compressum	*Stelladinium stellatum*	+	-	+	+	+	+	+	+	-	-
Protoperidinium conicoides	*na*	+	+	+	+	+	+	-	-	+	+
Protoperidinium conicum	*Selenopemphix quanta*	-	+	+	-	+	-	-	+	+	+
Protoperidinium latissimum	*Protoperidinium latissimum*	-	-	+	-	-	+	-	+	+	-
Protoperidinium leonis	*Quinquecuspis concretum*	+	+	-	-	-	-	+	-	+	+
Protoperidinium oblongum	*Votadinium calvum*	+	+	+	+	-	-	-	+	-	-
Protoperidinium sp	*Protoperidinium* sp	-	-	-	-	-	-	+	-	-	+
Phyrophacus steinii	*Tuberculodinium vancampoae*	+	+	-	-	-	+	-	+	+	-
Scrippsiella crystallina	*Scrippsiella crystallina*	+	-	-	-	-	+	+	+	-	+
Scrippsiella trochoidea	*Scrippsiella trochoidea*	+	+	+	+	-	-	-	-	-	+
Zygabikodinium lenticulatum	*Dubridinium caperatum*	-	-	-	-	-	-	+	-	-	+

Table 3. Cyst concentrations (cysts.g^{-1}) of each species, percentages (%) of cysts in each order

Species	Location									
	1	**3**	**4**	**5**	**7**	**8**	**9**	**12**	**13**	**14**
Gonyaulax scrippsae	12	0	0	0	0	0	0	0	0	0
Gonyaulax spinifera	21	25	0	0	0	0	0	0	32	0
Lingulodinium polyedrum	21	34	0	0	0	28	43	0	0	35
Protoceratium reticulatum	0	0	54	42	0	43	37	41	55	46
Percentages of Gonyaulacales cysts	**18.2**	**18.4**	**13.5**	**13.0**	**0**	**18.8**	**22.8**	**10.7**	**31.1**	**23.9**
Cochlodinium sp cf. *polykrikoides*	0	0	0	0	0	0	0	8	0	0
Gymnodinium catenatum	0	3	0	0	7	0	0	4	0	0
Phaeopolykrikos harmanii	23	31	0	0	0	29	38	0	0	34
Polykrikos kofoidii	0	0	0	0	0	0	19	0	0	0
Polykrikos schwartzii	17	12	0	0	0	0	0	0	0	0
Percentages of Gymnodiniales cysts	**13.5**	**14.4**	**0**	**0**	**2.2**	**7.7**	**16.3**	**3.1**	**0**	**10.0**
Protoperidinium compressum	47	0	72	81	88	67	93	77	0	0
Protoperidinium conicoides	43	41	126	89	72	95	0	0	30	45
Protoperidinium conicum	0	32	44	0	153	0	0	58	62	31
Protoperidinium latissimum	0	0	20	0	0	45	0	64	33	0
Protoperidinium leonis	42	39	0	0	0	0	34	0	21	55
Protoperidinium oblongum	34	43	47	73	0	0	0	55	0	0
Protoperidinium sp	0	0	0	0	0	0	47	0	0	39
Phyrophacus steinii	21	48	0	0	0	52	0	61	47	0
Scrippsiella crystallina	11	0	0	0	0	19	18	17	0	18
Scrippsiella trochoidea	5	12	37	39	0	0	0	0	0	17
Zygabikodinium lenticulatum	0	0	0	0	0	0	21	0	0	19
Percentages of Peridiniales cysts	**68.3**	**67.2**	**86.5**	**87.0**	**97.8**	**73.5**	**60.9**	**86.2**	**68.9**	**66.1**
Overall cyst concentration	**297**	**320**	**400**	**324**	**320**	**378**	**350**	**385**	**280**	**339**

sampling locations were ranged from 280 to 400 cysts.g^{-1} (Table 3).

DISCUSSION

Salinity and temperature recorded were considered as normal for marine ecosystem in the tropical areas. Average salinity was 31.25 ppt and average temperature was 28.60 °C, these parameters were high due to warm climate occurred in the country during the sampling activity.

Total number of cysts found in the sampling area was considered as low compared to other area in the Southeast Asia (Lirdwitayaprasit, 1997 & 1998). This finding, however, was similar to the survey done by Furio *et al.* (2006) in Sabah, Malaysia. Low number of cyst in the tropical seas might be caused by high pollution or eutrophication in many bays or beaches in the region. Matsuoka *et al.* (2003) observed similar findings in Tokyo Bay, which was considered as hypertrophic bay. They concluded that low cysts number in a hypertrophic bay was due to other factors, such as: dilution effects of terrestrial sediment particle transportation from land, low productivity of cyst-forming dinoflagellate in the water column, and sedimentary processes unfavourable for sedimentation.

Pospelova *et al.* (2005) reported that low species number of cysts in the sediment was due to toxic pollutants in an area. Dale (1983) added that sandy sediments were unfavourable for the settling of cysts, because cysts have similar hydrodynamic properties to fine silt particles and higher cyst abundance occurs in sediments with higher clay contents. Jakarta Bay, which was highly polluted and had more sandy surface sediments (Damar, 2003), was not conducive for dinoflagellate to form cysts in the area (Matsuoka and Fukuyo, 2000).

Three cysts were found only once, namely *G. scrippsae* that was found in location 1, *Cochlodinium* sp cf. *polykrikoides* was found in location 12, and *P. kofoidii* was found only in location 9. *P. schwartzii* was found in 2 locations, namely location 1 and 3. In addition, *Protoperidinium* sp and *Zygabikodinium lenticulatum* were found in location 9 and 14. The cysts found were not distributed equally in horizontal direction, since from 15 locations sampled, there were only 10 contain dinoflagellate cysts.

Only one cyst species found that was belonged to HAB, namely *Gymnodinium catenatum.* The presence of this cyst was new in the area, because no report on its cyst nor its planktonic cell in Jakarta Bay. The plausible explanation of the presence of *G. catenatum* cyst was that the cysts were brought by ships ballast water (Hallegraeff, 1995). No *Pyrodinium bahamense* var. *compressum* cyst found in all of the samples. One and un-verifiable research report mentioned the presence of *P. bahamense* var. *compressum* cyst in Hurun bay, Lampung (Widiarti, 2004).

Anderson (1989) noted that the presence of cysts of a species of interest was very potential for bloom initiation monitoring strategy. He suggested that the absence of detectable cysts of a species was not meant that an area was free from the threat of toxic and harmful algae. Since some toxic microalgae are now capable to become an invasive species to new areas through many ways, for instance water current (Anderson, 1989).

CONCLUSION

This present research concluded that 1) 20 morphophyte cyst species were found in the area that can be divided into three orders such as Gonyaulacales, Gymnodiniales, and Peridiniales, 2) cyst concentrations calculated from the 10 sampling locations were ranged from 280 to 400 cysts.g^{-1} which were considered as low number of cyst, and 3) more research on cyst distribution was needed to provide more HAB data in the area.

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