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**Distribution of Dinoflagellate Cysts in the Surface Sediment of
South China Sea : Area 2. Off Sabah, Sarawak and Brunei Darussalam**

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ABSTRACT

The surface sediment samples of 47 stations in Sabah, Sarawak and Brunei Darussalam waters were collected by M.V. SEAFDEC for identification and quantitative analysis of benthic dinoflagellate cysts. A total of 18 dinoflagellate cysts belonging to family Gonyaulacaceae, Pyrophacaceae and Protoperiniaceae were identified. The cyst density in this area was in a range of 6 to 278 cysts/cm³ with *Spiniferites bulloideus* was the dominant species. Cysts of harmful species were not observed in this study but a small number of *Alexandrium* cyst-like was found at a station near coastal area of Sarawak.

Key words : distribution, dinoflagellate cyst, south China Sea

Introduction

The distribution of modern organic-walled dinoflagellate cysts in middle and high latitudes of the North Atlantic, North of Japan and Southern Indian Ocean has been well documented [e.g. Wall *et al.*(1977), Harland (1983), Matsuoka (1987), Marret and de Vernal(1997)]. Some studies have been shown the relationship between cyst assemblages and sea-surface conditions, including temperature, salinity, seasonality and extent of sea-ice cover. A few studies have reported on neritic dinoflagellate cyst off Australia and New Zealand[Bolch and Hallegraeff (1990), McMinn (1990, 1991, 1992)].

In contrast with the southeast Asian waters the distribution of dinoflagellate cyst in this area is poorly documented. Recently, Asian waters have some severe problems deal with the toxic algal blooms. The toxic red tides of *Pyrodinium bahamense* were reported for the first occurrences along the coasts of Brunei and Sabah, the Philippines and Eastern Indonesia in 1976, 1983 and 1994, respectively [Maclean (1983), Wiadnyana *et al.*(1996)]. The bloom reoccurred annually in the Philippines waters since 1991 [Bajarias and Relox (1996)]. High cyst density that was found in surface sediment of the incident area could function as seed population to initiate the motile cells for the next bloom.

The study on distribution of dinoflagellate cyst in off shore waters was first carried out in the Gulf of Thailand and the east coast of Peninsular Malaysia by M.V. SEAFDEC under the collaborative research programme between Thai and Malaysian scientists. To provide more information on the abundance and distribution of dinoflagellate cyst in southeast Asian waters, the study in areas off Sabah, Sarawak and Brunei Darussalam was carried on under the same collaborative programme.

Materials and Methods

Surface sediment samples of 47 stations in Sabah, Sarawak and Brunei Darussalam waters were collected by gravity corer or grab during the collaborative research cruises from 4 July -9 August 1996 and repeated again from 25 April - 31 May 1997 by M.V. SEAFDEC. The study area was shown in Fig.1.

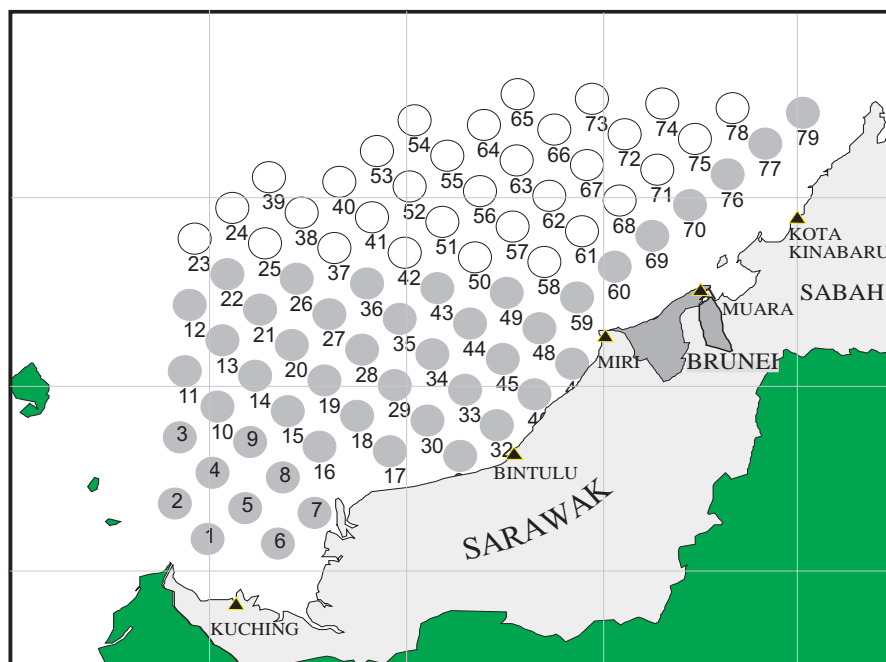


Fig. 1 Area and sediment sampling station in Sabah, sarawak and Brunei Darussalam waters

The first centrimetre of surface sediment samples from the corer or sub-sampling from the grab was prepared for identification and quantitative analysis of benthic dinoflagellate cysts by using the method described by Matsuoka et al. (1989). Surface sediment temperature, surface sediment characteristic and water depth were recorded when the sample was collected. Sample of each station was divided into two portion. A small portion was for cyst germination experiment on the ship board, the remaining portion was kept in formalin at final concentration of 5% for cyst identification in laboratory.

The main references used in this study for identification purpose were : Matsuoka and Fukuyo(1996), Matsuoka (1985,a,b,c) and Matsuoka(1987). Sedgwick Rafter chamber was used for counting cyst under the light microscope.

Results and Discussion

Environmental Conditions

The water depth, surface sediment temperature and surface sediment characteristic was shown in table 1. There was slightly different in this data set between the two cruises but has an identical surface sediment characteristic. Water depth and surface sediment temperature were in the range of 20-146 metres and 17.5-29.5 $^{\circ}\text{C}$, respectively. The sample collecting periods of the first cruise, July-August, 1996, and the secound cruise, April-May, 1997, could be considered in the same season which was one reason why the physical parametres were not so different and there was no clear relationship between these parameters and cyst densities.

Abundance and Distribution

The modern dinoflagellate cysts of 18 species belonging to family Gonyaulacaceae(6 species), Pyrophacaceae (1 species), Protoperidiniaceae (9 species) and uncertain family (2 species) were identified and shown in table 2. The abundance and distribution of both cruises were almost the same with average cyst densities were shown in table 3 and Fig. 2-19. Cysts in the

surface sediment sample were found in a range of 6-278 cysts/cm.³ which was very low density compared with the cyst density in other areas such as in the southern Indian Ocean which found in a range of 200-50,000 cysts/cm.³ at depth from 375-4350 metres [Marret and de Vernal (1997)]. Cysts in surface sediments of the Gulf of Thailand and east coast of Peninsular Malaysia were also very low density with a range of 12-84 cysts/cm.³ [Lirdwitayaprasit (1998)].

Spiniferites bulloideus was the dominant species in this study with 63.8% occurrence in 47 stations. Lirdwitayaprasit (1998) reported that genus *Spiniferites* was also the dominant species in the Gulf of Thailand and the east coast of Peninsular Malaysia. From this results suggested that this species widely distributed in southeast Asian waters.

Protopteridiniaceae found in this area is composed of more species than other family in this study but was low cyst density and low percentage occurrence in comparison with the Upper Gulf of Thailand that is a high productive area. The protopteridiniacean cyst abundance associated with high diatom productivity and closely related to the rich dissolved nutrients such as the upwelling areas [Bujak (1984) and Mutsuoka (1987)].

Although cyst harmful species have not been observed in this study but a small number of *Alexandrium* cyst-like was found at station 7 located near the coastal area of Sarawak. The cyst of toxic *Pyrodinium bhamense* var. *compressum* was not found in this study might probably due to the sampling stations which located in off shore area.

Cyst Germination Experiment

Several test tubes were used for cyst germination experiments on the ship board but no germinating cell was observed which was probably due to the unfavorable laboratory conditions or long dormancy period of the cysts.

Conclusions and Recommendations

1. *Spiniferites bulloideus* was the dominant species in this study.
2. This study provided more information on the distribution of dinoflagellate cysts off Sabah, Sarawak and Brunei Darussalam which is useful for promoting red tide and / or cyst monitoring programme in this area.
3. *Alexandrium* cyst-like was found in small number at the coastal station of Sarawak. It is important to note that almost of the member in this genus were reported as the PSP (Paralytic Shellfish Poisoning) toxin producing organism.

Acknowledgement

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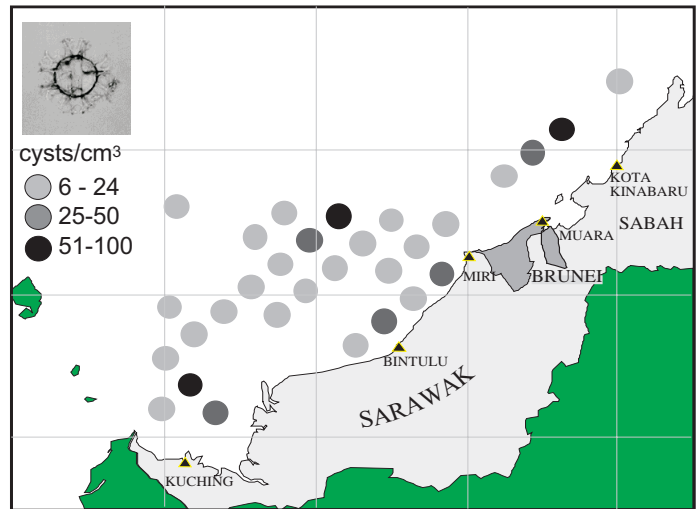


Fig. 2 Distribution and abundance of *Spiniferites bulliodeus*

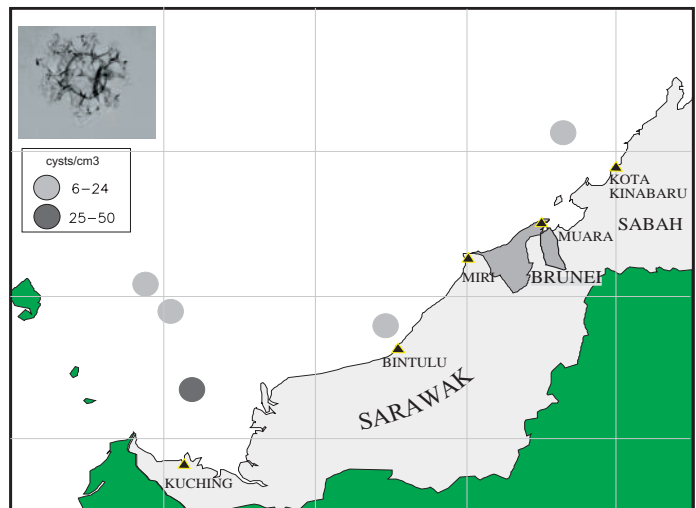


Fig. 3 Distribution and abundance of *Spiniferites cf. mirabilis*

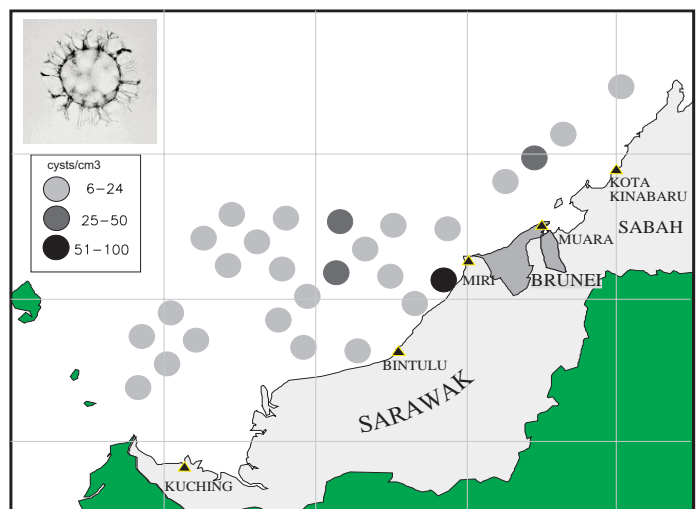


Fig. 4 Distribution and abundance of *Spiniferites ramosus*

Fig. 5 Distribution and abundance of *Spiniferites cf. rubinus*

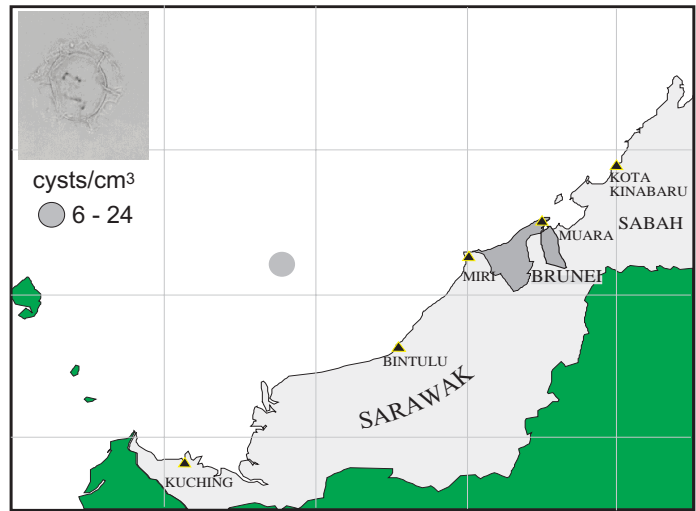


Fig. 6 Distribution and abundance of *Alexandrium sp.*

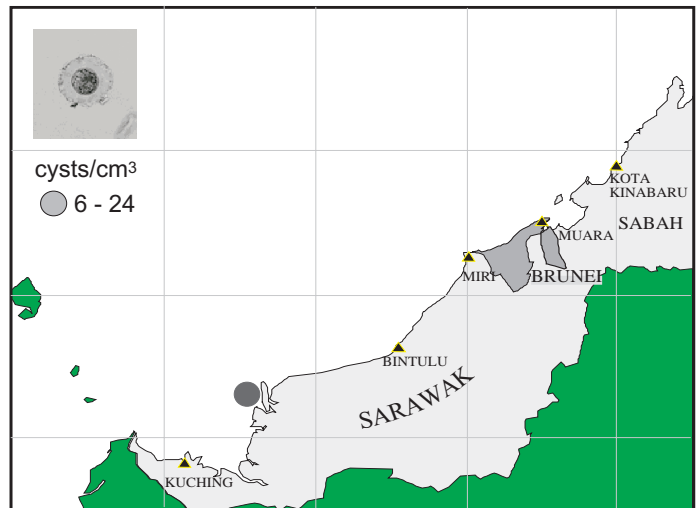
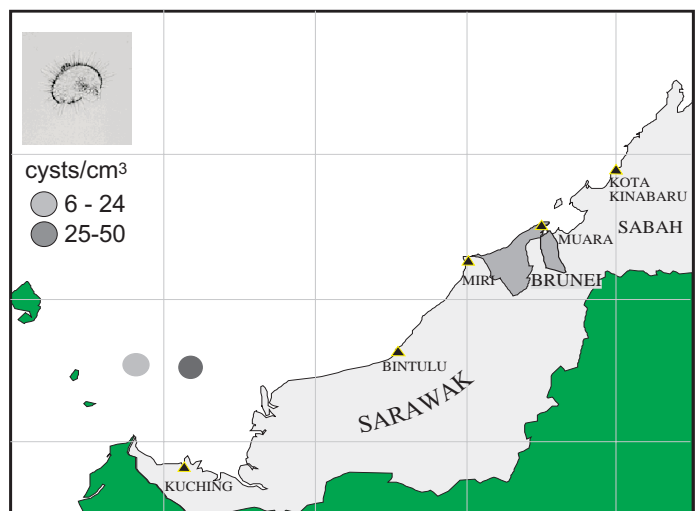


Fig. 7 Distribution and abundance of *Linguloginium machaerophorum*



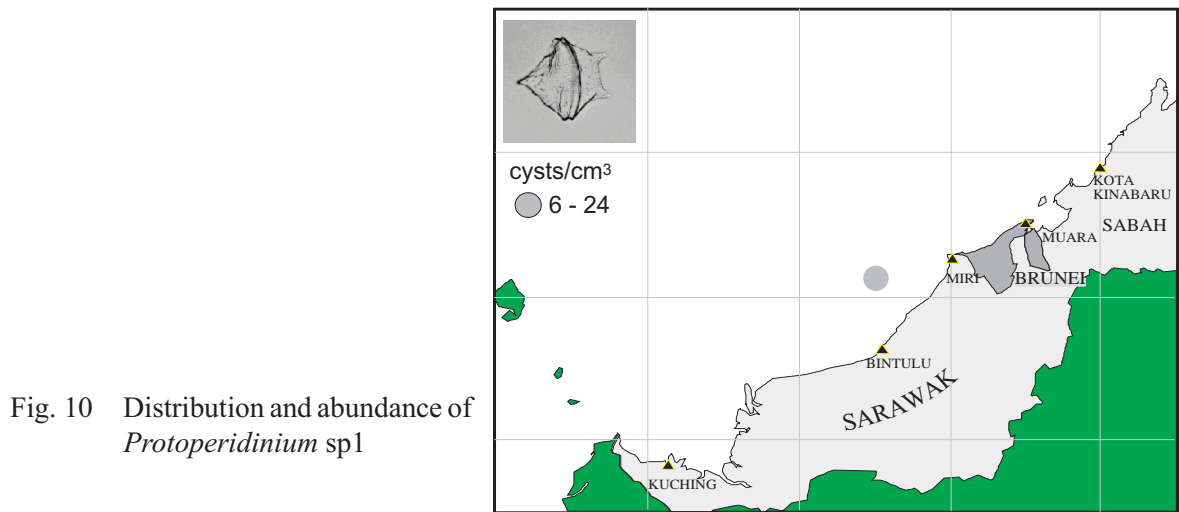
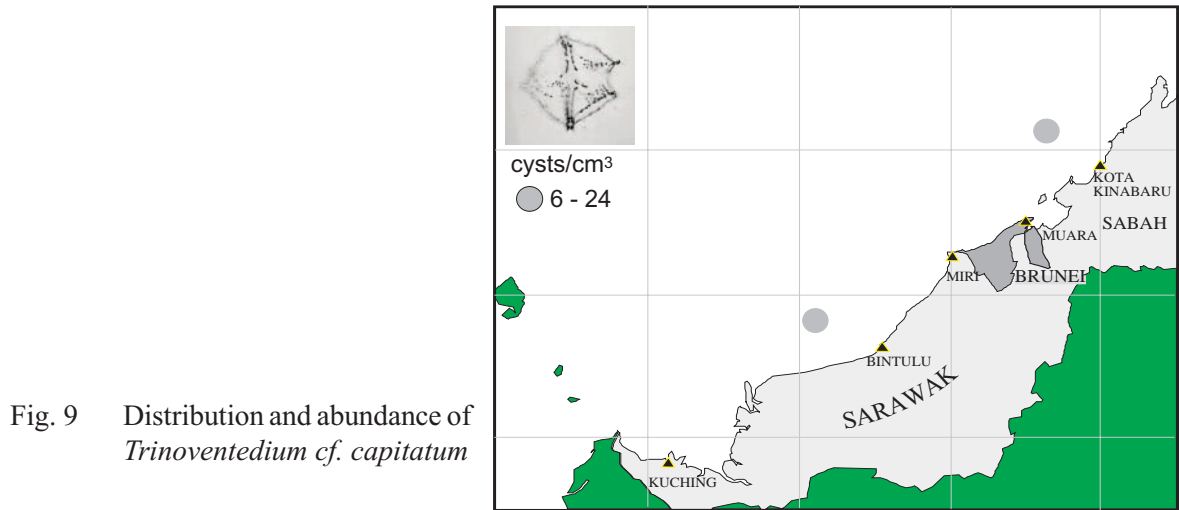
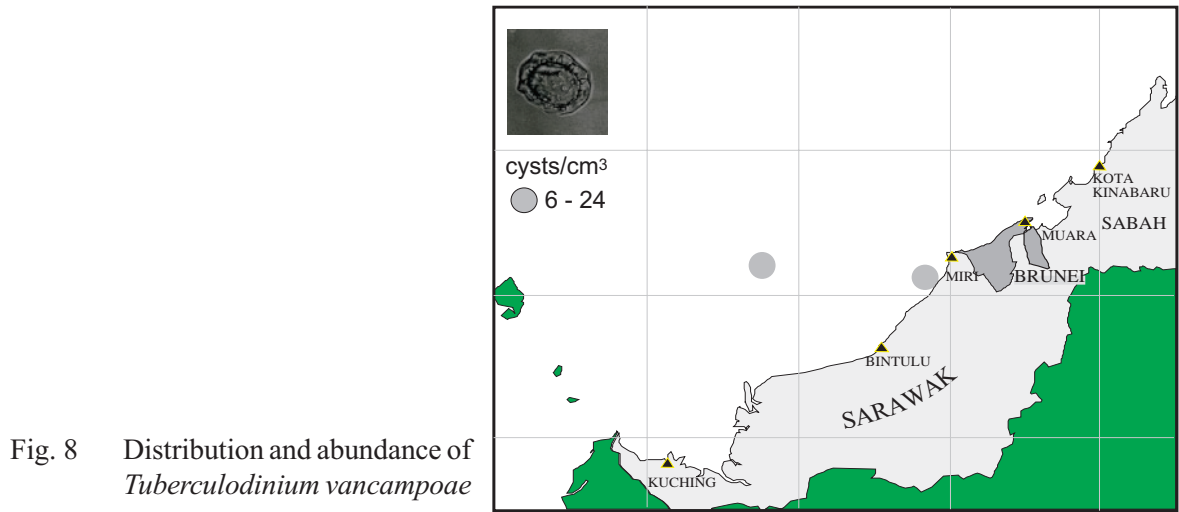


Fig. 11 Distribution and abundance of *Protoperdinium* sp2

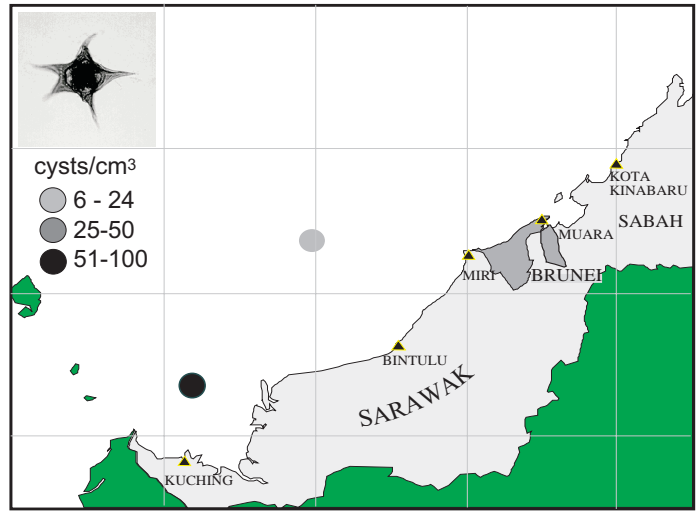


Fig. 12 Distribution and abundance of *Protoperdinium* sp3

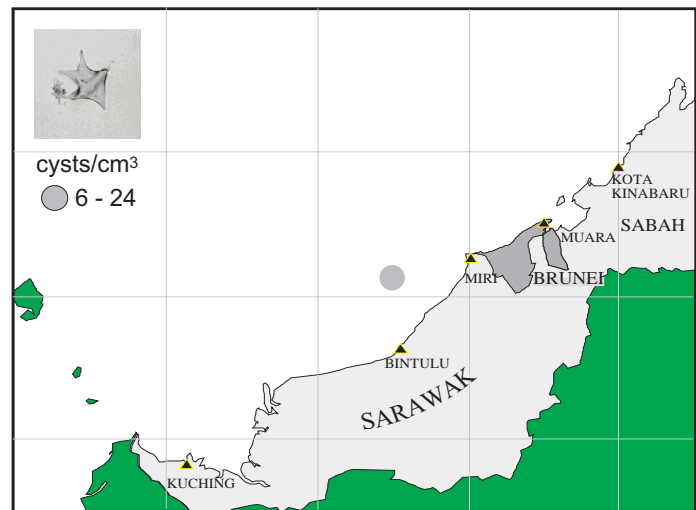
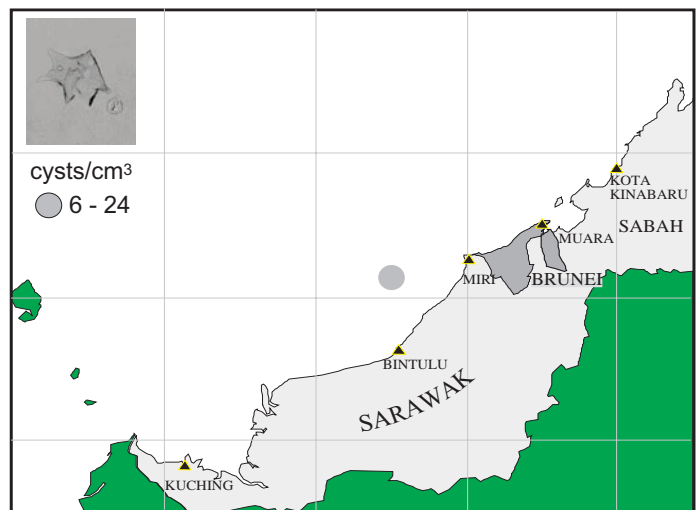


Fig. 13 Distribution and abundance of *Protoperdinium* sp4



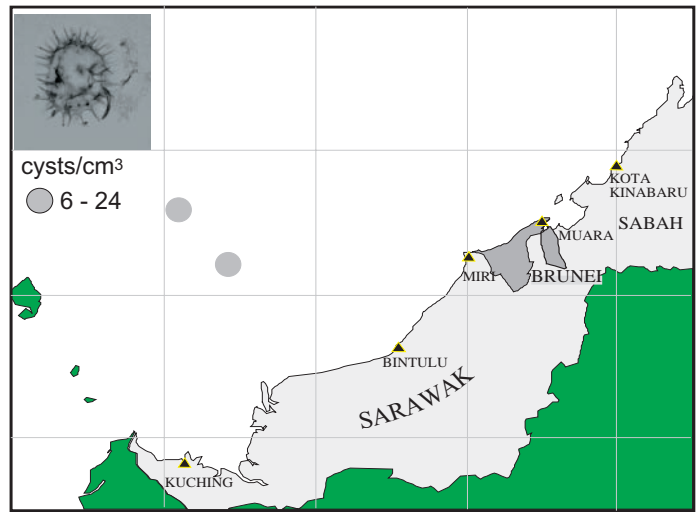


Fig. 14 Distribution and abundance of *Selenopemphix cf. quanta*

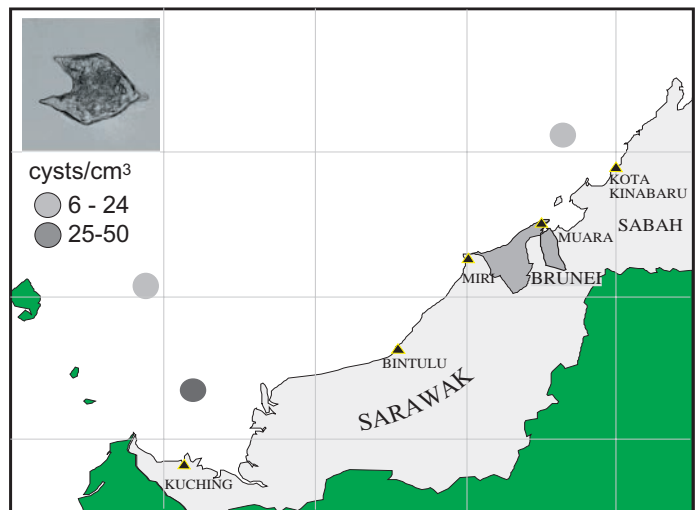


Fig. 15 Distribution and abundance of *Protoperidinium sp5*

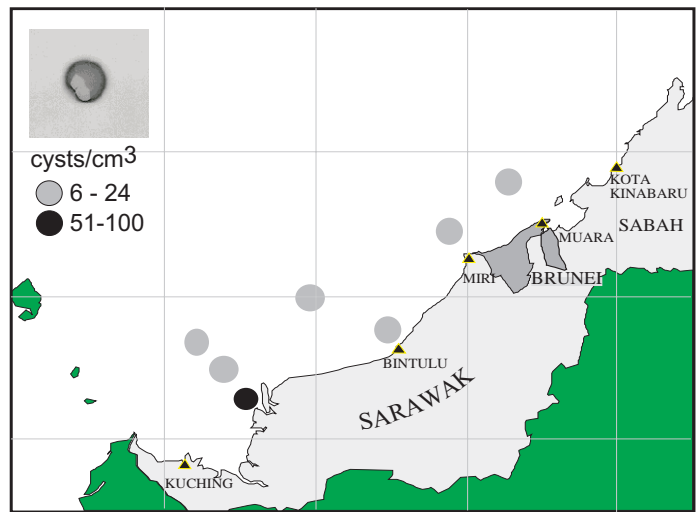


Fig. 16 Distribution and abundance of *Protoperidinium sp6*

Fig. 17 Distribution and abundance of *Protoperidinium* sp7

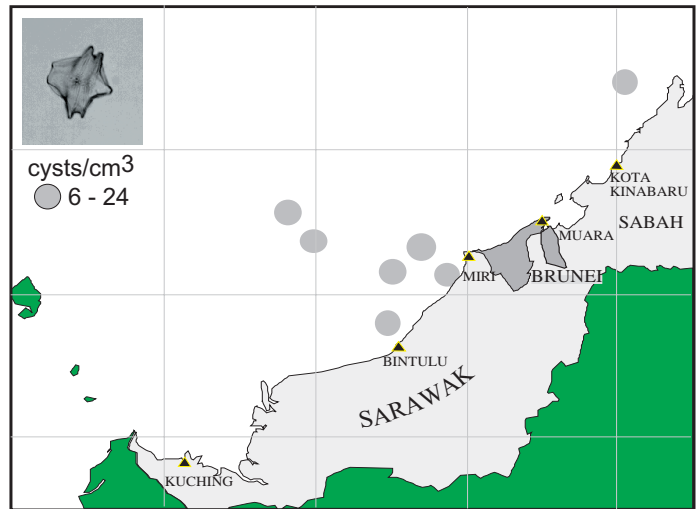


Fig. 18 Distribution and abundance of Dinoflagellate Cyst Type A

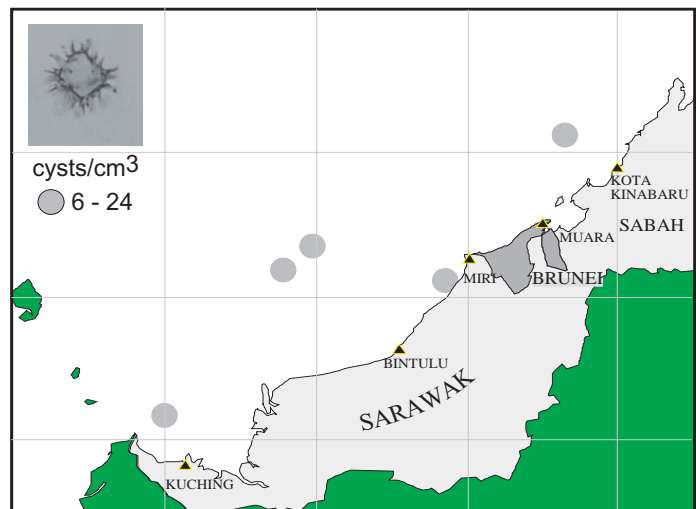
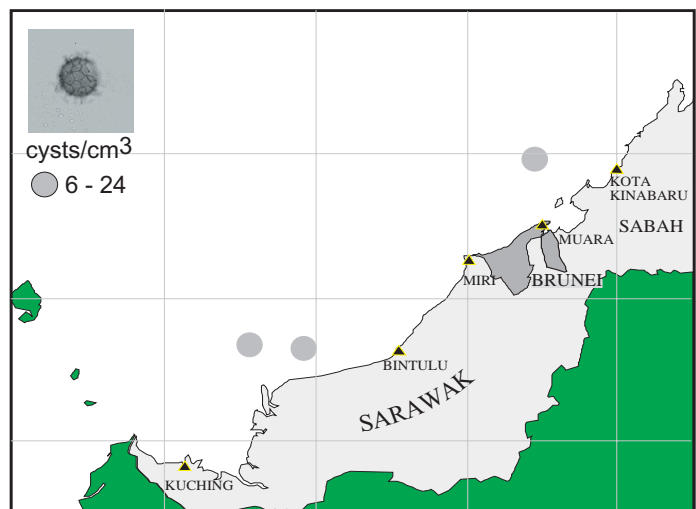


Fig. 19 Distribution and abundance of Dinoflagellate Cyst Type B



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Table 1 Physical parameter of the surface sediment samples and total cyst density
 1 = the first cruise, 2 = the second cruise

station	water depth (m.)		sediment temp.(c.)		surface sediment characteristic	cysts/cm ³	
	1	2	1	2		1	2
1	35.00	37.00	26.00	27.60	brownish coarse sandy mud	12	12
2	54.50	57.00	23.50	25.50	brownish coarse sandy mud	12	12
3	69.80	81.00	21.00	22.50	brownish fine sandy mud with shell fragments	5	7
4	66.00	67.00	24.60	24.30	brownish fine sandy mud with shell fragments	32	36
5	79.00	77.00	24.00	24.60	brownish fine sandy mud with shell fragments	270	286
6	43.50	41.00	29.00	26.20	brownish fine sandy mud with shell fragments	48	52
7	32.60	35.00	27.00	27.40	brownish fine sandy mud with shell fragments	90	112
8	39.00	40.80	29.00	27.60	brownish coarse sandy mud with shell fragments	4	8
9	67.50	65.00	25.20	24.10	brownish fine sandy mud with shell fragments	24	26
10	86.00	85.00	26.80	21.50	brownish fine sandy mud with shell fragments	22	24
11	100.00	101.00	23.30	20.80	brownish fine sandy mud with shell fragments	15	19
12	118.50	118.00	19.10	20.50	brownish fine sandy mud with shell fragments		-
13	115.00	114.00	19.80	20.40	brownish fine sandy mud with shell fragments		-
14	94.00	91.40	22.20	21.00	brownish fine sandy mud with shell fragments		-
15	65.50	66.00	23.40	23.00	brownish fine sandy mud with shell fragments	16	18
16	62.70	66.00	24.90	24.90	brownish fine sandy mud with shell fragments	10	12
17	30.00	29.50	28.50	27.70	brownish coarse sandy mud with shell fragments	18	16
18	45.00	48.10	27.30	26.40	brownish coarse sandy mud with shell fragments	12	10
19	70.00	71.60	23.60	23.70	brownish fine sandy mud with shell fragments	7	5
20	90.00	90.70	20.90	21.00	brownish fine sandy mud with shell fragments	12	12
21	119.00	118.00	19.80	20.20	brownish fine sandy mud with shell fragments	6	6
22	146.00	143.00	18.20	18.80	brownish fine sandy mud with shell fragments	22	24
26	123.00	123.00	18.60	19.60	brownish fine sandy mud with shell fragments	6	6
27	95.50	95.00	18.90	20.20	brownish fine sandy mud with shell fragments	18	18
28	79.00	80.00	21.90	21.40	brownish fine sandy mud	30	30
29	56.00	56.00	25.40	25.00	brownish fine sandy mud with shell fragments	22	26
30	32.00	34.00	29.20	27.80	brownish coarse sandy mud with shell fragments	6	6
31	21.50	21.00	29.80	29.00	brownish muddy clay	34	38
32	34.00	32.00	29.60	27.60	brownish fine sandy mud	58	64
33	49.00	51.20	26.50	25.90	brownish muddy clay		-
34	71.00	73.20	22.90	23.60	brownish muddy clay	70	76
35	88.00	88.00	22.00	22.20	brownish muddy clay	73	73
36	108.00	110.00	23.80	20.70	brownish fine sandy mud with shell fragments	74	72
43	105.00	105.00	20.00	20.60	brownish fine sandy mud with shell fragments	98	98
44	89.00	89.00	20.80	22.50	brownish fine sandy mud with shell fragments	20	28
45	66.00	67.10	23.30	23.90	brownish fine sandy mud with shell fragments	80	88
46	20.00	22.50	29.10	28.60	brownish fine sandy mud with shell fragments	44	52
47		29.50		27.20	brownish fine sandy mud with shell fragments	168	174
48	78.00	78.00	22.00	23.30	brownish fine sandy mud with shell fragments	48	48
49	105.00	106.00	19.50	19.00	brownish fine sandy mud with shell fragments	36	36
59	96.00	95.50	19.80	21.90	brownish fine sandy mud with shell fragments	36	36
60							NO
69	97.00	100.00	20.00	20.70	brownish fine sandy mud with shell fragments	58	62
70	124.00	140.00	18.30	17.40	brownish fine sandy mud with shell fragments	88	106
76	109.00	100.00	19.60	23.40	brownish coarse sandy mud with coral fragments	140	152
77	96.50	92.00	19.80	21.90	brownish fine sandy mud with shell fragments		-
79		57.00		25.60	brownish fine sandy mud with shell fragments	48	64

Note : - = no cyst was observed
 NO = no sediment sample could be collected

Table 2 List of dinoflagellate cysts found in the surface sediment samples

Paleontological name for cyst	Biological name for motile cell	% occurrence
Gonyaulacaceae		
1. <i>Spiniferites bulloideus</i>	<i>Gonyaulax scrippsae</i>	63.80
2. <i>Spiniferites cf. mirabilis</i>	<i>Gonyaulax spinifera complex</i>	10.60
3. <i>Spiniferites ramosus</i>	<i>Gonyaulax spinifera complex</i>	57.40
4. <i>Spiniferites cf. rubinus</i>	<i>Gonyaulax sp.</i>	2.10
5. <i>Alexandrium sp.</i>	<i>Alexandrium sp.</i>	2.10
6. <i>Lingulodinium machaerophorum</i>	<i>Lingulodinium polyedrum</i>	4.30
Pyrophacaceae		
7. <i>Tuberculadinium vancampoae</i>	<i>Pyrophacus stenii</i>	4.30
Protopteridiniaceae		
8. <i>Trinovedinium cf. capitatum</i>	<i>Protopteridinium pentagonum</i>	4.30
9. <i>Trinovedinium sp.1</i>	<i>Protopteridinium sp.1</i>	2.10
10. <i>Stelladinium sp.1</i>	<i>Protopteridinium sp.2</i>	4.30
11. <i>Stelladinium sp.2</i>	<i>Protopteridinium sp.3</i>	2.10
12. <i>Stelladinium sp.3</i>	<i>Protopteridinium sp.4</i>	2.10
13. <i>Selenopemphix cf. quanta</i>	<i>Protopteridinium conicum</i>	4.30
14	<i>Protopteridinium sp.5</i>	6.40
15	<i>Protopteridinium sp.6</i>	14.90
16	<i>Protopteridinium sp.7</i>	14.90
Uncertain Family		
17. Dinoflagellate cyst type A.		10.60
18. Dinoflagellate cyst type B.		6.40

