BIODIVERSITY OF DINOFLAGELLATES IN THE COASTAL WATERS OFF MALACCA, PENINSULAR MALAYSIA

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ABSTRACT. *Knowledge on the diversity of marine organisms such as the dinoflagellates is important because of the ability of some of the organisms in the group to produce toxins and to cause red tides or harmful algal blooms (HABs). During a study conducted in the coastal waters off Malacca, Peninsular Malaysia, a checklist of common marine dinoflagellates found in the area was produced with 35 species identified from 6 orders viz. Prorocentrales, Dinophysiales, Gonyaulacales, Peridiniales, Gymnodiniales and Noctilucales. Among these, 10 species were identified as potential HAB species. Although no serious cases have been reported due to these species in the sampling area, their occurrence in the Malacca Straits should be given attention due to the negative impacts of HAB species on economics, aquaculture, fisheries and tourism operations, as recorded in other countries in the world.*

KEYWORDS *: Red tides, harmful algal bloom (HAB), dinoflagellates, taxonomy.*

INTRODUCTION

Microscopic planktonic algae, such as the dinoflagellates, are important as primary producers and serve as food for filter-feeding bivalve shellfish such as oysters, mussels, scallops and clams. Occasionally, in response to favorable changes in environmental conditions, these algae can form blooms, which are termed “red tides” or more appropriately harmful algal blooms (HABs) (Shumway, 1990). The blooms may be either toxic or noxious which can be classified to be caused by three different groups of species (Hallegraff, 1993) viz. (1) species which produce harmless water discolorations but the dense bloom can cause indiscriminate kills of fish and invertebrates due to oxygen depletion (2) species which produce potent toxins causing a variety of gastrointestinal and neurological illnesses to humans and (3) species which are not toxic to humans but harmful to fish and invertebrates by damaging or clogging their gills. HABs, therefore, can cause negative effects to aquaculture, human health, economic, fisheries and tourism. This paper focuses on the potential HAB species identified at the shellfish growing area, describes their distribution and their impacts based on occurrences in other countries on public health, aquaculture and the fisheries industry.

MATERIAL AND METHODS

Dinoflagellate samples were collected from the shellfish growing area, Sebatu and Sungai Rambai, Malacca, in 1997, located from latitudes N 02º 05’ 42.8” to 5’ 57.2” and from longitudes E 102º 28’ 56.5” to E 102º 29’ 26.1”. Samples were concentrated using a 20 µm mesh plankton net and were preserved with 2% formalin. Taxonomic identification of thecate species was ascertained under light microscope with differential interference contrast. For Scanning Electron Micrograph (SEM) studies, samples were processed and dehydrated under a series of acetone with concentrations of 35%, 50%, 70%, 90% and 95%. Samples than were pipetted on aluminium foil coated with albumin, coated with gold using a Polaron SEM Coating Unit E5100 and observed under scanning electron microscopy

RESULTS AND DISCUSSION

A total of 35 species of dinoflagellates were indentified from the study area. Table 1 lists the species identified from the 6 orders. Of these, 10 species are potential harmful algal bloom (HAB) species. Table 2 lists the HAB species, their distribution and their ecological impacts.

CONCLUSIONS

The occurrences of these HAB species in other countries and the effect on public health, aquaculture and fisheries industry clearly indicate the potential implications of these species on coastal waters in Malaysia. While there are a number of theories which are eluded to causing HABs, one on the causal factors has been due to eutrophication and pollution effects in coastal waters. Therefore, with the identification of these species in the Sebatu and Sungai Rambai areas, it is imperative that there be a continuous monitoring programme in the coastal waters off Malacca to monitor the occurrences of these harmful dinoflagellate species. In addition, further research and development efforts should be undertaken to understand the favors which contribute towards bloom formation in efforts to conserve and protect the marine waters from potential effects of HABs.

Table 1. Dinoflagellate species identified from the study area

No	Order	Species
1.	Order Prorocentrales Lemmermann 1910	*Prorocentrum micans* Ehrenberg 1833
		P. gracile Schutt 1895
2.	Order Dinophysiales Lindermann 1928	*Dinophysis caudata* Saville-Kent 1881
		D. miles var. indica Bohm
		D. sp
		D. rotundata Claparede & Lachmann
3.	Order Gonyaulacales F.J.R. Taylor 1980	*Ceratium fusus* (Ehrenberg) Dujardin 1841
		C. furca (Ehrenberg) Claparede & Lachmann
		C. tripos (O.F.Muller) Nitzsch 1908
		C. trichoceros (Ehrnberg) Kofoid 1908
		Alexandrium tamiyavanichii Balech
		Gonyaulax spinifera (Claparede & Lachmann) Diesing 1866
		G. digitale Pouchet
		Pyrophacus horologium Stein 1883
		P. steinii (J.Schiller) Wall et. Dale 1971
4.	Order Peridiniales Lindemann 1928	*Protoperidinium monospinum* Paulsen 1907
		P. excentricum (Paulsen) Balech 1974
		P. depressum Bailey 1885
		P. oblongum (Aurivillius) Balech & Dodge 1976
		P. pentagonum (Gran) Balech 1974
		P. divaricumtum Meunier 1919
		P. conicum (Gran) Balech 1974
		P. crassipes Kofoid 1907
		P. pyrum Aurivillius
		P. punctulaum (Paulsen) Balech
		P. claudicans (Paulsen) Balech 1974
		P. pellucidum Bergh 1881
		P. balechii
		Diplosalopsis globula Abe
		D. minor (Paulsen) Pavillard 1913
5.	Order Gymnodiniales Lemmermann 1910	*Akashiwo sanguineum* Hirasaka 1922
		G. catenatum Graham
		Gyrodinium fusiforme Kof. & Swezy
		Polykrikos schwartzii
6.	Order Noctilucales Haeckel 1894	*Noctiluca scintillans* (Macartney) Ehrenberg

Table 2. List of HAB species identified from the study area, their distribution and ecological impacts

No	Species	Distribution	Ecological impacts
1.	*Prorocentrum micans* Ehrenberg 1833	Fairly common, found in all sampling stations.	• Known to be found in neritic (Dodge 1985, Steidinger and Tangen 1996), brackish (Bursa 1959) and estuarine (Lebour 1925) waters • Known to produce red tides in Vietnames waters (Fukuyo et al 1990), South Africa (Matthews & Pitcher, 1996)
2.	*Dinophysis caudata* Saville-Kent 1881	Fairly common, found in all sampling stations.	• Known to be found from temperate to tropical waters (Larsen & Moestrup, 1992) • Known to produce red tides in Tuticorin Bay, South India (Santhanam & Srinivasan, 1996) and potential DSP in Thailand (Sudara et al., 1984)
3.	*Dinophysis rotundata* Claparede & Lachmann	Very rare species, found in all sampling stations.	• Known to be found in Monterey Bay (Tai & Skosberg, 1934), Atlantic, Baltic and Mediterranean (Lebour, 1925). • Known as DSP species (Hallegraeff, 1993)
4.	*Ceratium furca* (Ehrenberg) Claparede & Lachmann 1859	Abundant in all sampling stations.	• Known to be found in warm to cold temperate waters (Steidinger & Tangen, 1996), common in river mouth and upwelling region (Graham & Bronikovsky, 1944) • Known to produce red tide in Japanese coast (Fukuyo et al., 1990), North Atlantic (Dodge & Marshall, 1994) and anoxia in Baltic Sea and German Bright (Smetacek et. al., 1991).
5.	*Alexandrium tamiyavanichii* Balech	Common in all sampling stations.	• Known to be found in Gulf of Thailand (Kodoma et al., 1988), Southwest of Thailand (Balech, 1995) • Known as a PSP species in Thailand (Balech, 1995).
6.	*Gonyaulax spinifera* (Claparede & Lachmann) Diesing 1866	Common in all sampling stations.	• Known to be found in neritic, estuarine and oceanic. • Known to produce red tides in southern part of Japanese coast (Fukuyo et. al., 1990).
7.	*Gymnodinium catenatum* Graham	Common only in certain month in station A and B	• Known to be found in Northwest Spain (Bravo & Anderson, 1994, Fermìn et al. 1996), Australia (Hallegraeff, 2002, Hallegraeff et al., 1988, 1989, 1995; Blackburn et al., 1989, Bolch et al. 1999), Japan (Ikeda et al., 1989), Portuguese Coast (Franca & Almeida, 1989), Philippines (Balech, 1995), Indonesia (Sidabutar et al. 2000) • Known as PSP species (Ohshima et al., 1993) in Southern Tasmania (Hallegraeff et al., 1995), Iberian Peninsular (Fraga, 1996)

8.	*Akashiwo sanguineum* Hirasaka 1922	Less common in all sampling stations	• Known to be found in temperate to tropical estuaries • (Steidinger & Tangen, 1996) including Australia (Hallegraeff, 2002) • Known to produce red tides (Fukuyo et al., 1990).
9.	*Polykrikos schwartzii*	Common in only certain month in sampling stations	• Known to e found in Mediterranean and English Channel (Lebour, 1925) • Known to produce red tides in Japanese coast (Fukuyo et al., 1990).
10.	*Noctiluca scintillans* (Macartney) Ehrenberg	Common in all sampling stations	• Known to be found in tropical to subtropical waters (Fukuyo et al., 1990) including Australia (Hallegraeff, 2002). • Known to produce red tides in Penang and Johore Straits, Peninsular Malaysia (Jothy, 1984), Japanese costal waters (Fukuyo et al., 1990), and forced closure of Sydney beaches and problems to feeding activity in salmonid pens in Tasmania (Hallegraeff, 2002).

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