DIVERSITY AND PERIODICITY OF MARINE HARMFUL ALGAE

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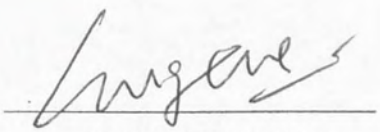

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ABSTRACT

Periodicity of marine Harmful Algal Blooms (HABs) is important to study and to understand as it is vital in HAB monitoring to predict the blooms. There were 15 species of harmful algae from two divisions, viz bacillariophyta and pyrrophyta, which can produce toxin or can cause harm to the marine organisms, including *Pyrodinium bahamens* var *compressum*. The harmful algal bloom caused by the causative species, *Cochlodinium polykrikoides* was observed throughout one week (21-27 July 2004) of the study. The bloom did not reappear within the study period. The diversity of marine harmful algal during bloom period was dominated by this causative species and its population achieved the highest density of 1772 $\pm$ 384 cell/ml on the first day of sampling at station one and the third day at station two. There was no periodicity observed for all marine algal species throughout the bloom period in the coastal water of UMS jetty. Population and density of marine harmful algal was low and fluctuated from August to November. The diversity of harmful algae throughout the four month study was low but increased from August to November at both stations at the UMS jetty. There was no periodicity observed due to irregular fluctuation in population and density of the harmful algal throughout the four month of study. Physical parameters showed no significant relationship with the density of marine harmful algae in this project. Monitoring should continue over longer period to study the periodicity of the HABs in the coastal water around the region. Study on the environmental factors and the inflow of nutrient from the terrestrial that affect the HABs population should be carried on as it stimulates the incidence of harmful algal bloom in the coastal water around Sabah.

ABSTRAK

(Kepelbagaian dan Kekalaan Alga Beracun Marin)

Kekalaan perkembangan alga beracun marin ataupun HABs merupakan satu bidang pelajaran yang amat penting untuk dipelajari dan difahami kerana bidang pelajaran tersebut memainkan peranan yang penting dalam aktiviti pemonitoran HABs untuk menjangka perkembangan alga beracun tersebut. Terdapat 15 spesies alga beracun marin daripada dua divisi, iaitu bacillariophyta dan pyrrophyta, yang berpotensi untuk menghasil toksin atau membawa keburukan kepada organisma marin telah dikenalpasti termasuklah *Pyrodinium bahamens* var *compressum.* Perkembagan alga beracun yang disebabkan oleh *Cochlodinium polykrikoides* telah diperhatikan selama satu minggu (21-27 Julai 2004) dalam kajian tersebut. Perkembagan algae beracun tersebut tidak berlaku lagi sepanjang waktu kajian tersebut. Kepelbagaian alga beracun semasa perkembangan alga beracun dinominasikan oleh species yang dikenali sebagai *Cochlodinium polykrikoides* and populasi spesies tersebut mencapai densiti yang tertinggi, iaitu 1772 $\pm$ 384 sell/ml pada hari pertama di stesen satu dan hari ketiga di stesen two. Kekalaan bagi semua alga beracun tidak dapat diperhatikan semasa perkembangan alga beracun tersebut di laut persisiran pantai berdekatan jeti UMS. Populasi dan densiti alga beracun marin adalah rendah dan berubah-ubah dari bulan Ogos hingga November. Kepelbagaian alga beracun dalam kajian sepanjang empat bulan adalah rendah tetapi meningkat dari bulan Ogos hingga November di kedua-dua stesen di jeti UMS. Kekalaan tidak dapat diperhatikan disebab oleh perubahan yang tidak stabil bagi populasi dan densiti alga beracun sepanjang waktu kajian tersebut. Parameter fizikal tidak memberikan hubungan yang signifikan dengan densiti alga beracun dalam projek ini. Aktiviti pemonitoran haruslah dijalankan dalam jangka masa yang lebih panjang untuk mempelajari kekalaan alga beracun di laut persisiran pantai tersebut. Factor persekitaran seperti pengaliran nutrian dari daratan ke laut yang akan menjejaskan populasi alga beracun haruslah dipelajari kerana ia dianggap sebagai pemangkin untuk menyebabkan perkembangan alga beracun di laut persisiran pantai di seluruh negeri Sabah.

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Symbol		Nomenclature
%	-	percent
cell/ml	-	cell per milliliter
cell/L	-	cell per liter
^{o}C	-	Degree Celsius
µl	-	microliter
ml	-	milliliter
mm	-	millimeter
mm^2	-	meter square
mm^3	-	meter cube
µm	-	micrometer
g	-	gram
µg	-	microgram
S.E.	-	Standard Error
ppt	-	part per trillion
NTU	-	Nephelometric Turbidity Units
W	-	week

CHAPTER 1

INTRODUCTION

1.1 Harmful Algae

Algae are photosynthetic organisms. They vary from small, single-celled species from one micrometer in diameter to a complex multi-cellular giant seaweed forms, such as the giant kelps or konbo in Japanese that grow up to more than 60 meters in length and form dense marine forests in most temperate country. Algae are abundant and ancient organisms that can be found in virtually every ecosystem in the biosphere. For billion of years algae have exerted profound effects on our planet and its biota, and they continue to do so today (Linda & Lee, 2000).

Algae, via photosynthesis, converts the energy of sunlight into chemical energy and they play an important rule as food in marine organism's food web. For example, phytoplankton which is a group of autotrophic plankton with pigments or chromatophors, are able to produce organic compounds through photosynthesis. Phytoplankton also serve as a critical food for filter feeding bivalve shellfish for example oysters, mussels, scallops, and clams as well as the larvae of commercially

important crustaceans and finfish. The proliferation of plankton algae or so-called the algae blooms up to million of cells per liter is beneficial for aquaculture and wild fisheries operations (Hallegraeff, 2003). However, not all the plankton algae are beneficial for marine life and also for aquaculture activities. These plankton algae are known as harmful algae that potential to cause negative impact to marine life and ecosystem.

Coastal waters worldwide experienced a dramatic increase in harmful algae blooms (HABs) or "red tides" over a period that spans several decades. The blooms are considered to be harmful because they can be toxic to marine life and humans, or they can occur as non-toxic forms that cause extensive environmental change and significant economic losses to coastal communities (Anderson *et al.*, 1993; Boesch *et al.*, 1997; Burkholder, 1998). Harmful algal blooms occur throughout the world as a result of high concentration of marine algae, many of which produce potent toxins such as paralytic shellfish poison (PSP) (Smayda, 1990). Among 5000 species of extant marine phytoplankton (Sournia *et al.*, 1991), some 300 species can at times occur in such high numbers that they obviously cause "red tides", which only about 80 species were known to have the capacity to produce potent toxins that can find their way through fish and shellfish to human (Hallegraeff, 2003). For example if the blooms are dominated by toxic algae species, toxins can be accumulated in the food chain and eventually be consumed by humans to cause diarrhetic or paralytic shellfish poisoning (Corrales and Gomez, 1990). According to Hallegraeff (2003), the causative alkaloid toxin known as paralytic shellfish poison (PSP) are so potent that a pinhead-size quantity which is about 500µg, which can easily accumulate in just one 100g serving of shellfish, could be fatal to humans. Harmful algae blooms that

produce toxic mostly come from dinoflagellate species from the division PYRROPHYTA.

Harmful algae blooms also cause harm by shading other aquatic life. When the bloom collapses the microbial respiration on the dead and decaying cells can lead to reduce oxygen concentrations that can kill fish and other aquatic organisms due to lack of oxygen in the water. Algal blooms occur in marine, often in response to pollution due to nutrients such as phosphate and/or nitrate. This nutrient pollution can usually be traced to human activities such as discharge of effluents containing sewage or industrial wastes, or the use of agricultural fertilizers. Increases in nutrients mainly nitrate and phosphate concentrations in the water which occur after rainfall episodes can initiate harmful algae blooms. However continuous rainfall does not sustain the blooms due to a decrease in the salinity of the water. Salinity and temperature were shown not to contribute to the initiation of harmful algae blooms (Anton *et al*, 2000).

1.2 Justification for the Project

The coastal waters of Peninsular Malaysia and Sabah had several incidents of harmful algae blooms (HABs) in the past several decades and it is still occurring today. In the state of Sabah, harmful algae blooms occurred mostly in the west coast of Sabah, where the causative organism is the dinoflagellate, *Pyrodinium bahamense* var *compressum*. Blooms are occur periodically every year in Sabah and the first blooms was occurred in Kimanis Bay, Sipitang in 1976 and it has been recurring frequently since then (Anton *et al*, 2000). Red tide was reported on 6th of January 2005 in Kota Kinabalu and the causative species of the bloom was the

dinoflagellate known as *Pyrodinium bahamense* var *compressum*. Warning was given out by both Fisheries Department and Health Department of Sabah to refrain from consuming any type of shellfish or bivalves immediately. In addition, the people should also refrain from collecting shellfish and bivalves from the sea areas in the west coast of Sabah with the intention to consume these shellfish by themselves or sold to general public as food (New Sabah Times, 2005).

The UMS jetty is chosen as a research area to study the diversity and periodicity of marine harmful algae in this project. The coastal waters around the UMS jetty are used for aquaculture activities in the open sea and in the hatchery of Research Institute of Marine Borneo. It is important to study the biodiversity and periodicity of harmful algae in this area. Harmful Algal Blooms (HABs) or "red tides" were reported on 19th of July 2004 and the causative organism is the dinoflagellate, *Cochlodinium polykrikoides* and *Pyrodinium bahamense* var *compressum* in the coastal water of UMS jetty. The blooms of *C. polykrikoides* which frequent occur in the coastal waters of Korea is most harmful species to kill farmed fish in that country and have been persisted in the whole coast of the southern coast of Korea every year from August to October since 1995 (Lee *et al.*, 2001). Reports received from the Research Institute of Marine Borneo, UMS, indicated that farm fish such as tiger grouper were killed due to the blooms in this coastal water.

According to Hallegraeff (2003), about 80 species have the capacity to produce potent toxins that can find their way through fish to human. If the water which is pumped into the aquaculture tanks consist of large densities of harmful algae species which have the potential to produce toxin, it will bring negative effects to

humans if we consume the fish from the aquaculture area. Besides, fish kill in the aquaculture area due to the harmful algae blooms can cause large economic loses to the fish farmers. This incident occurred in Hong Kong on the 17 of April 1998 where the causative species for this "red tide" is a new dinofagellate species; *Karenia digitata* had invaded nearly all the coastal water of Hong Kong, including 22 of the 26 fish farms and five swimming beaches. This harmful algae bloom caused 500 tones of fishes killed and a direct economic loss of HK$ 250 million (about RM 125 million) was estimated by the fish farmers (Yang and Hodgkiss, 2003). Beside that, the bloom also caused a negative impact to the marine life and ecosystem in this area. According to Yang and Hodgkiss 2003, the "red tide" not only killed various types of caged fishes but was also reported to affect nearly all species of natural coral fish and kill some of them such as butterfly fish, were claimed to have disappeared from the area which they previously inhabited.

This project is very important to study and monitor the periodicity of harmful algae in this area. By understanding the periodicity of the harmful algae in this area, precautions can be initialed of red tides pollutant influx into the aquaculture area if the density of harmful algae is very high. Beside, warning can be alerted to all the fish farmers around the area to minimize or prevent the potential fatal effect to their farm fishes.

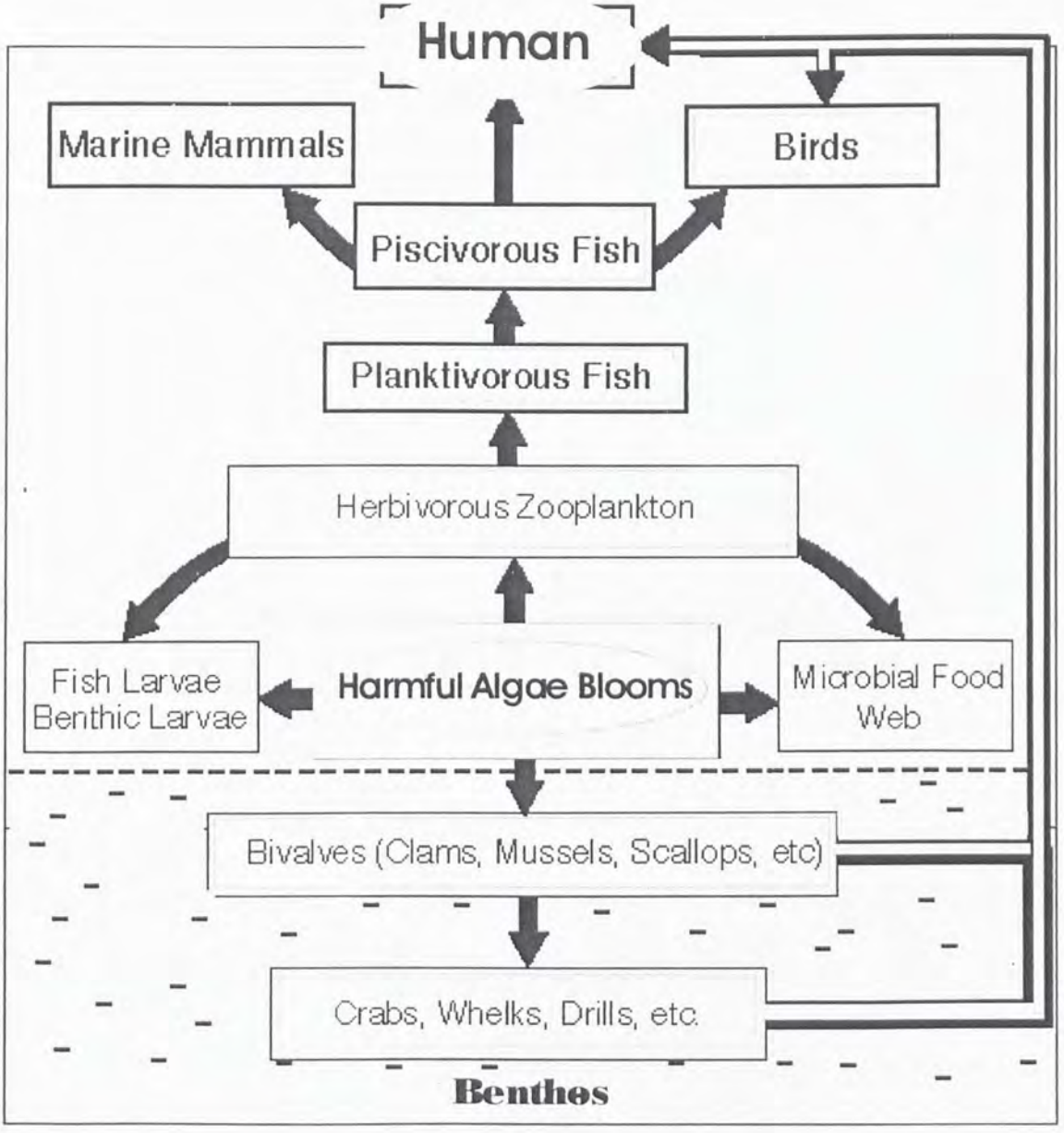

Figure 1.1: Transfer of Algal toxins through the food web to human (Modified from Anderson, 1996)

1.3 Objectives

The main objectives of this study are:

I. To study the diversity of marine harmful algae in the coastal water at the vicinity of the UMS jetty.

II. To study the periodicity of marine harmful algae in the coastal water at the vicinity of the UMS jetty.

1.4 Hypotheses

The hypotheses which will be quantitatively tested in this study are:

There is a positive correlation between the physical parameter:

a) Salinity

b) Temperature

c) Turbidity

with density of harmful algal during the study period.

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