Distribution of Dinoflagellates at Jakarta Bay, Taman Jaya, Banten, and Benoa Bay, Bali: A Report of an Incident of Fish Poisoning at Eastern Nusa Tenggara

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Introduction

"Red tide" is the name given to the phenomenon of red discolouration of marine and estuarine waters caused by a bloom of single-celled plants. The colour of the water can range from blood red to orange or brown in daylight and is often visible as phosphorescence at night (Carey 1983). Harmful red tides cause severe damage to local fishery resources, especially cultured oysters, mussels, and fish.

Some of the dinoflagellates associated with the red discolouration in coastal waters have been identified as *Noctiluca miliaris, Gymnodinium, Cochlodinium, Ceratium, Prorocentrum, Peridinium,* and *Goriyaulax.* Steidinger (1979) (as cited by Estudillo 1984) reported in her taxonomic account of toxic dinoflagellates that there are less than 20 dinoflagellate species known or thought to produce toxins. Unprecedented red tides have occurred all over the world, such as in Korean waters (Park 1982; Lee and Huh 1983). Park noted that the red tide in Jinhae Bay, Korea, due to *Gymnodinium* type 65, occurred during the period July to September 1981. Lee noted that the red tide at Jindon Bay, caused by *Ceratium furca,* occurred in August 1980. In Harima Nada, Japan, the main cause of red tides was *Chatonella antiqua* (Hada) Ono in 1977, 1978, and 1979. In each case the red tide was associated with mass fish mortality (Okaichi et al. 1981). In the Philippines, the main cause of a red tide was *Pyrodinium bahamense* var. *compressa.* Paralytic shellfish poisoning (PSP) was reported for the first time in late June to early September 1983 in Maqueda Bay of Western Samar (Estudillo 1984). In Hong Kong, red tides have been caused by *Gymnodinium* in clear water and *Trichodesmium* in offshore waters (Lam 1984). In Papua New Guinea, the major causative organism of red tides was *Pyrodinium bahamense* var. *compressa* (Maclean 1984).

In some Indonesian waters, phytoplankton populations generally consist of diatoms and dinoflagellates; diatoms are dominant, whereas dinoflagellates are very rare. Under certain conditions, however, unprecedented blooms, such as *Noctiluca* have occurred. Praseno and Adnan (1978) reported on a bloom of *Noctiluca* in May 1976 in Jakarta Bay. At that time the abundance of *Noctiluca* was 2×10^3 cells/ L.

This paper deals with an incident of fish poisoning in East Nusa Tenggara in November 1983 and the distribution of dinoflagellates in Jakarta Bay, Taman Jaya, and Benoa Bay.

Incidence of Fish Poisoning

An incident of poisoning due to ingestion of clupeid fish was reported in East Flores, the province of East Nusa Tenggara. This incident occurred on 24 November 1983 and resulted in four deaths and 191 people becoming ill. The incident began on 21 November when many fish were caught at Lewotobi, Wulanggitang, East Flores. On 24 November, after eating the fish, four people died. On 27 November, the same fish were caught by fishermen about 1 km from the previous area at Loowuran. After consuming the fish, 45 people became ill, suffering from numbness; dizziness; tingling sensations of the lips, tongue, and throat; and difficulty in breathing. The water and fish samples were identified at the National Institute of Oceanology. The fish were identified as *Sardinella* spp. and *Selaroides leptolepis.* The colour of the

water samples was similar to the colour of the contents of the gut of the fish, reddish-brown. Unfortunately, the organism responsible for discolouring the water could not be identified because of insufficient preservation. It is possible that the organism was *Pyrodinium bahamense* var. *compressa,* which has been the cause of red tides in the Philippines and in Papua New Guinea. This was the first incident recorded, however, in East Indonesia.

According to Wyrtki (1961, Plates 4 and 5), in August the surface currents flow from east to west, i.e., Pacific Ocean to Papua New Guinea to Arafura Sea to Banda Sea to Flores Sea to Java Sea to China Sea. Due to surface circulation, upwelling occurs in Arafura Sea and Banda Sea.[1]

In October, surface currents still flow from east (South Pacific) to west but the middle portion of the current moves back. From the China Sea and Pacific Ocean, currents flow through Sulu Sea down Macassar Strait to Flores Sea and some to Sawu Sea (East Nusa Tenggara).

It is thought that the red tide in East Nusa Tenggara might have been related to water movement, which could increase water enrichment. It is also thought that the cyst of *Pyrodinium bahamense* might be endemic and, given the proper conditions, would grow in most areas in Southeast Asian waters. Thus, the red tide in East Nusa Tenggara might have come from Philippine waters or Papua New Guinea: Lewotobi is located at the foot of Lewotobi mountain which faces the Sawu Sea.

From personal communications, the following incidences of red tide have been described.

(1) In a bay in Halmahera Sea, many fish were killed in July 1981. The fishermen there said that this occurs annually and is a natural phenomenon.

(2) In Jakarta Bay/Pari Island, an unusual condition occurred that caused the water to become dirty. This was due to a *Trichodesmium* bloom that took place over a large area. Prior to the bloom, the water had been calm, following rainfall in September 1982.

(3) At Kuta Beach, Bali, in November 1983, many dead fish were found along the coast. It is possible that the fish might have been thrown away by fishermen or they may have, in fact, died from other causes.

[1]Nontji (1975) described an increased plankton biomass and high rates of primary production in the region in July, August, and September due to nutrient enrichment resulting from the upwelling.

Materials and Methods

Phytoplankton samples were taken from three areas: monthly from Jakarta Bay from October 1982 to September 1983; twice from Taman Jaya, December 1983 and July 1984; and twice from Benoa Bay, Bali, June and December 1982.

The surveys were conducted using motorized boats. The phytoplankton samples were collected using a net 120 cm in length, a diameter of 31 cm, and a mesh size of 75μm. The net was towed horizontally for a duration of at least 5 min. A TSK flowmeter was used to determine the amount of water filtered through the net. Settling volume was measured after 24 hours of settlement had taken place in a 50-mL graduated cylinder. Identification and counting of cells was carried out on a fraction and poured into a "Sedgwick-Rafter Cell," which was observed under a microscope at magnification 15x10 (Davis 1955; Newel and Newel 1979; Yamaji 1966; and Wickstead 1965).

Results and Discussion

There were only four genera of dinoflagellates in Indonesian waters: *Noctiluca, Ceratium, Dinophysis,* and *Peridinium. Noctiluca* was the dominant genera, whereas *Dinophysis* and *Peridinium* were rare and even absent at many stations. The four general fluctuated in a similar manner in Jakarta Bay. The peaks of the fluctuations occurred from October to December 1982 and June to September 1983. From January to May 1983, only *Noctiluca* was found (Adnan 1984). About a mile from the shoreline, *Noctiluca* reached its highest concentration in July 1983. The concentration was 8×10^2 cells/L, nutrient concentrations were low, and temperature, salinity, and pH were relatively high. Also at this station, the following diatoms were found in high concentrations: *Skeletonema costatum,* 2.3×10^3 cells/L; *Chaetoceras* sp., 8.7×10^2 cells/L; and *Coscinodiscus,* 1.6×10^2 cells/L.

In the area where *Noctiluca* was abundant, the water was dirty and covered with small green leaves. This condition was similar to that which occured in Thai waters but was different from that which occurred in Japan and New Zealand. In Japan and New Zealand, for example, when *Noctiluca* was in bloom, the colour of the water was red (S. Sudara and T. Okaichi, personal communication, 1984). Okaichi and Sachio (1976) in their study on *Noctiluca miliaris* noted that ammonia was the principal toxin associated with red tides of *Noctiluca.* They found that the acidic extract of *N.*

miliaris was not only toxic enough to kill fish immersed in the extract but also to kill mice when injected intraperitoneally.

Five species of *Ceratium* were found in Jakarta Bay, *C. azonicum* and *C. macroceras* being the most common; the others are *C. externum, C. lineatum* and *C. imaginor* (Adnan 1984). On 21 January 1983, the concentration of *C. azonicum* was very high, 3.1 x 10^2 cells/L, whereas the concentration of *C. macroceras* was 2 x 10^2 cells/L. There was only one species of *Dinophysis* in the area, *D. homunculus,* which occurred in January 1983 in small numbers, 20 cells/L. Also, only one species of *Peridinium* was found, *P. depressum,* again in small numbers. Near the shoreline, *P. depressum* on 23 September 1983 had a concentration of 50 cells/L. Besides the dinoflagellates, *Oscillatoria* was found at all stations from October to November 1983. The highest concentration occurred in August, about 2 miles from the shoreline, 7 x 10^2 cells/L.

The phytoplankton populations in Taman Jaya were much higher than in Benoa Bay, Bali (Adnan 1984). In Taman Jaya, *Noctiluca* dominated the area. The highest concentration occurred in December 1983 near the shore, 2.7 x 10^2 cells/L. This was followed by *Thalassiothrix* sp. at 2.5 x 10^2 cells/L. The samples in December 1983 and July 1984 also contained large quantities of *Rhizosolenia* and *Chaetoceros.* In Benoa Bay, the samples also contained these except *Rhizosolenia,* but additionally contained *Streptotheca, Coscinodiscus, Ceratium, Nitzschia, Bacillaria* and *Hemialus.* The abundance of phytoplankton in Benoa Bay was greater in December 1982 than June 1982.

Conclusions and Suggestions

Dinoflagellates in Jakarta Bay, Taman Jaya, and Benoa Bay, Bali, in general, showed the usual species composition. There was no evidence of a red tide.

In East Nusa Tenggara, East Indonesian waters, in November 1983, an unprecedented event occurred, namely fish poisoning, which killed four people. It is hoped, therefore, that a research project can be carried out to study the occurrence of red tides and PSP in eastern Indonesian waters.

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