HARMFUL ALGAL BLOOM OCCURRENCE IN MURCIELAGOS BAY AMIDST CLIMATE CHANGE

J. Aquino[1], B. Flores[2] and M. Naguit[3]

Date Submitted: March, 2010
Date Revised: April, 2010
Word Count: 2, 362

Abstract

The phytoplankton species abundance in Murceilagos Bay was investigated for the first time at the onset of an outbreak on September, 2009. Monthly monitoring on Pyrodinium bahamense var. compressum densities and physic-chemical parameters were carried out on 12 sampling stations in Murceilagos Bay. In general, densities of Pyrodinium bahamense var. compressum were decreasing. Nutrient analyses showed traces of phosphates and nitrates.

Keywords: *Phytoplankton, Hydrobiological surveys, Density, ENSO, Cove, Toxic Algal Bloom*

Introduction

Practically every coastal country worldwide is affected by harmful algal blooms (HABs, commonly called “red tides”). This phenomenon comprises blooms of toxic, microscopic algae that direct to illness and death in fish, humans, marine mammals, seabirds, and other oceanic life. There are also non-toxic HABs that cause damage to ecosystems, fisheries resources, and recreational facilities. The term “HAB” also pertains to non-toxic macroalgae (seaweeds) that can cause major environmental impacts such as habitat alteration, the displacement of indigenous species and oxygen depletion in bottom waters.

Several decades ago, relatively few countries were affected by HABs, but now most coastal countries are threatened, in many cases over large geographic areas and by more than one harmful or toxic species (Anderson, 1989; Hallegraeff 1993). The causes behind this expansion are deliberated, with possible explanations ranging from natural mechanisms of species dispersal and enhancement (e.g., climate change) to a host of human-related phenomena such as pollution-related nutrient enrichment, climatic shifts, or transport of algal species via ship ballast water (Anderson, 1989; Smayda, 1989; Hallegraeff, 1993). Suchlike the reasons, coastal regions all over the

[1] *Jose Rizal Memorial State University – Katipunan Campus, Katipunan, Zamboanga del Norte*
[2] *Jose Rizal Memorial State University – Main Campus, Dapitan City*
[3] *Jose Rizal Memorial State University – Katipunan Campus, Katipunan, Zamboanga del Norte*

world are now area under discussion to an unprecedented multiplicity and frequency of HAB events.

According to Anderson (1989), Smayda (1990) and Hallegraeff (1993), in recent years, a dramatic expansion in the areas affected by PSP toxins has occurred throughout the world. A similar pattern applies to many of the other HAB types. Disagreement only arises with respect to the reasons for this expansion.Many have implicated that pollution or other human activities are involved, and this is indeed a factor in some areas, however, many of the "new" or expanded HAB problems have occurred in waters where pollution is not an obvious factor. The organisms accountable for HABs have been on earth for thousands or even millions of years, through which time they had abundant opportunities to disband, backed by the movement of tectonic plates, changing climate and other global changes.

In the Philippines, algal blooms have been reported since 1908. The first recorded occurrence of blooms of *Pyrodinium bahamense var. compressum*, a toxin-producing dinoflagellate was in 1983 in central Philippines, (Estudillo and Gonzales, 1984). In fact, harmful algal blooms in the country, predominantly Pyrodinium have lengthened both in time and space (Bajarias and Relox, 1996; Corrales and Gomez,1990). Blooms of *Pyrodinium* spread to around 22 coastal areas of the country. Paralytic shellfish poisoning due to *Pyrodinium* has increased in severity during the last two decades. The country has experienced more than 40 outbreaks of harmful algal blooms between 1983 and 2002 with successive shellfish poisoning episodes. However, most of the blooms have not been documented. Narrative of local folks of water discoloration in the remote coastal areas of the country abound, however, have not been validated and documented due to the archipelagic nature of the country with more than 7,100 islands and the lack of resources to monitor all the coastal waters.

According to Andersen (2000), HAB incidence in the country has been associated to flash flooding and unpredictable storm events as an upshot of climate change which modifies the phytoplankton community composition. During heavy rainfall, flashfloods occur in which dissolved phosphate and nitrate flows to the bay through creeks. An example is typhoon "Bebeng" that hit the Philippines in _ which triggered the HAB growth due to effluents of industrial and agricultural wastes and helped in spreading the *Pyrodinium* bloom along the 70 km stretch of Western Samar Coastline from Villareal to Gandara Island (Estudillo and Gonzales, 1984; Furio, 2004). Moreover, Usup, *et al.* (2000) observed that algal blooms usually occurred in early Southwest Monsoon while highest densities in the sediment during the Northeast Monsoon suggesting that there is a strong relationship between *P. bahamense* blooms and local weather events. The bloom of *Pyrodinium bahamense var. compressum* has also been correlated with higher surface temperatures and salinities (Abuso *et.al.*, 2000). Bajarias and Relox (1996) and Furio (2004) coined the blooms of toxic *Pyrodinium* to follow the intense warm temperature sequence and heavy rainfall akin to blooms in Manila Bay that transpired at the inception of the rainy season following a long dry period. As more research studies are considered in this view, it is evident that these meteorological events may modify the physical and chemical properties of the water column leading to the blooms of *P. bahamense* especially now that the climate is changing from the normal occurrence.

Recently, Paralytic Shellfish Poisoning had been declared in the municipality of Rizal, Zamboanga del Norte and nearby barangay of Sapang Dalaga, Misamis Occidental after ten persons landed in the hospital consuming boiled oyster (scientific name) locally known as "*Tagnipis*", with two died due to respiratory failure. The oyster was revealed to have been collected from Murcielagos Bay. Subsequent to the event, phytoplankton analysis of the seawater exposed a very high calculation of *Pyrodinium bahamense* signifying a bloom of the species, the first time ever documented in Zamboanga del Norte.

Murcielagos Bay is located in the northeastern side of Zamboanga del Norte (Figure 1). It is approximately 52 square kilometers with total water area of 7854.78 ha (78.5 sq.km) and 312.04 ha of islands. It has three major marine ecosystems, sea grass (2674.96 ha), mangroves (785.48 ha) and (27 ha) of marine sanctuary. Revealed in the inventory of surface water sources is that the coastal area has 25 river systems draining into Murcielagos Bay of which Dioyo river of Sapang Dalaga is the focal tributary. Three fourths of the bay is shallow and its shoreline is subjugated by a mud-covered substrate lined with patches of mangroves around its pedestal. Depth of the water ranges from 0.5-30m in the shallow sea and 120m in deep water portion. The Bay has been acknowledged as a well-off fishing ground and supposed to be one of the most diversified bays in Mindanao (Microsoft Encarta, 2007). Majority of the inhabitants in the coastal barangays engaged in fishing and collecting shells as their means of livelihood. Historical trends of the Bay show that in 1940's to 1970's, it is rich in fishery resources. Diverse commercial fish were abundant as well as shells, crabs, squids, octopus and prawns. As the major source of protein, shellfish have been a component of each household dish to local folks and people of Zamboanga del Norte.

Nowadays, mounting evidence links climate change to HAB. Recent studies showed that dinoflagellate blooms will increase due to increased temperature and salinity stratification resulting from climate change. This paper assessed the present state of Murcielagos Bay to determine what activated the harmful algal bloom particularly in the coastal areas of Sibutad and Rizal, Zamboanga del Norte.

Methodology

Sampling. Plankton analyses were collected by suspended vertical tow plankton net of 20 μm mesh size at a depth of 1m. Using electric compound microscope with a sedgewick-rafter counting chamber, plankton identification and counting were conducted at JRMSU lab.

The cell density was calculated using the following formula:

$$D\ (\text{cells/L}) = \frac{N.V_1}{}$$

V_S

Where: N = Number of cells in 1mL sample (average of two trials)

V_1 = Total volume of the plankton sample (mL)

V_S = Volume of the sea water filtered by plankton net within hauling depth (mL)

Physico-chemical parameters were also monitored during each survey. Temperature readings from predetermined depths were obtained using thermometer. Secondary data on air temperature and rainfall were also obtained from PAGASA office for comparison. Salinity and dissolved oxygen were also measured using the handheld refractometer and DO meter respectively. In addition, water samples meant for phosphate and nitrate analyses were collected and brought to Silliman University, Dumaguete City.

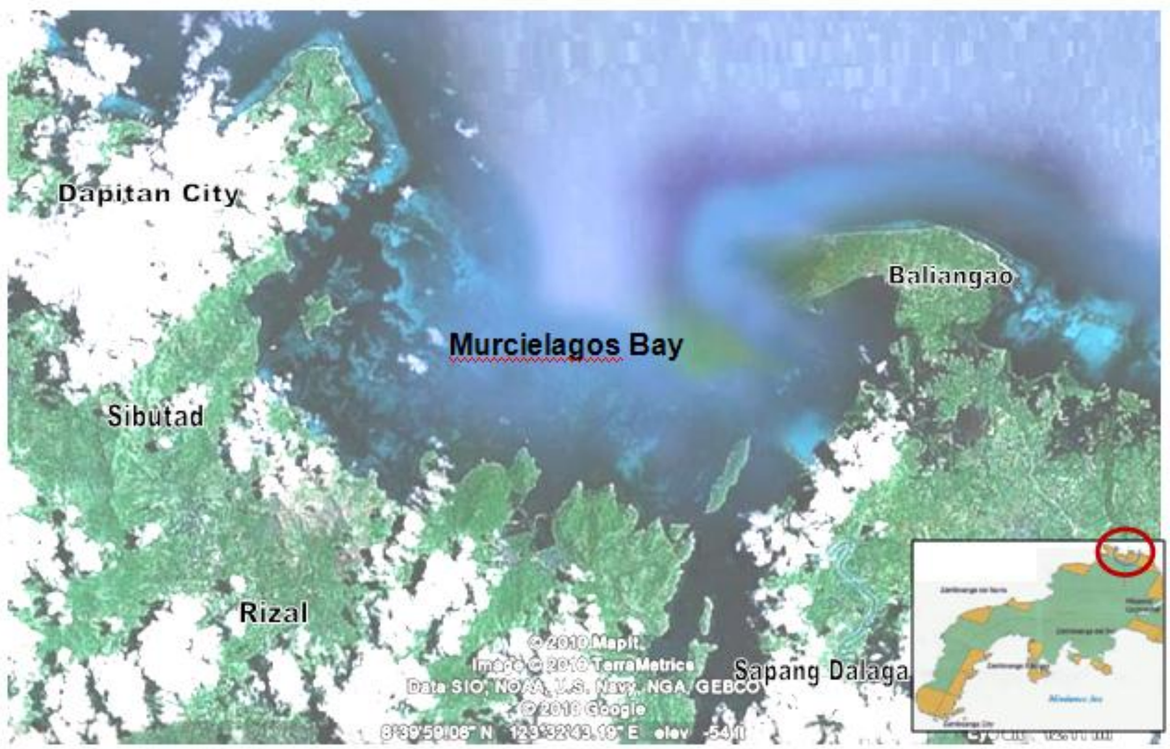


Figure 1. The Murcielagos Bay. Inset is the map of Zamboanga del Norte.

Results

A bloom of *Pyrodinium bahamense* occurred in Murcielagos Bay on September 2009 particularly in Barangay Damasing which resulted to a paralytic shellfish poisoning of eight persons who have eaten an oyster species locally known as *Tagnipis* which were collected from the Bay (BFAR Shellfish Bulletin, May 2010). Based on the report of the Bureau of Fisheries and Aquatic Resources, "Tagnipis" oyster had the highest toxin level of 2746 ug/100g shellfish meat (Appendix A). Hence, BFAR declared that shellfish from Murcielagos Bay was unfit for human consumption up to this writing (BFAR Shellfish Bulletin, May, 2010).

This paper presents the *Pyrodinium bahamense* concentration (cell densities) from October 2009 which was after the outbreak till May 2010. As shown in Figure 2, Damasing area had the highest cell density in October, 2009 at 11,000 cells/L, followed by Nangka area. The cells were forming chains numbering from 2-22 cells per chain. On the other hand, densities crashed to as low as 1-5 cells/L commencing November 2009 till May 2010, excluding Sawang in November and Calubi and Nangca in May 2010.

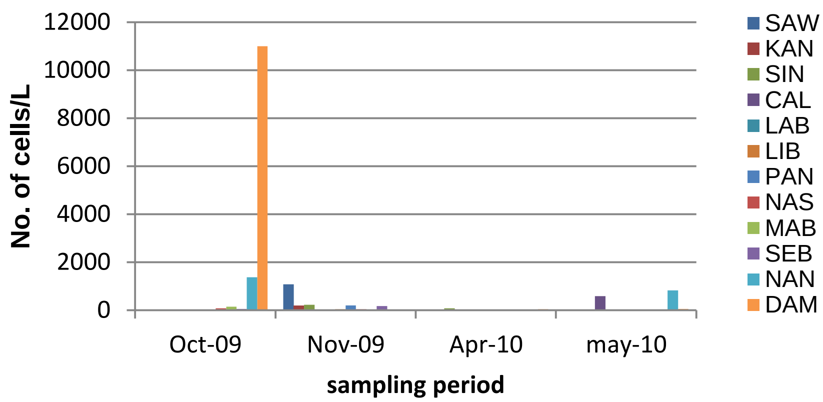


Figure 2. Densities of *Pyrodinium bahamense var.compressum* from October 2009 to April 2010.

Figures 3 and 4 present the average temperature and salinity during the HAB event. The water temperature ranged from 30°C to 32°C while the salinity ranged from 30 ppt to 35 ppt. Phosphates and nitrates were <0.01-0.08 mg/L and from 0.012-0.127 mg/L, respectively (Table1). Concentrations were below (10-15 mg/L NO_3-N; 0.5-5 mg/L PO_4) the DENR Administrative Order 2008 Water Quality Guidelines and General Effluent Standards.

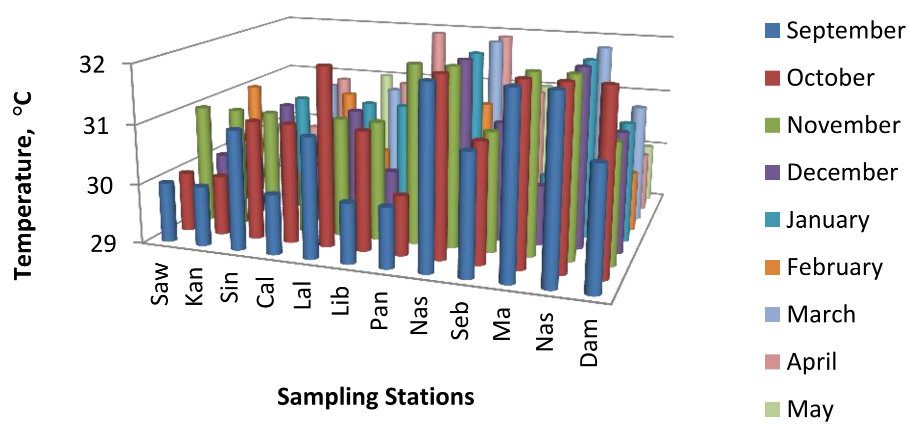


Figure 3. The Temperature (˚C) values of Murcielagos Bay obtained from September 2009 – May 2010. Legend: Sa-Sawang, Ka-Kanim, Si-Sinipay, Ca-Calubi, La-Lalab, Li-

Libay, Pa-Panganoran, Se-Sebaka, Na-Nasipang, Ma-Mabunao, Na-Nangka, Da-Damasing.

Discussion and Conclusion

Since the outbreak in September 23, 2009, densities of vegetative *P. bahamense* continued to be highest in October, 2009 and dropped beginning November 2009. Meteorological data on temperature and rainfall in Zamboanga del Norte from 2007 to 2009 (Figures 5a & 5b) revealed a decreasing trend in air temperature. There was a significant dropped of 1.22 ºC in the average annual temperature in 2009 (Figure 5, error bars).

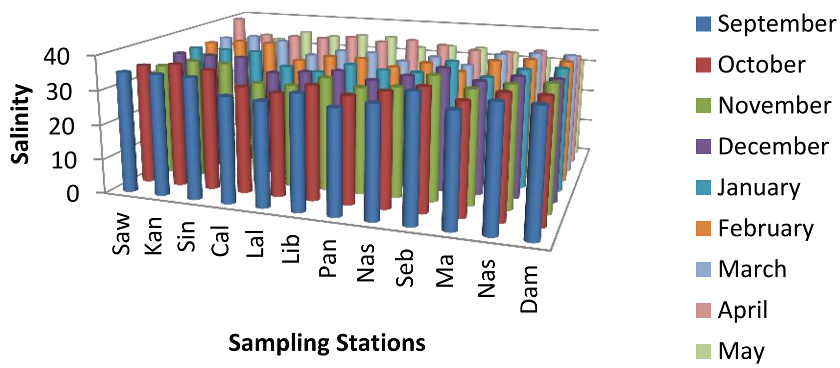


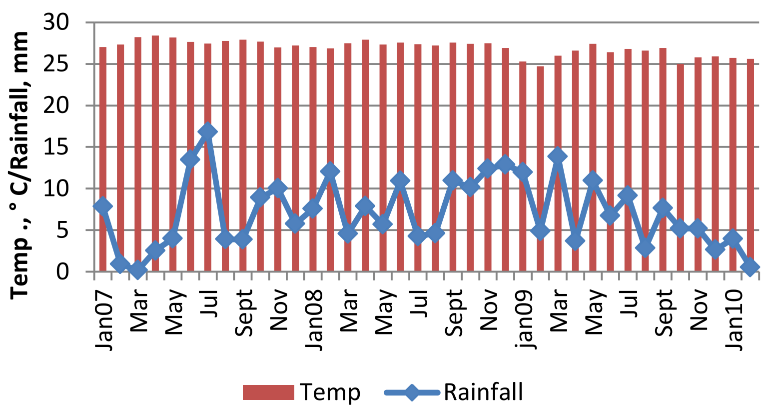
Figure 4. The Salinity (ppt) Values of Murcielagos Bay obtained from September 2009 – May 2010. Legend: Sa-Sawang, Ka-Kanim, Si-Sinipay, Ca-Calubi, La-Lalab, Li-Libay, Pa-Panganoran, Na-Nasipang, Se-Sebaka, Ma-Mabunao, Na-Nangka, Da-Damasing.

Table 1. Phosphate and nitrate content in selected sampling stations as of April 2010.

	Tot weight of NO3-N/L (mg)	Tot weight of PO4-P/L (mg)
Damasing	0.127	0.01
Sebaca	0.012	<0.01
Calube	0.032	0.08
Lalab	0.144	<0.01
Libay	0.029	<0.01
Nanca	0.022	<0.01

Rainfall was higher in 2008 compared in 2007 and 2009. Generally, rainfall was minimal from January to September 2009 with August as the lowest. As observed, the month (August 2009) prior to the outbreak had a very minimal rainfall followed by an increased rainfall brought about by typhoon Ondoy. This contested to the observation of Bajarias and Relox (1996) and Furio (2004) in which blooms of toxic *Pyrodinium* track the intense warm temperature sequence and heavy rainfall like blooms in Manila Bay that happened at the inception of the rainy season subsequent to a long dry period.

a) Monthly temperature and rainfall



b) Average annual temperature and rainfall

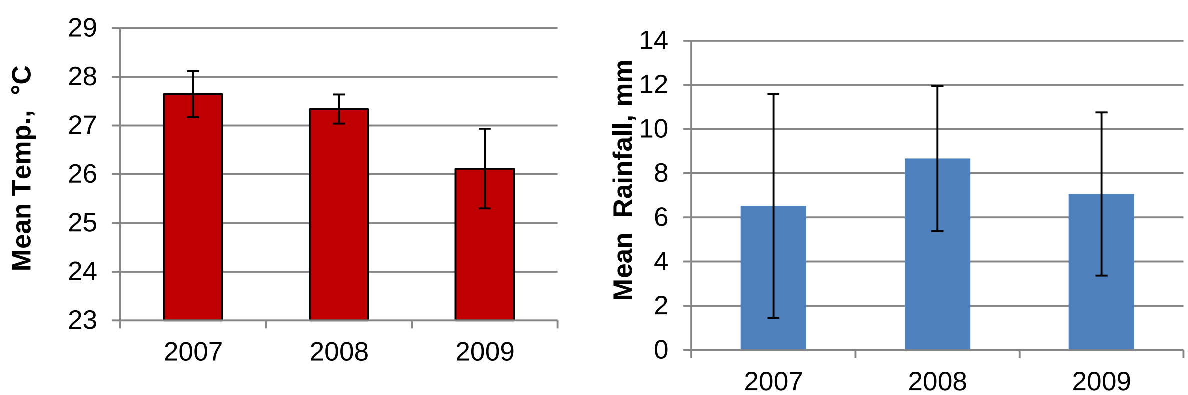


Figure 5. Monthly (a) and mean annual (b) rainfall and air surface temperature taken from 2007- January 2010 (PAGASA).

Moreover, it should be noted that September and October were also the southwest monsoon months (June to October). This implies that the outbreak of *Pyrodinium bahamense var.compressum* in Rizal, Zamboanga del Norte in late September 2009 could also be attributed to the local weather events. Usup, *et al*. (2000) observed that algal blooms usually occurred in early Southwest Monsoon while highest densities in the sediment during the Northeast Monsoon suggesting that there is a strong relationship between *P. bahamense* blooms. Hence, the combined effects of typhoon and local weather events as influenced indirectly by the global changing climate affected the physico-chemical conditions of the coastal waters of Rizal and Sibutad, Zamboanga del Norte triggered the harmful algal bloom of *Pyrodinium bahamense var.compressum*.

References

Abuso, Zenaida V. , Leah Mora T. Cabella and Luisa C. Tuazon. 2001.Red Tide Monitoring in Maqueda and Villareal Bays Samar, Central Philippines ASEAN Marine Environmental Proceedings of the Fourth ASEAN-CANADA Technical Conference On Marine Science.

Andersen, D. M. 2000.Monitoring and Management Strategies For Harmful Algal Blooms In Coastal Waters Asia Pacific Economic Program, Singapore and Intergovernmental Oceanographic Commission Technical Series No. 59.

________________. 2000. Physiological Ecology of Harmful Algal Blooms. Springer-Verlag Berlin Heidelberg New York.

Bajarias, Fe Farida A. 2001. Distribution of Marine Dinoflagellates in the Philippines ASEAN Marine Environmental Proceedings of the Fourth ASEAN-CANADA Technical Conference on Marine Science.

Borja, Valeriano M. and Elsa F. Furio. 2004. Collection of Samples for Paralytic Shellfish Poisoning Monitoring Practical Guide On Paralytic Shellfish Poisoning Monitoring in the Philippines.

Deauna, Melecio C. and Salvacion Lindio Dorado. 1999. Environmental Science for Philippine Schools Phoenix Publishing House, Inc.

DENR Administrative Order 2008 – XX. Water Quality Guidelines and General Effluent Standards.

Fulgueras, Virgilio P. Elsa F. Furio and Valeriano M.Borja. 2004. Biological And Ecological Nature of Paralytic Shellfish Poisoning Causative Dinoflagellates Practical Guide on Paralytic Shellfish Poisoning Monitoring in the Philippines Revised Edition.

Furio, Elsa F. and Cielito L. Gonzales. 2004. Toxic Red Tide and Paralytic Shellfish Poisoning Profiles In the Philippines Practical Guide On Paralytic Shellfish Poisoning Monitoring In The Philippines Revised Edition,.

Microsoft Encarta. 2007 Murcielagos Bay, Philippines. New York: Microsoft Incorporated.

Microsoft Encarta. 2009. Climate Change, Philippines. New York: Microsoft Incorporated.

Michael, David & Amit, Pandya. 2010 Coastal Zones and Climate Change. Oceanographic Commission Technical Series.

Montojo,Ulyses, Norvida L. Cruz , Mirriam A. Formeloza and Dennis N. Candia. 2004 Chemical and Pharmacological Properties Of Paralytic Shellfish Toxins Practical Guide On Paralytic Shellfish Poisoning Monitoring In The Philippines Revised Edition.

Odum, Eugene P. Fundamentals of Ecology. Saunders International Student Edition.

Relox, Jun R. Jr. 2004Plankton Analysis Practical Guide On Paralytic Shellfish Poisoning Monitoring In the Philippines Revised Edition.

Relox, Juan R.,Jr. and F. Farida A. Bajarias. Harmful algal blooms (habs) in the Philippines.

Usup, Gires and Rhodora V. Azanza. 2000.Physiology and Bloom Dynamics of the Tropical Dinoflagellate, *Pyrodinium bahamense var. compressum* www. Wikipedia.org. com/Bivalves