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Biotoxins in the Pacific Coast of Mexico

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ABSTRACT

Harmful phytoplankton blooms have made their impact in Mexico's fishery industry in recent years. In general, it has been concluded that all such events are of natural causes and seldom attributed to human activity or pollution. In this report we describe the nature of the toxins detected and identified in the Pacific coast of Mexico during the last 15 years.

1. INTRODUCTION

Mexico possesses a considerable coastline and is privilegiously located, influenced by ocean currents that determine its wide variety of climates and regions. Ancient reports about natives traditions related to the consumption of shellfish reveal that specially at the beginning of each year, the Indiäns avoided the consumption of such kind of sea food (Alvar Nuñez Cabeza de Vaca, XVI Century). Recent studies about "red tides" in the Pacific of Mexico include that of Cortés-Altamirano and Nuñez-Pastén (1992), which covers a 12 year follow up of "red tides" events at Mazatlán Bay, Sin., and also of Blasco (1977), who describes the most predominant dinoflagellates on the Baja California Peninsula. In the first report, the authors associate the "red tides" at Mazatlán Bay mostly with *Mesodinium rubrum,* which is considered as a non-toxic species, and *Gymnodinium catenatum,* and *Gonyaulax monilata* (currently *Alexandrium*

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monilatum) which produce the paralyzing shellfish poisoning syndrome, or Paralitic Shellfish Poisoning (PSP). According to these authors, 28 intoxication cases with three deceased, were recorded in two episodes. Yet, one of the most important "red tide" events produced *by Gymnodinium catenatum* in Mazatlán was recorded on April 1979, in which during 4 days an extensive fish kill occurred while 18 people were hospitalized with PSP symptoms (Mee *et al.*, 1986).

Mazatlán keeps suffering the attacks of harmful algal blooms and annually about 5 different "red tide" events are observed, in particular from January throughout May. In general, a succession of different organisms determine the nature and level of the toxicity in the area, most commonly *Mesodinium rubrum* appears first followed by *Protoperidinium* sp. and *Gymnodinium catenatum;* finally, sometimes the appearance *of Prorocentrum dentatum* closes the cycle. Cell densities can be as high as 31x 10^6 cells/L and, as pointed above, they often are related to PSP and Diarrheic Shellfish Poisoning (DSP) cases. The duration of a "red tide" event can be from few hours up to several days, and/or weeks, and the toxic contamination, as determined by the toxicity of shellfish, can last even months.

Blasco (1977), on the other hand, describes *Gonyaulax polyedra, Ceratium furca, Prorocentrum micans, Ceratium dens, Gonyaulax digitale* and *Gymnodinium* sp. as the main components of the dinoflagellate population on the "red tides" events observed at the West coast of the Baja California Peninsula on 1972. Another observation of a wide-spread "red tide" event was registered for Tortugas Bay on 1991 (Turrubiates-Morales, 1992). This time, however, *Gymnodinium sanguineum* was the predominant species, with cell densities higher than 860,000 cells/L at the major concentration site. The maximum toxicity levels detected in shellfish samples collected before the peak season was 36 µg of PSP/100 g of tissue, as determined by the mouse bioassay. Interestingly, during the peak toxicity, the absence of fish and sea birds in the area was notorious, and only one fish was incidentally found on the beach with evident symptoms of intoxication and its gills profusely invaded by the dinoflagellate.

On December 1989, at Oaxaca, a number of intoxications (in total 99 cases with 3 deceased) was the outcome of eating clams and oysters collected at Salina Cruz harbor. Previously, some dead fish and turtles were found on the beach and a great "red tide" spot that covered more than 800 km along the coastline was observed. Sea water analysis revealed large concentrations *of Gymnodinium catenatum* and the shellfish meat analysis revealed toxicity levels of 2-3,000 MU/l00g of tissue equivalent to 380-570 µg of STX/100 g of tissue (Saldate-Casteñeda *et al.*, 1991). Oaxaca, as Mazatlán, appears as a focus of "red tide" induction, or distribution, and at least one important event is experienced every year. On 1994, *Gymnodinium* sp. and *Gonyaulax* sp. were considered responsible of the toxicity levels of shellfish during March-April, which was 55-64 µg of STX/100 g of shellfish tissue, considered under the limit of the

toxicity declared by the Health authorities as maximum permissible (80 μg STX/100 g tissue) before adopting control measurements.

Finally, in early 1995 a large number of dolphins, whales, and sea birds appeared dead in the Northern part of the Gulf of California (PROFEPA, Mexico, 1995). A multi-institutional task force was organized trying to elucidate the cause, however this was never established. Among the hypothesis handled by the task force it was considered the involvement of a "red tide" event and, actually, some remains *of Noctilluca scintillans* and *of Phaeocystis* sp. were isolated from the area. In spite of being such species often associated with "red tides" phenomena in the area, no effort was done in detecting such organisms, or its toxins, in the dead animals.

The following is an excerpt of recent studies carried out by our group at the Center of Biological Research, CIBNOR, located in La Paz, Baja California, Mexico, and is complemented with the findings and observations of the recent "red tide" episode observed in Acapulco, Guerrero, Mexico, on late 1995. Altogether, these observations illustrate the actual situation on the environmental impact that harmful algal blooms are having on the Pacific coast of the country.

2. METHODOLOGY

Mouse Bioassay using AOAC (1984) technique and HPLC toxin analysis was always done following the recommendations of the IOC-UNEP-WHO-FAO report (1994). Animals were handled according to UFAW guidelines (1976). All chemicals and standards were of the highest purity and obtained from several commercial sources.

3. RESULTS AND DISCUSSION

Our group started to study the impact of "red tides" 5 years ago, when a massive death of clams was observed at Conception Bay, on the East coast of the Baja California Peninsula (Fig. 1). Monitoring during 1992-1994 (Sierra-Beltrán *et al.,* 1996), enabled us to conclude that harmful algal blooms are common in the area and show annual periodicity, being specially important, and recurrent, during the winter and early spring season (Fig. 2.). Toxic *Prorocentrum* sp. and *Alexandrium* sp. organisms were isolated as the main components of the dinoflagellate population in this case, which led the mollusks to show toxicity indexes as high as 2,400 MU per 100 g of tissue. The pattern variation of the cell density of these organism followed the same trend than the toxicity (Fig. 2), and the nature of the toxicity was confirmed by HPLC as

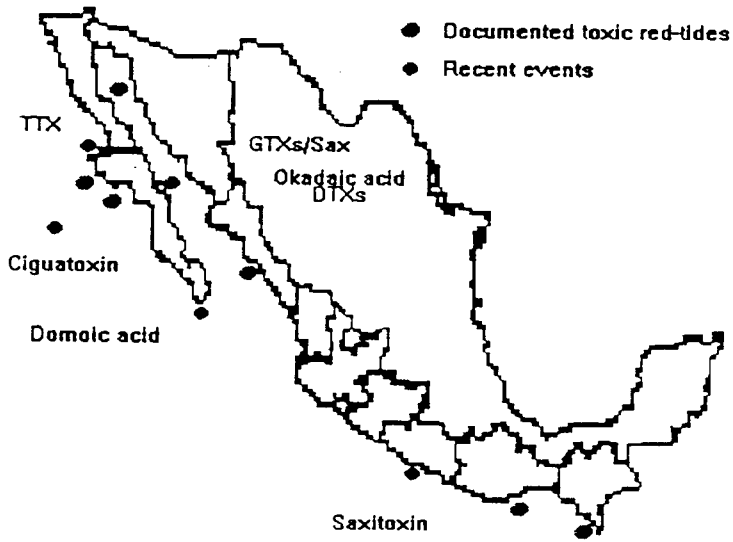

Figure 1. Documented toxic events on the Pacific coastline of México.

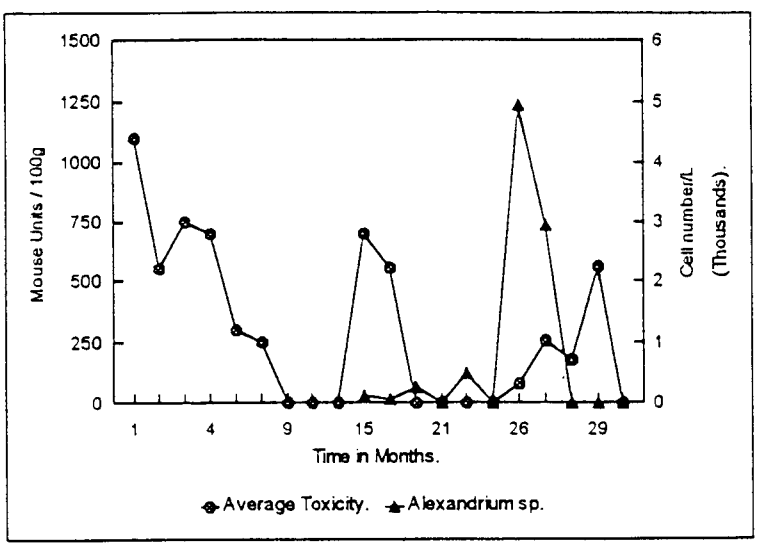

Figure 2. Periodicity of Toxicity and *Alexandrium* sp. blooms at Conceptions Bay, 1992-1994.

Saxitoxin and Gonyautoxin derivatives. Yet, and in spite of all these findings, the reason of the massive death of clams at Conception Bay in that year remains unclear.

Ciguatoxin was documented for the first time at Alijos Rocks, Mexico (24° 57' N, 115° 45' W) 300 miles off Magdalena Bay, at the West coast of the Baja California Peninsula (Lechuga-Deveze and Sierra-Beltrán, 1995). The intoxicated crew of a fishing boat showed all the symptoms of ciguatera and the mouse bioassay carried out with fresh fish fillet *(Serranidae* and *Labridae)* also confirmed the presence of a ciguatoxin-like compound. Yet, no final identification of the nature of the toxin, nor the isolation of causative organisms was achieved. Noteworthy is the report of Parrilla-Cerrillo *et al.* (1993) that describes a total of 200 intoxication cases with ciguatera in the State of Baja California Sur on 1984 alone, after consuming contaminated pargo *(Lutjanus* sp.).

In spring 1995, two people died as a result of eating puffer fish fillet at the Vizcaino Desert in the Southern State of Baja California, Mexico. Although we were unable to obtain samples from either the corpse autopsy or from the fish, we presume the origin and nature of the toxin as being Tetrodotoxin, TTX, assuming that the identification of the eaten fish was correct. Symptoms shown by the victims also suggest the ingest of TTX, and the incident should call the attention of the health authorities to delete from their list of edible fish species the one involved in such fatal cases. We have enough evidence about the toxicity of different species of puffer fish in the zone, which include *Sphaeroides annulatus, S. lobatus, Arothron meleagris, Lagocephalus laevigatus,* and *Canthigaster punctatissima.* Noteworthy is the finding that not only the fish liver and viscera are sites for concentrating the toxin, but also the flesh and tissues of some species show important amounts of TTX, therefore they should not be considered edible species (Manuscript in preparation).

In late October 1995, Acapulco Health authorities reported still another widespread "red tide" event at the South of the Pacific coast of Mexico (Colmenares and Barradas, 1996). The first shellfish samples analyzed indicated a toxin concentration from 63-138 μg of STX/100 g of tissue and they were linked with 52 cases of human intoxications. Later, samples with as much 3,091 μg of STX/100 g of tissue, were detected (Fig. 3). As the event progressed a total of 193 cases of intoxication and 3 human casualties were reported. Emergency control measurements were applied, such as the prohibition of shellfish collection and consumption, from November 17 throughout December 17. No new intoxication cases were reported, although a toxicity increment was noticed again from December 4 throughout December 19. This illustrates the effectiveness of the control measures adopted by the Health Ministry authorities. HPLC and water samples analysis concluded that the nature of toxin corresponded to STX and Neo-STX, and that the causative organism was again *Pyrodinium bahamense*, which has been already associated with a number of human intoxications (99) and casualties (3) on 1989 in Oaxaca

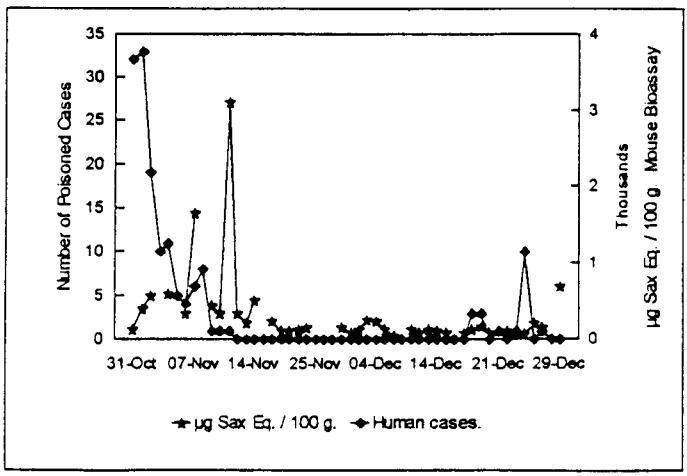

Figure 3. Toxin levels and poisoned cases during Acapulco's 1995 red tide.

(Corés-Altamirano *et al.*, 1993) and 187 intoxicated individuals and 26 deceased on 1987 in Guatemala (Velásquez-Recino, 1993).

At the beginning of 1996, more than 150 brown pelicans died as a result of feeding on mackerel fish *(Scomber japonicum)* contaminated with the toxic diatom *Pseudonitzchia* sp., a species producing Domoic Acid, at the tip of the Baja California Peninsula (Sierra-Beltrán *et al.*, 1997). The nature of the toxin, Domoic acid, was confirmed using the corresponding standard by HPLC (Quilliam *et al.*, 1989) and by the scratching characteristic response of the mousse bioassay (IOC Manual for Amnesic Shellfish Poisoning, 1995). Thus, for the first time mackerel fish may be included in the list of edible fish which can play a role as a toxicity vector, and a Domoic acid warning should be announced for the Baja California Peninsula.

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