

Paralytic Shellfish Poisoning Outbreaks in Costa Rica

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Abstract

Paralytic shellfish poisoning (PSP) outbreaks have increased in frequency and intensity over the last few years along the Pacific coast of Costa Rica. In 1999 and 2000, a harmful algal bloom dominated by *Pyrodinium bahamense* var. *compressum* ([Böhm] Steidinger, Tester, and Taylor) and *Gymnodinium catenatum* Graham 1943 affected the health of over 70 people. An episode of this magnitude had not been detected in over 20 years. The mollusk *Spondylus calcifer* Carpenter exhibited maximum levels of toxicity as determined by mouse bioassay. The bloom spread throughout the 1200 km-length Pacific coast of the country. Costa Rica's current phycotoxins monitoring program only takes into account PSP toxins in shellfish; however, the phytoplankton community is very diverse and includes a long list of potentially toxic phytoplankton species, such as *P. bahamense* var. *compressum*, *Gymnodinium catenatum*, *Alexandrium monilatum* Howell, *A. catenella* Whedon and Kofoid, *Protoceratium reticulatum* Claparède and Lachmann, *Prorocentrum lima* Ehrenberg, *Dinophysis caudata* Saville-Kent 1881, *D. mitra*, *Phalacroma rotundatum* Claparède and Lachmann and *Pseudo-nitzschia* spp. It is important to incorporate the detection of other phycotoxins, such as domoic acid and lipophilic toxins, into the current monitoring program.

Introduction

Costa Rica (10°N, 85°W) is a developing Central American country with a territorial extent of only 51,331 km² and coasts along the Caribbean Sea and the Pacific Ocean. The upper Gulf of Nicoya (Pacific Coast) is highly productive with 68% of the coastline covered by mangrove forests (Vargas, 1996; Gocke *et al.*, 2001). This gulf is one of the most important ecosystems for artisanal fishing and sustains approximately 600 families.

Among the species of mollusks commercially exploited in this region are the bivalves *Spondylus calcifer*, *Pinctada mazatlanica*, *Anadara tuberculosa*, and *Mytella guyanensis*. One hundred percent of their harvesting is carried out in natural areas of Costa Rica because there are no aquaculture projects to produce these species.

Towards the end of 1999 a toxic microalgal bloom was detected, thus obligating the government to ban the harvesting of bivalves along the central Pacific coast of Costa Rica. Unfortunately, this bloom was followed by other episodes that extended the ban by more than two years and practically included the entire Pacific coastline of the country. This situation had very important economic and social impacts. The extension of the closed season drastically affected the income of those lower income families who are dependent on the fisheries. With respect to public health, close to 70 cases of PSP were recorded, with at least six fatalities and some other victims who required hospitalization.

Because of consecutive blooms, the harvest ban was prolonged. However, the data suggest that the harmful algal bloom (HAB) events were an interrupted sequence of incidents, some of which overlapped in time and some of which showed a diversity of dominant toxic species.

The first HAB report in Costa Rica was in 1981 (Hargraves and Viquez, 1981) and was followed by Viquez and Hargraves (1995). There were no further reports until this present communication on the principal toxic phytoplankton species observed during the years 1999–2002 in the Gulf of Nicoya, Costa Rica.

Materials and Methods

Samples of phytoplankton present in the HABs that occurred from 1999–2002 were collected from the Gulf of Nicoya, central Pacific coast (10°00'N, 85°00'W), during both the rainy season (July–November) and the beginning of the dry season (December–June). Samples were obtained using a phytoplankton net (20 µm) and by a vertical Niskin bottle (1-liter) to collect surface water and water at five meters depth. Cells were enumerated with a Sedgwick-Rafter counting chamber. The samples were fixed with a modified Karnovsky solution (Karnovsky, 1965) consisting of 2.5% glutaraldehyde and 2% paraformaldehyde in sodium cacodylate buffer (0.1 M). After the samples were preserved, light and scanning electron microscopy were used for taxonomic identification.

Results and Discussion

Towards the end of 1999, *P. bahamense* var. *bahamense* (Fig. 1A) and *P. bahamense* var. *compressum* (Fig. 1B) blooms were observed, with the dinoflagellate *Gymnodinium catenatum* appearing later (Fig. 1C). Subsequently, as the concentration of *G. catenatum* declined, the concentration of the *Pyrodinium* varieties increased along with the concentration of the dinoflagellates *Ceratium dens*, *C. furca* and *C. fusus* (Fig. 1D). For several months, all of these species coexisted in the same bloom. A bloom dominated by the cyanobacterium *Trichodesmium erythraeum* was later observed, followed by a *Cochlodinium* cf. *polykrikoides* bloom (Figs. 1E,F).

In other areas of the gulf, an increase was observed in the concentration of the other species listed in Table 1.

During the period studied, concentrations of 10–60 cells per mL were determined in some species. The most significant species were *Dinophysis caudata*, *P. bahamense* var. *compressum*, and *P. bahamense* var. *bahamense*, *Gymnodinium catenatum*, *Pseudo-nitzschia* spp., *Noctiluca scintillans*, *Prorocentrum micans*, *Ceratium dens* and *Cochlodinium* cf. *polykrikoides*.

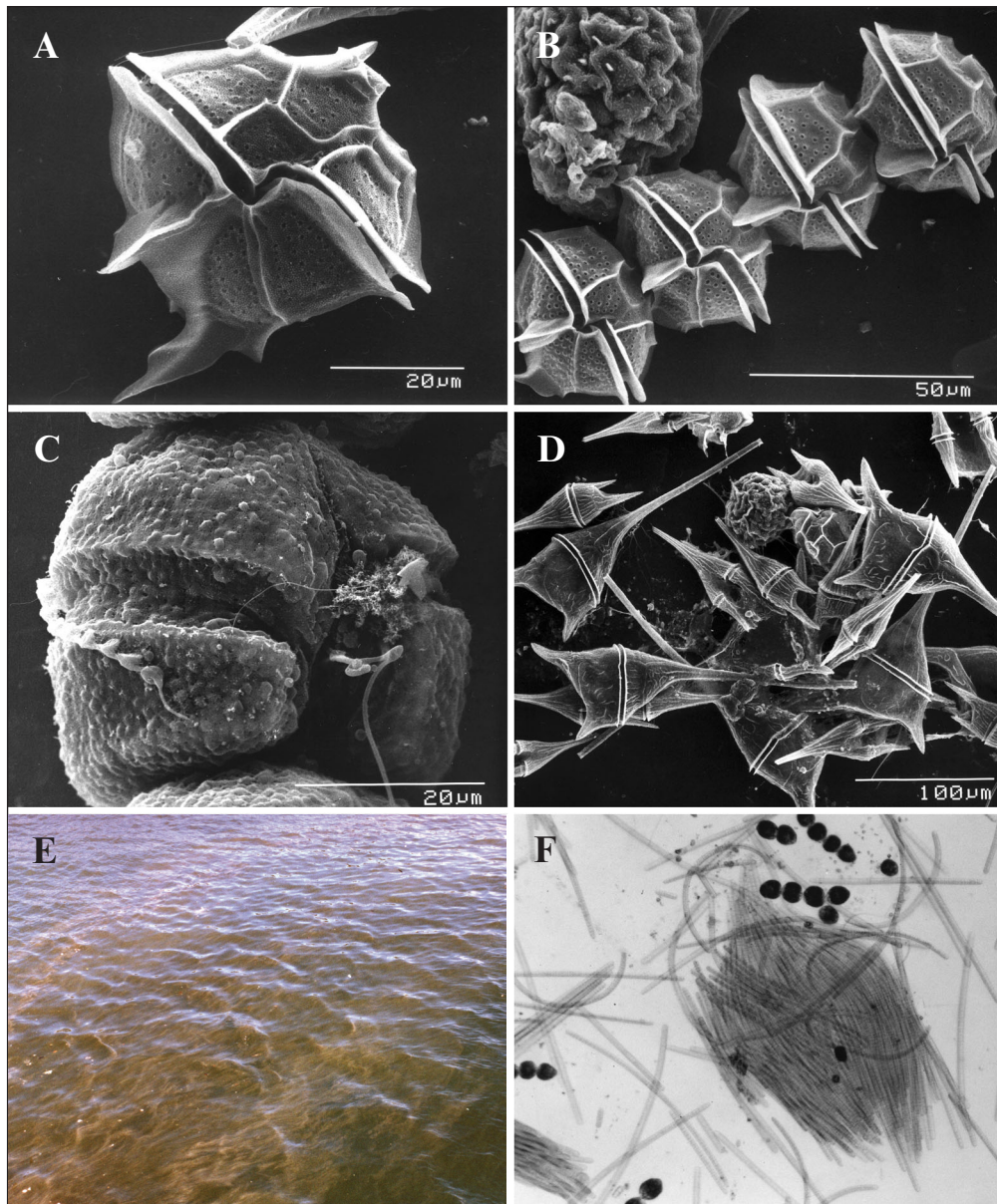


Figure 1 **A** *P. bahamense* var. *bahamense* and **B** *P. bahamense* var. *compressum* HAB producers in Costa Rica; **C** *Gymnodinium catenatum*, **D** dinoflagellates *Ceratium* spp. together at the same bloom; **E** Cyanobacteria bloom from *Trichodesmium erytraeum* and **F** *T. erytraeum* and *Cochlodinium* cf. *polykrikoides* bloom (light microscopy 40×). (Source: INCOPESCA, Costa Rica)

Over the last decade an increase in the number of HAB species along the Pacific coast of Costa Rica has been observed. A great diversity of dinoflagellates exists in this country, especially in the Gulf of Nicoya (Vargas-Montero, 2001). Many of these species have the capacity to produce potent toxins that affect human beings as well as other organisms. Furthermore, in Costa Rica there is no established monitoring plan to relate oceanographic conditions with the occurrence of toxic microalgae.

Due to the lack of resources, Costa Rica has been limited to the analysis of the PSP toxins, however HABs producing other types of toxins have been observed. For example, *Dinophysis caudata* is associated with the production of dinophysistoxins and causing Diarrhetic Shellfish Poi-

soning (DSP), *Pseudo-nitzschia* spp. is associated with the production of domoic acid and causing Amnesic Shellfish Poisoning (ASP), and other species produce lipophilic toxins. It is important to emphasize the need for implementing the detection of other phycotoxins into the current monitoring program.

The concentration of paralytic shellfish poisoning (PSP) found in different species of bivalves demonstrated an increase in July and October (2001) and a decrease toward the end of December (2001) and the beginning of February (2002) (Fig. 2).

Acknowledgements

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Table 1 Estimate of the frequency of harmful species water samples from the Gulf of Nicoya from 1999 to 2002.

Microalgal Species	Occurrence	Season	Blooms	Type of Toxicity*
Dinoflagellates				
<i>Alexandrium catenella</i>	rare	July	Not observed	PSP (saxitoxin)
<i>Alexandrium monilatum</i>	very frequent	Oct	Sometimes	non toxic
<i>Dinophysis caudata</i>	very frequent (2002)	July	Not observed	DSP
<i>Gymnodinium catenatum</i>	frequent (1999–2001)	July–Sept	Frequent	PSP (saxitoxin)
<i>Noctiluca scintillans</i>	frequent (always)	present all year	Frequent	non toxic
<i>Pyrodinium bahamense</i> var. <i>bahamense</i>	frequent (1999–2002)	Nov–Jan	Frequent	non toxic
<i>P. bahamense</i> var. <i>compressum</i>	frequent (1999–2002)	July, Dec	Frequent	PSP (saxitoxin)
<i>Prorocentrum lima</i>	frequent	Jan	Not observed	non toxic
<i>Prorocentrum micans</i>	very frequent (2001–2002)	Feb	Not observed	non toxic
<i>Protoceratium reticulatum</i>	rare	Oct	Not observed	yessotoxin
<i>Ceratium dens</i>	very frequent (1999)	Oct, Dec	Frequent	fish kills
<i>Ceratium furca</i>	frequent	Oct, Dec	Sometimes	non toxic
<i>Ceratium fusus</i>	frequent	Oct, Dec	Sometimes	non toxic
<i>Cochlodinium</i> cf. <i>polykrikoides</i>	frequent (2002)	Sept–Oct	Sometimes	fish kills
Diatoms				
<i>Chaetoceros curvisetus</i>	rare	Apr–May, Sept	Not observed	non toxic
<i>Chaetoceros lorenzianus</i>	frequent (1999)	Apr–May, Sept	Not observed	fish kills
<i>Pseudo-nitzschia</i> spp.	frequent (1999)	Feb–Mar, Oct	Sometimes	ASP
Cyanobacteria				
<i>Trichodesmium erythraeum</i>	rare (2002)	May–June, Jan	Sometimes	fish kills

*Only the PSP analysis for saxitoxin was done; potential toxicity in the other species was suggested by the comparison with recent publications.

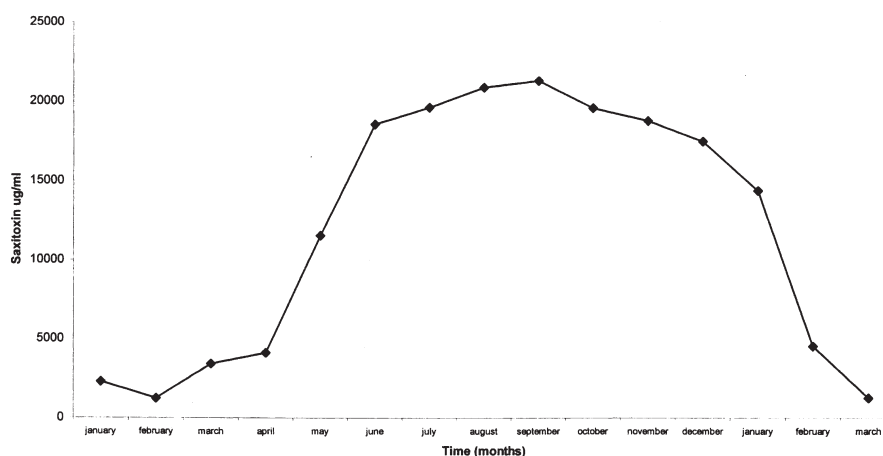


Figure 2 Distribution of saxitoxin in the mollusk *Spondylus calcifer* during 2001. (Source: Instituto Costarricense de Pesca y Acuicultura (INCOPECA), Costa Rica, 2002)

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