

Dinoflagellate blooms in eutrophic zones of Bahía de Cienfuegos, Cuba

In recent years, increasing supplies of nutrients to water bodies by human activities has been associated with growth in the predominance of algal blooms. Increased nutrient fluxes to estuarine and coastal areas result from agriculture, aquaculture, and discharges of industrial and domestic wastes. The resulting blooms lead to hypoxia, fish mortalities, toxicity of food organisms, and damage to benthic communities resulting from reduced light penetration and resulting alterations in trophic interactions throughout the ecosystem [1].

Bahía de Cienfuegos, one of the most valuable natural resources of the province of the same name, is distinguished by its extent and its beauty (Fig. 1). The variety of developments in the surroundings and exploitation of the bay itself have impacted both the water and the coastal zone, and for these reasons it has been chosen for study within the framework of the Ramal Scientific-Technical Program, "Cuban Environmental Protection and Sustainable Development". Estimates indicate that direct nutrient discharges from urban areas contribute 15,1% to the total discharges from the river

systems [2].

At the beginning of the rainy season, July 2009, about 50 to 100 dead fish were observed near domestic waste discharged from Cienfuegos city, near station 12 (Fig. 1). According to local dock-workers, the fish had reached the shore showing signs of lack of oxygen, and red patches had been seen repeatedly that week.

The monitoring the day after showed these coincided with blooms of *Heterocapsa*. Cell shape and the position of the nucleus and pyrenoid coincide with the description of *H. circularisquama* [3]. The patch covered about 500 m².

Heterocapsa circularisquama has caused mass mortalities of bivalves in Japan [4]. Cells of this dinoflagellate

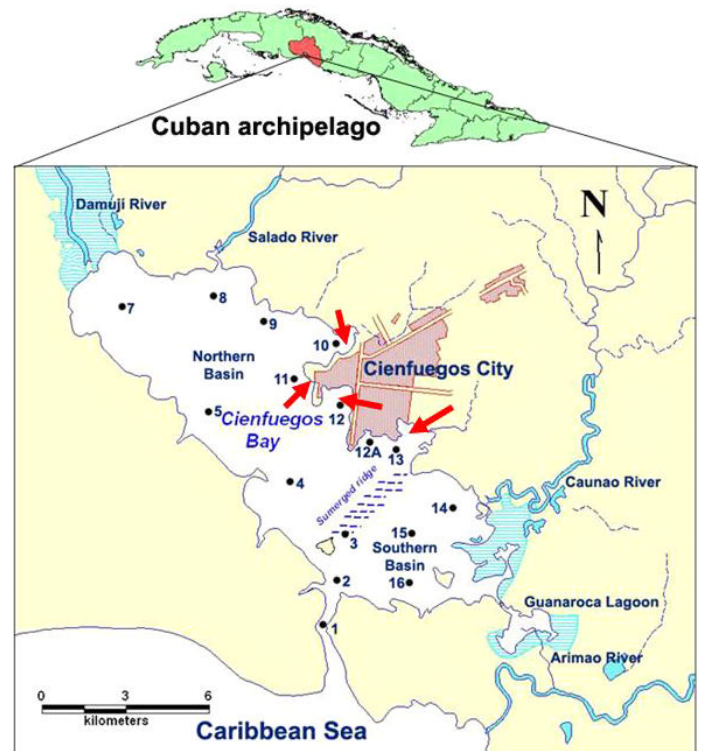


Fig. 1. Bahía de Cienfuegos. State monitoring network. Arrows show main discharge zones of domestic and industrial wastes.

were abundant in the fishes gills, but cells of the benthic *Amphidinium* cf. *carterae* (Fig. 3), which produces haemolytic ichthyotoxins, were also found there. *A. cf. carterae* was present in the plankton samples, but in low concentrations. Its presence in the gills might indicate that it was relatively abundant in the nearby benthos. One other benthic species, *Prorocentrum rathymum*, also appeared in moderate numbers in the plankton samples. In the areas close to the domestic discharges, substrates for benthic microflora are abundant, with flourishing filamentous macroalgae and hydrozoans, and carpets of cyanobacteria, most of them toxic.

Meteorological conditions at the time were calm with high air temperatures (35–36° C) typical of summer in Cuba, and scarce rainfall.

Other toxic or noxious species (Fig. 4) have been seen accompanying blooms in other parts of the bay, and seem to be established components of the microflora here. Amongst these are *Gymnodinium* cf. *catenatum*, a potential source of paralytic toxins, *Cochlodinium* cf. *polykrikoides* with ichthyotoxic properties, *Dinophysis caudata* and *D. ovum*, producers of

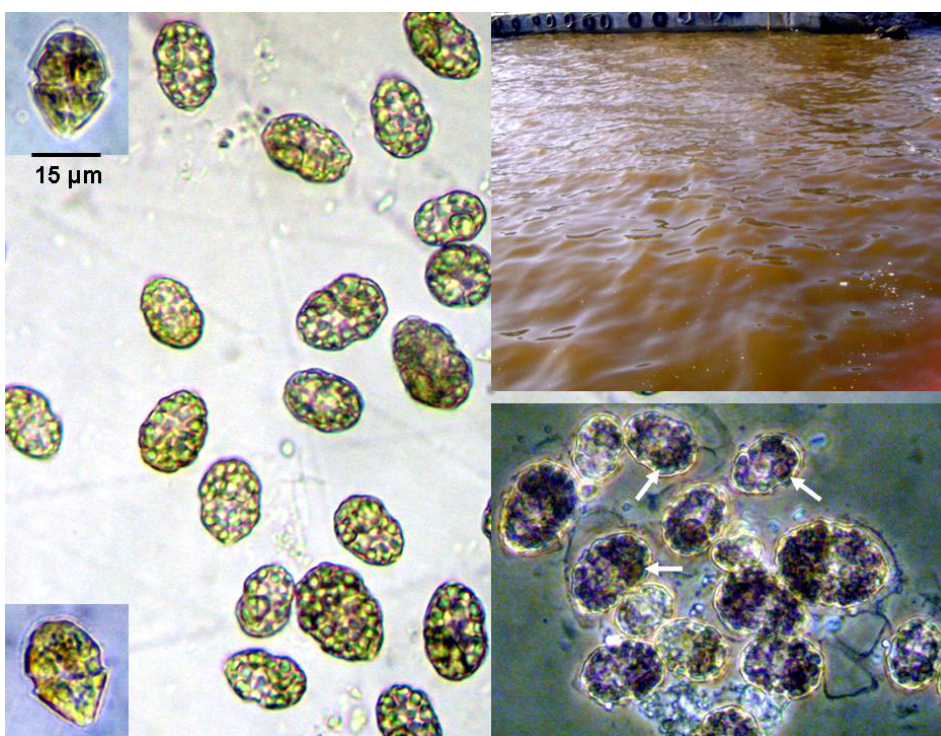


Fig. 2. *Heterocapsa cf. circularisquama* in Lugo preserved sample. Arrows indicate location of pyrenoid.



Fig. 3. *Amphidinium cf. carterae*

diarrhetic toxins, *Prorocentrum minimum*, producer of neurotoxins, and *Gonyaulax polygramma* y *G. spinifera*, associated with ichthyotoxic events.

Blooms of nontoxic dinoflagellates also occur, mainly at the end of the dry season and beginning of the rainy season, when temperatures increase. These include *Gyrodinium instriatum*, *Gymnodinium estuariale*, *Peridinium quinquecorne* and *Prorocentrum compressum* (Fig. 5) close to stations 10 and 12, contributing to decline of the density and biomass of *Halodule wrightii*, the most abundant phanerogam in the bay, as well as the large rhodophytes (*Gracilaria*, *Acanthophora*, *Hypnea*) typical of this ecosystem. Blooms of *Gymnodinium estuariale* close to the outlet of the River Salado and near the industrial sector

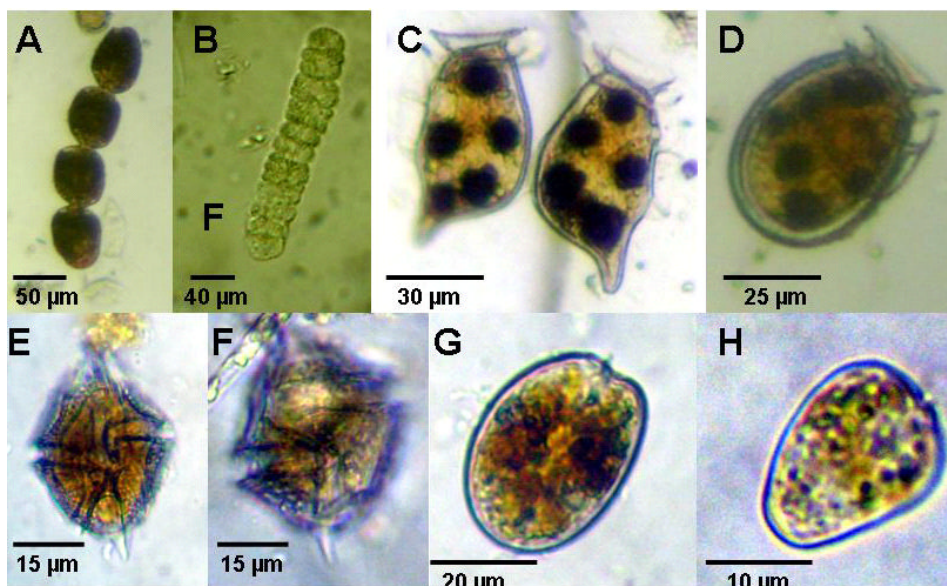


Fig. 4. Other toxic or noxious species associated with blooms in waste discharge areas; A) *Gymnodinium cf. catenatum*, B) *Cochlodinium cf. polykrikoides*, C) *Dinophysis caudata*, D) *D. ovum*, E) *Gonyaulax polygramma*, F) *G. spinifera*, G) *Prorocentrum rhathymum*, H) *P. minimum*

(stations 8 and 9) increase chlorophyll *a* concentrations up to $38.17 \mu\text{g L}^{-1}$. These blooms of nontoxic dinoflagellates and the abundant epiphytes of the filamentous macroalgae and hydrozoans reduce light levels in the marine meadows and lead to their deterioration.

Acknowledgements

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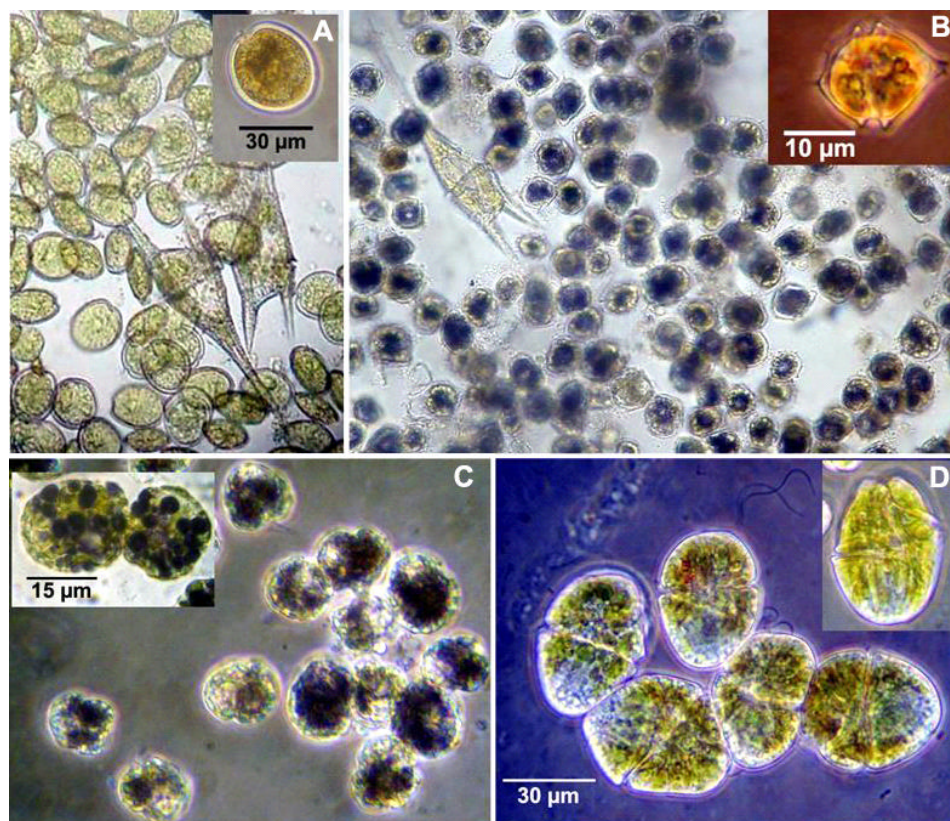


Fig. 5. Nontoxic species which form blooms in discharge areas; A. *Prorocentrum compressum*, B. *Peridinium quinquecorne*, C. *Gymnodinium estuariale*, D. *Gyrodinium instriatum*

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