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Dinoflagellate abundance in the Laguna Botos, Poás Volcano, Costa Rica

by

Paul E. Hargraves* and Roxana Víquez M.**

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Abstract: Phytoplankton of the Botos lagoon of Poás volcano is dominated by dinoflagellates. The two species of greatest abundance in March 1979 were *Peridinium incospicuum* Lemm. and *P. volzii* Lemm. which represented 96% of total cells. The identity of these species was confirmed by electron microscopy. Both species are cosmopolitan. Without further research it is premature to compare Botos Lagoon with similar lakes in Central America.

Poás volcano is one of the more accessible volcanos in Central America; the active crater is reported to be among the largest in the world. Adjacent to the active crater in an ancient inactive crater, whose walls reach 2700 m, is the Botos lagoon. Vegetation surrounding the lagoon within the crater is classified as "Montane Rain Forest" (Macey, 1975) and is dominated by a 15-20 m forest canopy consisting primarily of the trees *Clusia odorata, Didymopanax pittieri*, and *Weinmannia trianea.* The lagoon has an area of several hectares and a maximum depth of 8 m (Macey, 1975), the dominant macrophyte is *Isoetes storkii.* During a visit to the lagoon in March 1979 and again in March 1980, water samples were collected as part of a survey of freshwater diatoms of CostaRica. The presence of a considerable population of dinoflagellates approaching bloom concentrations prompted a more intensive examination of the organisms responsible. Apparently there are no previous published reports of dinoflagellate blooms from freshwaters of Costa Rica, or of plankton from the Botos lagoon.

METHODS

Samples were first collected on 29 March 1979. Plankton tows along the NE and SE shoreline were taken with a 10 μm mesh plankton net, and water samples were collected in 500 ml polythylene bottles. Temperature was measured with a mercury immersion thermometer accurate to 0.2 C. Samples were later collected on 4 March 1980. At that time, in addition to water samples, pH was estimated

* Graduate School of Oceanography, University of Rhode Island, Kingston, Rhode Island 02881 U.S.A.

** Escuela de Ciencias Biológicas, Universidad Nacional, Heredia, Costa Rica.

(accurate to about 0.5 pH) with PANPEHA hydrion paper. Subsequent chemical analysis of the water for pH, alkalinity, chloride, and sulfate was made with a Delta Model 50 Portable Laboratory instrument. Because of the limits of accuracy of this instrument, and because two days passed between collection and analysis, the values must be considered only as approximations.

Photomicrographs were made with a Cambridge S-4 Scanning Electron Microscope using Polaroid 55 P/N film, and Kodak Ektamatic SC paper. Cell counts were made on unconcentrated subsamples with a Sedgewick-Rafter counting chamber and a Zeiss Photomicroscope II.

RESULTS

Chemical Characteristics: Because of the limited availability of analytical instruments, only general information can be given on water chemistry. The pH of the water at time of collection was about 6.5. This remained stable when measured with a more accurate instrument two days later. Calcium carbonate alkalinity was less than 20 ppm; chloride, 8 ppm; and sulfate, 5.5 ppm. Water temperature at the surface was 16 C in March 1979 and 13.5 C in March 1980. Nutrients and dissolved gases were not measured because of the time between collection and analysis (for the 1980 samples).

Phytoplankton: The range in phytoplankton numbers at four locations along the NE and SE shore of Laguna Botos was $3.1\text{-}3.8 \times 10^4$ cells/liter. The dominant organism, in bloom proportions, was *Peridinium inconspicuum* Lemm., which made up $2.7\text{-}3.3 \times 10^4$ cells/liter. Second in abundance was *Peridinium volzii* Lemm., which amounted to $3.1\text{-}3.5 \times 10^3$ cells/liter. *P. inconspicuum* represented 86% of the total phytoplankton cells, and *P. volzii* made up 10% of the total. The remaining species consisted primarily of benthic species whose presence in the plankton was fortuitous. These included the diatoms *Eunotia monodon, Frustulia rhomboides, Navicula* spp., *Pinnularia biceps, P. maior,* and *Surirella linearis*; and the green algae *Cosmarium* cf. *moniliforme* and *Oedogonium* sp. Occasional cells of *Cryptomonas* sp. and *Chlamydomonas* sp. were also seen. Because of their abundance, the two dinoflagellates are treated in more detail.

P. inconspicuum is shown in Figure 1. The cells are broadly oval with a conical apex, and measure 20-26 μm in the apical axis (height) and 13-22 μm in the transapical axis (width). Cells are somewhat flattened dorso-ventrally. The epitheca (Fig. 1-A, B, C) composed of four apical, two anterior intercalary, and seven precingular plates (4', 2a, 7"). A prominent feature of the epitheca is a complex pore with a distinctly raised rim (Fig. 1-A, B). The cingulum is median, straight, and has six cingular plates. The hypotheca (Fig. 1-A, B, D) is composed of five postcingular, no posterior intercalary, and two antapical plates (5"' Op 2""). The sulcus is quite wide at the antapex, narrow toward the cingulum, and is made up of an indeterminate number of plates. The right sulcal plate is well developed and partly occludes the sulcal area (Fig. 1-B). The junctures of the post cingular and antapical plates often are extended to form short spines (Fig. 1-A, D). *P. inconspicuum* is photosynthetic, and possesses numerous trichocysts, the pores of which are particularly visible in Fig. 1-C. There are many chloroplasts which are parietal and red-brown in color.

Peridinium volzii is shown in Figures 2 and 3. The cells are broadly oval and dorso-ventrally flattened. The apical axis (height) is 41-48 μm, the transapical axis

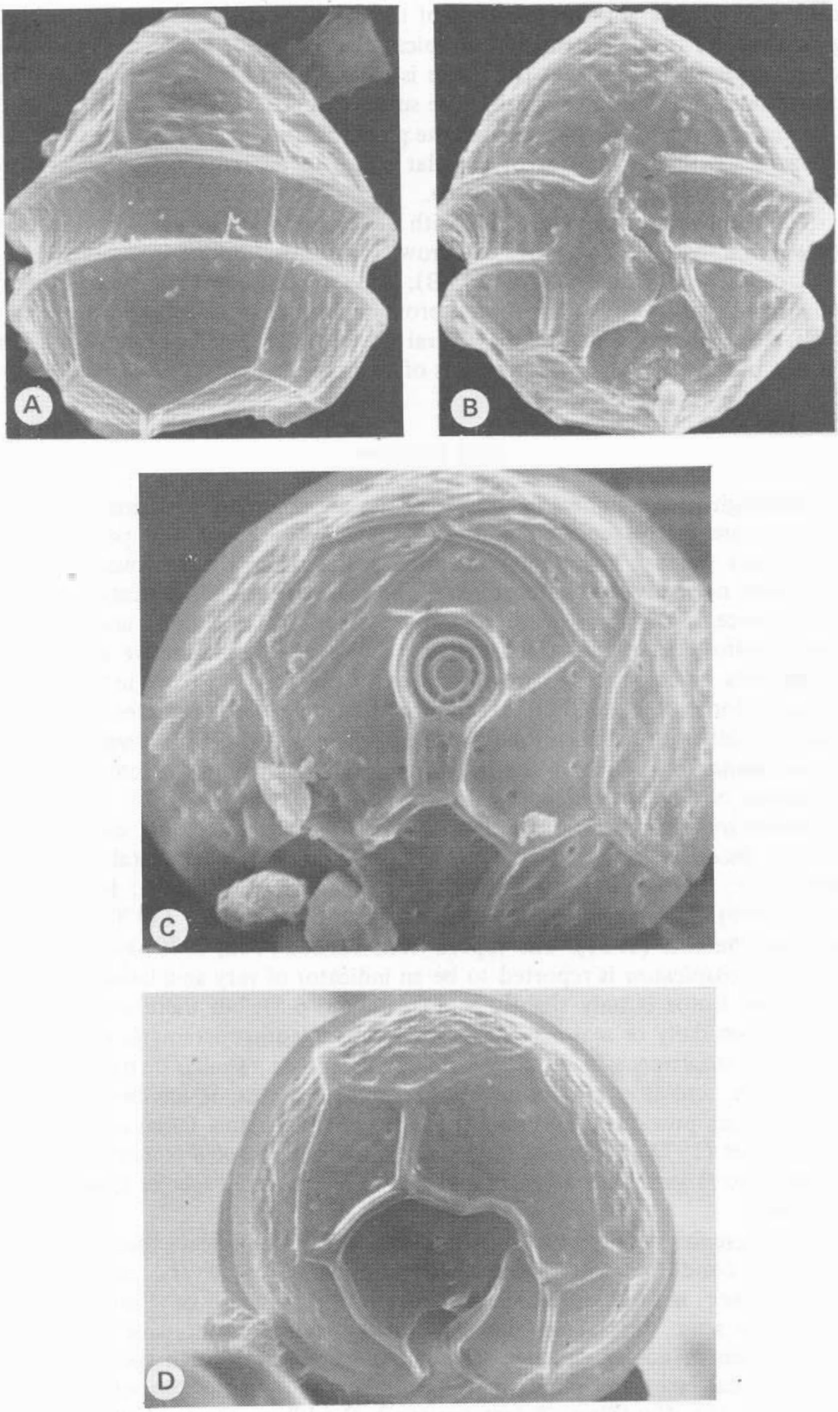

Fig. 1. *Peridinium incospicuum*

A. Dorsal side 4000x
B. Ventral side 4000x

C. Apex, 6500x
D. Antapex, 4300x

(width) is 34-41 μm, and the thickness of the cell is about 30-32 μm. The epitheca (Fig. 2 and 3A) is composed of four apical, three anterior intercalary, and seven precingular plates (4', 3a, 7"). The girdle is median, and offset on the ventral side by about one girdle width (Fig. 2-B). The sulcus extends partway into the epitheca, and becomes wider in the hypotheca. The plates of the cingulum appear to be five, which agrees with the number of cingular plates in related species. Sulcal plates appear to be five or six (Fig. 2-B and 3-B).

The thecal plates are quite thick with a strongly reticulate surface. Trichocyst pores were rarely seen. Vegetative cell growth without cytokinesis was observed in several cells (e.g. Fig. 2-A and 3-B); a common event in many thecate dinoflagellates. This species has several brown chloroplasts distributed throughout the cell, also a stigma located on the ventral side near the flagellar origin. The stigma is usually not mentioned in descriptions of this species; only Pfiester and Skvarla (1979) have reported it previously.

DISCUSSION

Although large numbers of dinoflagellates are common in marine waters (red tides) they are rarely reported in fresh water. Even though the population in Laguna Botos was not high enough to discolor the water, the cells were higher in number than normally seen in most lakes. The cause of such concentrations may be physical processes such as wind (causing surface accumulation) and sunlight (causing phototaxis of the cells) rather than a high reproductive rate of the dinoflagellates. Such processes were believed to cause a "red tide" in Clear Lake, California (Horne *et al.*, 1971). Except for these two dinoflagellates, there were almost no other true planktonic species, except for *Cryptomonas* sp. and *Chlamydomonas* sp., which were very rare. The remaining microalgae were characteristic of the benthos; mostly diatoms.

Peridinium inconspicuum and *P. volzii* are both common cosmopolitan species. *P. inconspicuum* is well known from Europe (Huber-Pestalozzi, 1968), Canada (Yan, 1979), and the United States (Thompson, 1947 ; Pfiester and Skvarla, 1979). It has been reported from Cuba by Popovsky (1970) and from Panama by Prescott (1951). The report from Canada (Yan, 1979) is noteworthy because *P. incospicuum* is reported to be an indicator of very acid lakes (pH = 5 or less). Laguna Botos is only slightly acid (pH about 6.5): but there is no accurate information on daily or seasonal changes in pH, or any other parameter which might influence the occurrence of dinoflagellates. *P. volzii* has a similar distribution to *P. inconspicuum*, and is often found in the same locations. It has been found in Central America previously by Prescott (1951) in the Panama Canal (Gatun Lake) and by Loffler (1972) in Mexico (and also Colombia). *P. volzii* is morphologically very similar to *P. gatunense* Nygaard and also to several other species found only in fresh water.

The presence of these two dinoflagellates does not indicate their preference for tropical conditions. As pointed out previously by several authors, high mountain lakes in the tropics can function as refuges, or "islands" in a biogeographic sense, for species that have their maximum centers of distribution and abundance in cooler climates. The initial migration of such species to high altitude tropical lakes and ponds may have taken place at the time of Pleistocene glaciation in the Cordillera Talamanca and Cordillera Central (Weyl, 1956). Therefore, one might expect to find these species in "montano pluvial" or "páramo" conditions throughout Costa Rica.

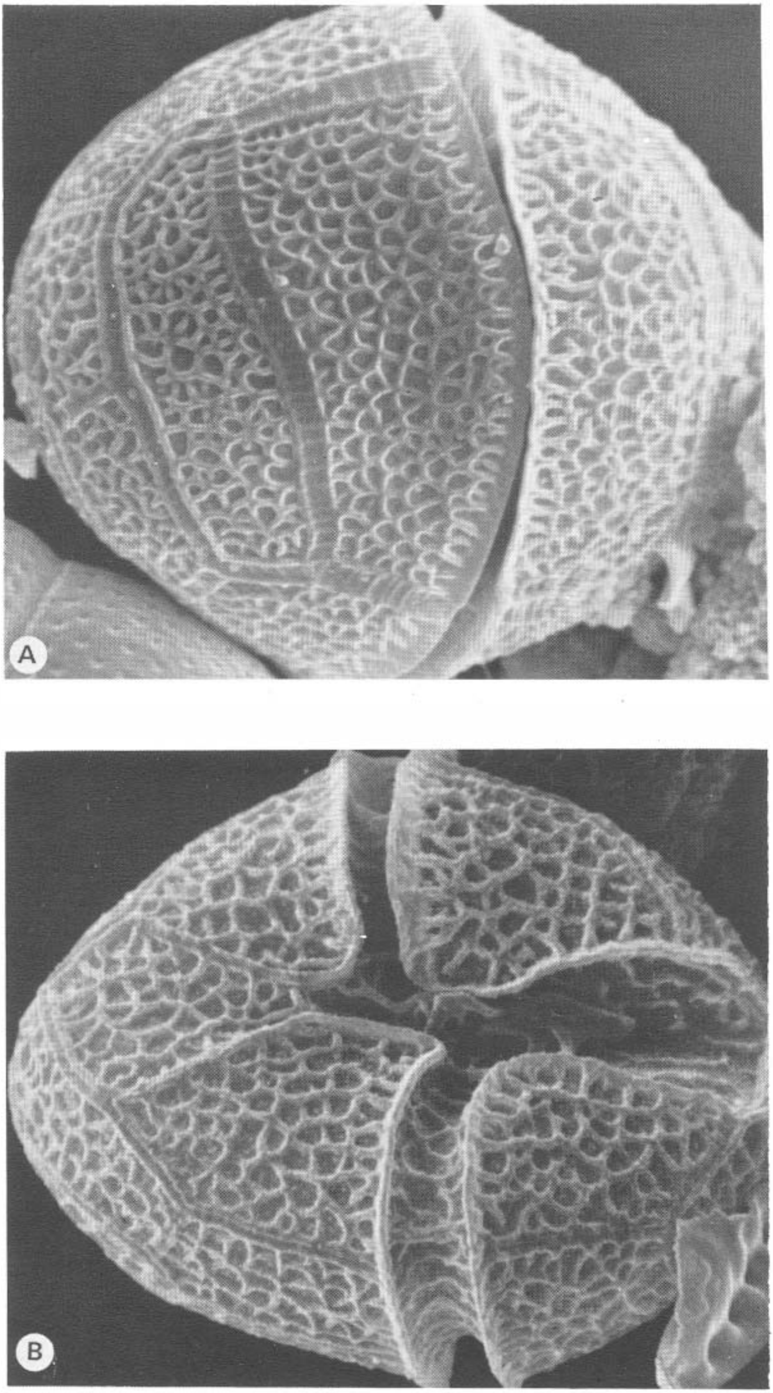

Fig. 2. *Peridinium volzii*
A. Dorsal side, 2800x
B. Ventral side, 3000x

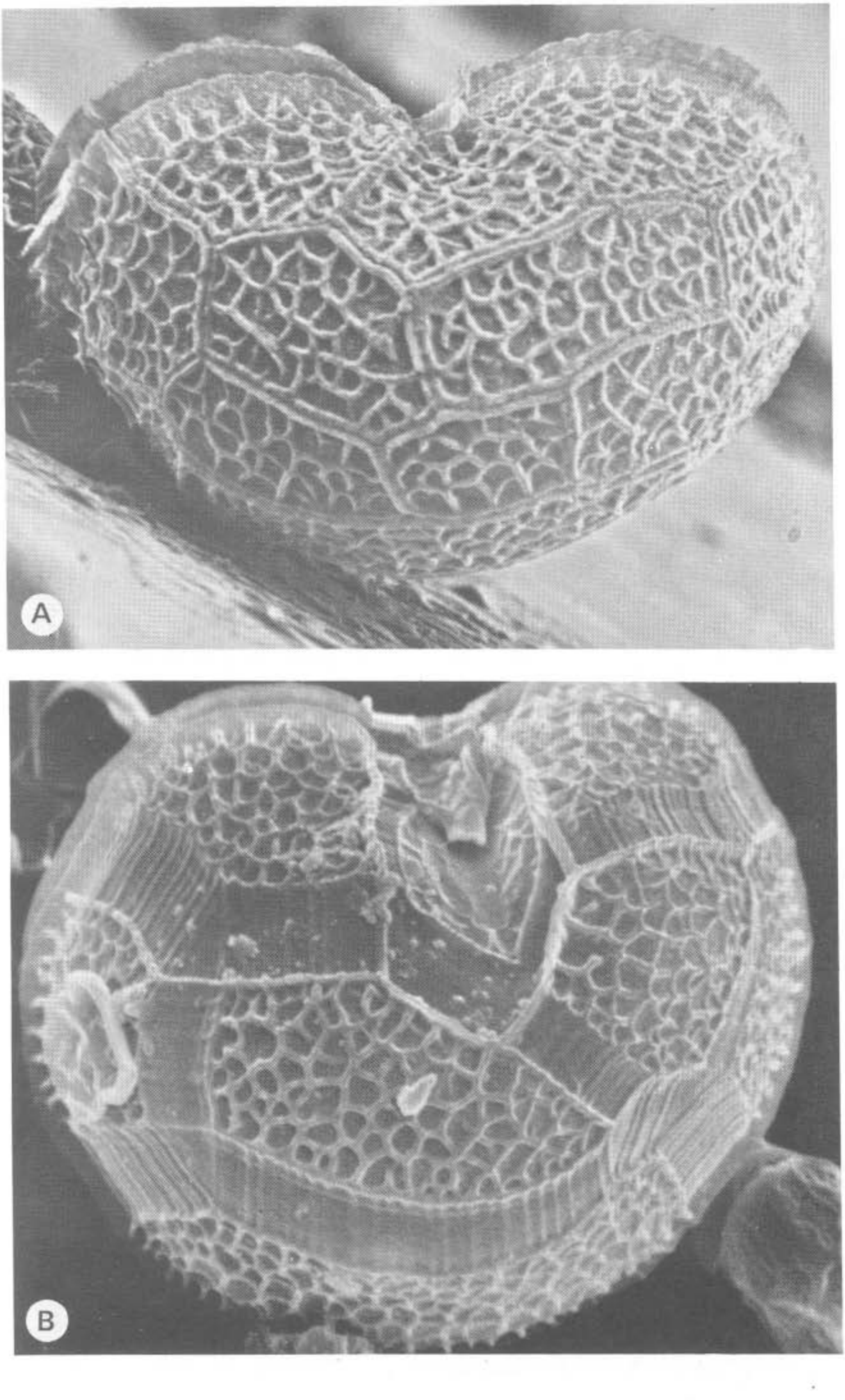

Fig. 3. *Peridinium volzii*
A. Apex, 3100x
B. Antapex, 2800x

There is little published information on the chemistry of Laguna Botos which can be related to the organisms found there. Loffler (1972) reports a depth of 8 m, high transparency, and a Forel-Ule water color of 6 (blue/green) for Laguna Botos, and says that the páramo lakes of Costa Rica and Guatemala are similar in algal flora and low electrolyte content, but dissimilar in copepod fauna. There are apparently many differences between Laguna Botos and volcanic lakes of El Salvador (Cole, 1963) but the data is very sparse. Because the biology and chemistry of Laguna Botos (and other Costa Rican mountain ponds, lakes, and streams) is poorly known, we suggest a thorough limnological survey be done. Results of such a study would have several benefits: a) to further define the environment of the dinoflagellates and other plankton; b) to provide valuable data on the composition of volcano crater lakes; c) to provide information on the suitability of such lakes for stocking with fish for recreational purposes.

RESUMEN

Los dinoflagelados dominan el fitoplancton de la Laguna Botos del Volcán Poás. Las dos especies con mayor abundancia en Marzo de 1979 fueron *Peridinium incospicuum* Lemm. y *P. volzii* Lemm. y representaron 96% de las células totales. Las identidades de estas especies fueron confirmadas con el microscopio electrónico. Ambas especies son cosmopolitas. Sin investigaciones adicionales es prematuro comparar la Laguna Botos con lagos similares de América Central.

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