**Diatom assemblages from the Camastro Diatomite, Costa Rica**

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**Resumen:** Se estudió las diatómeas de 23 muestras tomadas en tres depósitos lacustres en la cuenca de Loma Camastro (Plioceno) cerca de Liberia, Guanacaste, Costa Rica. Las especies principales fueron *Aulacoseira ambigu*, *Cyclotella meneghiniana*, *Fragilaria brevisirata*, *Fragilaria pinnata*, *Navicula meniscus*, *Nitzschia amphibia*, *Stephanodiscus dubius* y *Synedra ulna*. Se reconocieron siete comunidades, todas sugerentes de un lago que era somero, eutrofico, ligeramente básico (pH 7.8 a 8.5), con poca o mediana cantidad de sílica, y baja conductividad. Unas pocas capas pueden sugerir cambios en el estado trófico.

**Key words:** Fossil diatoms, diatomite, Costa Rica, tropical, paleolimnology, paleoclimatology.

Despite considerable scientific activity in Costa Rica, few paleoecological studies have been published. Papers and reviews include Gómez (1986), Hooghiemstra et al. (1992), and Horn (1992, 1993). Most of the paleoecological work has focussed on pollen grains (and, at some sites, charcoal); lake ecology and diatoms have been virtually ignored until quite recently (Horn and Haberyan, 1993; Haberyan et al., 1995, 1996).

Thirteen diatomites are known in Costa Rica, mainly from the Pacific slope (Berrange et al., 1990; Mathers et al., 1990). The largest of these is the Loma Camastro diatomite, about 5 km² in area, which is closely associated with Pliocene-Quaternary volcanism. This diatomite was examined by Segura (1945), Salazar (1978), and Lágayo and Soto (1978), especially for commercial extraction.

The Loma Camastro basin is located on the western flank of the Rincón Santa María stratovolcano (10°49’N, 85°30’W; Fig. 1). To the north and east are deposits of the modern Cacao and Rincón de la Vieja volcanoes, and to the south and west is a low range of hills formed by dacite domes and andesitic flows. The entirety of the diatomite is probably Pleistocene in age, and reportedly totals at least 80 m in vertical thickness (Mathers et al., 1990).

Twenty-three samples were collected from three localities: an exposure made by commercial mining operations (Site 1), a river bluff (Site 2), and a borehole (Site 3). Samples of approximately 200 mg were treated with hot 35% H₂O₂, followed by 50% HCl to remove carbonates and settling in distilled water to remove coarse particles. Subsamples were dried on coverslips and mounted in Naphrax. For each, 500 valves were counted at 1000x and identified with the reference collection of the government oil company (RECOPE). Interpretation is based on Gasse (1986), S.D.J. Inglethorpe (pers. comm.), Umaña (pers. comm.), and modern distributions (Haberyan et al., 1996).
Twenty-six taxa were identified (Table 1), but only eight were found in abundances exceeding 10%. Each section was subdivided according to differences in the flora, for a total of seven biostratigraphic units (Table 2). We do not suggest any temporal correlation between the units at different sites.

Site 1. The Site 1 diatomite is 8 m thick, and most of the section contains mainly Nitzschia amphibia and Synedra ulna, which are both found in modern Costa Rican lakes (Haberyan et al. 1995). In Section A (the more recent sediments), C. meneghiniana exceeded 70% of all diatoms; this species has been found in productive, low-hardness waters in warm habitats (Umaña 1991). All three taxa prefer shallower waters and slightly alkaline pH (7.8 to 8.5), but are broadly tolerant of conductivity; S. ulna is reported to be an indicator of eutrophy (Gasse 1986). In modern Costa Rican lakes, N. amphibia and S. ulna were common in the
TABLE 1

<table>
<thead>
<tr>
<th>Taxa identified in the Loma Camastro diatomites.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taxa that exceed 10% in at least one sample are indicated by an asterisk.</td>
</tr>
</tbody>
</table>

**Centrales**

- Aulacoseira ambigua*
- A. granulata
- Cyclotella meneghiniana*
- Stephanodiscus dubius*

**Pennales**

- Acenathes clevei, A. exigua, A. lanceolata, A. minutissima, A. reversa
- Cocconeis cf. diminuta, C. placentula
- Cymbella affinis
- Epithemia sp.
- Fragilaria brevistriata*, F. pinnata*
- Navicula cari, N. meniscus*, N. peregrina, N. semi-nulum
- Nitzschia amphibia*, N. cf. microcepahala
- Opephora sp.
- Rhopalodia sp.
- Staurodes anceps
- Surirella sp.
- Synedra ulna*

Taxa more productive lakes Fraijanes and Gonzalez (Horñ and Haberyan 1993, Haberyan et al., 1996). The modern distribution of Synedra and Navicula suggests that silica levels were low to moderate (less than 50 mg/l).

**Site 2.** The Site 2 diatomite is at least 7 m thick, and the most common diatom at virtually all levels is Stephanodiscus dubius. The ecology of this species is poorly known, but other members of the genus are generally thought to be low-silica indicators (Kilham 1971).

- Fragilaria pinnata accounted for about 25% of the diatoms in the Section B, but was replaced in Section A by S. ulna and A. ambiguus. These diatoms are common in shallow waters, and S. ulna may indicate a trend toward eutrophy in upper samples (Gasse 1986). Silica levels during the time of deposition of these sediments were probably low to moderate, as in Section A (Haberyan et al. in prep).

**Site 3.** Overall, the most common diatom here was S. dubius, which reached maximum relative abundance about 20 m deep in the section. Two species of Fragilaria, F. pinnata and F. brevistriata, were especially common near 14 m and 6 m. F. brevistriata, when abundant, indicates low alkalinity (Gasse 1986). Aulacoseira granulata was largely replaced by A. ambiguus upsection, especially between 4 and 8 m. Haberyan et al. (in prep) found that A. granulata dominated Lago Cote (93%) and was common in Cachí (31%). Like the other sites we examined, the species here seem to indicate shallow, eutrophic waters of low alkalinity and conductivity. Silica levels were probably low to moderate (Haberyan et al. 1996).

All three sites were dominated by species that seem to prefer shallow, eutrophic water, slightly basic pH, and low conductivities. Comparison to the modern Costa Rican diatom distribution suggests that silica levels were low to moderate.

The three sites all contain diatom assemblages that suggest the lake at the time was typical of

TABLE 2

<table>
<thead>
<tr>
<th>Site</th>
<th>Section</th>
<th>Depth</th>
<th>n</th>
<th>Aulacoseira ambigua</th>
<th>Cyclotella meneghiniana</th>
<th>Stephanodiscus dubius</th>
<th>Fragilaria brevistriata</th>
<th>Fragilaria pinnata</th>
<th>Name</th>
<th>Navicula meniscus</th>
<th>Nitzschia amphibia</th>
<th>Synedra ulna</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>0.0-0.5</td>
<td>1</td>
<td>3</td>
<td>83</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>6</td>
<td>0</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>0.5-4.0</td>
<td>3</td>
<td>6</td>
<td>5</td>
<td>16</td>
<td>6</td>
<td>5</td>
<td>13</td>
<td>20</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>0.0-3.5</td>
<td>4</td>
<td>20</td>
<td>2</td>
<td>48</td>
<td>1</td>
<td>4</td>
<td>8</td>
<td>0</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>3.5-7.0</td>
<td>4</td>
<td>11</td>
<td>0</td>
<td>54</td>
<td>3</td>
<td>25</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>A</td>
<td>0.0-11.0</td>
<td>5</td>
<td>20</td>
<td>1</td>
<td>29</td>
<td>4</td>
<td>1</td>
<td>8</td>
<td>1</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>11.0-17.0</td>
<td>3</td>
<td>7</td>
<td>0</td>
<td>19</td>
<td>10</td>
<td>30</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>17.0-22.0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>50</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>0</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>
the modern lakes in the area: shallow, slightly basic pH, and low in conductivity. A few layers may suggest changes in trophic status. Without independent stratigraphic correlations and radiocarbon dates, it is difficult to compare these data to other sites. Additional analysis will be needed to refine these ecological interpretations; other projects have been started to establish the temporal framework of the Camastro deposits, which may span 30,000 years or more (Haberyan et al. in progress).

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REFERENCES


