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# Diatom assemblages from the Camastro Diatomite, Costa Rica

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**Resumen:** Se estudió las diatómeas de 23 muestras tomadas en tres depósitos lacustrinos en la cuenca de Loma Camastro (Plioceno) cerca de Liberia, Guanacaste, Costa Rica. Las especies principales fueron *Aulacoseira ambigua, Cyclotella meneghinana, Fragiliaria brevistriata, Fragilaria, pinnata, Navicula menisculus, Nitzschia amphibia, Stephanodiscus dubius* y *Synedra ulna*. Se reconocieron siete comunidades, todas sugerentes de un lago que era somero, eutroficado, ligéramente básico (pH 7.8 to 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 km$^2$ in area, which is closely associated with Pliocene-Quaternary volcanism. This diatomite was examined by Segura (1945), Salazar (1978), and Lacayo 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 commerical mining operations (Site 1), a river bluff (Site 2), and a borehole (Site 3). Samples of approximately 200 mg were treated with hot 35% $H_2O_2$, 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).

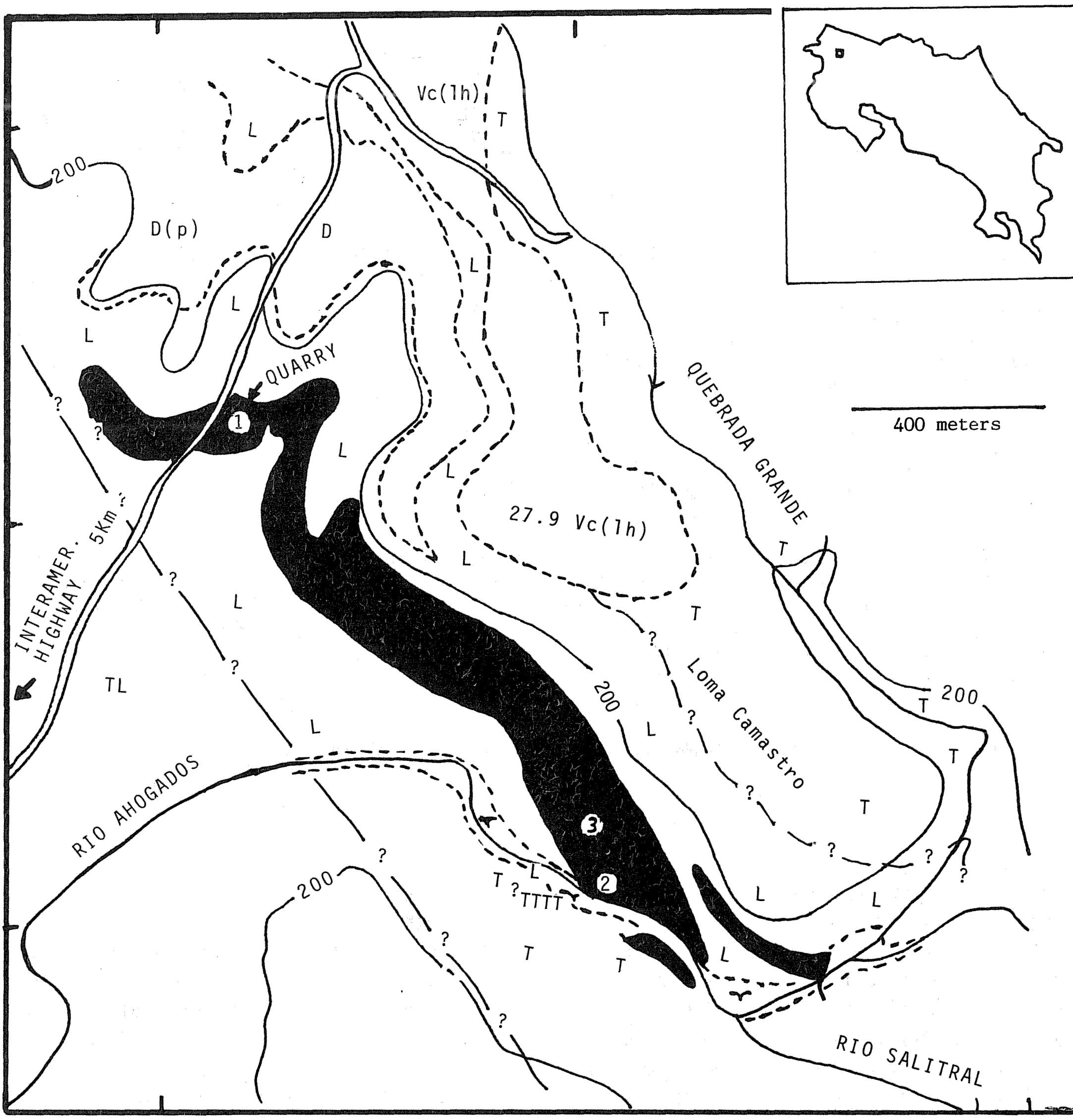


Fig. 1. Loma Camastro diatomites (after Mathers *et al.* 1990); inset shows the location of Loma Camastro in northwestern Costa Rica. Digits indicated site localities. Abbreviations: D, diatomite; D(p), diatomite-peperite; L, other lacustrine deposits; T, tuffs; TL, white rhyolitic tuff; Vc(lh), Volcano Cacao lahars; ?, inferred fault.

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

*Taxa identified in the Loma Camastro diatomites. Taxa that exceed 10% in at least one sample are indicated by an asterisk*

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

Pennales
- *Acnanthes 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. menisculus**, *N. peregrina, N. seminulum*
- *Nitzschia amphibia**, *N.* cf. *microcepahala*
- *Ophephora* sp.
- *Rhopalodia* sp.
- *Stauroneis anceps*
- *Surirella* sp.
- *Synedra ulna**

more productive lakes Fraijanes and Gonzalez (Horn 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. ambigua.* 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. ambigua* 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

*The occurences of the primary diatoms at the three sampling sites, as percent of all diatoms. No stratigraphic correlation is implied. Section boundaries are approximate, and rounded to the nearest half meter below the top of section. Abbreviations: n, number of samples; Auam,* Aulacoseira ambigua*; Ccme,* Cyclotella meneghiniana*; Stdu,* Stephanodiscus dubius*; Frbr,* Fragilaria brevistriata*; Frpi,* Fragilaria pinnata*; Name,* Navicula menisculus*; Niam,* Nitzschia amphibia*; Syul,* Synedra ulna

| Site | Section | Depth | n | Auam | Ccme | Stdu | Frbr | Frpi | Name | Niam | Syul |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | A | 0.0-0.5 | 1 | 3 | 83 | 0 | 2 | 1 | 6 | 0 | 5 |
| 1 | B | 0.5-4.0 | 3 | 6 | 5 | 16 | 6 | 5 | 13 | 20 | 29 |
| 2 | A | 0.0-3.5 | 4 | 20 | 2 | 48 | 1 | 4 | 8 | 0 | 16 |
| 2 | B | 3.5-7.0 | 4 | 11 | 0 | 54 | 3 | 25 | 2 | 0 | 4 |
| 3 | A | 0.0-11.0 | 5 | 20 | 1 | 29 | 4 | 1 | 8 | 1 | 5 |
| 3 | B | 11.0-17.0 | 3 | 7 | 0 | 19 | 10 | 30 | 2 | 0 | 2 |
| 3 | C | 17.0-22.0 | 3 | 0 | 0 | 50 | 0 | 1 | 6 | 0 | 3 |

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

Berrange, J.P., S.J. Mathers, N. Morales & F. Alvarado. 1990. The nonmetallic industrial minerals and rocks of Costa Rica. Refinadora Costarricense de Petróleo, San José, Costa Rica. 181 p.

Gasse, F. 1986. East African diatoms: taxonomy, ecological distribution. Bibl. diatom. 11: 1-201.

Gómez, P. 1986. Vegetación de Costa Rica: apuntes para una biogeografíia costarricense. Universidad Estatal a Distancia, San José. 327p.

Haberyan, K.A., S.P. Horn & B.F. Cumming. 1996. Dratum essemblages from Costa Rican lakes: an initial ecological assessment. J. Paleolimnol. (in press.).

Haberyan, K.A., G. Umaña, C. Collado & S.P. Horn. 1995. Observations on the plankton of some Costa Rican lakes. Hydrobiologia 312: 75-85.

Hooghiemstra, H., A.M. Cleef, G.W. Noldus & M. Kappelle. 1992. Upper Quaternary vegetation dynamics and palaeoclimatology of the La Chonta bog area (Cordillera de Talamanca, Costa Rica). J. Quat. Sci. 7: 205-225.

Horn, S.P. 1992. Microfossils and forest history in Costa Rica. *In* H.K Steen & R.P. Tucker (eds.), Changing tropical forests: historical perspectives on today's challenges in Central and South America. Forest History Society, Durham, North Carolina.

Horn, S.P. 1993. Postglacial vegetation and fire history in the Chirripo paramo of Costa Rica. Quat. Res. 40: 107-116.

Horn, S.P. & K.A. Haberyan. 1993. Costa Rican lakes: chemical and physical properties. Nat. Geogr. Res. Explor. 9: 86-103.

Kilham, P. 1971. A hypothesis concerning silica and the freshwater planktonic diatoms. Limnol. Oceanogr. 16: 10-18.

Lacayo, B & G. Soto. 1978. Aspectos generales, técnicos y económicos del proyecto diatomita. Bol. Geol. Reserv. Miner. (Costa Rica) 1: 1-19.

Mathers, S.L., L. Chavez, F. Alvarado & S.D.J. Inglethorpe. 1990. Detailed investigations of selected Costa Rican diatomites. Refinadora Costarricense de Petróleo (RECOPE), San José. 37 p.

Salazar, A.J. 1978. Geología de lòs depósitos de diatomita de las Brisas, Cañas Dulces y Loma Camastro, Liberia, Guanacaste, y su evaluación preliminar. Bol. Geol. Reserv. Miner. (Costa Rica) 1: 296-319.

Segura, A. 1945. Rápidos apuntes sobre los mármoles de Guanacaste y otros aspectos geológicos. Rev. Inst. Defensa Café (Costa Rica) 15: 337-347.

Umaña, G. 1991. Estudio comparativo del la limnología básica de tres lagunas: Cote, Hule, Bonilla. Informe Final. Vicerrectoría de Investigacion, Universidad de Costa Rica, San José, Costa Rica.