A Modern Pollen Record from the Central Gulf of California

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ABSTRACT: As one facet of an effort to tie the pollen record of central Gulf of California deep cores (Byrne et al., this volume) to modern analogs, pollen was analyzed in the uppermost 150-200 years of varved core 7807-1410 taken nearby. Sampling at 2- to 8-year resolution yielded a noncomplacent record, suggesting pollen in these sediments may be a potential high resolution proxy record of short-term climatic events. The pollen spectrum as a whole matches that of uppermost DSDP Site 480 (means of all samples). Lack of a ratio or influx shift following damming of local rivers and a surplus of low-spine Compositae pollen relative to mainland sites support Baumgartner's theory that terrigenous influx to the site is largely aeolian and also suggest that a significant fraction of the pollen influx may come from Baja California.

INTRODUCTION

Cores taken at Deep Sea Drilling Project Sites 479 and 480 (Byrne et al., this volume) have yielded a rich pollen record extending to the mid-Pleistocene. Much of the length of those cores is varved, potentially allowing high resolution analysis. To bring the fossil record up to the present and to tie it to modern marine (Cross et al., 1966) and mainland (Orvis, 1985) pollen surface samples, analysis was undertaken of samples from similarly varved short core 7807-1410 taken nearby (Figure 1) in 1978 by Baumgartner and others, using an open-vented box corer (Soutar, 1978).

Objectives of the study were twofold:

- First, to see whether higher resolution analysis of pollen from these varved sediments could provide any information regarding patterns of pollen production and processes of sediment transport and accumulation on the Guaymas slope.
- Second, to see whether modern human disturbance has greatly altered the regional pollen spectrum. (If it has, the applicability of modern surface pollen studies would be called into question.)

METHODS

Samples were taken from a 43-cm column about 3x1 cm, at an outside corner of the core, and were cut along varve boundaries as nearly as possible. Samples were prepared routinely according to procedures adapted to the long core material (Byrne, 1982), with *Lycopodium* tracers added to allow influx calculations. Unfortunately the samples were too small, given the relatively low pollen concentrations of uncompacted near-surface sediments; two samples were abandoned, and many others were combined. Samples as counted contained 2 to 10 varves.

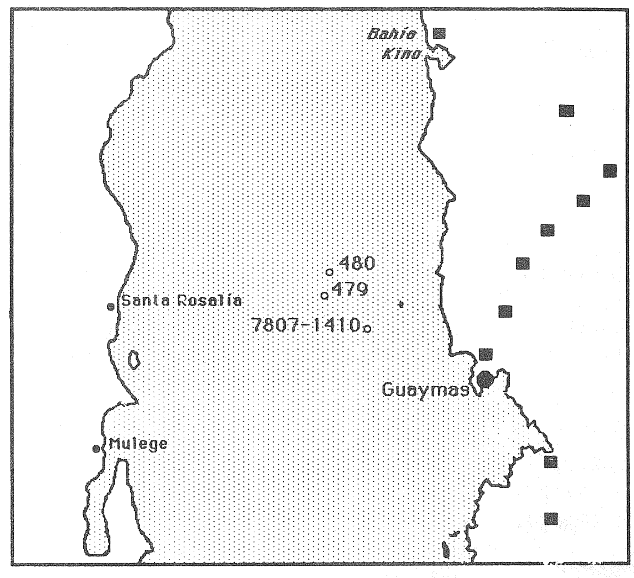

Figure 1. Map of central Gulf of California showing sites referred to in text. Squares mark mainland sample sites within map area.

Pollen counts reported here were made by L.D.Wright after a preliminary series of calibration counts by both Wright and R. Byrne. Discussion in this paper is limited to major taxa, for which discrepancies between analysts are least likely to occur. Sample size limited count totals in some cases (average count was 204, with four counts below 100 and eight others below 200), so the diagram must be regarded as preliminary; comparisons will be based on summed counts (Table 1).

RESULTS

The uppermost sample on the diagram (Figure 2; horizontal units are grains per square centimeter per year) extends through 1967, and individual varves have been accurately dated as far back as 1907 despite nonconformities, by cross-correlating varve patterns with other local cores (Baumgartner et al., 1988a). Using the reconstructed varve sequence, the base of the 18.5 cm sample corresponds approximately to June 1908. A

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Table 1. Pollen spectra for comparison; see text. N is total pollen counted in samples; other values are within-table percentages (rows sum to 100) to facilitate comparison of material from different studies.

	N	*Pinus*	T-C-T	*Quercus*	*Dodonea*	*Celtis*	*Artemisia*	Low-Sp. Comp.	Hi-Sp. Comp.	E-R-A	Gramineae	Cheno-Am.
Core 1410, Post-1958:	834	15.5	0.0	13.8	1.5	0.2	0.6	21.2	6.2	1.4	8.9	30.8
Core 1410, Pre-1908:	2,316	17.0	0.0	9.9	0.9	0.5	1.3	27.2	4.2	1.9	9.9	27.3
Site 480, 0-160 cm:	2,140	9.2	1.9	9.8	0.0	1.0	1.4	28.0	4.1	1.3	13.3	30.1
Adjacent Mainland:	6,042	0.7	0.1	0.5	0.0	2.7	0.0	2.6	13.9	15.6	40.2	23.7
Bahía Kino Sample:	446	0.6	0.0	0.0	0.0	2.7	0.0	45.0	10.9	21.9	3.8	15.1
Core 1410, Semi-homogen.:	451	10.3	0.0	9.8	0.1	0.2	1.2	42.1	4.4	0.7	5.6	25.5

major discontinuity prevents accurate dating farther down, but ^{210}Pb dating suggests that this and several minor discontinuities represent relatively few lost years, and the 85 varves in the lower samples probably place the bottom of the diagram near 1800.

The diagram is far from complacent, exhibiting marked change on two scales. Adjacent samples often differ, suggesting the record is sensitive to short-term changes in pollen production, transport or deposition; and longer-term trends are evident as well. For example, *Pinus, Quercus,* and Gramineae are relatively prominent at the top and bottom and much less so in the center, while low-spine Compositae and Cheno-Am (Chenopodiaceae/Amaranthaceae) remain very prominent in the center.

Absent from the diagram is any evidence of influx diminution. In fact, the top two samples, which include material deposited from 1958-1967 after lower-basin dams were in place on all major central Gulf rivers (Baumgartner et al., 1988b), exhibit the highest and third highest overall influx rates, at 3,337 and 2,650 grains per cm^2 per year. These rates are due in part to high influxes of Cheno-Am, which on the adjacent mainland is typically associated with human disturbance, especially irrigated agriculture (Orvis, 1985), which expanded greatly following completion of the dams.

Even with the rise in Cheno-Am, the averaged pollen spectrum of the two uppermost samples closely resembles that of the pre-1908 samples, while both resemble that of the upper 160 cm of DSDP Site 480 (Table 1; see also Byrne et al., this volume).

None of these, however, closely resembles the spectrum averaged from adjacent mainland samples (Table 1 and Figure 1). Many of the contrasts between the marine and mainland spectra can be expected – *Pinus* and *Quercus* percentages tend to increase offshore due to their excellent transport characteristics, for instance – but the high marine concentration of low-spine Compositae is difficult to explain. The nearest mainland region with commonly comparable low-spine concentrations lies over 250 km to the northeast (Orvis, 1985; compare also Hevly et al., 1965).

One single lowland sample, from near Bahia Kino to the north of the core sites (Figure 1; see Orvis, 1985), yielded a low-spine Compositae concentration comparable to that of the marine spectra (Table 1). Interestingly, the sample site was located in a narrow northern mainland coastal band within which – and nowhere else on the mainland – many of the unique floristic elements endemic to central Baja California can be found. Thus it is conceivable, if the endemism is climatically induced, that low-spine Compositae may be an important pollen constituent in central Baja California.

In addition to the varved material, the core contained "lenticular or tabular bodies" (Baumgartner et al., 1988a) of homogeneous material. Pollen concentrations in this material were extremely low: one pure sample could not be counted at all, while two others yielded concentrations of 536 and 1,776 grains per gram wet weight respectively (the mean for varved samples was 6,787, with a standard deviation of 2,179). Samples of or containing homogeneous material were excluded from the diagram, but all such counts have been summed in the last line of Table 1; the very limited data obtained suggest the contrast with the spectra of varved samples would be more striking in pure homogeneous material.

DISCUSSION

Each of the stated objectives of the study was served admirably, in spite of poorer stratigraphic resolution and some lower counts than expected. The short-term variability observed (even among very robust counts) augurs well for the pollen record's utility as a proxy climate record; a high resolution study of the most recent century could be very rewarding.

In any future study, stratigraphic resolution should be as high as possible and the sequence as complete as possible, making full use of the reconstructed varve sequence (see Baumgartner et al., 1988a). Varved samples must contain at least 5-7 g of wet sediment to ensure statistically robust counts, and homogeneous samples at least 15-20 g.

The impact of human disturbance on the Gulf of California pollen record is reassuringly limited and, in

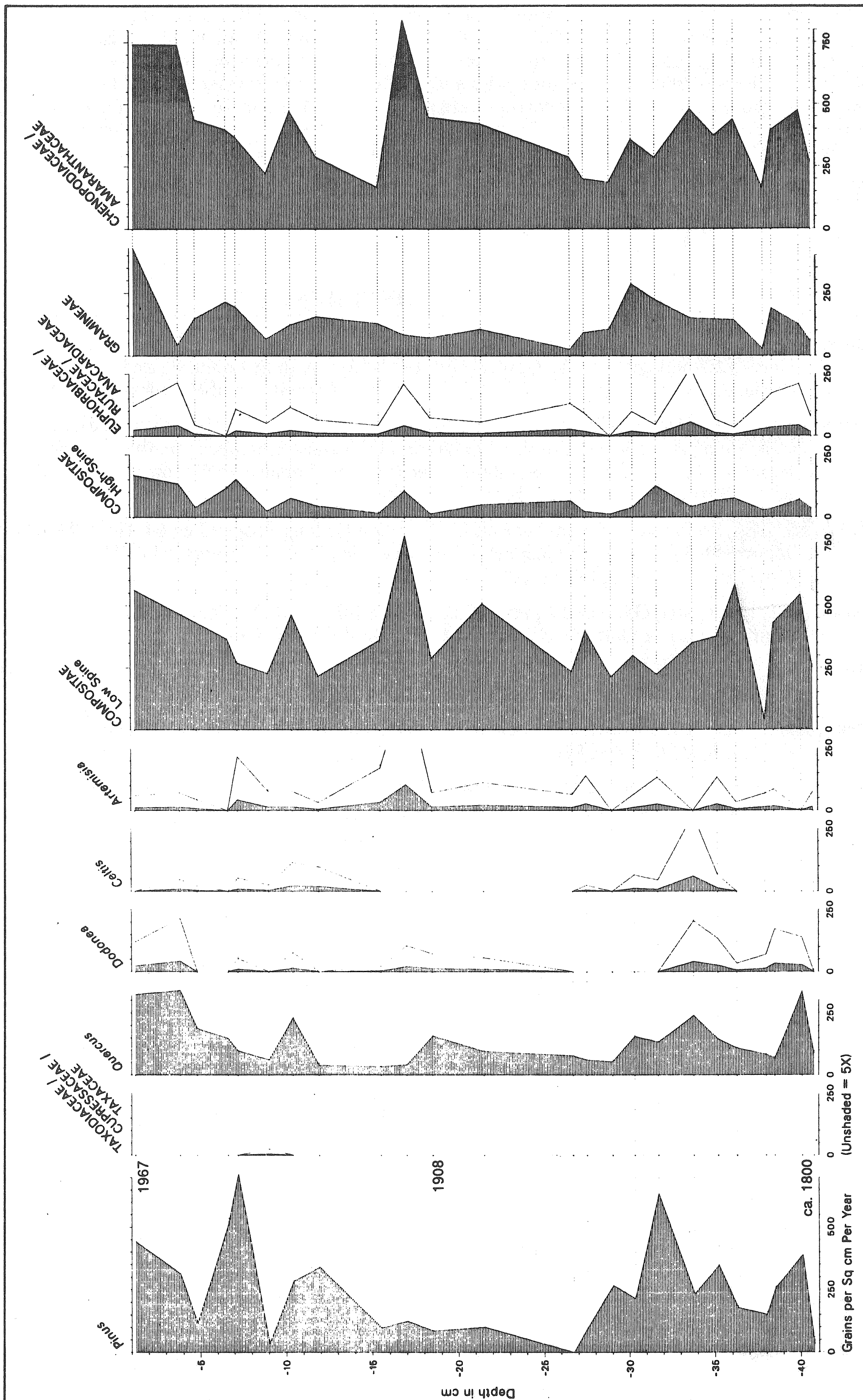

Figure 2. Influx diagram of varved samples, short core 7807-1410.

fact, surprisingly so. Beginning with Hoover Dam on the Colorado River in 1936, dams and the attendant use of water for irrigation have drastically cut fluvial sediment transport to the Gulf, yet pollen influx at the core site remained as strong as before, with a virtually unchanged pollen spectrum. This serves as strong independent corroborating evidence for Baumgartner's conclusion (Baumgartner et al., 1988b) that much of the terrigenic flux at the core site is aeolian rather than fluvial.

The high concentrations of low-spine Compositae pollen in the Gulf cannot be adequately explained by differential long distance transport or other sorting of pollen originating on the mainland. The alternative hypothesis, obliquely supported by the pollen spectrum of the Bahia Kino mainland sample, is that a significant fraction of the cores' pollen influx originates in Baja California. This should be tested.

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