POLLEN EVIDENCE FOR LAND USE AND VEGETATION CHANGE AT PIZZICA-PANTANELLO

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ABSTRACT

Pollen analysis of 18 sediment samples from an ancient reservoir site at Pizzica-Pantanello has provided a 500-year record of local vegetation change and farming activities. During this period there was a nearly constant reliance on cereals, grapes and forage species. Olive production reached its greatest importance during the 4th century B.C., then declined. The upland record suggests that stands of maquis represented the only woodland near the site. These findings are consistent with macrofossil and faunal evidence.

As part of the University of Texas at Austin's archaeological work in the Territory of Metaponto, the author processed and analyzed the fossil pollen content of eighteen sediment samples from a rural sanctuary site at Pizzica-Pantanello. The samples cover a 500-year period (late 7th to 1st century B.C.), and reveal several changes in the vegetation. The pollen record, when combined with historic, plant macrofossil and faunal evidence, provides a picture of the changing environment and economy at the site.

Most of the samples were collected from sediments that had accumulated in a reservoir constructed in the mid-4th century as part of the rural sanctuary complex at Pizzica-Pantanello. The reservoir was fed by water issuing from a nearby spring. The reservoir measured 11 x 14 meters, and was lined with a stone pavement. In the third century B.C. a nearby structure collapsed and the reservoir sediments were sealed between the roof tiles of the collapsed building and the underlying pavement.

About two-thirds of the samples processed were collected from the reservoir deposits; the remaining samples came from deposits above and below the reservoir sediments.

The present report summarizes the results of the pollen analysis and presents new information beyond that previously reported (Sullivan, 1983).

Laboratory Methods

The procedure used to extract pollen from the sediments is presented in Appendix A. One tablet containing 11,300 ± 300 Lycopodium spores was added to each sample at the beginning of the preparation. These spores are counted separately from the pollen in each sample and permit calculation of pollen concentration.

Counts were made using a Leitz Dialux microscope with 10x oculars and a 40x objective. On average over 400 identified pollen grains were counted for each sample, with actual totals ranging from 248 to 606.

Although thirty-four samples were collected at the site, only eighteen were actually analyzed. The remaining sixteen were eliminated for several reasons. Five were eliminated because of potential contamination with modern pollen (these were taken from "exposed surfaces"). Others were eliminated because they contained pollen in low concentrations (less than 15,000 pollen grains/cc), or because pollen preservation was so poor as to render a high proportion of the grains unrecognizable, or because they duplicated other samples.

Stratigraphy of the Section

The sediment samples were taken from several locations in the reservoir collecting basin. The chronological arrangement of the samples was determined from geologic cross-sections of the deposits.

Eighteen samples, dating from the 7th through the 1st century B.C. were used in the analysis. Sediments from the mid-4th through early 3rd/late 4th century were the most heavily sampled, and make up about 2/3 of the samples used in the pollen analysis. Sediments deposited in the early 3rd through mid-4th century were laid down in the reservoir, and are essentially lacustrine sediments.

The uppermost and lowermost sediments were probably not laid down in a lacustrine environment, and contain generally lower pollen concentrations than the reservoir deposits (table 1). The pollen evidence suggests that these sediments are spring or bog deposits, and the sediment matrix is generally coarser than those of the reservoir deposits. There is some evidence to suggest that the lower concentration of pollen in the upper and lower zones is a function of increased sedimentation rates, and not the result of oxidation of the pollen. First, there is no increase in the percentage of 'indeterminant' pollen in the upper and lower strata. If the pollen in these zones had been oxidized one would expect that these zones would include a large number of grains in poor condition. Second, the percentage of thin-walled pollen grains, such as grasses and Cyperaceae, was not substantially lower in these zones. If destruction of the pollen had occurred in these zones, such grains would presumably be among the first to be destroyed.

Pollen Types Encountered

Before discussing the variation in pollen frequencies through the section it seems useful to outline the likely significance of several of the pollen types encountered.

The only upland or forest taxa which occur in significant proportion samples are Quercus (oak) and Pinus (pine). Oaks and pines are generally overrepresented in pollen diagrams, because pines and most oaks produce proportionally greater amounts of pollen than do most other plants. The low percentages of oak and pine strongly suggest that there was no substantial area of forested land near the Pizzica site during the period represented by the samples. Acer (maple) pollen also appears in low concentrations.

While the low Acer, Pinus and Quercus percentages argue against a widespread woodland, it is possible that maquis was locally present. Bottema (1974) found that the presence or absence of maquis and pseudomaquis is difficult to establish palynologically because the dominant maquis species are insect pollinated and therefore rarely encountered in the fossil record. Indicators of maquis, scrub oak, Pistachia, Phillyrea and Labiatae (mint family) for example, are present in most of the Pizzica samples. This suggests that maquis-type vegetation was locally common, possibly that maquis was scattered in a mosaic distribution, as it is today in much of the Mediterranean region.

Graminae pollen representing both cultivated and wild grasses was encountered. It is possible to distinguish between wild and domesticated grasses by size. Palynologists frequently categorize grass pollen greater than 40 microns diameter as cereal pollen. This probably produces a somewhat conservative estimate as some pollen less than 40 microns diameter is produced by cereals. In addition, cereals are not wind-pollinated, so are underrepresented in fossil pollen assemblages. It is assumed here that at least some of the grass pollen less than 40 microns in diameter represents cereal pollen or weedy grasses associated with agriculture, and that the Graminae curve roughly corresponds to changes in the relative importance of cereals. It has been noted in earlier reports (Carter, 1980, 1981; Costantini, 1982a, 1982b, 1983) that cereals, particularly Hordeum and Triticum, were important in the Metaponto region.

Centaurea spp. and Plantago spp. are weedy plants that are associated with grazing of domesticated animals. For the purposes of this report I have used the abundance of these pollen types as an indication of the relative importance of grazing.

The pollen of the Chenopodiaceae and Amaranthaceae is generally indistinguishible and is here combined in one curve as the Cheno/Am type. Increases in the Cheno/Am frequencies are interpreted as reflecting colonization by weedy species. This may indicate invasion of former agricultural fields by weeds. Changes in the Cheno/Am frequencies may also indicate fluctuatuions in the water level in the reservoir as weedy members of these families colonize land exposed as the water recedes.

Typha spp, Sparganium spp., Polygonum persicaria, *Sagittaria* spp., *Alisma* spp., and probably *Lythrum* spp., are aquatics that inhabit ponds or channels. (*Typha* monads and *Sparganium* pollen are counted together). The presence of these pollen types suggests that the reservoir contained standing water with aquatics rooted along the margins or in the bottom sediments. Where *Polygonum persicaria*, *Sagittaria*, *Lythrum* and *Alisma* are absent, or present in very low amounts, I assume that the reservoir was dry or nearly so.

Cyperaceae-type pollen represents the sedge and rush families. Typically members of this group grow in marshy or boggy environments. They are frequently encountered in large numbers where springs keep the soil moist. Higher percentages of Cyperaceae, in conjunction with lower *Typha*/*Sparganium* and *Alisma* counts, are interpreted as periods when the reservoir was dry or at very low levels.

Pollen of the Leguminosae is usually not an important component in most pollen diagrams. The consistent presence of such pollen in the Pizzica samples probably reflects the local cultivation of leguminous crops and/or forage species. Macrofossil evidence from the Pizzica site has previously shown that legumes were grown for forage and human consumption.

The Liguliflorae category represents a subfamily of the Compositae. Costantini (1982a) found abundant seeds of *Sonchus* spp. in the Pizzica deposits, and it seems likely that at least some of the high Liguliflorae pollen counts reflect the presence of *Sonchus* in waste agricultural fields.

Results and Discussion

The Pizzica pollen record indicates several interesting changes in local vegetation and land use during the 500 years represented in the samples. The results are shown graphically in figures 1,2 and 3. All percentages are based on a pollen sum that excludes the aquatic types. For the purposes of discussion four pollen zones are identified in the pollen diagram based on changes in critical taxa. Terrestrial and aquatic (or reservoir-related) taxa will be dealt with separately.

Pollen Zone IV Samples in zone IV are from below the reservoir pavement and date to the late 7th-6th century B.C. Pollen concentrations for the three samples range from 16,000 to 32,000 grains/cc. This zone is characterized by high percentages of Graminae (grass) and Liguliflorae pollen. In addition, the frequencies of pollen from *Centaurea* spp. (star thistle) and *Plantago* spp. (plantain) are higher in this zone than in any other.

Pine, oak and maple pollen percentages are generally low through zone IV, though there is a small peak in pine in the upper part of the zone.

Olive pollen is relatively rare in lower zone IV, but increases in abundance in the upper sample. Leguminosae pollen makes up three to five percent of the pollen sum. *Vitis* (grape) pollen is present, but in low percentages, in lower zone IV.

Cyperaceae is the dominant aquatic pollen type, indicating that sedges and rushes grew on wet ground near the spring. *Typha/Sparganium* percentages are low, while the pollen of *Alisma* and other aquatics are virtually absent, indicating that there was little standing water.

It appears from the pollen evidence that wild and/or cultivated grasses made up an important part of the local vegetation. Carter (1980) noted that leguminous plants may have been alternated or intermixed with grasses to improve forage and soil fertility. Olive, on the other hand, appeared in very low numbers in the oldest sediments, and does not appear to have been as important in the late 7th-early 6th century as it became in zones III and II.

The relatively high *Centaurea* and *Plantago* counts in zone IV probably reflect the importance of grazing in the local area. Faunal evidence from Incoronata indicates that sheep and/or goats were important in the 8th-6th century. High Liguliflorae counts suggest that fallow or waste fields were numerous.

Pollen Zone III This zone corresponds to the lower part of the reservoir deposits and represents the second half of the 4th century B.C. Pollen concentrations are higher than in zone IV, and range from 41,000 to 144,000 grains/cc. This zone is characterized by generally high percentages of olive (*Olea europaea*) (15-24%), grass pollen (22-34%) and Leguminosae pollen (4-11%). *Vitis* frequencies show an increase over the zone IV values. *Centaurea*, *Plantago* and Liguliflorae pollen are less important here than in zone IV.

Pine and maple pollen frequencies are quite low through zone III, but oak pollen shows an increase over zone IV levels.

Typha/Sparganium has generally high frequencies while Cyperaceae is rare. *Alisma* is present in significant amounts, along with other aquatics, in lower zone III and reached a peak in upper zone III. This suggests that the reservoir margin provided habitat for these species.

The pollen record suggests that during the second half of the 4th century B.C. a dramatic change took place in the local economy as olive increased in importance. Grasses, legumes and grape also appeared to increase in importance over zone IV. There was a marked decrease in grazing indicators such as *Plantago* and *Centaurea*.

Pollen Zone II This zone represents the upper part of the reservoir deposits and dates to the late 4th-early 3rd century B.C. Pollen concentrations ranged from 26,000 to 115,000 grains/cc. Here, olive is less important (6-12%) while Graminae increases (to 25-44%). Leguminosae shows a peak in lower zone II, then decreases in importance for the remainder of the zone; *Vitis* pollen is less important in most of the zone II samples.

Pine and maple pollen remain at low percentages. Oak percentages diminish slightly in upper zone II.

Cyperaceae and Cheno/Am pollen increase in zone II. There is a peak in Cyperaceae pollen in lower zone II, followed by a peak in Cheno/Am pollen in the middle of zone II. This could suggest that the reservoir was at the time growing shallower, probably due to siltation. The Cyperaceae may have colonized the newly emerged shoreline.

Typha/*Sparganium*, *Alisma* and *Sagittaria* continue to be important through zone II, so, while the reservoir may have been silting in, there apparently was still some standing or slowly moving water in the basin. In upper part of zone III there is a brief rise in *Typha*/*Sparganium* and *Sagittaria*.

At the base of zone II olive declined in importance, while Graminae pollen increased. There was also a slight decrease in legume and grape pollen. These changes suggest a shift in emphasis toward grain-growing, possibly at the expence of olive and grape cultivation and pasture.

Pollen Zone I Zone I sediments were deposited above the layer of roof tiles, and date from the early 3rd to 1st century B.C. Pollen concentrations decrease to 19,000-36,000 grains/-cc. Leguminosae and *Vitis* pollen percentages drop sharply and Graminae pollen declines steadily here. Compositae, Cheno/Am and Liguliflorae pollen all increase in importance.

Oak and maple remain substantially unchanged from zone II, but pine percentages increase slightly.

In zone I Cyperaceae shows high values and Cheno/Am is again important. *Typha*/*Sparganium* decrease nearly to the zone IV levels, and *Alisma*, *Polygonum* and *Sagittaria* were not encountered. Based on the above, it appears that by this time the basin had completely filled in, although the ground was kept moist by the spring, and supported populations of sedge and rush.

The pollen spectra indicate a steady decrease in the area under cultivation as Graminae, olive, grape and legume pollen percentages all diminish. There is a corresponding increase in Cheno/Am, Liguliflorae and other Compositae pollen, signifying that abandoned agricultural land was overrun by weedy plants.

Conclusion

While the time span represented by the Pizzica sediments is short, the palynological work is significant not only because it provides a record of vegetation change, but also because it represents a rare, successful use of ancient reservoir sediments to reconstruct local vegetation.

The Pizzica pollen samples provide a record of vegetation change in the region over a 500 year period. The agricultural record suggests a nearly constant reliance on grasses and legumes from the 7th to 1st centuries B.C. Olive cultivation appears to have grown in importance up to the late 4th century, then declined.

The aquatic record suggests marshy, wet ground at the site before and after the existence of the reservoir.

The record of forest pollen types indicates that little forest was to be found near the site, except for a mosaic of maquis.

The pollen record can be combined with the historical, macrofossil and faunal evidence to provide a coherent picture of economic and environmental change at the Pizzica site. The combined data illustrate that the economic changes that took place in the region produced landscapes of markedly different character from one period to the next.

References

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Appendix A

1. 1.2 cc of sediment placed in test tube;

2. 10% HCl, to remove carbonates (up to 24 hours), centrifuge and decant (this step was sometimes preceded by a detergent/dispersant wash to break up the sample;

3. wash with distilled H_2O (dH_2O), sieve through 125 micron screen, centrifuge and decant;

4. concentrated HF, to remove silicates (24 hours), centrifuge and decant;

5. wash with dH_2O, centrifuge and decant;

6. 10% HNO_3 (4 minutes), to remove sulfates and sulfides, centrifuge and decant;

7. wash with dH_2O, centrifuge and decant;

8. wash with Glacial Acetic acid, to dehydrate, centrifuge and decant;

9. Acetolysis (9 parts Acetic Anhydride : 1 part Sulfuric Acid) in hot water bath (5 minutes), to remove cellulose, centrifuge and decant;

10. rinse with Glacial Acetic acid, centrifuge and decant;

11. 10% 4OH in hot-water bath, to deflocculate (5 minutes), centrifuge and decant;

12. wash with dH_2O 5-6 times, centrifuge and decant after each wash;

13. stain with 1% Safranin O, centrifuge and decant;

14. Tertiary Butly alcohol, to dehydrate, transfer extract to

vials for storage, centrifuge and decant;

15. Silicone Oil (2000 centistokes), as mounting medium, slides made up as needed.

TABLE 1: POLLEN CONCENTRATION

GRAINS PER CUBIC CENTIMETER

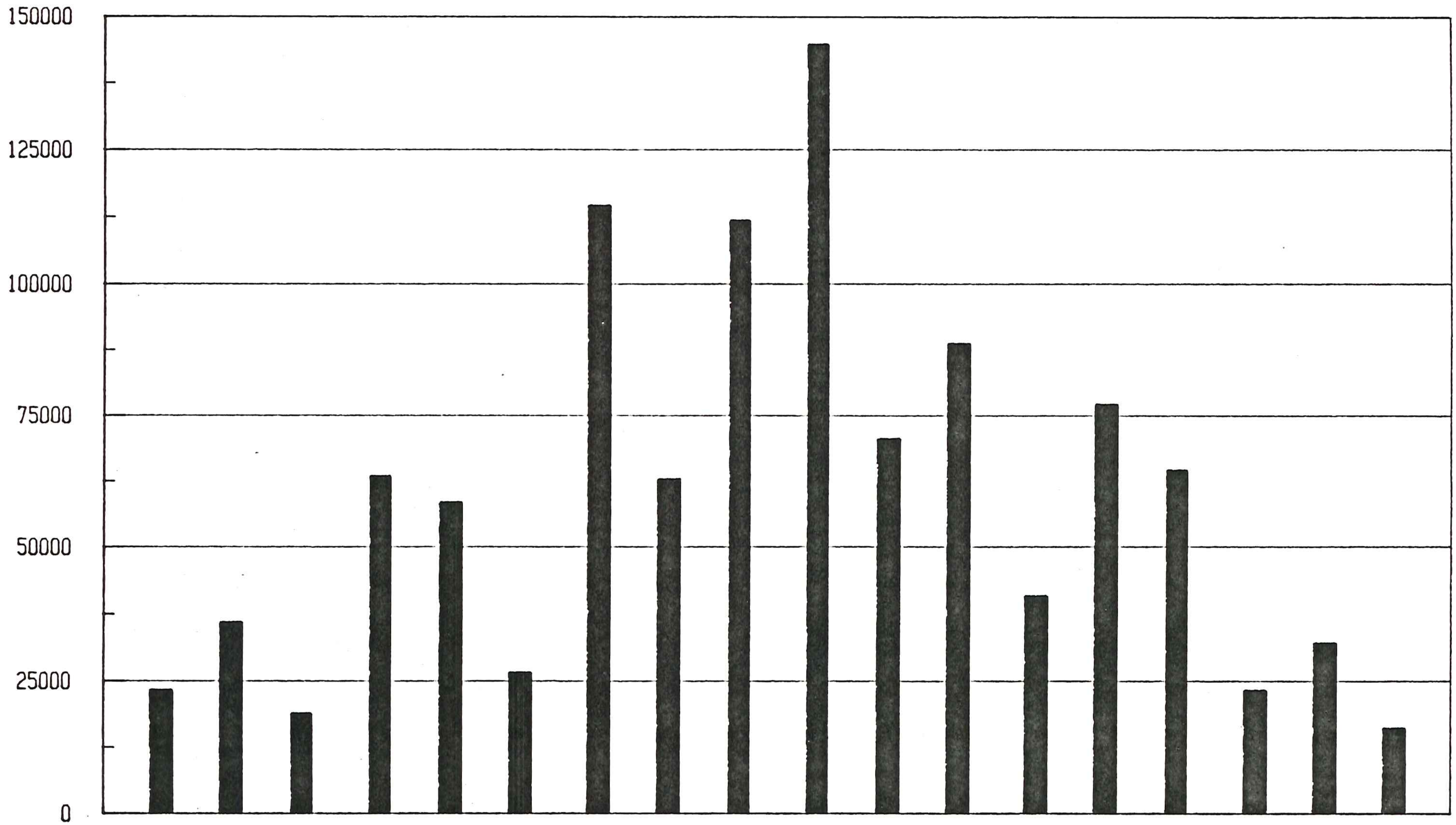

Figure 1. Woodland, maquis and weedy pollen types

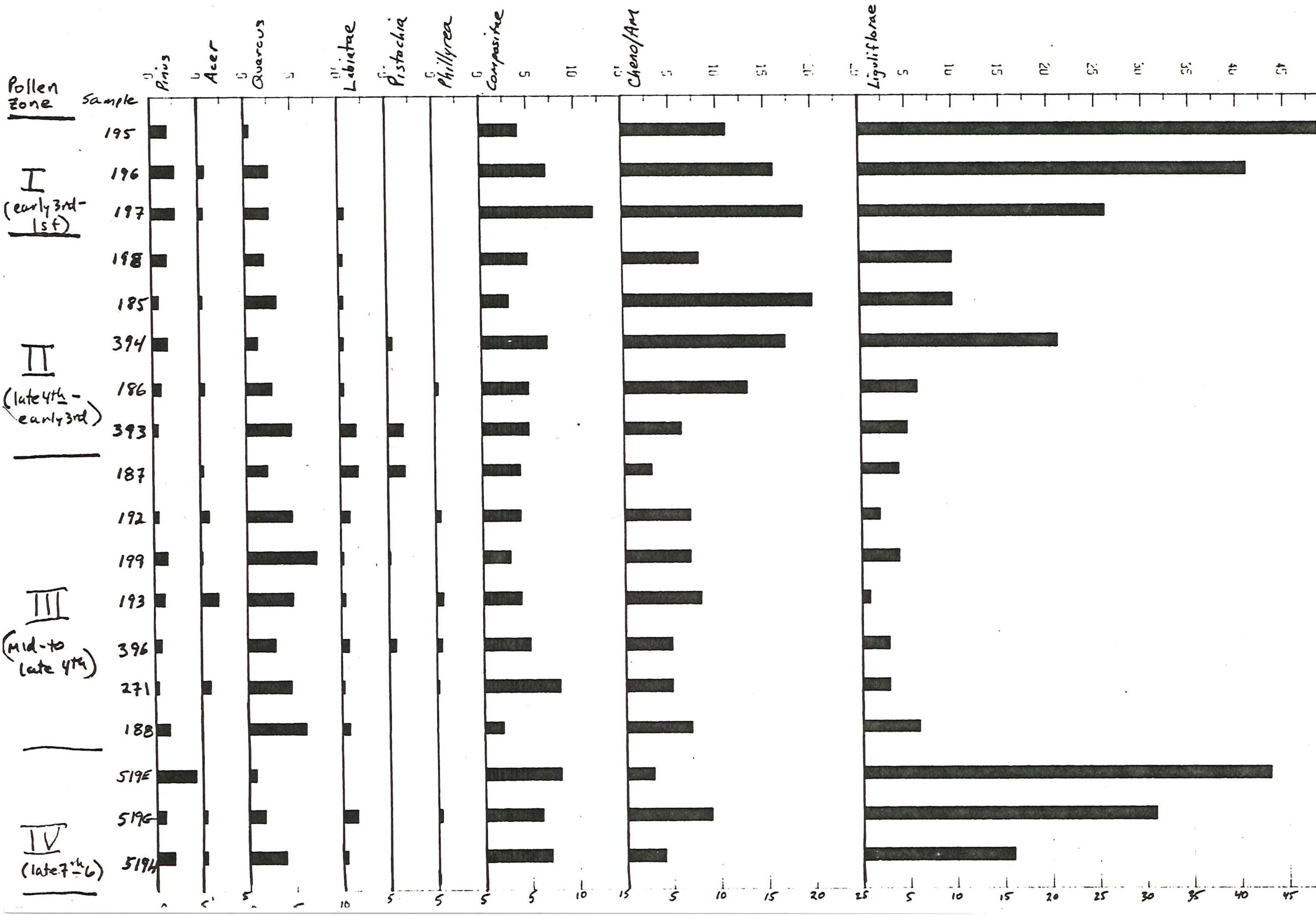

Figure 2. Grasses, cultivated plants and grazing indicators

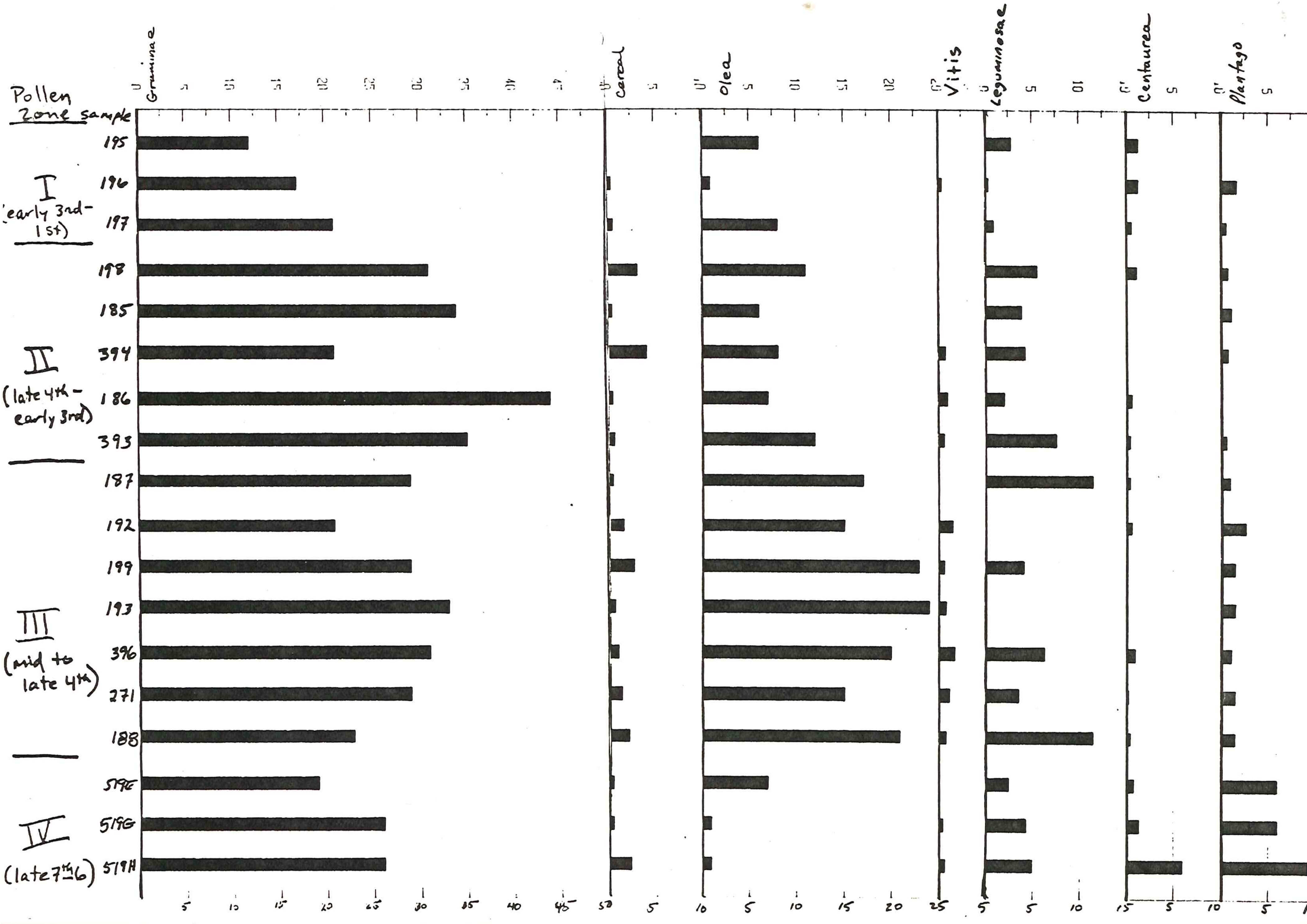

Figure 3. Aquatics