44. PALYNOLOGICAL ANALYSIS OF DSDP LEG 42B (1975) CORES FROM THE BLACK SEA

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INTRODUCTION

Initial palynological study of the Black Sea sediments from DSDP Leg 42B (1975), Sites 379, 380, and 381, is based on investigation of core-catcher samples, about 250 in all. The spacing of the core-catcher units, approximately 10 meters apart, is too wide for the study to provide more than very broad answers to the many questions with which palynology should be expected to help regarding chronology, paleoclimatology, paleoecology, and stratigraphy. Study of more closely spaced samples is underway. The Black Sea sediments contain numerous palynomorphs for marine sediments; practically every sample contains them, both spore/pollen and phytoplankton.

Site reports elsewhere within this volume present a major aspect of the palynological results, that is the "steppe-index" and "marine-influence-index" information for the three sites. The curves obtained by these two indices suggest revelation of important facts about climatic and sedimentary history of the Black Sea basin; the reader is directed to the site chapters for plots of the index data.

MATERIALS AND METHODS

Core-catcher samples studied were mostly silty clays with varying amounts of carbonate. Most samples were unconsolidated, although a few indurated samples, including some limestones, were encountered. During shipboard work, prolonged heating in 20% HCl, followed by boiling with Calgon detergent, and gravity separation with $ZnCl_2$ solution (specific gravity 2.0) produced satisfactory preparations from nearly all samples, but substitution on shore of 52% HF digestion for detergent dispersion resulted in more concentrated and cleaner preparations.

SYSTEMATIC COMMENTS

Pollen and Spores

Most of the identifiable palynomorphs that were recovered are referable to genera (Figures 1-3 and Tables 1-3). *Pinus* and *Cedrus* are combined because of difficulties in separating them in routine analysis; presumably most of the counts are of *Pinus*. Similarly, *Abies* and *Picea* are combined and most of the counts are probably *Abies*. In addition to these four, other kinds of bisaccate conifer pollen occur. For the most part these are presented here as undifferentiated bisaccates, although future work may enable more precise identification. The "bisaccate problem" is intensified by the occurrence, at some levels, of obviously reworked Mesozoic and Paleogene conifer pollen.

"Mesozoic-Paleogene triporates" (Tables 1-3) include a variety of Normapolles and post-Normapolles. Similarly, "trilete spores, undifferentiated include many Mesozoic-Paleogene reworked spores (most of which are identifiable), as well as spores presumably referable to extant genera.

Acritarchs

This category of palynomorphs includes forms of uncertain relationship. As their identity is established, acritarchs are classified with other groups, for example, as dinoflagellates when tabulation, archeopyles-opercula, and/or other characteristic dinoflagellate structures are observed. "Dinoflagellate 19-20", was originally considered to be a pollen grain, then an acritarch until good archeopyles and opercula were observed. Another form (fungal 10 = acritarch 10a), originally classified as an acritarch, later was determined to be a fungal spore. Still other acritarchous forms could conceivably turn out to be dinoflagellates, such as acritarch-13 (quite possible, as some likely dinoflagellate archeopyles were seen) and acritarch-8 (less likely, but not impossible). Although one "acritarchous" form turned out to be a fungal spore, the overwhelming majority of them can be assumed to be part of the life cycle of a marine alga—that is, some sort of phytoplankton. Thus the calculation of "marine-influence indices" from the combined totals of dinoflagellates and acritarchs (Figure 5, Site 379; Figure 5, Site 380; Figure 4, Site 381) is an acceptable procedure. Plate 1, Figures 1-4, and 12-17, show some of the characteristic acritarch types from the Black Sea cores.

Dinoflagellates

Fossil dinoflagellates are, in nearly all instances, the resistant-walled encysted stages of the life cycle of this group of one-celled organisms. Most fossil cysts are of marine origin, although fossil fresh-water dinoflagellate cysts are known. Because much of the history of the Black Sea represented by our cores was that of a fresh or brackish lake, dinoflagellates do not make up as large a part of the fossil record as they would in a truly marine sequence. Nevertheless, they are sufficiently abundant, at certain levels, to represent marine incursions.

Also, as mentioned above, a number of nondescript, "baggy" forms turned out to be undoubted although rather bizarre dinoflagellates, such as dinoflagellates 19, 20, 24a, and 29. These "baggy" cysts are probably brackish water and specialized forms that flourished

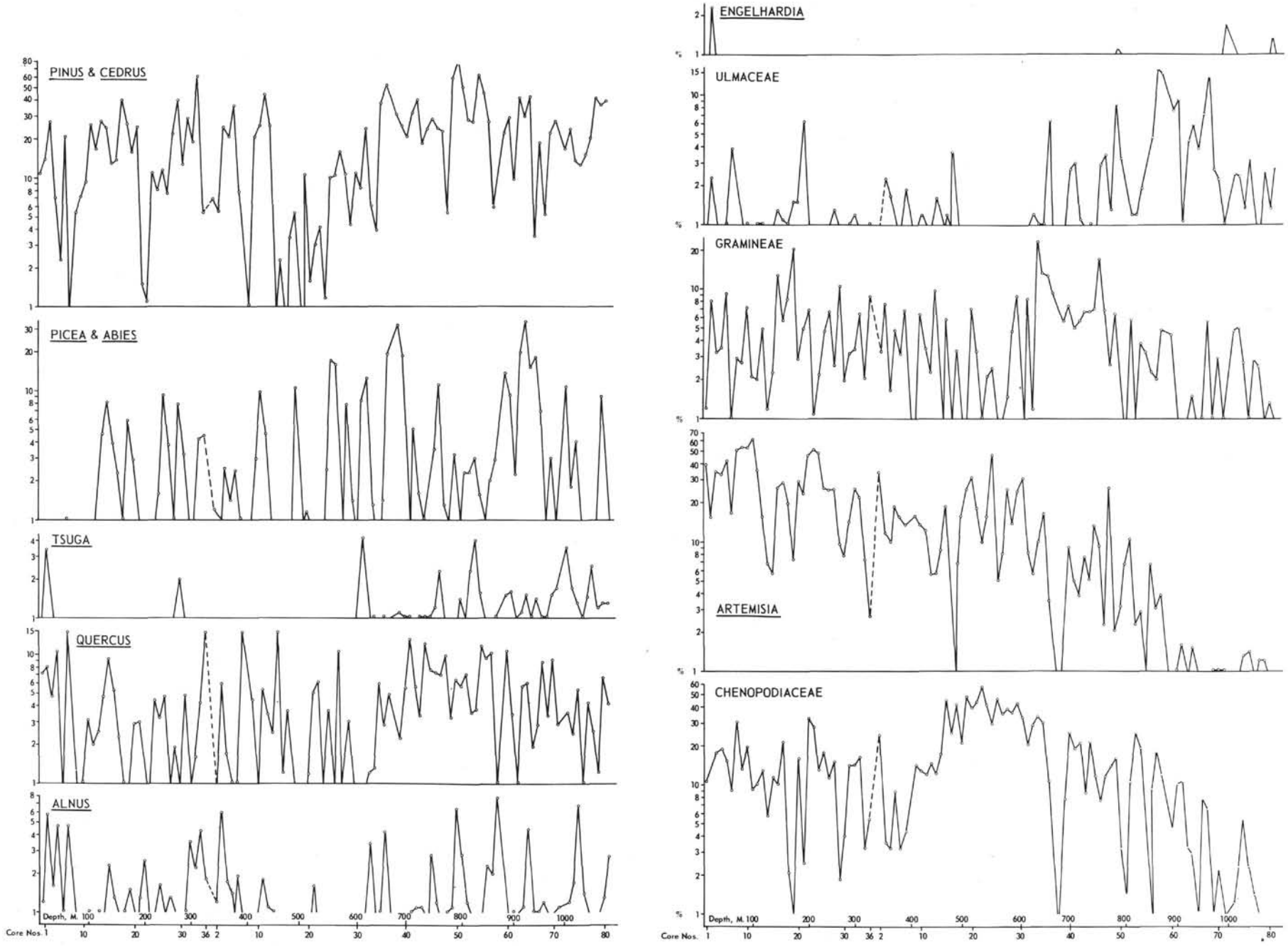

Figure 1. *Pollen distribution, major types, Holes 380/380A, core-catcher samples, plotted semi logarithmically. The small circles represent cores. Where the curve intersects the bottom line with no circle showing, a number less than one is indicated. Circles on the baseline indicate a percentage of one. As explained in the site reports, Core 37 of Hole 380 is correlated palynologically with Core 1 of Hole 380A.*

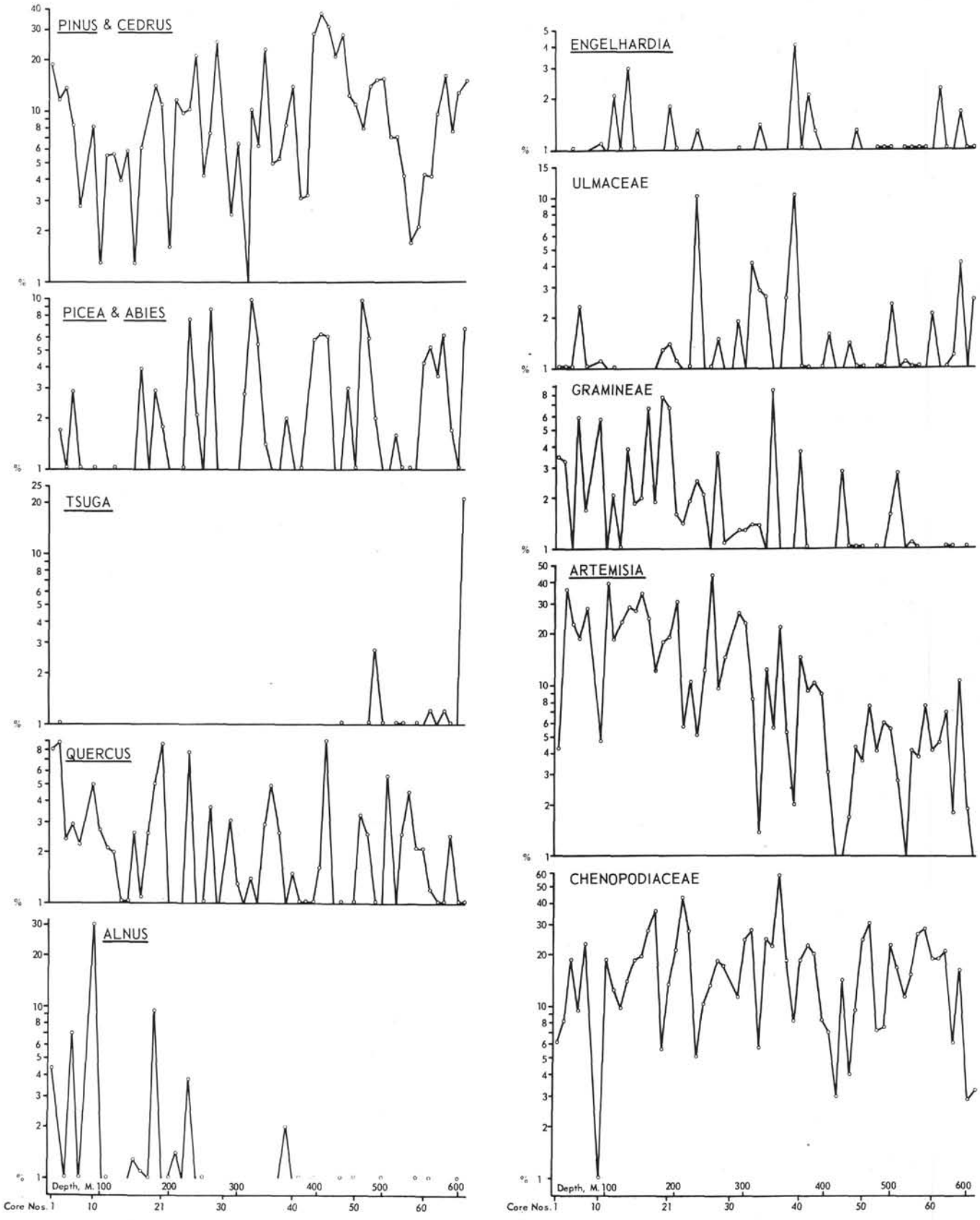

Figure 2. *Pollen distribution, major types, Hole 379, core-catcher samples, plotted as explained in the caption to Figure 1.*

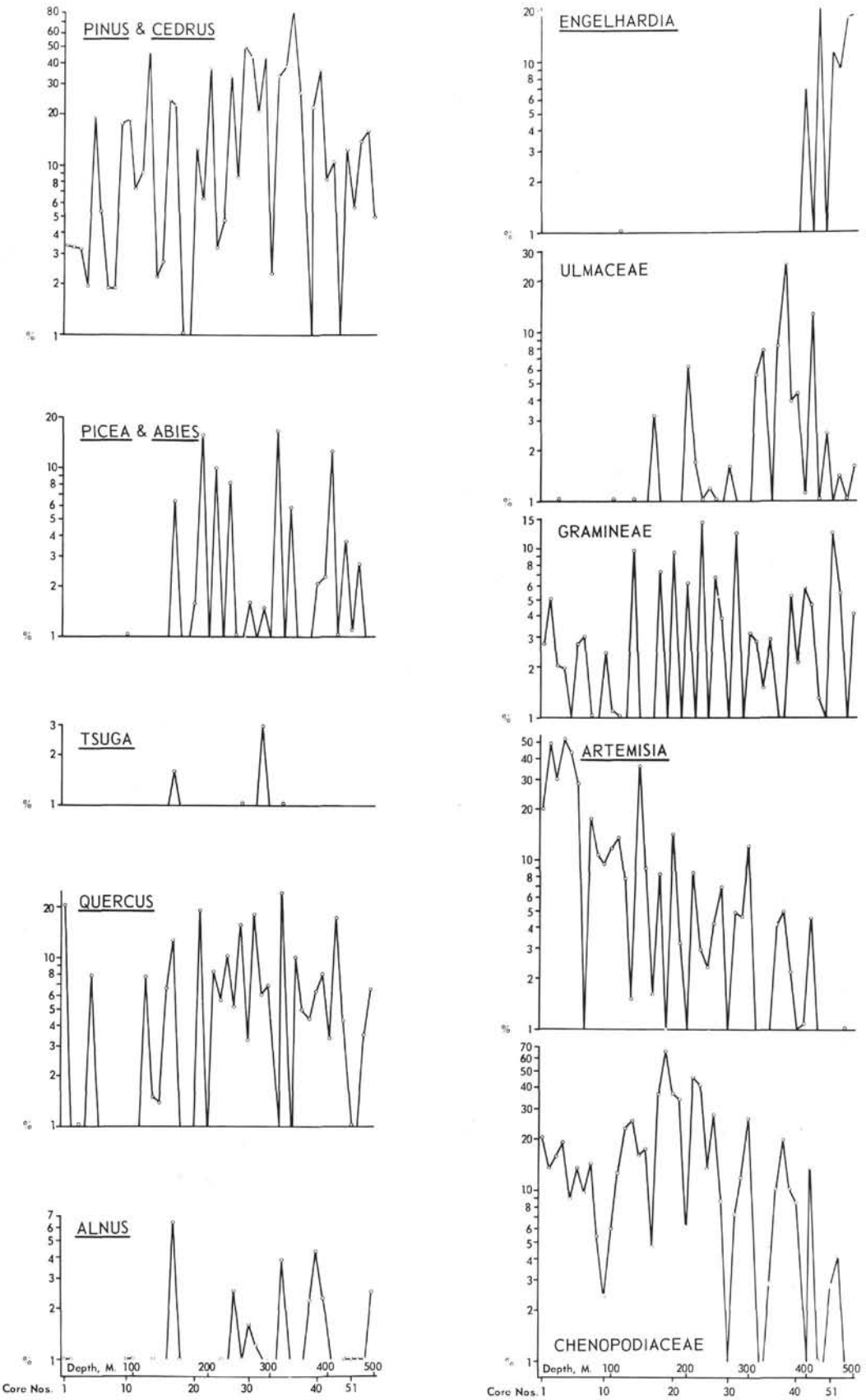

Figure 3. *Pollen distribution, major types, Hole 381, core-catcher samples, plotted as explained in the caption to Figure 1.*

when the water freshened. They tend to be present locally in great abundance as in the case of dinoflagellate-29 which makes up almost 100% of the microfossils found in Sample 381-38, CC (Table 3); a single slide contains at least 4000 specimens! This sort of occurrence must bespeak of an unusual set of ecological circumstances.

Fungal Spores

As can be seen from Tables 1-3, fungal spores and fruiting bodies are a regular constituent of the palynoflora of the Leg 42B cores. Fragments of fungal mycelia are also common, particularly in samples containing a large amount of organic debris. Fungal-10 and fungal-11, which are the dominant elements in some samples are, according to W.C. Elsik who studied my slides, possibly phycomycetes. From my experience it is rare for fungal spores to be so overwhelmingly dominant in a marine or near-marine sediment as these forms are in certain samples (see, for example, Sample 381-35, CC, where the 4000 fungal spores counted are practically all fungal-11).

PALYNOMORPH DISTRIBUTION

Figures 1-3 show graphically the distribution of major components of the palynoflora of the Black Sea sediments. The sample spacing, one per core, is too wide (approximately one per 10 m) to follow minor fluctuations in climate, but broad trends are shown. Summary figures from the Site Chapters representing the same samples should be used in conjunction with the present Figures 1-3. However, the Site Chapter curves are drawn on the basis of a running average. The present curves are straight plots of the data on semilogarithmic paper, to accentuate the smaller percentages. Although these graphs are based on widely spaced samples, they do show that floral changes, reflecting climatic and other environmental factors, were dramatic and frequent during the part of the Neogene sampled, as would be expected (see van der Hammen et al., 1971). The curves in Figures 1-3 show distribution of only a relatively few palynomorph types: *Pinus* + *Cedrus* (mostly *Pinus*), *Picea* + *Abies* (mostly *Abies*), *Tsuga*, *Quercus*, *Alnus*, *Engelhardia*, Ulmaceae, Gramineae, *Artemisia*, and Chenopodiaceae. These and all other counts obtained in this study are presented in Tables 1-3.

Holes 380/380A

These holes (Figure 1) are the standard for the other two because the record is more nearly complete; Hole 381 probably penetrates older sediments.

Age: The much higher percentages of total conifers from about Hole 380A, Core 35 down probably represents the preglacial part of the Pleistocene. *Tsuga* is particularly important in this regard. Small *Tsuga* counts (2%-3%) in two of the higher samples are somewhat puzzling, because *Tsuga* is not likely to be reworked, being insufficiently resistant, but *Tsuga* pollen is present in practically all samples from Core 32 downwards. This fits well with the greater abundance of Ulmaceae pollen below Core 38. The almost complete absence of *Artemisia* pollen below Core 60 probably represents the Pliocene-Pleistocene interface; in applied palynology in the American Gulf Coast, such an advent of *Artemisia* would be interpreted as the onset of a colder, drier, Pleistocene climate. The much lower values of Chenopodiaceae in this part of the record is coordinated with the *Artemisia* data. As noted in the Site Chapters, presumed palm pollen (monocolpate, reticulate) occurs from Core 71 downward. This probably represents early Pliocene sediment. The counts of *Engelhardia* in a few samples below Core 70 may be of reworked specimens, but if they are not, it would indicate that the cores at this level are late Miocene (van der Hammen et al., 1971), or earliest Pliocene in age (Planderová and Gabrielová, 1975). There is no question, however, that at Site 381 older sediments than at Site 380 are penetrated.

Site 379

Although the curves presented in the Site Chapters, based on running averages, present a fairly clean picture, the curves shown here (Figure 2) are somewhat difficult to interpret, in part because there is obvious reworking. A good example of this is *Engelhardia*, all counts of which are presumably reworked pollen. The relatively high *Tsuga* counts at the bottom of Site 379, in Core 68, probably do correlate with similar counts beginning about Core 32 of Hole 380A. *Tsuga* pollen is not as likely to survive reworking as well as *Engelhardia* pollen, and the *Tsuga* counts probably do not represent reworked pollen to a significant extent. The *Artemisia* curve shows the same decline as seen in the lower part of the 380/380A record. As noted in the Site Chapters, based on correlations of the "SFI" and "MI" the bottom of Site 379 probably is not older than Waalian, that is, about mid-Quaternary.

Site 381

The curves for Site 381 are shown in Figure 3. As noted in the Site Chapters, the record appears to be interrupted, representing at most two of the cold periods ("Alpha" and "Gamma"). The *Tsuga* counts, while not many or large, show the existence of the preglacial Quaternary from about Core 15 downward, which ties in well with abundant ulmaceous pollen and general decline of *Artemisia*. As also noted earlier, the abundant *Engelhardia* pollen below Core 43 indicates early Pliocene or late Miocene age, and the lowest part of the record, which also has fairly abundant palm pollen (monocolpate, reticulate) and a number of early Neogene forms such as various "*Tricolpites*" spp. (for example, "*T. microhenricii*") indicates that the bottom of Site 381 is well into Miocene rocks (van der Hammen et al., 1971; Planderová and Gabrielová, 1975).

SUMMARY AND CONCLUSIONS

If the information from the marine-influence ("MI") curves and steppe-influence ("SI") curves are combined with the percentage curves and total count information provided here, a reasonable overall picture of the palynological analysis of the Black Sea cores is obtained, but more detailed analyses from more closely

TABLE 1
Palynological Analyses, Site 379

	1	4	6	7	8	9	10	11	12	13	14	15	16	17	18	19	21
Fungal spores	1	3	2	13	1		5	6	7	11	10	1	26	6	33	14	16
Dinoflagellates																	
Undifferentiated	1	3	3	8	1		–	5	–	3	1	11	8	8	3	2	8
Dino-11	–	–	–	13	–		–	–	–	–	–	–	–	–	–	–	–
Dino-14	–	24	1	–	–		–	–	–	–	–	–	–	–	–	–	–
Dino-19&20	–	–	–	4?	1	±	–	–	–	–	–	–	3	1	–	1	1
Botryococcus						B											
Pediastrum						A				1				1			
Acritarchs						R											
Undifferentiated	46	28	29	23	7	R	16	9	10	17	14	7	31	13	17	13	48
Ac-8	–	31	10	6	1	E	3	3	9	3	4	8	15	1	1	7	2
Cymatiosphaera	–	–	–	–	–	N	–	–	–	–	–	–	–	–	–	–	–
Tasmanites	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–	–
"Circuli-"	1	–	–	–	–		–	–	–	–	–	–	–	–	–	–	–
Trilete spores																	
Undifferentiated	2	–	–	1	–		–	–	–	–	–	1	1	–	–	1	1
Cicatricosisporites, rew.	–	–	–	–	–		–	1	–	–	–	–	–	–	–	–	–
Klukisporites	–	–	–	–	–		–	–	1	–	–	–	–	–	–	–	–
Sphagnum	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–	–
Monolete spores	–	–	–	–	–		2	–	–	–	–	–	–	–	–	1	2
Undetermined pollen	48	35	66	48	51	1	41	42	67	87	45	35	42	36	51	89	36
"Tetrad-1"	1	–	–	–	–		–	–	–	–	–	–	–	–	–	–	1
Monocolpate	–	–	1	1	–	–	–	–	–	3	–	–	–	1	–	3	3
Mesozoic-Paleogene triporates	–	–	1	–	–	–	1	–	1	–	1	–	–	–	–	–	1
Conifers-Gymnosperms																	
Bisaccate	–	6	–	–	–	–	3	–	–	3	3	3	1	1	–	1	7
Inaperturate	–	1	–	–	–	–	2	–	2	7	1	1	–	–	7	7	2
Cedrus	–	6	4	–	1	–	1	–	1	2	–	–	–	1	–	2	1
Picea-Abies	–	3	2	5	1	–	2	–	–	1	–	–	–	7	–	11	4
Pinus	21	15	24	14	4	–	21	2	7	9	5	6	2	10	1	51	23
Sciadopitys	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sequoia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tsuga	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Vitreisporites	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–
Corollina	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ephedra	–	1	–	–	–	–	–	–	–	2	–	1	1	–	–	–	1
Monocots																	
Cyperaceae	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	3	–
Gramineae	4	6	–	10	3	–	16	–	3	2	5	2	3	12	3	30	15
Palmae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Typha	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dicots																	
Alnus	5	–	1	12	1	1	84	–	1	–	-	–	2	2	1	36	–
Amaranthaceae	–	1	2	1	2	–	–	4	2	1	1	–	4	3	2	–	2
Betula	–	–	–	–	1	–	–	3	–	–	–	–	–	1	1	2	3
Carpinus - Ostrya	5	2	1	5	4	–	14	1	2	–	1	–	–	1	–	5	–
Carya	–	1	–	–	–	–	–	1	–	–	–	1	1	1	–	–	2
Castanea	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Celtis	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	–
Chenopodiaceae	7	15	38	16	41	–	2	28	18	19	18	19	30	50	55	21	30
Compositae																	
Undifferentiated	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Artemisia	5	66	46	32	50	–	13	59	27	47	37	28	53	44	19	69	43
Long-spined	–	3	7	5	5	–	–	3	3	7	3	2	5	2	2	5	9
Fenestrate	–	–	–	–	2	–	1	–	1	1	–	–	1	–	–	–	1
Corylus	1	–	1	–	–	–	4	1	–	–	1	1	–	1	3	1	–
Engelhardia	–	–	1	–	–	–	3	–	2	2	4	1	–	–	–	–	4
Ericaceae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Fagus	1	–	1	6	5	5	42	–	2	–	1	–	–	3	5	12	5
Fraxinus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Myrica	–	–	–	2	–	–	1	–	–	–	–	–	–	–	–	1	1
Nyssa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pterocarya	–	1	2	3	2	–	1	–	–	–	–	–	–	2	1	3	2
Quercus	9	16	5	5	4	–	14	4	2	4	1	1	4	2	4	19	19
Tilia	–	–	–	–	–	–	2	–	1	–	1	1	–	–	–	–	–
Ulmaceae	1	1	1	4	1	–	3	–	1	–	–	–	–	–	–	5	3
Umbelliferae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Zelkova	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1

TABLE 1 – *Continued*

22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
13	–	12	1	–	6	–	6		1	–	–	–	–	–	2	2	1	–	2	4
1	–	–	–	–	7	1	–		1	4	–	–	–	–	–	–	–	–	2	–
–	–	–	–	–	–	–	–	±	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	B	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	30	6	–	A	–	–	–	–	–	40	450	–	1	–	–	–
–	–	–	–	–	–	–	–	R	–	–	1	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	R	–	–	–	–	–	–	–	–	–	–	–	–
								E												
13	6	40	28	40	11	16	6	N	8	20	15	10	15	12	–	2	5	7	18	9
1	–	–	–	–	2	–	–		6	–	–	–	–	–	–	–	1	4	2	–
–	1	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1	–	–	–
–	–	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–
1	–	1	1	–	–	–	–	1	–	–	4	–	–	5	–	–	–	–	1	1
–	–	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	1	1	2	1		–	–	3	2	–	2	–	1	1	1	1	2
67	20	40	22	20	35	54	30	1	67	29	22	26	37	14	2	20	25	36	81	76
–	–	–	–	–	–	–	–		1	–	–	–	–	–	–	–	–	–	–	–
–	–	–	1	–	1	–	–	–	1	–	–	–	–	1	–	–	–	–	–	–
1	–	2	1	–	–	–	1	–	3	1	–	–	–	–	1	–	1	–	3	–
7	–	–	4	1	–	4	2	–	2	–	2	10	2	–	–	1	3	9	17	9
1	–	–	–	–	–	–	–	–	4	–	1	1	–	–	–	1	–	–	5	1
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–
–	–	1	6	1	–	12	–	4	–	–	2	7	6	1	–	–	1	–	1	–
3	8	10	8	10	5	10	22	–	4	5	–	7	7	16	2	2	4	17	5	5
–	2	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	1	–	1	–	–	1	1	–	–	–	–	–	–	3	–	3
–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
3	1	2	2	1	–	5	1	–	2	1	1	1	–	6	–	–	–	5	2	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1	1	–	3	–	1	–	–	–	–	–	–	–	–	–	–	–	1	–	1	–
–	1	1	–	–	2	2	1	1	–	–	–	1	–	1	1	1	–	2	4	4
–	–	1	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	1	–	–
–	–	1	4	1	–	1	–	–	–	–	1	–	1	–	–	1	–	2	–	–
–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
41	30	29	4	5	16	25	15	–	18	19	20	4	28	16	24	7	4	24	44	31
–	3	4	1	1	–	–	–	–	–	3	3	1	2	1	–	–	–	–	–	–
61	4	11	4	6	53	13	13	–	43	18	6	1	14	4	9	2	1	19	18	16
4	–	–	–	–	3	–	–	–	5	–	–	–	–	–	–	–	–	6	4	2
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1	–	–	1	–	–	–	–	–	–	–	1	–	2	–	–	–	–	–	–	–
1	–	–	1	–	–	–	–	–	1	–	–	1	–	–	–	–	2	1	4	2
–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–
–	–	–	1	1	–	–	–	–	–	–	–	2	1	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	6	–	1	5	–	–	5	1	–	1	–	2	2	1	–	2	1	1
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
2	–	1	8	–	1	2	–	–	3	–	3	2	3	–	–	1	5	1	1	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 1 – *Continued*

	43	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Fungal spores	2	1	1	1	4	–	–	–	–	–	2	–	5	5	5	12	1
Dinoflagellates																	
Undifferentiated	–	1	–	–	–	6	–	4	2	–	–	1	–	1	7	6	19
Dino-11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dino-14	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dino-19&20	2	–	–	–	2	–	1	384	100	14	–	1	28	3	44	45	165
Botryococcus	–	1	2	–	–	–	1	–	–	–	1	–	–	–	–	–	–
Pediastrum	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Acritarchs																	
Undifferentiated	26	19	4	4	32	15	3	5	23	11	11	6	12	16	20	57	11
Ac-8	4	7	4	1	–	5	4	1	3	–	–	1	5	2	–	–	2
Cymatiosphaera	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tasmanites	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
"Circuli-"	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Trilete spores																	
Undifferentiated	2	1	1	1	6	1	4	1	6	–	1	–	–	3	2	–	–
Cicatricosisporites, rew.	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
Klukisporites	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sphagnum	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1
Monolete spores	1	–	–	–	1	–	2	–	5	1	1	–	3	1	–	1	–
Undetermined pollen	69	34	10	15	125	73	25	24	76	44	39	25	103	152	149	104	23
"Tetrad-1"	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–
Monocolpate	–	–	–	–	1	–	1	–	2	1	1	–	1	–	–	2	2
Mesozoic-Paleogene triporates	–	–	–	–	1	–	1	–	–	–	–	–	3	1	–	2	–
Conifers-Gymnosperms																	
Bisaccate	12	15	2	2	25	62	13	9	46	40	20	13	20	19	7	18	3
Inaperturate	–	–	1	–	9	5	–	1	3	2	–	–	3	1	4	13	1
Cedrus	–	5	3	1	28	13	4	–	8	3	3	1	3	1	3	–	1
Picea-Abies	11	8	2	–	–	7	1	9	14	3	–	–	3	1	2	1	2
Pinus	52	42	7	6	52	15	8	7	25	19	16	4	10	11	2	6	1
Sciadopitys	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sequoia	–	–	–	–	1	1	–	–	1	–	–	–	–	–	–	–	–
Tsuga	–	–	–	–	1	–	–	–	1	4	1	–	1	1	–	2	–
Vitreisporites	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
Corollina	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Ephedra	1	–	–	–	2	–	1	–	–	1	–	–	–	–	–	–	–
Monocots																	
Cyperaceae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gramineae	–	–	–	1	3	1	1	–	2	–	2	2	–	3	1	–	–
Palmae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Typha	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dicots																	
Alnus	1	–	–	–	1	–	1	–	–	–	1	–	–	–	–	2	–
Amaranthaceae	–	1	–	1	–	1	5	–	–	–	–	1	2	7	4	2	–
Betula	–	–	–	–	1	2	–	–	–	–	–	–	–	–	–	1	–
Carpinus - Ostrya	1	1	1	1	2	1	–	–	–	–	–	–	1	1	–	–	–
Carya	–	–	–	1	1	–	–	–	1	1	–	–	–	1	–	–	–
Castanea	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Celtis	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
Chenopodiaceae	16	9	1	5	12	22	27	28	17	11	28	12	21	44	76	81	9
Compositae																	
Undifferentiated	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Artemisia	17	4	–	–	5	10	4	7	10	9	7	2	–	12	11	22	2
Long-spined	3	3	–	–	7	10	7	1	2	2	–	3	5	8	4	14	2
Fenestrate	–	–	–	–	1	3	–	1	1	–	–	3	2	2	–	1	–
Corylus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Engelhardia	–	–	–	–	–	3	–	–	2	1	1	–	1	2	3	–	–
Ericaceae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Fagus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Fraxinus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Myrica	–	–	1	–	2	–	–	–	1	–	–	1	1	–	–	–	–
Nyssa	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
Pterocarya	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1	1	–
Quercus	1	2	3	–	2	–	1	3	6	1	–	4	1	7	13	6	1
Tilia	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–
Ulmaceae	1	2	–	–	4	1	1	–	1	1	3	–	2	1	3	–	1
Umbelliferae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Zelkova	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 1 – *Continued*

62	63	64	65	66	68
6	5	1	3	9	39
8	4	8	3	15	4
–	–	–	–	–	–
–	–	–	–	–	–
88	10	182	6	2	2
–	–	–	–	–	2
–	–	–	–	–	–
26	14	20	21	59	28
2	–	1	1	2	25
–	–	–	–	–	–
–	–	–	1	–	–
–	–	–	–	–	–
3	1	1	2	4	3
–	–	–	–	–	–
–	1	–	–	–	–
–	–	–	–	–	–
1	1	1	1	2	3
59	38	31	33	61	55
–	–	–	–	–	1
4	2	–	–	–	–
1	–	–	5	2	–
29	14	62	11	75	50
1	–	–	1	5	1
1	6	3	1	1	23
9	4	10	2	2	16
6	5	23	8	25	13
–	–	–	–	–	–
–	–	1	–	–	–
2	–	2	1	8	52
–	1	2	2	–	1
–	–	–	–	–	–
1	2	–	–	–	–
–	–	–	–	–	–
–	1	1	–	2	–
–	–	–	–	–	–
–	–	–	–	–	–
1	–	–	–	1	–
1	2	1	1	–	–
–	–	–	–	–	1
–	–	–	–	1	–
1	–	–	1	1	1
–	–	–	–	–	–
–	–	–	–	–	–
33	24	10	20	6	8
–	–	–	–	–	–
8	8	3	13	4	–
4	6	7	4	4	4
1	–	1	–	2	1
–	–	–	1	–	–
4	1	–	2	2	2
–	–	–	–	–	–
–	–	–	–	–	–
–	–	–	–	–	–
–	–	–	–	–	–
–	–	–	–	–	–
–	–	–	–	–	2
2	1	1	3	1	2
–	–	–	1	–	–
–	1	2	5	–	6
–	–	–	–	–	–
–	–	–	1	–	–

spaced samples will be required to follow Neogene climatic and vegetational fluctuations, of which the Black Sea cores provide a unique record. The palynological study demonstrates the prevailingly fresh to brackish water conditions in the Black Sea basin during most of Neogene time, and the record also supports a picture of dramatically fluctuating climatic conditions during the Pleistocene with, however, an indication of a limited number of large-scale cold (probably three) and warm periods. One very significant point that emerges from the palynological analyses is that the apparent transgressive periods in Black Sea history were not all necessarily coordinated with the warmer periods, as might have been expected from the post-glacial record (see Traverse, 1971). Indeed, the most dramatic transgressive episode occurred during cold period "Alpha" (see Site chapters, especially pollen figure for Site 380).

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PLATES 1 AND 2, ILLUSTRATING REPRESENTATIVE PHYTOPLANKTONIC AND FUNGAL FORMS

General note: Most of the palynomorphs encountered in these cores are common, well-known forms of pollen and spores. It is really not necessary to illustrate or describe such well-known fossils as *Artemisia* and *Alnus* pollen grains and *Sphagnum* spores. However, a number of unusual fungal-spore and phytoplanktonic fossils do occur and are abundant and important in certain samples. These will be described and illustrated here, though the descriptions are brief and informal, and no formal nomenclature will be introduced at this time. All photos are ±1000×, except where otherwise noted.

TABLE 2
Palynological Analyses, Holes 380/380A

380	1	2	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Fungal spores	–	–	–	–	–	1	–	–	–	–	–	2	–	–	–	–	–	–	–	–
Dinoflagellates																				
Undifferentiated	1	2	–	–	–	–	–	–	–	–	–	1	–	9	–	–	–	–	1	1
Dino-19&20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Botryococcus	–	–	–	2	–	2	14	–	–	–	–	–	–	–	–	–	–	–	–	–
Pediastrum	–	2	1	–	1	–	1	–	–	–	2	1	–	–	2	–	–	–	–	1
Acritarchs																				
Undifferentiated	4	15	1	45	1	83	59	2	–	3	3	5	7	–	4	4	5	43	1	2
Ac-1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ac-8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cymatiosphaera	–	5	–	1	–	2	–	–	–	–	–	–	1	–	–	–	–	1	–	–
Tasmanites	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
"Circuli"	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Trilete spores																				
Undifferentiated	1	2	1	–	–	–	–	3	1	2	–	9	8	2	–	2	1	2	–	2
Sphagnum	–	–	–	–	–	–	–	–	–	–	–	2	1	–	–	–	–	–	–	–
Klukisporites	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Monolete spores	1	–	–	1	1	–	–	–	–	1	4	3	5	1	2	–	–	1	1	–
Undetermined pollen	16	19	1	5	25	27	6	17	6	4	11	9	8	3	3	11	12	6	8	11
"Tetrad-1"	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Monocolpate	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mesozoic-Paleogene triporates	–	3	–	–	2	–	–	1	–	1	1	–	–	1	–	–	1	–	1	3
Conifers-Gymnosperms																				
Bisaccate	1	4	2	–	–	1	–	2	–	–	3	25	16	13	2	2	1	3	2	9
Inaperturate	–	1	–	2	1	–	–	3	1	–	1	2	2	2	2	2	3	5	3	1
Cedrus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Keteleeria	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Picea-Abies	–	–	–	–	–	1	–	–	–	–	–	–	4	7	3	2	1	4	2	–
Pinus	9	12	17	6	3	32	–	6	7	9	26	21	24	21	10	12	38	18	11	20
Sciadopitys	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–
Sequoia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Taxodiad	–	1	1	–	–	–	–	–	–	–	–	–	–	–	2	1	–	3	–	–
Tsuga	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Vitreisporites	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Corollina	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–
Ephedra	–	–	1	–	–	1	1	–	–	–	–	–	–	–	1	1	–	–	–	–
Monocots																				
Cyperaceae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gramineae	1	7	2	3	12	1	2	3	7	2	2	6	1	2	9	5	8	14	2	4
Palmae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Typha	–	–	–	–	1	2	–	–	–	–	–	1	–	1	–	–	–	–	–	–
Dicots																				
Alangium	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Alnus	1	5	1	4	1	7	–	–	–	1	–	1	–	2	1	–	1	1	–	1
Amaranthaceae	–	–	–	–	1	–	1	1	–	–	–	–	–	1	–	2	–	–	–	–
Betula	–	1	–	1	–	3	–	–	2	1	–	1	–	–	2	–	1	–	1	–
Carpinus - Ostrya	1	–	1	2	3	3	–	–	–	–	–	1	–	3	–	–	1	1	–	–
Carya	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
Castanea	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Castanopsis	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Celtis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Chenopodiaceae	9	–	11	16	20	14	21	15	19	9	10	16	5	10	8	19	2	–	11	2
Compositae																				
Undifferentiated	4	2	–	1	2	1	3	1	–	3	–	1	1	2	4	–	3	2	2	3
Artemisia	33	14	22	29	56	26	35	60	52	60	35	19	6	5	20	25	19	5	20	19
Long-spined	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Fenestrate	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Corylus	1	–	–	3	1	1	–	–	–	–	–	–	1	2	2	1	1	–	1	–
Engelhardia	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–
Ericaceae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Fagus	–	–	–	1	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Fraxinus	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ilex	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Itea	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Labiatae	–	–	–	–	–	1	–	–	–	–	1	1	–	–	–	–	–	–	–	–
Liquidambar	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Moraceae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Myrica	–	2	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	–	–
Nyssa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Parthenocissus	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–
Pterocarya	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–
Quercus	6	7	3	9	–	23	–	–	1	3	2	3	4	8	4	2	1	–	2	–
Salix	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–
Tilia	–	–	–	1	1	2	–	–	–	–	–	–	–	–	1	–	–	–	–	–
Ulmaceae	–	2	–	–	1	6	–	–	1	–	1	1	–	–	1	1	1	1	1	5
Umbelliferae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Zelkova	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 2 – *Continued*

22	23	24	25	26	27	28	29	30	31	32	33	35	36	37	38	39	40
1	1	1	–		1	–	1	1	–	–	1	–	–	–	–	2	–
–	–	–	–		–	–	–	1	–	–	–	1	–	–	–	2	–
–	–	–	–		–	–	–	–	–	8	17	–	6	–	1	18	–
–	–	–	–		–	–	–	–	–	1	–	–	–	–	–	–	–
–	–	–	–		–	2	–	–	4	–	–	–	–	–	–	–	–
				B													
1	2	3	2	A	3	2	4	1	10	3	39	6	102	–	2	13	–
–	–	–	–	R	–	–	–	–	–	–	1	–	–	–	–	–	–
–	–	–	–	R	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	E	–	–	–	–	–	–	–	–	3	–	–	–	–
–	–	–	–	N	–	–	–	1	–	–	–	–	–	–	–	–	–
–	–	–	–		–	–	–	–	–	–	–	–	–	–	1	–	–
–	1	1	1		1	1	6	4	2	–	–	–	–	2	–	–	6
–	–	–	–		–	–	2	2	–	–	–	–	–	–	–	–	1
–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	1	1		–	1	1	3	3	–	–	–	1	3	1	–	1
3	11	3	11		6	17	15	17	18	13	27	4	22	–	6	23	–
–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–
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1	–	2	4		–	3	6	–	3	–	1	–	–	–	–	–	1
–	–	–	3		14	7	14	5	12	1	3	–	–	–	–	2	4
–	2	1	1		–	2	3	5	12	3	–	–	7	1	2	17	3
–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	1		8	3	1	8	4	–	–	4	5	–	1	–	2
3	1	5	5		10	6	23	40	16	25	23	58	6	10	10	14	6
–	–	–	–		–	–	–	–	–	–	–	–	1	1	–	–	–
–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–
1	–	–	–		–	–	1	–	1	–	2	1	4	–	–	–	–
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2	–	–	–		–	–	–	–	–	–	1	–	–	–	–	–	–
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14	1	1	3		6	2	11	2	4	3	8	2	10	1	1	10	3
–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–
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–	–	1	–		–	2	–	–	–	–	2	–	–	–	–	–	1
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–	–	–	–		–	–	–	–	–	–	2	1	12	–	–	–	–
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5	–	–	1		–	1	–	–	1	3	2	4	2	–	–	2	–
–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–
66	25	6	11		10	12	2	4	17	12	20	3	6	4	4	18	13
4	–	–	2		5	–	7	–	6	–	1	2	1	–	–	3	–
93	47	22	16		22	20	10	8	18	22	27	7	3	3	5	21	35
–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–
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–	–	–	–		–	–	–	–	–	1	1	2	13	–	–	–	–
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–	1	–	–		–	–	–	–	–	1	–	1	–	–	–	–	–
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6	–	2	2		4	–	2	–	6	–	2	4	17	1	1	14	1
–	–	–	–		–	–	–	1	–	–	–	–	–	–	–	–	–
–	–	–	–		–	–	–	–	–	–	–	–	1	–	1	–	–
–	–	–	–		–	1	–	–	1	1	–	–	1	–	–	1	1
–	–	–	–		–	–	–	–	–	–	–	–	–	–	–	–	–
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TABLE 2 – *Continued*

380A	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Fungal spores	–	–	1	–	4	–	–	–	–	2	6	–	–	2	–	–	–	–	1	–
Dinoflagellates																				
Undifferentiated	1	–	–	6	1	–	1	–	9	–	–	–	1	–	–	3	–	–	–	–
Dino-19&20	4	–	4	1	–	–	2	–	21	–	–	25	3	49	46	44	36	500	20	75
Botryococcus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–
Pediastrum	1	–	–	2	–	1	–	–	–	1	–	–	1	–	–	–	–	–	–	–
Acritarchs																				
Undiferentiated	3	10	5	9	6	1	2	–	17	2	7	6	13	12	10	6	1	1	–	–
Ac-1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ac-8	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1	–	–	–	–
Cymatiosphaera	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tasmanites	–	–	–	–	–	–	–	1	–	3	–	1	–	–	–	–	–	–	–	–
"Circuli"	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Trilete spores																				
Undifferentiated	2	3	1	2	6	5	1	2	–	6	3	–	–	1	–	1	6	1	–	1
Sphagnum	–	–	–	2	–	1	–	–	2	–	–	2	1	1	–	1	2	–	–	–
Klukisporites	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Monolete spores	3	1	1	3	1	3	–	–	2	11	3	1	2	1	–	–	–	3	1	–
Undetermined pollen	9	12	58	24	34	22	60	–	63	39	16	9	25	15	11	16	3	2	12	3
"Tetrad-1"	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Monocolpate	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mesozoic-Paleogene triporates	–	2	–	3	3	3	–	–	–	1	1	1	1	–	–	–	1	–	–	–
Conifers-Gymnosperms																				
Bisaccate	11	2	1	22	10	–	1	1	3	3	4	4	4	2	–	–	1	2	–	–
Inaperturate	–	2	21	2	3	1	5	1	–	–	1	–	–	–	1	–	–	–	–	–
Cedrus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Keteleeria	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Picea-Abies	7	1	–	3	2	3	1	2	–	5	11	4	–	–	–	–	–	2	–	1
Pinus	33	6	12	30	30	46	16	3	1	36	29	39	33	–	2	–	1	1	–	9
Sciadopitys	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sequoia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Taxodiad	–	–	5	3	1	–	1	–	–	1	–	–	–	–	–	–	–	1	–	–
Tsuga	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Vitreisporites	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Corollina	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ephedra	–	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	1
Monocots																				
Cyperaceae	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–
Gramineae	4	3	17	2	7	4	14	–	–	11	4	2	12	–	5	–	1	–	–	6
Palmae	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–
Typha	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dicots																				
Alangium	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Alnus	–	1	13	2	2	–	4	–	–	–	2	1	1	–	–	–	–	–	–	–
Amaranthaceae	–	2	–	–	–	1	–	–	–	1	3	–	2	–	7	–	–	–	3	2
Betula	–	–	–	–	–	5	1	–	1	–	–	–	1	–	–	1	–	–	–	–
Carpinus - Ostrya	–	–	15	–	–	1	11	–	–	–	–	–	–	–	1	–	–	–	–	–
Carya	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–
Castanea	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Castanopsis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Celtis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Chenopodiaceae	1	21	8	4	13	4	9	2	16	23	14	13	15	6	38	7	12	4	42	33
Compositae																				
Undifferentiated	–	1	2	–	3	2	2	–	–	2	–	2	8	–	3	–	–	–	–	1
Artemisia	3	30	26	12	27	19	28	–	18	23	14	5	7	3	16	–	2	3	22	26
Long-spined	–	–	–	–	–	–	–	–	9	–	–	–	–	–	–	–	–	–	–	–
Fenestrate	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Corylus	2	–	5	2	–	1	16	–	–	1	1	–	2	–	–	–	–	–	–	–
Engelhardia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ericaceae	–	–	3	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Fagus	–	–	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–
Fraxinus	–	–	9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ilex	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Itea	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Labiatae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Liquidambar	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Moraceae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Myrica	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Nyssa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Parthenocissus	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–
Pterocarya	–	–	1	–	–	–	–	–	–	–	–	2	1	–	–	–	–	–	6	–
Quercus	2	–	13	2	1	1	32	–	5	–	6	3	3	5	1	1	–	–	–	1
Salix	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tilia	–	–	–	–	–	–	–	–	–	2	1	–	1	–	–	–	–	–	–	–
Ulmaceae	1	–	5	2	–	–	4	–	–	2	–	–	2	–	1	1	–	–	–	–
Umbelliferae	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Zelkova	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 2 – *Continued*

21	22	23	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1	–	–	–	–	–	–	–	–	–	1	–	2	1	–	–	–	–	1
1	–	–	–	–	1	–	–	–	–	–	2	–	1	2	38	4	10	2
60	25	250	2	100	75	90	80	3000	15	40	–	–	1	–	13	–	40	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	2	2	3	–	3	5	2	2	15	2	–	21	4	1	–	1	55	150
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	80	20	–	–	–	–	–
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–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	1	1	–	1	1	1	–	1	1	1	1	–	2	1	–	–	–	1
–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	1	1	–	–	–	1	–	–	1	2	–	–	1	2	–	–	–	1
13	17	23	7	6	2	10	10	10	9	4	11	17	36	14	1	3	13	18
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
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–	–	1	–	2	–	–	–	–	–	–	–	–	–	1	1	–	–	1
–	–	1	–	–	–	–	–	–	–	–	–	5	–	5	–	–	4	–
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–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	2	10	6	–	5	1	–	2	11	3	–	2	4	1	29	–
1	3	4	1	6	4	11	7	3	5	2	21	14	8	55	11	–	28	28
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
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–	–	–	–	–	–	–	–	–	–	1	–	1	–	1	–	–	1	1
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1	–	–	1	–	1	–	–	–	–	–	–	1	–	–	–	–	–	–
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2	1	2	2	–	–	1	3	6	–	2	1	52	28	18	2	–	5	8
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1	–	–	–	–	–	–	–	–	–	–	3	–	2	6	–	–	–	–
1	1	–	2	1	–	1	–	1	1	–	–	11	6	–	–	–	–	3
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27	57	39	25	27	13	26	23	30	15	5	25	76	62	15	–	–	7	27
1	2	5	1	2	1	–	4	–	–	2	4	2	3	1	–	–	–	2
11	10	15	40	3	3	17	9	17	14	2	5	23	34	5	–	1	–	10
–	–	–	–	–	–	–	–	–	–	–	–	4	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–
–	–	1	–	1	–	–	–	–	–	1	1	4	5	1	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
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3	6	–	3	–	4	–	2	–	–	–	1	3	12	4	1	–	2	6
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	1	1	1	9	–	–	–	3
–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 2 – *Continued*

	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58
Fungal spores	–	–	–	–	–	–	–	–	–	–	–	–	1	2	1	–	1	1
Dinoflagellates																		
Undifferentiated	6	17	14	9	16	2	10	35	1	40	40	46	42	70	22	66	2	3
Dino-19&20	–	2	1	1	1	–	–	1	–	–	5	–	3	9	–	–	–	–
Botryococcus	–	1	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
Pediastrum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Acritarchs																		
Undifferentiated	100	104	42	33	20	7	7	19	77	39	19	33	25	103	240	118	708	32
Ac-1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ac-8	–	–	69	45	15	28	–	–	–	–	–	–	–	–	–	–	–	–
Cymatiosphaera	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tasmanites	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
"Circuli"	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Trilete spores																		
Undifferentiated	1	1	–	–	–	3	1	4	2	–	–	1	3	2	1	–	–	1
Sphagnum	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–
Klukisporites	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Monolete spores	2	–	–	1	1	1	4	–	–	–	–	–	–	–	–	–	–	–
Undetermined pollen	10	28	46	25	26	16	19	14	41	4	5	1	16	29	8	5	12	37
"Tetrad-1"	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Monocolpate	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
Mesozoic-Paleogene triporates	–	1	–	–	–	–	–	–	1	–	–	–	3	–	–	–	–	–
Conifers-Gymnosperms																		
Bisaceate	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1
Inaperturate	–	1	–	2	1	–	–	–	–	–	–	–	–	–	–	–	2	–
Cedrus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Keteleeria	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Picea-Abies	18	9	3	1	–	6	10	2	–	1	–	2	2	3	1	–	2	3
Pinus	21	58	74	24	34	48	21	36	5	18	51	43	24	28	39	20	26	6
Sciadopitys	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sequoia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Taxodiad	–	–	–	1	3	5	–	–	–	–	–	–	–	1	1	–	1	1
Tsuga	1	–	1	1	1	2	2	–	–	–	1	–	2	4	1	–	–	1
Vitreisporites	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Corollina	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ephedra	–	1	–	–	–	–	–	–	2	–	–	–	1	1	–	–	1	–
Monocots																		
Cyperaceae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gramineae	5	10	12	9	10	29	6	4	6	–	–	5	–	4	2	1	2	5
Palmae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Typha	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dicots																		
Alangium	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Alnus	1	2	2	–	4	2	–	1	1	2	2	1	–	–	–	1	2	8
Amaranthaceae	–	3	2	7	3	3	–	–	–	–	–	–	1	2	1	–	1	–
Betula	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–
Carpinus - Ostrya	–	3	3	1	2	4	–	4	–	1	–	1	–	–	–	1	–	3
Carya	–	–	1	2	1	2	–	4	3	–	1	2	–	–	1	1	1	1
Castanea	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Castanopsis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Celtis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Chenopodiaceae	19	38	16	30	17	13	11	22	15	1	1	9	22	20	–	4	17	12
Compositae																		
Undifferentiated	–	3	1	5	2	1	1	4	1	–	2	4	2	1	–	1	–	1
Artemisia	5	7	14	7	19	16	2	41	2	1	5	9	2	3	–	3	3	4
Long-spined	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Fenestrate	–	–	–	1	1	–	–	1	1	–	–	–	–	–	–	1	1	1
Corylus	–	1	2	1	3	–	–	1	2	–	–	–	1	–	–	–	–	1
Engelhardia	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–
Ericaceae	–	–	–	–	2	–	–	–	–	–	–	–	1	1	–	–	–	–
Fagus	1	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–
Fraxinus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ilex	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Itea	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Labiatae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Liquidambar	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Moraceae	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Myrica	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1
Nyssa	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Parthenocissus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pterocarya	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1	–
Quercus	13	10	6	17	11	12	6	15	3	2	4	6	3	4	7	4	10	1
Salix	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tilia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ulmaceae	3	2	–	1	–	5	3	2	8	1	–	1	1	2	–	2	16	15
Umbelliferae	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–
Zelkova	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 2 – *Continued*

59	60	61	62	63	64	65	66	67	69	70	71	72	73	74	75	76	77	78	79	a 80	b 80
–	3	–	22	–	1	2	–	4	2	2	1	–	3	100	8	1	4	1	9	–	–
–	–	–	–	–	–	–	–	–	1	–	1	1	–	–	–	1	–	–	–	–	1
1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	84	21	15	2	–	1	1	8	168	23	–	–	3	24	10	21	19	16	16	4	8
–	–	–	–	–	–	–	–	–	–	–	57	–	–	–	–	–	–	–	–	–	–
–	–	–	15	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
2	–	–	–	–	1	1	–	1	1	2	3	–	4	1	3	1	2	2	2	2	1
–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	1	–	–	1	3	1	4	–	2	4	1	3	7	2	–	2	3
–	16	41	107	19	–	28	72	48	110	49	74	–	24	67	18	68	33	30	33	10	12
–	–	–	–	–	–	–	–	2	1	9	9	–	5	5	–	4	2	1	1	1	3
–	–	–	–	–	–	–	–	–	3	2	15	–	8	12	2	11	4	7	3	2	4
1	–	–	–	–	1	–	–	–	–	1	–	–	–	2	1	2	1	1	1	2	2
–	–	–	26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–
–	–	–	2	–	–	–	1	2	–	–	–	–	–	3	1	1	–	–	–	1	3
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	2	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–
–	9	11	4	13	23	16	26	12	–	4	–	–	9	3	3	–	–	–	–	7	–
–	15	34	18	37	20	45	5	31	8	30	47	1	14	42	10	16	11	16	33	29	29
–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	–	–	–	–	1
–	1	–	–	1	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–	–
–	1	2	–	1	1	1	2	1	1	2	3	–	3	3	1	1	1	2	1	1	1
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	3	–	–	–	1	–	1	10	1	4	1	–	4	10	2	1	2	2	–	1	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	4	1	1	–	2	2
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–
–	–	1	–	1	3	1	1	2	–	–	2	–	1	3	5	–	1	–	–	1	2
–	–	–	–	2	–	–	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1
–	–	1	1	1	1	1	3	2	1	1	–	–	1	–	1	–	–	–	–	–	–
–	2	–	–	1	2	–	–	–	–	–	1	–	2	3	4	–	–	1	–	1	1
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	3	12	20	3	2	1	11	11	1	3	–	–	1	4	4	3	1	–	–	–	–
–	1	–	–	1	–	2	5	1	2	3	–	1	1	–	–	–	–	1	–	–	–
–	–	1	3	–	1	–	–	–	1	1	1	–	–	–	1	–	1	1	1	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–
–	1	1	–	–	–	–	1	3	8	7	8	–	1	4	5	4	2	7	2	3	–
–	–	–	1	–	–	–	–	1	–	–	3	–	–	–	–	1	–	1	–	1	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1	–	–	1	–	2
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1
–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	4	–	–	–	–	1	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
–	3	–	–	–	–	2	–	3	–	–	–	–	–	–	–	–	–	–	–	1	1
–	7	4	1	5	4	2	4	15	5	12	5	–	3	5	4	1	3	2	1	5	3
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1	–	–	1	–	–	–
1	5	11	2	4	4	4	10	26	4	3	1	1	2	4	1	4	–	–	2	1	2
–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 3
Palynological Analyses, Site 381

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Fungal spores	–	7	10	1	1	2	10	8	2	13	13	2	–	14	1	4	–	9	–	9
Dinoflagellates																				
Undifferentiated	–	3	2	1	–	–	6	–	4	1	–	3	–	17	2	7	19	18	1	–
Dino-11	–	–	–	–	–	–	–	–	–	–	–	–	5	–	–	–	–	–	–	–
Dino-14	–	–	–	–	–	–	–	–	–	–	–	–	–	7	–	–	–	–	–	–
Dino-18	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	6	–	–	–	–
Dino-19&20	–	–	–	–	–	–	7	5	63	3	1	1	50	20	341	855	5	54	25	7
Dino-22	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	8	–	–
Dino-24	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dino-24a	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dino-24b	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dino-25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dino-26	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–
Dino-28	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dino-29	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Botryococcus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pediastrum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Acritarchs																				
Undifferentiated	15	1	3	2	3	–	–	1	25	6	–	3	2	19	2	–	6	94	1	15
Ac-4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ac-8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	131
Ac-10b	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ac-11	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ac-12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cymatiosphaera	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
Trilete spores																				
Undifferentiated	–	–	–	–	1	–	–	–	–	2	1	–	1	3	–	–	2	–	–	2
Sphagnum	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	–	1	1	–	–
Monolete spores	5	–	–	–	1	–	–	1	6	–	1	2	–	3	–	–	1	1	–	1
Undetermined pollen	14	47	100	48	10	51	117	112	25	66	58	40	1	51	30	15	11	30	2	16
"Tetrad-1"	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Monocolpate	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–
Mesozoic-Paleogene triporates	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–	–	–	1	–	–
Pc3-10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Conifers-Gymnosperms																				
Bisaccate	–	1	1	–	–	3	4	13	2	4	23	15	–	4	1	–	–	2	–	–
Inaperturate	14	–	2	2	1	–	–	11	1	6	–	3	–	9	–	1	–	–	–	–
Cedrus	–	1	1	1	–	3	–	–	–	4	8	1	–	–	–	–	–	–	–	–
Keteleeria	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Picea-Abies	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	4	–	–	1
Pinus	5	5	7	3	17	3	3	4	10	20	11	9	6	3	2	11	14	1	–	8
Podocarpus	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sciadopitys	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sequoia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
Taxodiad	5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tsuga	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
Vitreisporites	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Corollina	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–
Ephedra	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
Moncots																				
Gramineae	4	9	5	4	–	3	5	1	–	3	3	1	–	13	–	–	–	7	–	6
Typha	2	–	1	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–
Dicots																				
Alnus	1	1	–	–	–	–	–	–	–	1	2	–	–	1	–	–	4	1	–	–
Amaranthaceae	–	1	6	1	–	–	1	4	–	1	4	3	–	4	–	1	–	3	–	4
Betula	1	–	–	1	–	–	1	–	–	1	–	1	–	–	–	–	2	1	–	–
Carpinus - Ostrya	1	–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–
Carya	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Caryophyllaceae	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Chenopodiaceae	30	25	41	38	8	15	16	32	3	3	16	14	3	34	12	8	3	36	4	24
Compositae																				
Undifferentiated	2	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–
Artemisia	30	90	76	110	39	31	17	39	6	12	31	15	1	2	26	4	1	8	–	9
Long-spined	–	1	3	2	–	1	–	5	–	–	6	3	–	4	–	1	–	5	–	–
Fenestrate	–	–	1	–	–	–	–	1	–	–	–	–	–	1	–	1	–	–	–	–
Corylus	2	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	4	–	–	–
Engelhardia	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–
Fagus	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ilex	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Myrica	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
Pterocarya	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–
Quercus	30	–	1	–	7	–	–	–	–	–	–	–	1	2	1	3	8	–	–	–
Schizandra	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tilia	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ulmaceae	–	–	1	–	–	–	–	–	–	–	1	–	–	1	–	–	2	–	–	–
Umbelliferae	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

TABLE 3 – *Continued*

22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
–	9	–	10	2	6	–	12	1	3	–	20	–	3976	–
2	36	6	12	8	51	17	44	3	24	56	21	14	31	150
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	8	6	1	2	–	–	–	–	–	56	2	1	–	90
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	18,000	–	–	–	–	–	21	–	3	–	–	–	–	–
–	–	–	1250	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	60	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	18	–	–	–
–	–	–	–	–	–	–	–	–	40	–	5	–	–	–
–	–	–	–	–	–	–	–	–	–	–	22	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	1	–	–	–	1	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	–	8	–	15	10	10	64	15	9	140	13	54	33	800
–	–	–	–	–	–	–	–	–	–	–	–	–	50	–
–	–	–	–	–	48	–	6	–	14	–	6	–	1	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–		–	–	–	–	–	–	–	–	–	–	–	266	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	1	–	1
–	–	–	–	1	1	–	–	1	1	4	–	1	–	–
–	–	–	–	–	–	–	–	–	1	–	–	–	–	–
–	–	–	–	–	–	2	–	1	–	–	–	–	–	–
8	5	12	14	14	26	13	36	15	21	12	56	10	19	1
–	–	–	–	–	–	1	–	2	–	–	–	–	–	–
2	–	–	–	–	1	–	–	1	–	1	–	–	1	–
–	–	–	2	–	–	–	3	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	1	–	–	–	2	–	–	–	–	–	–	–	–	–
2	–	–	–	5	3	5	–	–	1	–	–	2	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
10	–	6	–	7	1	7	–	1	–	1	–	6	–	2
4	6	2	5	29	10	25	51	26	17	29	3	12	49	27
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	1	–	–	–	–	–	1	–	–
–	–	–	–	1	–	4	–	–	–	1	–	–	–	–
–	–	–	–	–	–	–	1	–	–	2	–	–	1	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	1	–	15	–	8	4	4	–	10	–	4	1	2	1
–	–	–	–	–	1	–	–	–	–	–	–	–	–	–
–	–	–	1	–	3	–	1	1	1	–	1	–	5	–
–	–	1	4	–	10	–	1	–	3	–	–	–	–	–
–	–	–	1	–	1	–	–	–	–	–	–	–	–	–
–	–	–	1	–	–	–	1	–	2	–	–	–	1	2
–	–	–	2	2	–	1	1	–	–	–	–	–	3	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
22	1	28	44	12	33	11	9	6	6	8	35	–	1	1
–	–	–	–	3	–	1	–	1	–	1	–	1	1	–
2	–	5	3	2	5	8	7	–	4	3	16	–	–	–
–	–	–	4	–	4	–	2	–	–	–	5	–	–	–
–	–	–	2	–	–	–	–	–	–	–	–	–	–	–
1	–	–	–	1	–	2	–	2	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	1	–	–	–	–	–	–
–	–	–	–	–	–	–	1	–	–	–	1	–	3	–
–	1	–	–	–	1	4	–	–	–	–	1	–	2	–
12	–	5	6	9	6	13	16	2	15	4	9	–	32	–
–	–	–	–	1	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–	1	1	1	1	1	4	–	1	–	–	–	2	10	–
–	–	–	–	–	1	–	–	–	–	–	–	–	–	–

TABLE 3 – *Continued*

	37	38	39	40	43	44	45	46	48	49	51	52	16	21
Fungal spores	7	–	6	–	12		12		28	105	15	17	16	21
Dinoflagellates														
Undifferentiated	21	–	6	1	–		10		9	16	9	–	6	8
Dino-11	–	–	–	–	–		–		–	–	–	–	–	–
Dino-14	–	–	–	–	–		–		–	–	–	–	–	–
Dino-18	–	–	–	–	–		–		–	–	–	–	–	–
Dino-19&20	–	7	–	–	–		–		–	–	–	–	2	–
Dino-22	–	–	–	–	–		–		–	–	–	–	–	–
Dino-24	–	–	–	–	–		–		–	–	–	–	–	–
Dino-24a	–	–	–	–	–		–		–	–	–	–	–	–
Dino-24b	–	–	–	–	–		–		–	–	–	–	–	–
Dino-25	–	–	–	–	–		–		–	–	–	–	–	–
Dino-26	1	–	–	–	–		–		–	–	–	–	–	–
Dino-28	–	–	–	–	–		–		–	–	–	–	–	–
Dino-29	–	3600	–	–	–		–		–	–	–	–	–	–
Botryococcus	–	–	–	–	1		–		–	–	–	–	–	–
Pediastrum	–	–	–	4	–		–		1	–	–	–	–	–
Acritarchs														
Undifferentiated	94	452	23	4	10		14		21	25	13	17	9	5
Ac-4	46	–	–	–	–		–		–	–	–	–	–	–
Ac-8	–	–	5	–	3		18		9	15	5	1	2	12
Ac-10b	1300	–	–	–	–		–		–	–	–	–	–	–
Ac-11	–	–	–	–	–		–		–	–	–	–	–	–
Ac-12	–	–	–	–	–		–		–	47	–	–	1	–
Cymatiosphaera	–	–	–	–	–		–		–	–	–	–	–	–
Trilete spores						B		B						
Undifferentiated	–	–	–	1	1	A	–	A	2	–	7	3	8	1
Sphagnum	–	–	–	–	–	R	–	R	–	–	–	–	–	–
Monolete spores	–	–	2	–	5	R	–	R	1	1	4	5	6	7
Undetermined pollen	15	7	88	8	42	E	23	E	75	104	97	80	88	61
"Tetrad-1"	–	–	–	–	–	N	–	N	–	–	–	–	–	–
Monocolpate	–	–	4	–	1		–		6	7	4	–	–	2
Mesozoic-Paleogene triporates	–	–	–	–	1		–		–	1	–	–	–	1
Pc3-10	–	–	–	–	–		–		–	–	–	18	1	9
Conifers-Gymnosperms														
Bisaccate	–	–	–	–	–		–		1	–	–	–	–	–
Inaperturate	–	–	–	–	–		–		–	–	1	–	–	–
Cedrus	–	–	1	–	–		–		–	–	–	–	1	–
Keteleeria	–	–	–	–	–		–		–	–	–	–	–	–
Picea-Abies	–	–	–	1	2		11		1	6	2	4	–	–
Pinus	13	–	50	17	7		9		–	20	10	20	27	6
Podocarpus	–	–	–	–	–		–		–	–	–	–	–	–
Sciadopitys	–	–	–	–	–		–		–	–	–	–	–	–
Sequoia	–	–	3	–	–		–		–	–	–	–	–	–
Taxodiad	–	–	–	1	–		–		–	–	–	–	–	–
Tsuga	–	–	–	–	–		–		–	–	–	–	–	–
Vitreisporites	–	–	–	–	–		–		–	–	–	–	–	–
Corollina	–	–	–	–	–		–		–	–	–	–	–	–
Ephedra	–	–	1	1	–		1		–	–	–	–	–	–
Monocots														
Gramineae	–	–	12	1	5		4		2	–	22	8	–	5
Typha	–	–	–	–	–		1		–	1	–	–	–	–
Dicots														
Alnus	–	–	3	2	2		–		–	1	1	1	1	3
Amaranthaceae	–	–	–	–	–		–		–	–	–	–	–	–
Betula	–	–	2	2	2		1		3	3	1	–	–	1
Carpinus - Ostrya	–	–	3	–	2		–		–	2	–	–	1	–
Carya	–	1	2	–	1		1		1	2	1	3	1	2
Caryophyllaceae	–	–	–	–	–		–		–	–	1	1	–	–
Chenopodiaceae	5	4	25	4	–		12		1	–	5	6	–	–
Compositae														
Undifferentiated	4	–	5	–	–		3		–	–	–	–	–	–
Artemisia	2	1	5	–	1		4		–	–	–	–	1	–
Long-spined	–	–	–	–	–		–		–	–	–	2	–	–
Fenestrate	–	–	–	–	–		–		–	–	1	–	–	–
Corylus	–	–	–	3	–		–		–	–	–	–	–	–
Engelhardia	–	–	–	–	6		–		31	–	20	13	31	22
Fagus	–	–	–	–	1		1		–	–	–	–	–	–
Ilex	–	–	–	–	–		–		–	–	–	–	–	–
Myrica	–	–	1	1	–		–		–	–	–	–	–	–
Pterocarya	–	–	1	–	–		2		–	2	–	–	–	–
Quercus	5	1	10	3	7		3		26	7	1	–	6	8
Schizandra	–	–	–	–	–		–		–	–	–	–	–	–
Tilia	–	–	–	–	–		–		–	1	–	–	1	1
Ulmaceae	4	5	9	2	1		11		1	4	–	2	1	2
Umbelliferae	1	1	2	–	–		1		–	–	–	1	–	–

PLATE 1

Figures 1-4 Acritarch-10b. Very abundant in a few samples, such as in Sample 381-37, CC. More or less spherical, light brown in color but usually takes some safranin or basic-fuchsin stain. Often split open. Little or no sculpture. According to W.C. Elsik, this could be either fungal or algal. D.W. McLean favors algal relationship. Size: about 9 μm.

Figures 5-9 Fungal-11. Dominant in some samples, as in Sample 381-35, CC. Ovoid, light brown in color, usually takes little stain. Sculpture variable, from echinate (Figures 5-7, 9) to reticulate (Figure 8), or even *Cymatiosphaera*-like. Often has an oval "operculum" at one end (Figures 5-7). W.C. Elsik favors fungal, probably "mold" relationship. Size: about 10 μm long.

Figures 10, 11 Fungal-10. Very abundant in a few samples, such as Sample 381-36, CC. Capsule-shaped. Two-layered wall. Very minute positive sculpture. W.C. Elsik identifies as probably fungal spores. Size: about 11 μm long.

Figures 12, 13 Acritarch-8. Wrinkled, bag-like palynomorphs occurring in many samples; often abundant. Very thin walled, filmy, easy to miss in routine analysis. Takes some safranin-o stain. Psilate to faintly scabrate. Sometimes (Figure 13) has an almost operculate opening. Certainly phytoplanktonic. Size: about 28 μm.

Figure 14 Acritarch-7. Spherical, short-spined echinate palynomorph, moderately abundant in some samples. Does not usually stain. Similar acritarchs have been described previously ("acritarch-6" from Traverse, 1974) from Black Sea surface samples; (Traverse and Ginsburg, 1966, pl. 1, fig. 3, 4) from Bahamas sediment. From distributions in Bahamas, it is concluded that this is a phytoplankton form probably closely related to the dinoflagellates. Size: about 18 μm.

Figures 15-17 Acritarch-13. Figures 15 and 16 are two levels of focus of the same specimen. This distinctive palynomorph is abundant in a few samples, (i.e., Sample 381-27, CC). Takes a small amount of safranin-o. Sculpture rugulate-reticulate. "Eye-spot" characteristic of many dinoflagellate cysts always present, as well as some hint of an archeopyle (see Figure 15, especially). This may well prove to be another of the Black Sea "baggy" dinoflagellates, but the proof (opercula, tabulation) has not as yet been found. Size: 23 μm.

Figures 18-23 Dinoflagellate-24a. Dominant in a few samples (i.e., Sample 381-23, CC). Probably one of the "baggy" dinoflagellates of the Black Sea sediments. At first, this was considered an acritarch, but eventually archeopylar evidence of probable dinoflagellate relationship was discovered (see especially Figure 21). However, no tabulation has been seen. Stains lightly with safranin-o. Very thin walled. More or less psilate, with some granules. Size: about 22 μm.

Figures 24-27 Dinoflagellate-29. A nondescript, "baggy" dinoflagellate such as typifies the Black Sea sediments. In one sample (Sample 381-38, CC) this form is overwhelmingly dominant; the organic residue in that sample consists practically 100% of this dinoflagellate. "Baggy", thin walled, lightly staining, micro-scabrate sculpture. Tabulation never observed. Figure 24 is an isolated operculum. These pre-cingular opercula can be seen in situ in Figures 25-27. Size: about 55 μm. (Figure 24 is approximately 30% more magnified than Figures 25-27.)

Figure 28 Dinoflagellate-28. Common in some samples, such as Sample 381-33, CC. Orange-brown color, usually non-staining. Sculpture densely scabroverrucate. Figure shows an operculum torn loose but still partly attached. Some specimens show signs of weakly developed tabulation. Size: about 68 μm long.

PLATE 1

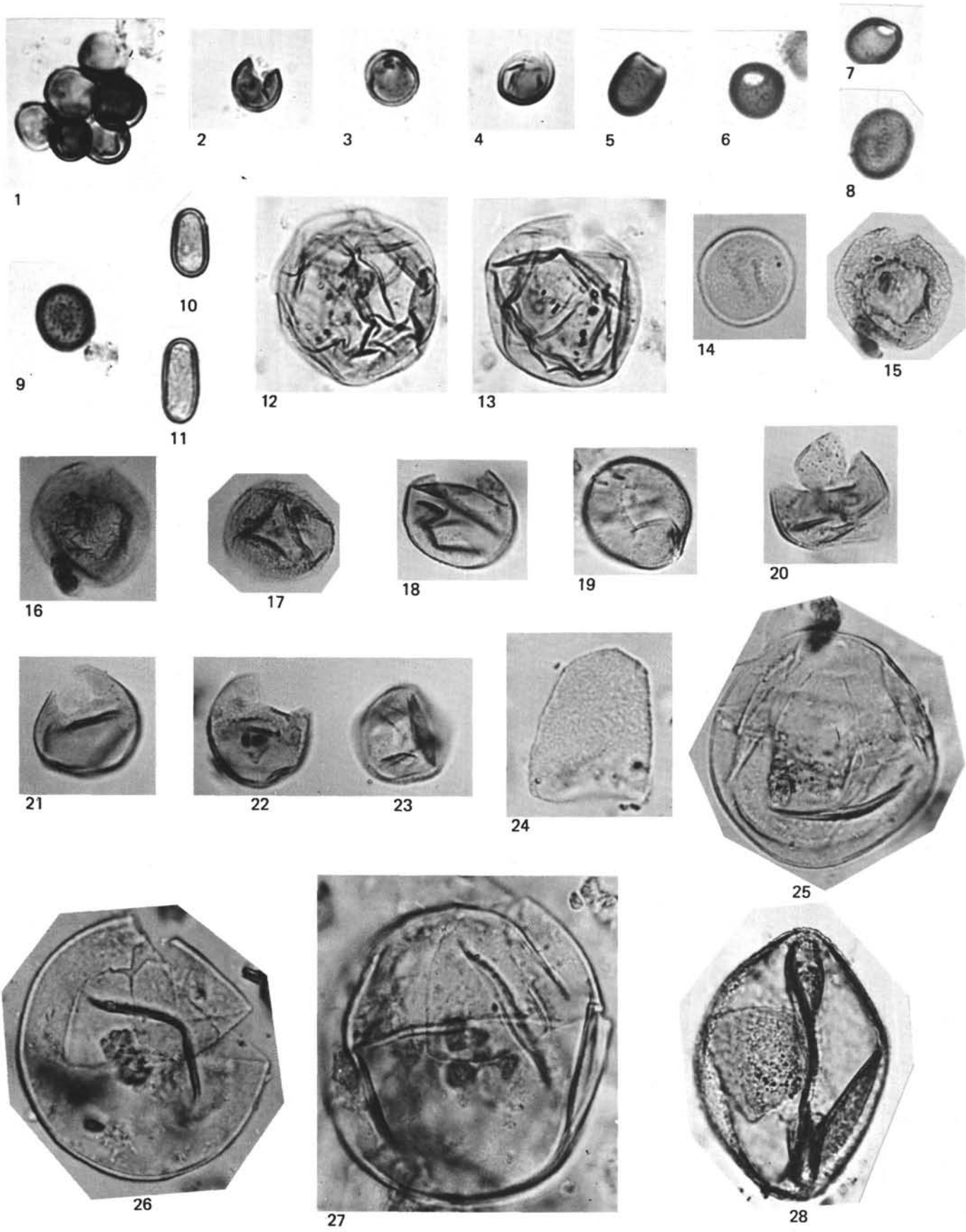


PLATE 2

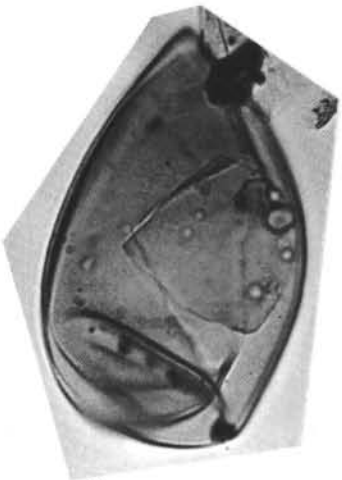
Figures 1-6, 8 Dinoflagellates 19-20. This is one of the most important palynomorphs in the Black Sea sediments. When first encountered, these "bags" were thought to be inaperturate pollen grains, but discovery of good pre-cingular archeopyles and opercula (Figures 2, 3) made it obvious that this is a dinoflagellate, though a peculiarly featureless and often contorted one, in which the simple "bags" show no sign of tabulation. Dinoflagellate-19 is virtually psilate (Figures 1, 3), whereas Dinoflagellate-20 is reticulate (Figure 8). The two forms intergrade, however (see Figure 4), and it is probable that the two are really one species. Characteristically, many examples of this dinoflagellate occur as tightly folded specimens that, at first glance, seem unrelated to the expanded forms (see Figures 5 and 8). However, all intergradations between specimens even more tightly folded than that shown in Figure 5, and normally expanded cysts, exist. Dinoflagellates 19-20 apparently are sensitive indicators of some ecologic factor, as they fairly often dominate the planktonic flora. Usually a golden or orange color, taking little or no stain. Size of expanded cysts: about 70 μm maximum dimension.

Figures 7, 9 Dinoflagellate-26. Another "baggy" dinoflagellate. Microreticulate, with no evidence of tabulation, but (see Figure 7) a characteristic, presumably, pre-cingular, archeopyle is present. Orangish in color, usually non-staining. Variable in size; about 60 μm on the average.

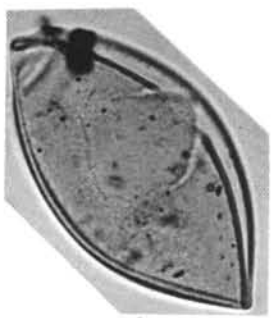
Figure 10 Undifferentiated dinoflagellate. This sort of more "normal" dinoflagellate cyst is common in some samples. Verrucate sculpture. Prominent cingulum and rather evident tabulation. Size: about 70 μm.

PLATE 2

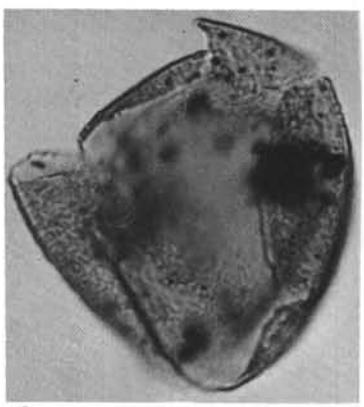

1

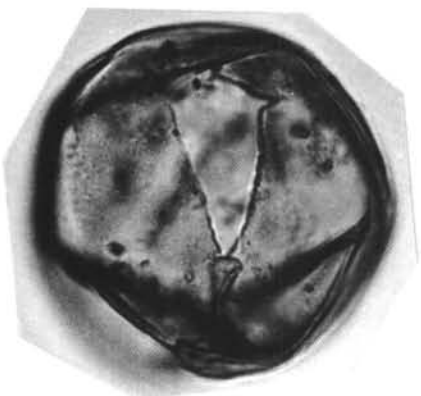

2


3


4


5


6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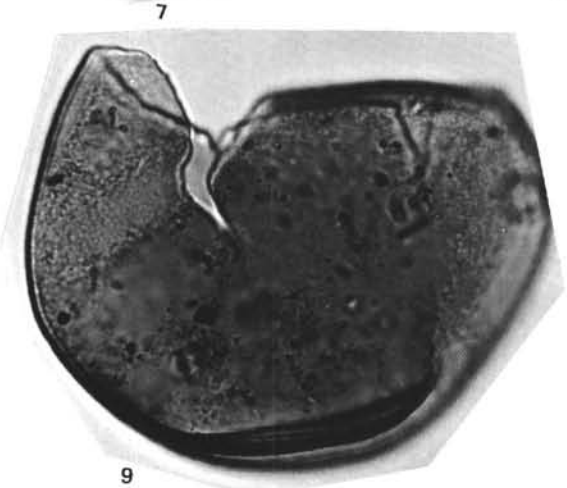
8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