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Correlation between *Sequoia* Type Pollen and Lower Oligocene Transgressive Deposits in the Eastern Gulf Coast

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Two taxodiaceous conifer pollen species form the dominant components among sporomorphs of the Lower Oligocene Vicksburg Group in the eastern Gulf Coast. The two species, Sequoiapollenites lapillipites *and* Sequoiapollenites *sp. 1, are very prominent (20-70%) in the Mint Spring Marl and Marianna Limestone at two localities in SE Mississippi and SW Alabama. These two lithostratigraphic units constitute the transgressive systems tract of the Tejas A Gulf Coast (TAGC)-4.4 sequence defined by Tew and Mancini (1992). Thus, the concentration of these two* Sequoia *type pollen species may be used as a marker for these transgressive deposits in the eastern Gulf Coast. This paper provides sporomorph information for all but one of the lithostratigraphic units of the Vicksburg Group, and infers paleoclimatic conditions from the sporomorph assemblage.*

INTRODUCTION

Several stratigraphic and paleontologic studies (e.g., Murray, 1961; Glawe, 1969; Hazel et al., 1980; Mancini and Waters, 1986; Dockery, 1990) have been carried out on outcrops and subsurface cores in the eastern Gulf Coast (Fig. 1) because the strata represent one of the most continuous successions of Upper Eocene to Oligocene epoch sediments in the world. With the increasing applications of sequence stratigraphic concepts to regional studies, several workers have provided sequence stratigraphic interpretations for the marginal marine and marine sediments in this area (Loutit et al., 1983, 1988; Baum and Vail, 1988; Mancini and Tew, 1988, 1991; Pasley and Hazel, 1990; Pasley, 1991; Gregory and Hart, 1992; Tew, 1992; Tew and Mancini, 1992; Miller et al., 1993; Pasley and Hazel, 1995).

Previous work on sporomorphs in the Vicksburg Group have focused only on the lower part of the sequence, i.e., Red Bluff Clay and Forest Hill Sand (see Fig. 2 for stratigraphic division; Frederiksen, 1980a, 1988).

This paper presents initial results of sporomorph distribution and paleoclimatic deduction in all of the Vicksburg units except the Byram "marl," and emphasizes two species of *Sequoia* type pollen: *Sequoiapollenites lapillipites* and *Sequoiapollenites* sp. 1. Samples were obtained from outcrops at the St. Stephens Quarry (SW Alabama) and 0.4 km NE of Bucatunna Creek (Wayne County, SE Mississippi; Fig. 1). The samples and sporomorph taxa were subjected to principal components analysis and average linkage cluster analysis, in order to determine any associations that might be formed among the samples. Percent values of nonmarine palynomorphs (sporomorphs and fungal spores), relative to marine palynomorphs (dinoflagellates, acritarchs and microforaminiferal test linings), were also determined, with a view to interpreting the influence of sea-level fluctuations on the lithostratigraphic units.

Table 1—Correlation between symbols used for St. Stephens Quarry samples in Figures 5 and 6.

Figure 5	Figure 6	Lithostratigraphic units
A	R2070K	Lower Tongue Red Bluff
B	R2070AA	Lower Tongue Red Bluff
C	R2070L	Lower Tongue Red Bluff
D	R2070AB	Bumpnose Limestone
E	R2070AH	Upper Tongue Red Bluff
F	R2070N/AJ	Upper Tongue Red Bluff
G	R2070O	Upper Tongue Red Bluff
H	R2070P/AM	Mint Spring Marl
I	R2070Q	Mint Spring Marl
J	R2070R	Marianna Limestone
K	R2070S	Marianna Limestone
L	R2070T	Marianna Limestone
M	R2070U	Marianna Limestone
N	R2070V	Marianna Limestone
O	R2070W	Glendon Limestone
P	S2043Q	Glendon Limestone
Q	S2043L	Bucatunna Clay
R	S2043M	Bucatunna Clay
S	S2042N	Bucatunna Clay
T	UCR 8159/2	Chickasawhay Limestone

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0883-1351/95/0010-0371/$3.00

FIGURE 1—Map showing locations of sections studied.

RESULTS AND DISCUSSIONS

Counts of at least three hundred sporomorphs per slide were attempted (Appendix A and B), but additional scans revealed that some other taxa that were not counted were present. Because the samples from the Marianna Limestone and Glendon Limestone were poor in sporomorphs at the St. Stephens Quarry, the total count was much less than 300 even when an entire slide was scanned (see Appendix A). The upper part of the Marianna Limestone was extremely poor in both sporomorphs and marine palynomorphs at this locality. More than two hundred taxa, several of which were outside the counted areas on slides, were identified in the samples from the Bumpnose/Red Bluff, Forest Hill, Mint Spring, Marianna Limestone, Glendon Limestone and Bucatunna Clay. One sample from the Chickasawhay Limestone, which overlies the Vicksburg Group (Fig. 2), was examined. Sample numbers and their respective lithostratigraphic units are shown in Tables 1 and 2.

Table 2—Sample numbers and lithostratigraphic units of the sample positions shown in Figure 4 and the Wayne County locality.

Figure 4	Sample numbers	Litho-stratigraphic units
A	R2092A	Forest Hill
B	R2092B	Forest Hill
C	R2092C	Mint Spring
D	R2092D	Marianna

Figures 3 and 4 present some of the taxa that dominate (mainly >3%) the sporomorph assemblage at the St. Stephens Quarry and Wayne County

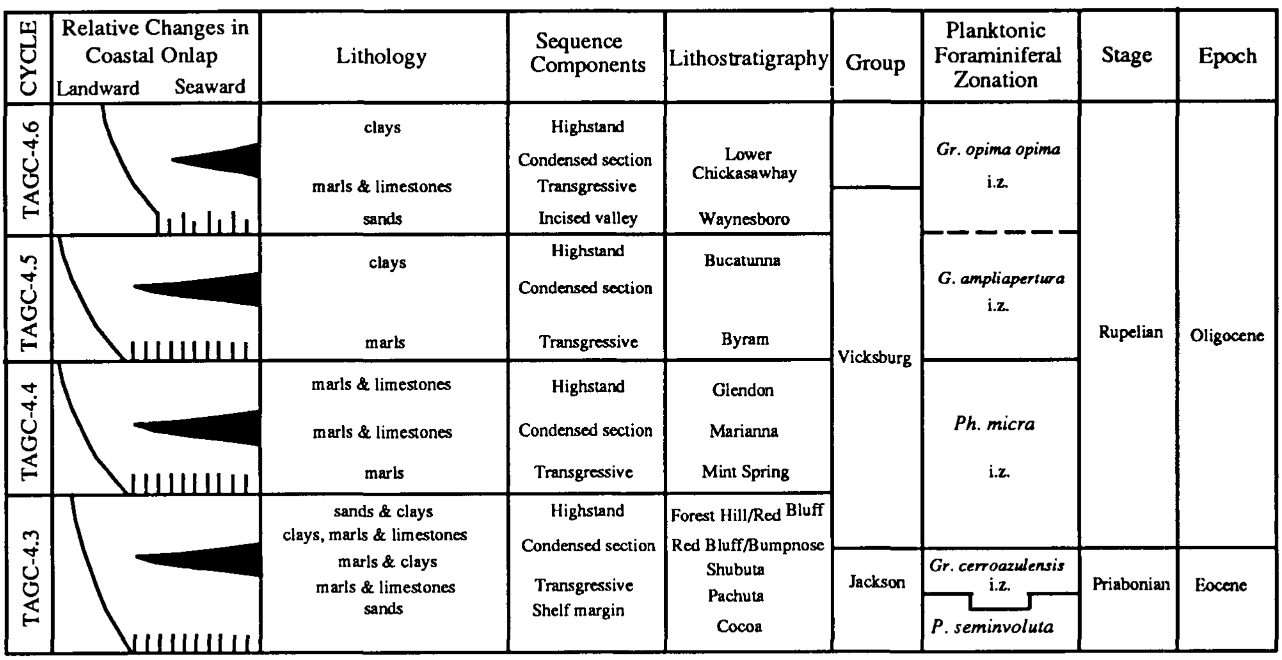
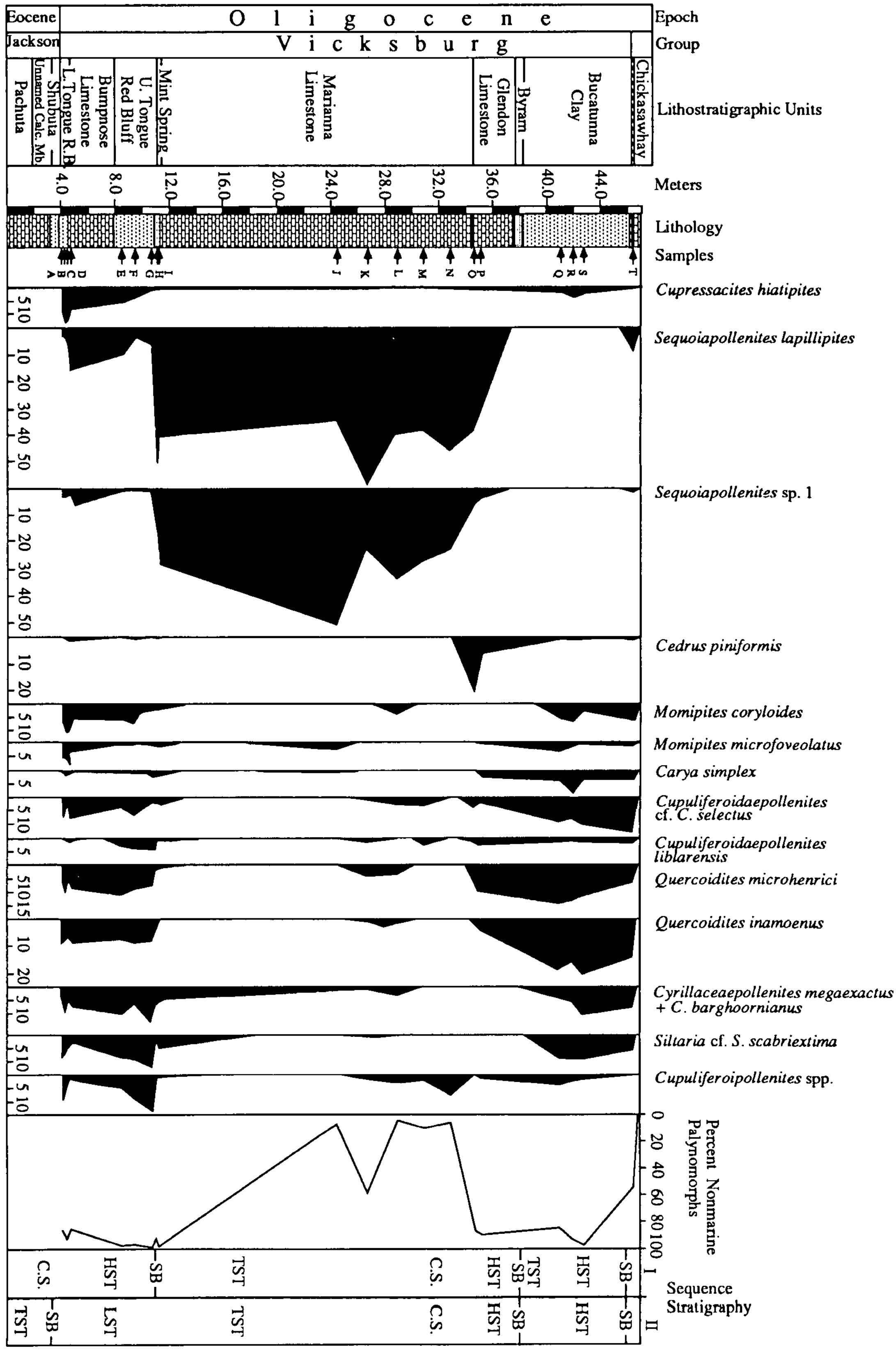
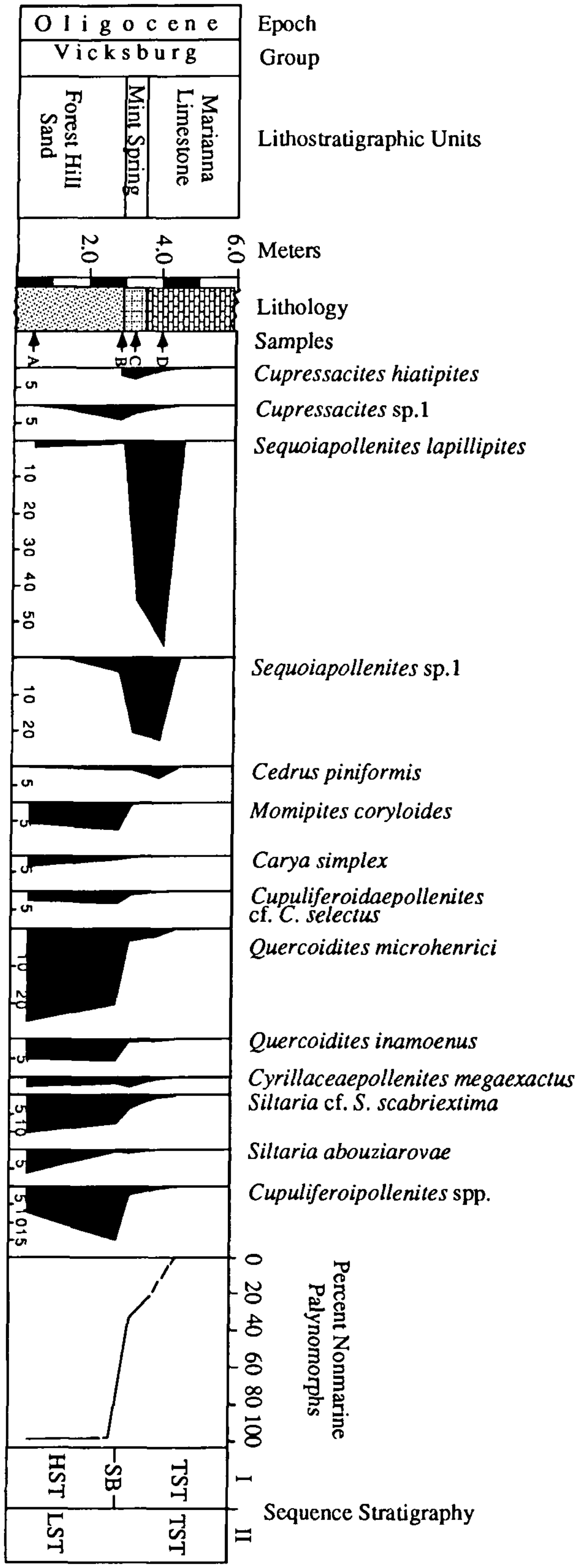


FIGURE 2—Coastal onlap chart illustrating the sequence stratigraphy of the Upper Eocene and Lower Oligocene in southeastern Mississippi and southwestern Alabama (from Tew and Mancini, 1992).

→

FIGURE 3—Percent values for some dominant sporomorphs, and for total nonmarine palynomorphs in the St. Stephens Quarry section. Sequence stratigraphic interpretations I and II are those of Tew and Mancini (1992) and Pasley and Hazel (1995), respectively; HST = highstand systems tract; TST = transgressive systems tract; LST = lowstand systems tract; SB = sequence boundary; C.S. = condensed section.


Eocene
Oligocene
Epoch
Jackson
Vicksburg
Group
Pachuta
Shubuta
Unnamed Calc. Mb.
L. Tongue R.B.
Bumpnose Limestone
U. Tongue Red Bluff
Mint Spring
Marianna Limestone
Glendon Limestone
Byram
Bucatunna Clay
Chickasawhay
Lithostratigraphic Units
Meters
Lithology
Samples
Cupressacites hiatipites
Sequoiapollenites lapillipites
Sequoiapollenites sp. 1
Cedrus piniformis
Momipites coryloides
Momipites microfoveolatus
Carya simplex
Cupuliferoidaepollenites cf. C. selectus
Cupuliferoidaepollenites liblarensis
Quercoidites microhenrici
Quercoidites inamoenus
Cyrillaceaepollenites megaexactus + C. barghoornianus
Siltaria cf. S. scabriextima
Cupuliferoipollenites spp.
Percent Nonmarine Palynomorphs
Sequence Stratigraphy
C.S.
HST
SB
TST
LST



locality, respectively. The figures reveal that two species of *Sequoia* type pollen, *Sequoiapollenites lapillipites* and *Sequoiapollenites* sp. 1, are extremely abundant (20–70%) in the Mint Spring and Marianna samples. These two units form the lower and upper transgressive deposits of the TAGC-4.4 depositional sequence of Tew and Mancini (1992). The two *Sequoia* type pollen species are slightly less abundant (4–40%) in the Glendon samples. However, the diversity of sporomorph taxa, and the total numbers of specimens in the Mint Spring, Marianna and Glendon samples, are fewer than those in the preceding Vicksburg deposits (Bumpnose/Red Bluff and Forest Hill), which were previously interpreted as highstand systems tract of the TAGC-4.3 sequence, Pasley and Hazel (1995) recently interpreted these deposits as lowstand systems tract (Fig. 3), based on regional stratigraphic relationships and graphic correlation of biostratigraphic data. Their study shows that the upper part of the Shubuta Member (Yazoo Clay), which represents the highstand systems tract in Mississippi, occurs as a stravation surface (i.e., is missing) at the St. Stephens Quarry.

The diversity and total numbers of sporomorph taxa in the Mint Spring Marl, Marianna Limestone and Glendon Limestone are also fewer than those of the Bucatunna Clay, which represents the highstand deposit of the TAGC-4.5 sequence. Sporomorph numbers decrease even further toward the top of the Marianna Limestone. In comparison to other units, the samples from this upper Marianna section have many dinoflagellate specimens belonging to a low diversity assemblage. The upper Marianna probably represents the deepest part of the sequence, and this observation is consistent with its interpretation as a condensed section

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FIGURE 4—Percent values for dominant sporomorphs, and for total nonmarine palynomorphs in the Wayne County section. See Figure 3 for sequence stratigraphic terminology.

(Tew, 1992; Tew and Mancini, 1992; Gregory and Hart, 1992). The Mint Spring and Marianna intervals are clearly dominated by marine palynomorphs at the Wayne County locality (Fig. 4), whereas at the St. Stephens Quarry, the Mint Spring has >93% nonmarine palynomorphs. This can be attributed to the fact that transgression progressed from southeast to northwest, resulting in a thinner, older (Bybell, 1982; Siesser, 1983) and more marginal Mint Spring facies in Alabama that was dominated by nonmarine palynomorphs. The base of the Mint Spring Marl was previously interpreted as a type 2 sequence boundary, but because of its time-transgressive nature across the area, Pasley and Hazel (1995) have suggested that the base of unit represented a transgressive surface between the lowstand systems tract (Red Bluff Clay) and transgressive systems tract (Mint Spring Marl).

At the St. Stephens Quarry, the Glendon Limestone yields few nonmarine and marine palynomorphs. Since this is the regressive, progradational highstand interval of the TAGC-4.4 depositional sequence, it would be expected to contain more nonmarine palynomorphs than the underlying transgressive deposits. One possible reason for the paucity of palynomorphs may be the diagenetic processes that have affected the sediments. The Glendon consists of alternating beds of indurated rocks (fossiliferous packstone and grainstone) and non-indurated rocks (mudstone, wackestone and argillaceous marl). The tight cementation and patchy remnant cement in the indurated beds (MacNeil, 1944; Tew and Mancini, 1992) could have a bearing on the preservation of palynomorphs in such beds. The two *Sequoia* type pollen species are still important components (4–40%) of the poor assemblage recovered from the unit.

Sequoiapollenites lapillipites and *Sequoiapollenites* sp. 1 are absent from the Bucatunna Clay, the highstand deposit of the TAGC-4.5 depositional sequence, which overlies the Byram "marl" at the St. Stephens Quarry. Apart from the absence of the *Sequoia* type pollen, the Bucatunna Clay has a sporomorph assemblage similar to that of the Bumpnose/Red Bluff and Forest Hill Sand. The two *Sequoia* species reappear in the Chickasawhay unit, where they each make up 1–10% of the sporomorphs counted (Fig. 4).

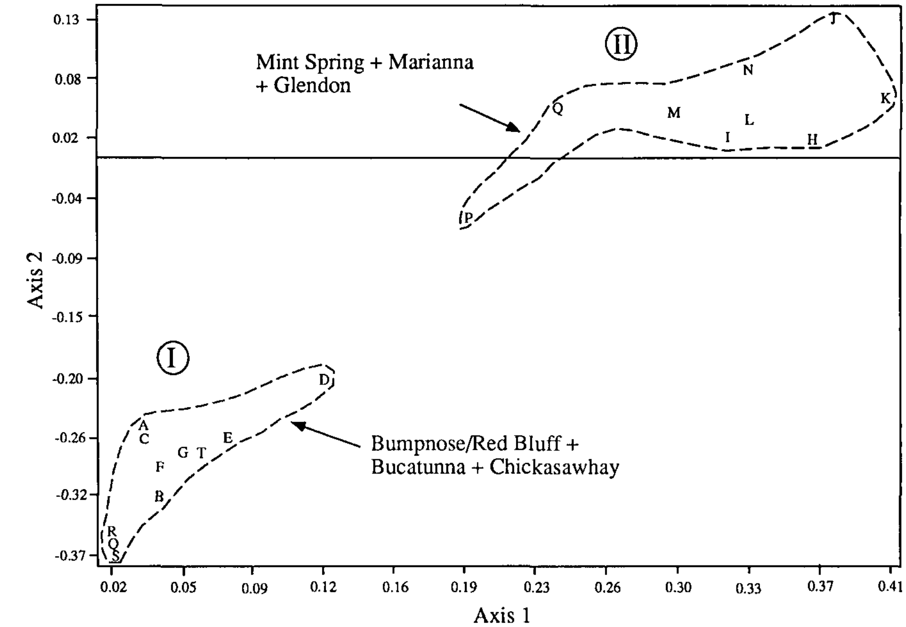

FIGURE 5—Scatter diagram of principal components analysis of samples from the St. Stephens Quarry; axes 1 and 2 account for 84% of the total variance. See text for explanation of sample groups; and Figure 3 and Table 1 for identification of samples (from Oboh and Reeves Morris, 1994).

The St. Stephens Quarry samples and sporomorph taxa were analyzed by principal components analysis and average linkage cluster analysis, using programs written by Kovach (1993). Table 1 shows the correlation between the symbols used for the samples in Figures 5 and 6, which were generated from the two types of analyses. Two principal components account for 84% of the total variance for the samples, and a plot of the first two axes shows that there are two groups of samples (Fig. 5). The two groups have been defined by the number of taxa counted in each sample, as well as the sporomorph types.

Group I samples have very diverse sporomorph taxa, have few *Sequoia* type pollen grains or none (in the tightly clustered samples R, Q, S), and are rich in taxa related to *Quercus* (oak) pollen. Other dominant sporomorphs in this group can be related to the following extant taxa: *Carya, Taxodium, Alfaroa, Oreomunnea, Cyrilla, Planera/Zelhova*; *Cupuliferoipollenites* spp. is related to the extinct genus *Dryophyllum* (Fagaceae) and/or to subfamily Castaneoideae. These sporomorph taxa, and others such as *Cedrus,* suggest warm temperate conditions during the Early Oligocene. Frederiksen (1980b, 1991) used *Quercus* pollen to infer cooler and drier conditions relative to the warm Eocene in the Gulf Coast, while Grimm et al. (1993) used the oscillation between *Pinus* and *Quercus* + *Ambrosia* type pollen to interpret the Late Pleistocene–Holocene climate in Florida. The *Pinus* phase represented wetter intervals relative to *Quercus* + *Ambrosia.* Group I samples all represent highstand deposits of the Bumpnose/Red Bluff and Bucatunna Clay, the only exception being the Chickasawhay sample (T), which represents a transgressive deposit.

Group II comprises samples from the Mint Spring, Marianna and

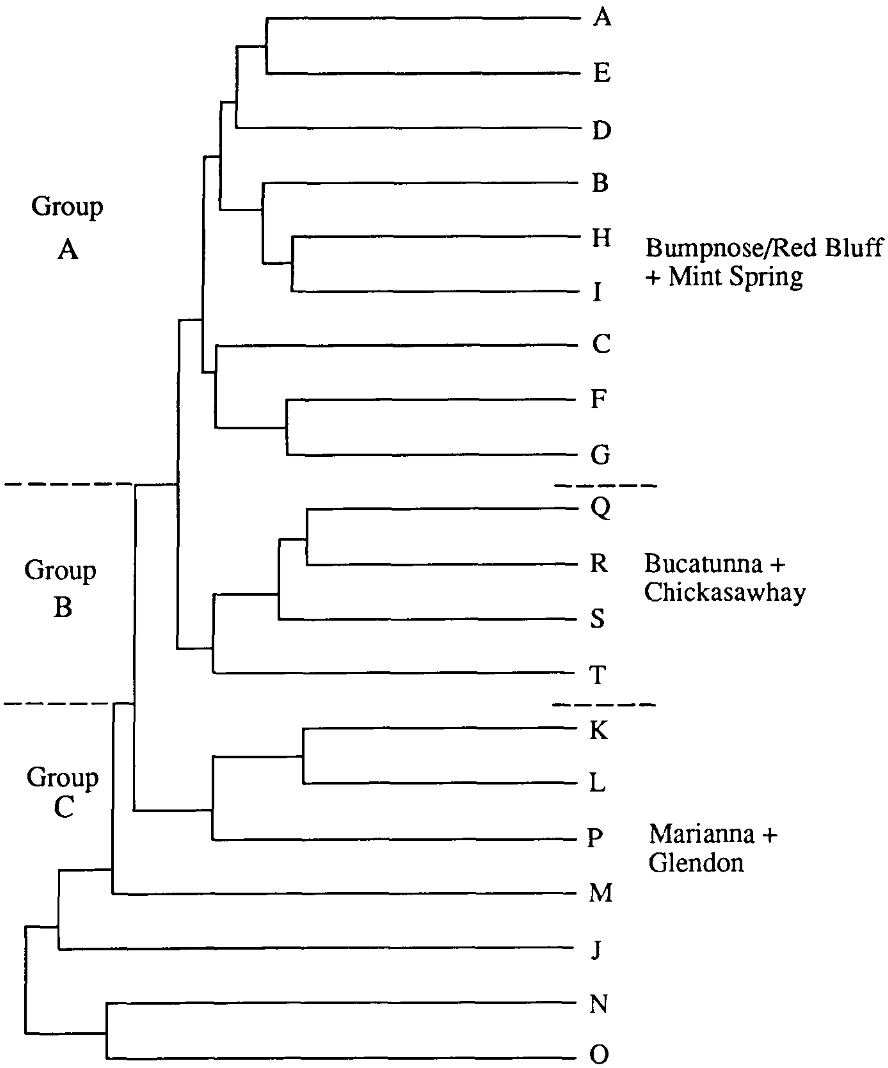

FIGURE 6—Dendrogram of average linkage cluster analysis of samples from the St. Stephens Quarry. See text for explanation of samples groups, and Table 1 for identification of samples (from Oboh and Reeves Morris, 1994).

Glendon, all of which have fewer taxa in comparison with group I samples. They are dominated by the two species of *Sequoia* type pollen. The two Glendon samples (O, P) are more closely related in the cluster (Fig. 5), and they are much richer in bisaccate pollen than samples from other lithostratigraphic units.

Figure 6 shows three groups of samples identified by unweighted pair average linkage cluster analysis. The data matrix was generated by the Spearman rank-order correlation coefficient. In this analysis, group A samples (Bumprose/Red Bluff and Mint Spring) have a relatively high diversity of sporomorphs (see Fig. 3), and they can be correlated with group I samples in Figure 5. However, the Mint Spring samples (R2070P/AM and R2070Q), which are much richer in *Sequoia* type pollen, clustered here because minor amounts of the dominant sporomorphs in the other samples are present. Group B contains the three tightly clustered Bucatunna samples (R, Q, S) in group I (Fig. 5), all of which lack *Sequoia* type pollen, and the Chickasawhay sample (UCR 8159/2) with minor amounts of *Sequoia* pollen. Group C samples largely correspond to group II in Figure 5 (see Table 1).

CONCLUDING REMARKS

Quantitative and semi-quantitative analyses of palynological samples revealed that *Sequoia* type pollen can be used to identify one group of samples, all of which are marine. This pollen type is more prominent in the transgressive deposits of the Mint Spring Marl and Marianna Limestone, possibly as a result of abundant production on land at that time, and their easy dispersal into the offshore environments represented by these sediments. If further work on other localities in Mississippi and Alabama reveals that this concentration is indeed unique to these two lithostratigraphic units, then *Sequoiapollenites lapillipites* and *Sequoiapollenites* sp. 1 can be used as markers for the Mint Spring Marl and Marianna Limestone in the area.

The percent values for nonmarine palynomorphs, in comparison with marine palynomorphs, is in agreement with the sequence stratigraphic interpretations of Gregory and Hart (1992), Tew and Mancini (1992), among others. However, the recent revision of the sequence stratigraphic framework for the St. Stephens Quarry by Pasley and Hazel (1995) demonstrates the need to use this criterion with caution when discriminating between the lowstand and highstand systems tracts. For example, Gregory and Hart (1992, fig. 14) showed that the percent nonmarine palynomorphs for the lowstand systems tract and the upper part of the highstand systems tract were very similar. Integration of palynology with other stratigraphic criteria would, therefore, enhance its use as a sequence stratigraphic tool.

Paleoclimatic inference can be drawn from the sporomorph assemblage in which *Quercus* type pollen is a prominent constituent. The composition suggests a warm temperate climate, which was cooler than the tropical to subtropical conditions of the Early and Middle Eocene epoch. *Ephedra*, *Abies*, Gramineae, and other pollen which typify dry conditions are insignificant in this assemblage.

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APPENDIX A

Percent data for sporomorph taxa at the St. Stephens Quarry locality. An asterisk (*) indicates total count for horizons where two slides were scanned. See Table 1 for sample numbers and lithostratigraphic units.

Taxa	Samples																			
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
Spores																				
Laevigatosporites haardti	0.64	0.62	0.29	0.65	1.40	0.77	0.57	0.27	1.06	0.00	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.53
Laevigatosporites javanicus	0.32	0.00	0.88	0.00	0.28	0.46	0.29	0.00	0.00	0.00	0.00	0.00	2.13	0.00	0.00	0.00	0.00	0.00	0.00	0.27
Laevigatosporites josensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polypodiisporonites alienus	0.32	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.47	0.27
Polypodiisporonites favus	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polypodiisporonites afavus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.00	0.00
Microfoveolatosporis pseudodentata	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27
Undulatosporites concavus	0.64	0.00	0.00	0.00	1.12	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Undulatisporites sp.	0.32	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cicatricosisporites dorogensis	4.47	1.24	3.53	0.33	0.56	0.46	0.29	0.27	0.53	0.00	0.00	0.00	2.13	0.00	0.00	0.00	0.25	0.45	0.47	0.00
Cicatricosisporites paradorogensis	0.32	0.00	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.23	0.00	0.00
Granulatisporites luteticus	0.00	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Granulatisporites sp.	0.00	0.31	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lygodiumsporites adriennis	2.88	0.31	1.18	0.33	0.00	0.31	1.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.23	0.00
Gleicheiniidites senonicus	0.32	0.31	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27
Gleicheiniidites simplex	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sphagnum triangulatus	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sphagnum antiquasporites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sphagnum australum	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sphagnum steroides	0.00	0.00	0.00	0.00	0.00	0.00	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Selaginella perinata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00
Selaginella sp. 1	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Toroisporis longitora	0.64	0.00	0.29	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00
Pteridium sp.	0.32	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Triplanosporites sp.	0.00	0.00	0.59	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pteris dentata	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Indet. cingulate spore	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lycopodium heskemensis	0.00	0.00	0.00	0.00	0.00	0.15	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyathidites senonicus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gymnosperm pollen																				
Podocarpus? cappulatus	0.64	0.00	0.29	0.00	0.00	0.15	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Podocarpus maximus	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.55	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pinus cembraeformis	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.14	0.26	0.00	0.00	0.00	0.00	0.00	0.00	4.21	0.25	0.00	0.00	0.00
Pinus labdaca	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.26	0.00	0.00	0.00	0.00
Cedrus piniformis	0.00	0.62	0.29	0.65	0.00	0.15	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00	20.88	6.32	0.25	0.45	0.23	0.27
Pityosporites cedrisacciformis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pityosporites longifoliaformis	0.00	0.00	0.00	0.00	0.28	0.15	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.05	0.00	0.00	0.00	0.00
Pityosporites insignis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.99	0.00	0.00	0.00	0.00	0.00
Picea grandivescipites	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.35	0.70	0.80
Ephedra hungarica	0.96	0.00	0.59	0.00	0.00	0.15	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.06
Ephedra claricristata	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.27
Ephedra exiguua	0.32	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cupressacites hiatipites	10.22	13.00	13.24	7.84	5.62	4.33	2.01	1.24	0.79	0.68	0.68	0.00	0.00	0.00	2.20	0.00	2.22	4.29	2.35	0.80
Cupressacites sp. 1	3.51	3.72	7.94	2.61	1.40	0.93	2.30	0.55	0.26	2.70	0.00	0.00	2.13	0.00	0.00	0.00	0.99	0.68	0.00	1.33
Hedyosmum type	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53
Dilwynites? granulatus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sequoiapollenites lapillipites	2.24	2.79	2.65	16.01	9.83	3.71	5.46	53.16	41.53	39.19	59.32	40.00	38.30	46.15	38.46	31.58	0.00	0.00	0.00	7.98
Sequoiapollenites sp. 1	2.88	2.48	2.06	6.54	1.69	1.85	1.72	19.64	28.04	52.70	23.39	33.33	27.66	23.08	6.59	4.21	0.00	0.00	0.00	1.60
Sequoiapollenites sp. 2	0.00	0.62	0.00	0.33	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	3.19
Sequoiapollenites sp. 3	0.00	0.00	0.00	0.00	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.05	0.00	0.00	0.00	0.00
Metasequoia? type	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.74	0.00	0.00	0.00	0.00
Taxodiacidites? sp.	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Retipollenites? confisus	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Angiosperm pollen																				
Graminidites graminoides	0.00	0.00	0.59	1.63	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.47	0.53
Graminidites sp.	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.27
Sparganiaceiopollenites cf. *S. reticulatus*	0.00	0.00	0.29	0.00	0.00	0.15	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Momipites coryloides	7.99	11.15	12.65	5.56	6.74	7.88	3.74	0.55	0.53	0.00	0.00	0.00	4.26	0.00	0.00	0.00	5.42	6.32	2.58	7.18
Momipites microfoveolatus	6.07	5.57	7.94	2.94	2.25	3.09	2.01	0.69	0.26	0.00	1.36	0.00	0.00	0.00	0.00	1.05	4.19	2.26	1.17	2.13
Carya simplex	0.64	0.00	0.00	1.31	1.40	2.01	2.01	1.92	3.70	0.00	0.68	0.00	0.00	0.00	0.00	2.11	4.19	7.90	3.76	3.72
Carya veripites	0.00	0.00	0.00	0.33	0.00	0.93	0.57	0.00	1.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27
Casuarinites? cf. *C. granilabratus*	0.32	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Subtriporopollenites nanus	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Subtriporopollenites sp.	0.32	0.00	0.00	0.33	0.56	0.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.23	0.00
Triatriopolleniets lubomirovae	0.00	0.00	0.29	0.00	0.00	0.77	0.57	0.00	0.00	0.00	0.00	0.00	0.00	7.69	2.20	0.00	1.23	0.00	0.47	0.53
Triatriopollenites paradoxus	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Triatriopollenites triangulus	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.05	0.00	0.23	0.00	0.00
Triatriopollenites cf. *T. subtriangulus*	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plicatopollis lunata	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plicatopollis sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00
Trivestibulopollenites betuloides	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	1.10	0.00	0.49	0.00	0.00	0.27
Pseudovacuopollis? sp.	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

APPENDIX A
Continued.

Taxa	Samples A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
Celtipollenites gracilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.49	0.00	0.00	0.00	0.00	0.00
Retitriporites sp. 1	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corsinipollenites sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00
Proteacidites? latus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ulmipollenites thompsonianus	0.32	0.93	2.35	0.33	1.40	0.93	0.57	0.00	0.26	0.00	0.00	0.00	4.26	0.00	0.00	0.00	1.72	4.29	2.35	1.86
Myriophyllum type	0.00	0.62	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.10	0.00	0.00	0.23	0.00	0.27
Echitetraporites? sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00
Indet. Tetraporate, psilate	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pterocarya stellata	0.32	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.23	0.80
Alnus vera	0.32	0.31	0.00	0.33	0.28	0.46	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00
Juglans nigripites	0.64	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.33	0.00	0.00	0.00	0.00	0.49	0.23	0.23	0.00
Juglanspollenites infrabaculatus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.40	0.00	0.00	0.00	0.47	0.53
Parsonsidites conspicuus	0.00	0.62	0.00	0.33	0.84	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.69	0.00	0.00	2.71	2.48	1.64	1.06
Keonigia type	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27
Lymingtonia cf. *L. rhetor*	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27
Confertisulcites fusiformis	1.28	0.31	0.59	0.00	1.12	0.31	0.57	0.14	0.26	0.68	0.00	0.00	2.13	0.00	0.00	1.05	0.49	0.00	0.70	0.53
Confertisulcites sp. 1	0.96	0.31	0.88	0.33	1.12	0.31	0.29	0.27	0.26	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.47	0.00
Liliacidites tritus	0.64	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Liliacidites vittatus	0.00	0.00	0.00	0.33	0.56	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.00	0.53
Sabal cf. *S. granopollenites*	0.32	0.00	0.00	0.00	0.00	0.15	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Monocolpopollenites tranquillus	0.32	0.62	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Monocolpopollenites sp. 1	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Monosulcites asymmetricus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Indet. monosulcate, verrucate	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Indet. monosulcate, baculate	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Longapertites sp.	0.32	0.31	0.00	0.65	0.56	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	7.69	0.00	0.00	0.00	0.00	0.00	0.27
Arecipites columellus	0.00	0.31	0.29	0.65	0.00	0.00	0.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00
Arecipites sp. 1	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Racemonocolpites sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00
Quercoidites microhenrici	6.39	9.91	6.47	8.82	10.67	9.74	7.18	2.88	1.59	0.00	4.75	3.33	2.13	0.00	0.00	10.53	14.04	13.32	13.38	7.18
Quercoidites inamoenus	9.27	7.12	6.47	7.84	7.30	9.74	7.76	1.24	0.53	0.00	0.68	3.33	0.00	0.00	0.00	4.21	17.98	15.12	19.48	13.83
Fraxinoipollenites variabilis	0.32	0.31	0.00	0.00	0.28	0.62	0.29	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fraxinoipollenites medius	0.00	0.62	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.06
Fraxinoipollenites spp.	0.64	0.00	0.29	0.33	0.28	0.15	0.57	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.27
Cupuliferoidaepollenites liblarensis	1.92	1.55	0.59	1.63	1.97	2.94	3.16	0.55	1.32	0.00	1.02	0.00	0.00	0.00	1.10	2.11	1.23	0.90	1.17	1.33
Cupuliferoidaepollenites cf. *C. selectus*	2.56	7.12	2.94	7.84	4.21	6.80	2.87	0.96	1.32	0.00	0.68	3.33	4.26	0.00	4.40	3.16	9.11	7.90	10.56	14.36
Indet. tricoplate, baculate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53
Salixpollenites parvus	1.92	0.31	0.29	1.31	0.56	0.31	0.00	0.14	0.00	0.00	1.02	3.33	0.00	0.00	0.00	0.00	1.23	0.45	0.00	0.00
Retibrevitricolpites sp.	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.10	0.00	0.00	0.00	0.00	0.00
Platanus occidentalis	0.00	0.00	0.00	0.00	0.28	0.62	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.45	0.23	0.53
Eucommia type (tricolpate)	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.80
Tricolpites reticulatus	0.00	0.00	0.00	0.00	0.28	0.31	0.00	0.00	0.00	0.00	0.00	0.00	2.13	0.00	0.00	0.00	0.00	0.23	0.00	0.00
Tricolpites interangulus	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acer? striatellum	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Indet. tricolpate, psilate, prolate	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cassia certa	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Foveotricolpites prolatus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27
Indet. tricolpate, granulate, oblate	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ambrosia? type	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.33	0.00	0.00	0.00	3.16	0.00	0.00	0.00	0.00
Indet. stephanocolpate, granulate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00
Cupuliferoipollenites spp.	8.95	4.64	2.65	2.94	4.78	8.81	13.22	0.96	3.17	0.00	2.03	3.33	2.13	7.69	0.00	1.05	3.69	2.93	2.82	0.53
Siltaria abouziarovae	0.00	0.00	0.00	0.00	0.00	1.24	1.72	0.41	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.45	0.90	2.35	0.80
Siltaria cf. *S. scabriextima*	7.99	7.74	6.18	3.27	8.43	10.05	12.36	2.61	4.23	0.00	1.69	0.00	0.00	0.00	0.00	0.00	8.87	9.26	9.15	5.85
Ilex infissa	0.00	0.00	0.29	0.00	0.00	0.00	0.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.47	0.27
Ilex media	0.32	0.00	0.00	0.33	0.00	0.31	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.27
Cyrillaceaepollenites kedvesii	0.64	0.00	0.00	0.00	3.93	2.16	3.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.94	0.80
C. megaexactus + barghoornianus	1.28	9.91	5.88	6.21	10.39	6.65	13.79	7.01	6.08	2.03	1.36	3.33	0.00	0.00	0.00	0.00	4.43	5.19	10.09	7.98
Araliaceiopollenites granulatus	0.00	1.24	1.18	0.33	0.00	1.08	0.86	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.90	0.94	0.00
Araliaceiopollenites megaporifer	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.27
Araliaceiopollenites profundus	0.00	0.00	0.29	0.00	0.00	0.62	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.23	0.00	0.27
Eucommia type (tricolporate)	0.32	0.00	0.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rousea araneosa	0.32	0.00	0.00	0.00	0.84	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00
Rousea monilifera	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.14	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.68	0.47	0.00
Symplocos virginiensis	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Symplocos contracta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00
Symplocos ceciliensis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Symplocus sp. 1	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Symplocospollenites cf. *S. orbis*	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Myrtaceidites parvus parvus	0.00	0.00	0.00	0.00	0.00	0.46	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.23	0.00	0.27
Myrtaceidites parvus anesus	0.00	0.00	0.29	0.00	0.00	0.00	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00
Myrtaceidites parvus subsp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00
Tetracolporopollenites prolatus	0.00	0.00	0.29	0.00	2.25	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.22	4.06	1.64	0.27
Tetracolporopollenites megadolium	0.00	0.00	0.00	0.65	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00
Boehlensipollis hohlii	0.00	0.62	0.59	1.63	0.00	0.15	0.00	0.14	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.06
Rhoipites angustus	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.00	0.00	0.00
Rhoipites capax	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00
Intratiporopollenites stavensis	0.00	0.00	0.00	0.65	0.00	0.15	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

APPENDIX A

Continued.

Taxa	Samples																			
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
Nyssapollenites pulvinus	0.00	0.00	0.00	0.00	0.00	0.46	0.57	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nyssapollenites spp.	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.47	0.27
Tilia instructa	0.00	0.00	0.00	0.00	0.56	0.15	0.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.45	0.70	0.00
Horniella modica	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00
Horniella sp. 1	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00
Horniella sp. 2	0.00	0.00	0.00	0.65	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Horniella sp. 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00
Foveotricolporates sp.	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00
Gothanipollis? sp.	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lanagiopollis crassa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00
Lanagiopollis? eocaenica	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chrysosplenium type	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Syncolporites sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00
Tetracolporopollenites brevis	0.00	0.00	0.00	0.00	0.00	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.97	0.23	0.00	0.27
Tetracolporopollenites lesquereuxianus	0.00	0.00	0.29	0.00	0.00	0.15	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.45	0.23	0.00
Ericipites redbluffensis	0.32	0.00	0.29	1.31	0.28	0.00	0.00	0.00	0.00	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.45	0.00	0.00
Indet. grain A	1.60	0.31	0.29	0.65	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Indet. grain B	0.96	0.00	0.29	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Indet. grain C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00
Indet. grain D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.11	0.00	0.00	0.00	0.00
Total sporomorphs	313	323	340	306	356	647*	348	728*	378	148	295	30	47	13	91	95	406	443	426	376

APPENDIX B

Percent data for sporomorph taxa at the Wayne County locality. See Table 2 for sample numbers and lithostratigraphic units.

Taxa	Samples A	B	C	D
Spores				
Laevigatosporites haardti	1.33	0.66	0.00	0.32
Cicatricosisporites dorogensis	0.00	0.00	0.00	1.27
Granulatisporites luteticus	0.33	0.00	0.00	0.00
Lygodiumsporites adriennis	0.00	0.00	0.00	0.00
Sphagnum antiquasporites	0.00	0.33	0.00	0.00
Sphagnum steroides	0.00	0.33	0.00	0.00
Selaginella perinata	0.33	0.00	0.00	0.00
Toroisporis longitora	1.00	0.00	0.00	0.00
Pteris dentata	0.33	0.00	0.00	0.00
Lycopodium heskemensis	0.00	0.33	0.00	0.00
Gymnosperm pollen				
Podocarpus? cappulatus	0.33	0.00	0.00	0.00
Pinus cembraeformis	1.00	0.00	0.65	0.32
Pinus labdaca	0.33	0.00	0.00	0.00
Cedrus piniformis	0.00	0.33	0.32	2.54
Pityosporites longifoliaformis	0.00	0.33	0.00	0.63
Picea grandivescipites	0.00	0.33	0.00	0.00
Abiespollenites? sp.	0.00	0.00	0.00	0.32
Ephedra hungarica	0.00	0.66	0.00	0.00
Cupressacites hiatipites	0.00	1.65	2.92	0.95
Cupressacites sp. 1	0.67	4.29	1.95	1.27
Sequoiapollenites lapillipites	2.00	0.99	46.43	57.78
Sequoiapollenites sp. 1	0.67	3.63	21.43	22.86
Angiosperm pollen				
Momipites coryloides	6.33	7.59	0.65	0.00
Momipites microfoveolatus	1.00	1.98	1.62	0.32
Carya simplex	4.33	1.32	0.97	0.00
Carya veripites	1.33	0.00	0.00	0.00
Subtriporopollenites sp.	0.00	0.00	0.00	0.95
Triatriopollenites lubomirovae	0.00	0.33	0.32	0.00
Triatriopollenites triangulus	0.00	0.66	0.00	1.27
Triatriopollenites cf. *T. subtriangulus*	0.67	0.00	0.00	0.00
Triporopollenites? maternus	0.33	0.00	0.00	0.00
Plicatopollis lunata	0.67	0.00	0.00	0.00
Plicatopollis magnorbicularis	0.00	0.33	0.00	0.00
Trivestibulopollenites betuloides	0.00	0.33	0.32	0.00
Celtipollenites gracilis	0.00	0.00	0.00	0.32
Ulmipollenites thompsonianus	0.00	0.33	0.00	0.00
Alnus vera	0.00	0.33	0.00	0.00
Juglanspollenites infrabaculatus	0.00	0.33	0.00	0.00
Chenopodipollis sp.	0.00	0.00	0.00	0.32
Lymingtonia cf. *L. rhetor*	0.00	0.00	0.00	0.63
Liliacidites tritus	0.00	0.00	0.32	0.00
Liliacidites vittatus	0.67	0.00	0.00	0.00
Arecipites columellus	0.33	0.33	0.00	0.00
Quercoidites microhenrici	25.00	21.45	4.87	2.22
Quercoidites inamoenus	5.67	6.60	0.97	0.95
Fraxinoipollenites variabilis	0.00	0.33	0.00	0.00
Fraxinoipollenites medius	0.00	0.00	1.30	0.00
Cupuliferoidaepollenites liblarensis	0.33	1.32	0.32	0.00
Cupuliferoidaepollenites cf. *C. selectus*	2.67	3.30	0.97	0.32

APPENDIX B

Continued.

Taxa	Samples A	B	C	D
Salixpollenites parvus	0.00	0.00	0.00	0.32
Platanus occidentalis	0.67	1.32	0.00	0.00
Cassia certa	0.33	0.00	0.00	0.00
Cupuliferoipollenites spp.	7.67	15.84	2.60	0.63
Siltaria abouziarovae	6.00	3.30	0.65	0.00
Siltaria cf. *S. scabriextima*	10.00	7.59	3.57	1.27
Ilex infissa	0.67	0.33	0.00	0.00
Ilex media	0.67	1.32	0.00	0.00
Cyrillaceaepollenites kedvesii	2.67	2.31	0.00	0.63
C. megaexactus + barghoornianus	2.33	1.98	2.92	0.95
Araliaceiopollenites granulatus	1.33	0.00	0.00	0.00
Araliaceiopollenites megaporifer	0.00	0.00	0.00	0.63
Araliaceiopollenites profundus	0.67	0.00	0.32	0.00
Rousea monilifera	0.00	0.33	0.00	0.00
Symplocos contracta	0.67	0.66	0.00	0.00
Verrutricolporites tenuicrassus	0.33	0.00	0.65	0.00
Reticulataepollis reticlavata	0.67	0.33	0.65	0.00
Myrtaceidites parvus parvus	0.00	0.00	0.32	0.00
Myrtaceidites parvus anesus	0.00	0.33	0.00	0.00
Tetracolporopollenites prolatus	0.33	0.33	0.00	0.00
Tetracolporopollenites megadolium	0.67	0.33	0.00	0.00
Rhoipites latus	0.33	0.00	0.00	0.00
Rhoipites angustus	0.00	0.33	0.00	0.00
Rhoipites capax	0.33	0.00	0.00	0.00
Intratiporopollenites stavensis	0.67	0.33	0.00	0.00
Nyssapollenites spp.	0.67	0.33	0.00	0.00
Tilia instructa	1.33	0.33	0.00	0.00
Horniella genuina	0.00	0.66	0.00	0.00
Horniella sp. 1	0.00	0.66	0.00	0.00
Horniella sp. 2	1.33	0.00	0.00	0.00
Syncolporites sp.	0.67	0.00	0.00	0.00
Tetracolporopollenites brevis	0.33	0.00	0.00	0.00
Ericipites redbluffensis	0.33	0.33	1.95	0.00
Ericipites ericus	0.33	0.00	0.00	0.00
Total sporomorphs	300	303	308	315