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Palynology of Paleocene lignite beds and associated detrital strata from Louisiana and Mississippi

By

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ABSTRACT

Seventeen samples of Paleocene lignite and associated detrital rock from Louisiana and Mississippi were examined for palynomorphs to determine the ages of the strata and the nature of the vegetation that influenced the composition of the peats. Most of the samples were from the Dolet Hills and Oxbow lignite mines in northwestern Louisiana, which expose strata from the uppermost part of the Naborton Formation and lowermost part of the Dolet Hills Formation. The Chemard Lake Lignite Lentil (Naborton Formation) in these mines can be divided into two spore/pollen zones. Comparison of mainly autochthonous palynomorph assemblages from lignites with allochthonous assemblages from detrital rocks above and below the lignite lentil suggests that ferns were more abundant in the vegetation of the peat swamps than in areas with muddy substrates, whereas bisaccate conifer pollen, mainly of the pine family, probably originated from trees growing on mineral soils outside the swamp.

A pollen assemblage from a lignite bed younger than the Chemard Lake Lignite Lentil (probably the "Yellow Bed" in the Cow Bayou Formation) in northwestern Louisiana contains a very high relative frequency of triporate pollen from hardwood shrubs and trees and in this respect is similar to the assemblage from the upper part of the Chemard Lake Lignite Lentil in the Dolet Hills mine.

Known stratigraphic ranges of pollen species in Alabama indicate that the interval from the upper part of the Naborton Formation to the Cow Bayou Formation is correlative with strata near the boundary between the Oak Hill and Coal Bluff Marl Members of the Naheola Formation in Alabama, that is, upper part of the Midwayan Stage, middle Paleocene.

Two samples of lignite from the Tuscahoma Formation (upper Paleocene) of east-central Mississippi contain spore/pollen assemblages that appear distinctly younger than those from the middle Paleocene of Louisiana.

INTRODUCTION

This report considers 17 samples of coal and associated detrital rock from Louisiana and Mississippi (fig. 1), collected by us in April and December, 1993. Twenty-four samples were actually processed for palynomorphs, and 16 of them contained enough well preserved spores and pollen grains that counts could be made to determine relative frequencies of the various taxa to obtain information about the ages of the strata, the environments of deposition, and the flora and vegetation of the peat swamps and the surrounding region. A seventeenth productive sample, R4827, was examined only for the presence of age-diagnostic taxa.

METHODS

Two sets of slides were made for all samples. One set was made from residues that were not sieved after the original samples had been broken down using HNO_3 (lignites) or HCl and HF (detrital rocks). The other set of slides was made from residues that had been sieved to retain the size fraction larger than 8µm. Counts were based on unsieved residues when possible, but in fact few palynomorphs were present smaller than 8µm in size; therefore, it is not likely that the two sets of slides for a sample contained significantly different assemblages.

Counting of specimens was unexpectedly time consuming because of the presence of very abundant particles of plant tissues in the slides made from both coal and detrital rock samples; therefore, a minimum of only 100 rather than 200-300 palynomorphs were counted per sample. These counts are believed to be adequate to show significant differences among sample assemblages, and larger counts would not necessarily be more reliable because preservation of specimens in each sample ranged from good to poor.

PALYNOMORPH ASSEMBLAGES - LOUISIANA SAMPLES

Samples from Louisiana were from the Naborton, Dolet Hills, and Cow Bayou Formations (in ascending order), and mainly from the Chemard Lake Lignite Lentil that forms the top of the Naborton Formation in northwestern Louisiana (table 1). The Naborton Formation in turn forms the base of the Wilcox Group (fig. 3; Williamson, 1986; Breyer, 1993).

Dolet Hills and Oxbow Mines

Tables 2 and 3 are lists of the samples processed for palynomorphs from the Dolet Hills and Oxbow mines (fig. 1), and sample positions are shown in figure 2.

The Chemard Lake Lignite Lentil was sampled extensively in both the Dolet Hills and Oxbow mines, but most lignite samples processed from the Oxbow mine were barren of palynomorphs or contained only poorly preserved specimens (samples having Result B, table 3). Therefore, the main record of palynomorph assemblages from the lignite lentil is from the Dolet Hills mine.

In the Dolet Hills mine, there is a clear difference between assemblages from the lower part of the lignite lentil and those from the upper part, although the boundary between assemblage zones is gradational (table 4). The lower part of the lentil contained many more psilate fern spores ("psilate monoletes" and "psilate triletes"), and in some samples more pollen grains of miscellaneous angiosperms, whereas the upper part of the lentil contained more lycopod and non-psilate fern spores (both grouped under "miscellaneous spores"), and high to very high abundances of "miscellaneous triporate" pollen, most of which represents hardwood shrubs and trees of the Myricaceae-

Betulaceae complex (wax-myrtle and birch families). "Miscellaneous angiosperms" are represented by a considerable variety mainly of finely reticulate tricolporate and oblate tricolpate pollen grains characteristic of many families. Unfortunately, the growth forms (whether herbs, shrubs, or trees) of the plants that produced these grains are unknown, but it is thought that relatively few taxa of angiosperm herbs existed in the Paleocene (Frederiksen, 1985). Apparently, ferns and other small spore-producing plants were the ecological equivalents of modern herbs in the Paleocene.

Sphagnum (peat moss) spores were distributed irregularly through the lignite lentil and reached moderately high relative frequencies at the top of the lower palynomorph zone and also in a sample from the upper zone. TCT gymnosperm pollen probably represents trees similar to modern bald cypress, and relative frequencies of this pollen were highly variable from sample to sample within the lignite lentil.

In all interpretations based on the relative frequencies displayed in tables 4 and 5, it must be remembered that different plant taxa produce spores or pollen grains at very different rates. Undoubtedly the producers of wind-pollinated TCT gymnosperm pollen and wind-pollinated "miscellaneous triporate" angiosperm pollen were not as abundant in the vegetation as the high relative frequencies of these pollen types would seem to indicate. Conversely, most "finely reticulate ... tricolpate to tricolporoidate pollen" and "miscellaneous angiosperm" pollen was probably insect-transported, thus produced in relatively low numbers; therefore, the plants producing these pollen types were probably much more abundant in the vegetation than the relative frequencies of pollen taxa suggest. However, these disparities in pollen productivities do not alter the picture of distinct differences in the peat-forming vegetation types during the early and late stages of development of the lignite lentil.

The only lignite sample analyzed from the Oxbow mine (R4878G) was from the lowermost part of the lentil, and it contained mainly "miscellaneous angiosperm" pollen as well as "finely reticulate ... tricolpate to tricolporoidate" pollen that is morphologically similar to most of the "miscellaneous angiosperm" pollen and probably has similar botanical affinities. In short, the lowermost part of the lignite lentil in the Oxbow mine has a palynomorph assemblage similar to that at the base of the lentil in the Dolet Hills mine.

Counts were made of palynomorph assemblages from five detrital rock samples, mainly from the Oxbow mine (tables 4, 5), and rough quantitative data were also available from detrital rock sample R4827 (table 4). These assemblages may be compared with those from the seven coal samples of the two mines. The assemblages from detrital rocks probably contained some specimens washed in from non-peaty areas together with some that may have been eroded from nearby peat swamps. Sample R4878 O (fig. 2; table 5) is of interest because it is from a claystone parting in the lignite that is thought to be composed partly of altered

volcanic ash (Ruppert and Warwick, 1994). Few spores and pollen grains would have been delivered to the site of deposition during ashfall; therefore, the presence in the sample of these fossils, which were mainly or entirely transported to the site by water, supports mineralogic evidence that the parting is composed partly of detrital material (Ruppert and Warwick, 1994).

The detrital rock samples generally contained more TCT gymnosperm pollen but fewer fern spores than assemblages from lignite samples. Bisaccate conifer pollen (mainly of the pine family) was rare or absent in all lignite samples but was rather abundant in two of the detrital rock samples, R4878B (lower part of the Dolet Hills Formation) and R4827 (floor of the lignite lentil). These data suggest that ferns were more abundant in the vegetation of the peat swamps than in areas with muddy substrates. Bisaccate pollen probably originated from trees growing on mineral soils outside the peat swamp.

One of the most interesting species found in the lignite and detrital rock samples is *Choanopollenites* sp. B of Tschudy (1973), which was previously known only from one sample of the Naborton Formation (sample D1849 of Tschudy, 1973) from "NW 1/4 SW 1/4 sec. 6, T. 11 N., R. 11 W., De Soto Parish, La." This locality is in Pelican 7.5 min. quadrangle, approximately 1.3 km southeast of the Dolet Hills mine. The lithology of the sample was not described. *Choanopollenites* sp. B is present in three samples from the Dolet Hills mine (R4875 T, W, B), from the upper palynomorph zone of the lignite lentil and in the overlying clay of the lowermost Dolet Hills Formation. This species has not been reported from middle Paleocene rocks of Mississippi and Alabama; therefore, its geographic range may be small.

Probable freshwater plankters (remains of apparent planktonic organisms) were rarely found in lignite samples from the Dolet Hills mine, possibly indicating a scarcity of lakes during peat formation. However, interpretation of the plankter data is difficult because an unfavorable water chemistry may have prevented plankton growth even if lakes were present. One dinoflagellate cyst was found in a lignite sample, possibly indicating a small influence of brackish tidal water because there is no evidence of reworked palynomorphs in the lignite samples. Scattered dinoflagellate cysts were found in sample R4827 (floor of the lignite lentil), which may represent the influence of brackish or marine water during deposition or may represent reworked specimens. Dinoflagellate cysts were not found during palynomorph counts of the other detrital rock samples. However, these samples were not scanned for additional palynomorph taxa after the counts had been completed; thus, the possibility exists that dinoflagellate cysts were present in some of these samples but in low relative frequencies.

Miscellaneous samples from Louisiana

In addition to the samples from the Dolet Hills and Oxbow mines, three samples were processed from northwestern Louisiana

(fig. 1; table 6). Two of them contained enough well preserved palynomorphs to make counts, and these quantitative results are displayed in table 7. Both of these samples were from an abandoned clay mine in the Mansfield 15 min. quadrangle and probably represent the "Yellow Bed" of the Cow Bayou Formation (table 1; fig. 3) and directly underlying strata.

The palynomorph assemblage from the detrital rock sample (R4877A) was noteworthy because it contained somewhat more TCT gymnosperm pollen and much more "finely reticulate ... tricolpate to tricolporoidate" pollen and "miscellaneous angiosperm" pollen than the lignite sample. It also contained a considerable amount of bisaccate conifer pollen (mainly of the pine family) which probably came from outside the peat swamp. In contrast, the lignite sample (R4877B), which is younger than the Chemard Lake Lignite Lentil, contained a very high relative frequency of "miscellaneous triporate" pollen, nearly entirely from hardwood shrubs and trees of the Myricaceae-Betulaceae complex. In this respect, the lignite sample had an assemblage similar to that of the upper part of the Chemard Lake Lignite Lentil in the Dolet Hills mine.

Age and correlation of the Naborton, Dolet Hills, and Cow Bayou Formations

The age and correlation of the Naborton, Dolet Hills, and Cow Bayou Formations have been uncertain (fig. 3) because few marine fossils have been found in these strata. For this report, correlations with dated units in Alabama were determined for (1) the Chemard Lake Lignite Lentil (uppermost part of the Naborton Formation) and adjacent strata (upper part of the Naborton Formation and lowermost part of the Dolet Hills Formation) and (2) two samples from the Cow Bayou Formation.

Correlation and age determination for the upper part of the Naborton Formation and lowermost part of the Dolet Hills Formation were based on a combined list of taxa found in the samples. However, sample R4827 (tables 2, 4) was especially important because it was examined in detail for species content, and this sample contained several useful species not listed in tables 4 and 5. Four species have significance for age and correlation, and their range tops or bases in Alabama are shown in figure 4.

Although *Caryapollenites prodromus* group (the ancestor of *Carya* <29µm) was present in sample R4827, no *Carya* <29µm, a small version of modern hickory pollen, was found in the sample. The range base of *Carya* <29µm is in the Gravel Creek Sand Member of the Nanafalia Formation (which forms the base of the Sabinian Stage); in other words, the absence of *Carya* <29µm suggests that this sample is Midwayan. To be more exact, the known ranges of *Aesculiidites circumstriatus*, *Caryapollenites prodromus* group, and *Choanopollenites discipulus* in Alabama suggest that the samples are no older than the upper part of the Oak Hill Member and no younger than the lower part of the overlying Coal Bluff

Marl Member of the Naheola Formation. Thus, the samples from the upper part of the Naborton Formation and the lowermost part of the Dolet Hills Formation appear to be correlative with strata near the boundary between these two members within the Naheola Formation; that is, late Midwayan Age, middle Paleocene (fig. 3).

The two samples from the Cow Bayou Formation (table 7) had few age-diagnostic species. However, the presence of *Choanopollenites discipulus* suggests that the samples are no younger than the lower part of the Coal Bluff Marl Member of the Naheola Formation in Alabama (fig. 4).

Among the correlations summarized in figure 3, those of Fairchild and Elsik (1969) were presumably based at least in part on spores and pollen grains. These authors did not present any species lists from their stratigraphic units, but their correlation of the Naborton and Logansport Formations of Louisiana with units in Alabama is similar to ours.

As noted on page 3, the base of the Wilcox Group in Louisiana is defined as coinciding with the base of the Naborton Formation. However, in Alabama, the base of the Wilcox Group is defined as coinciding with the base of the Nanafalia Formation (e.g., Dockery, 1986). Therefore, if the base of the Naborton Formation is approximately the same age as the base of the Naheola Formation, as suggested here and by Fairchild and Elsik (1969), then the base of the Wilcox Group is distinctly diachronous. It was because the boundaries of the Wilcox Group had no chronostratigraphic uniformity that Murray (1955) created the Midwayan and Sabinian Stages that were intended to be chronostratigraphic units with isochronous boundaries.

PALYNOMORPH ASSEMBLAGES - MISSISSIPPI SAMPLES

Two samples of lignite from Mississippi (fig. 1, test hole no. 5), both from the upper Paleocene Tuscahoma Formation (fig. 3), were processed for palynomorphs, and both contained abundant specimens. The samples were as follows:

Paly-nology number	Field number	Lithology and location
R4879A	NF93MS-100	Mississippi Office of Geology test hole 5, SW 1/4 NW 1/4 NW 1/4 SE 1/4 sec. 27, T. 9 N., R. 16 E., Daleville 7.5 min. quadrangle, Kemper County. Depth 56 ft (17.1 m), lignite.
R4879B	NF93MS-101	Same core, depth 59 ft (18.0 m), lignite.

Table 8 presents relative frequencies of the main taxa. The two palynomorph assemblages are similar to each other. Both

are characterized by having abundant triporate pollen mainly representing hardwood shrubs and trees of the Myricaceae-Betulaceae complex and pollen of "miscellaneous angiosperms"; there is very little TCT gymnosperm pollen. Tuscahoma Formation lignites having this type of palynomorph assemblage are considered to have been deposited in freshwater swamps (Carroll, 1993). In the two samples examined here, "miscellaneous angiosperm" pollen includes a variety of undescribed species of generally small psilate to punctate pollen grains some of which may be wind-pollinated; finely reticulate grains (mainly or entirely insect-pollinated) typical of "miscellaneous angiosperms" in the middle Paleocene, are less abundant. "Psilate to punctate fagaceous tricolpate and tricolporate pollen" (fagaceous means the grains are similar to some modern pollen of the oak family) is present in low relative frequencies; this type of pollen is extremely abundant in many Eocene lignites of the Gulf Coast. *Carya* <29µm (similar, except for its small size, to modern hickory pollen) is present; as noted previously, this pollen type has its first appearance at the base of the Sabinian Stage.

CONCLUSIONS

The Chemard Lake Lignite Lentil (uppermost part of the Naborton Formation) in northwestern Louisiana can be divided into two distinct spore/pollen zones which represent two different kinds of vegetation that successively occupied the peat swamp during its deposition. However, in a general way, ferns, gymnosperm trees, and above all angiosperm trees and shrubs were the main groups that produced the peat throughout its growth. Spore/pollen data from detrital strata above and below the lignite lentil indicate that ferns were more abundant in the peat swamps than in areas with muddy substrates. A spore/pollen assemblage probably from the "Yellow Bed" of the Cow Bayou Formation (which overlies the Naborton and Dolet Hills Formations) is much more similar to the upper zone than to the lower zone of the Chemard Lake Lignite Lentil.

Pollen species indicate that the interval from the upper part of the Naborton Formation to the Cow Bayou Formation in northwestern Louisiana is of late Midwayan Age, middle Paleocene.

Two lignite samples from the Tuscahoma Formation (upper Paleocene) of east-central Mississippi contain spore/pollen assemblages that are distinctly younger than those of the Chemard Lake and are composed mainly of angiosperm pollen largely from trees and shrubs.

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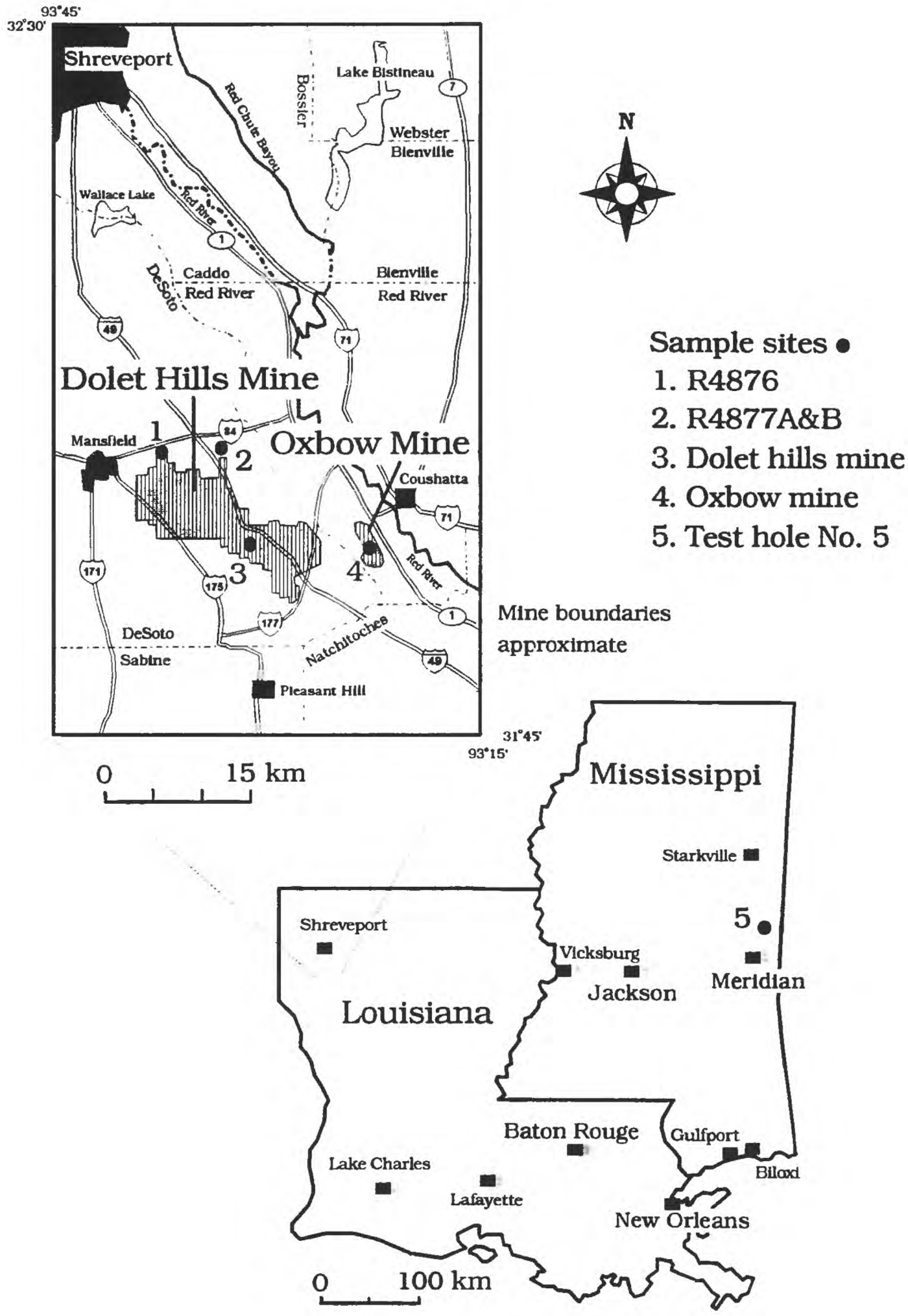

Figure 1. Location of the Dolet Hills and Oxbow mines in northwestern Louisiana, sampled sites within these mines, and location of samples from eastern Mississippi. Sample numbers refer to table 6.

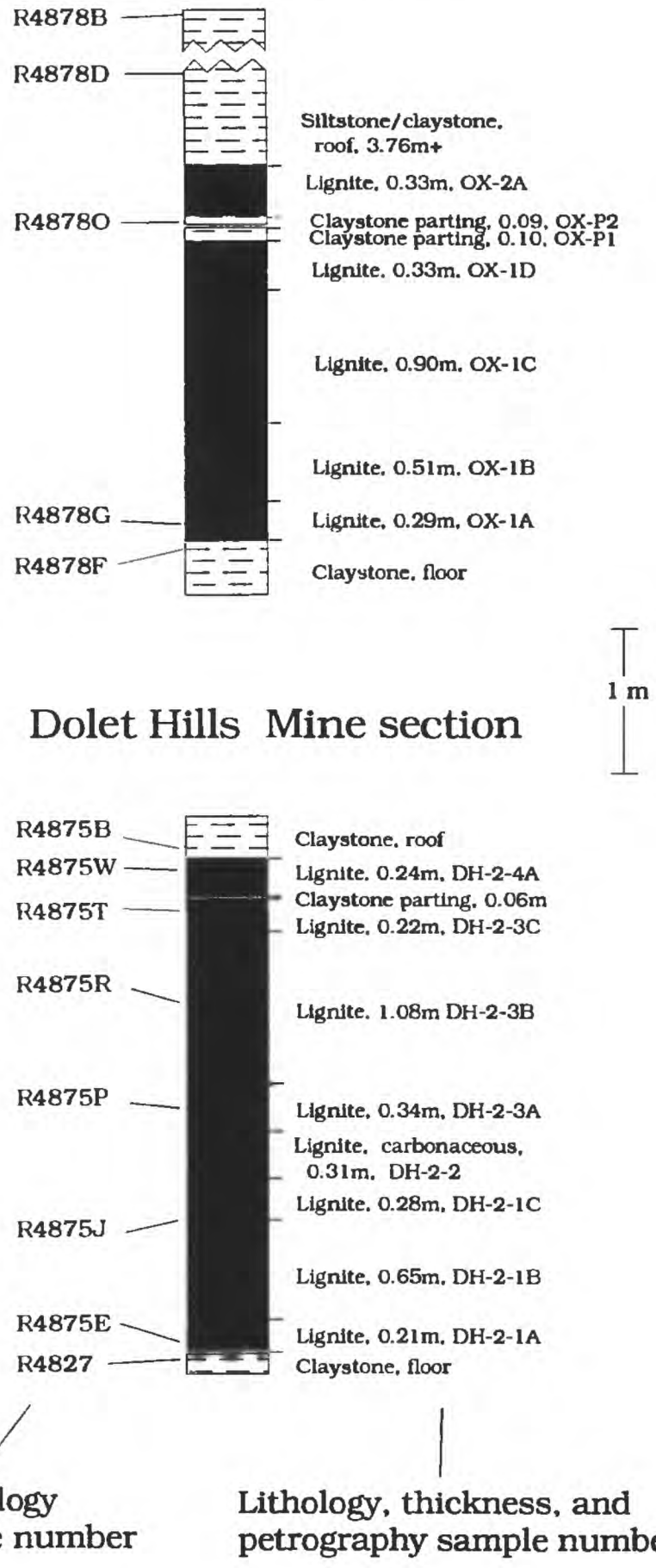

Figure 2. Measured sections of the Chemard Lake Lignite Lentil of the Naborton Formation, and adjacent strata, in the Dolet Hills and Oxbow mines. The claystone roof overlying the lignite lentil forms the base of the Dolet Hills Formation. Stratigraphic positions of palyniferous samples are shown here and described in tables 2 and 3.

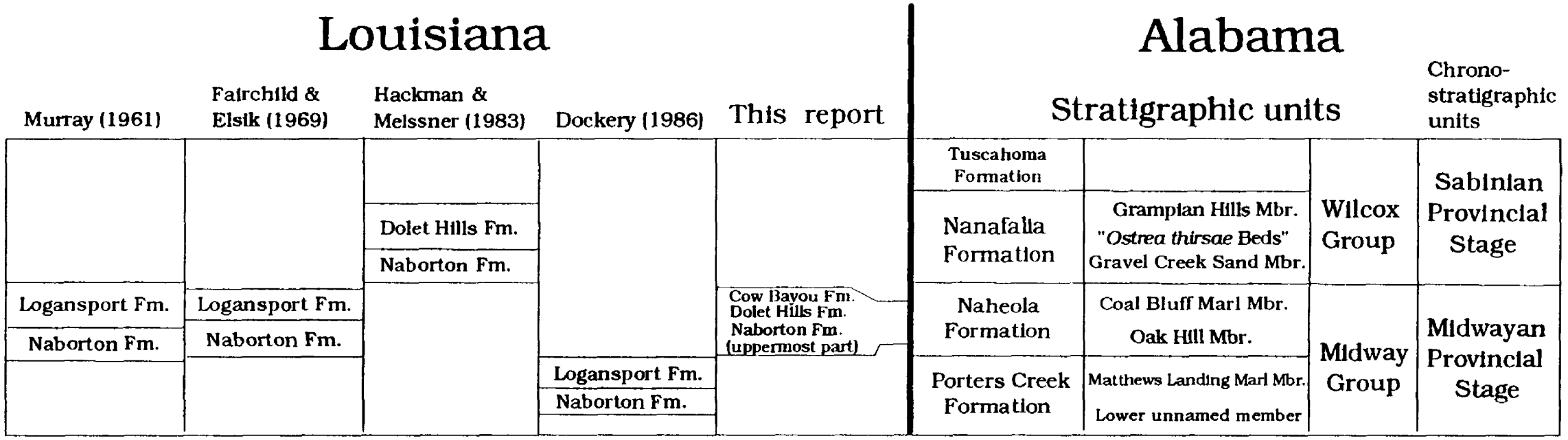

Figure 3. Correlations of the Naborton, Dolet Hills, and Cow Bayou Formations of Louisiana with units in Alabama. The present Dolet Hills and Cow Bayou Formations make up the lower part of the Logansport Formation of Murray (1941).

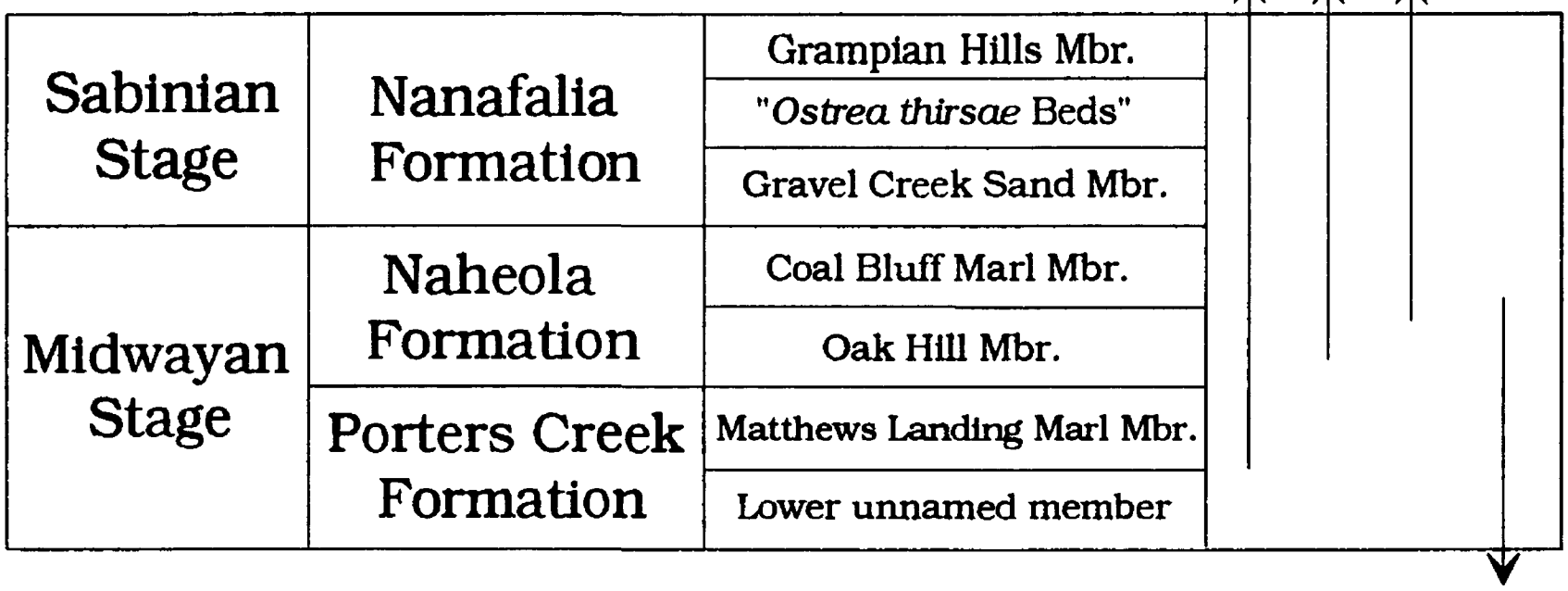

Figure 4. Significant range tops and bases, in Alabama, of pollen species occurring in the uppermost part of the Naborton Formation and adjacent strata of the Dolet Hills and Oxbow mines. Ranges of taxa in Alabama are mainly from Frederiksen (1980, 1991, and unpublished data).

Table 1. Formations and some of the coal beds in the lower part of the Wilcox Group in northwestern Louisiana (Williamson, 1986; Breyer, 1993). See also figure 3.

Cow Bayou Formation[1]
"Yellow Bed" or "D" seam
Dolet Hills Formation[1]
Naborton Formation
Chemard Lake Lignite Lentil = "Blue Bed" or "C" seam
"Red Bed" or "B" seam
"Green Bed" or "A" sean

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[1]The Dolet Hills and Cow Bayou Formations are included as members within the Logansport Formation by some authors, but the name Logansport Formation of Murray (1941), for Paleocene rocks of the Gulf Coast, was suppressed by Wilson and others (1957) in favor of the Logansport Formation of Cooper and Warthin (1941) for Devonian rocks in Indiana.

Table 2. List of samples processed for palynomorphs from the Dolet Hills mine, NE 1/4 sec. 1, T. 11 N., R. 12 W., SW of Evans Cemetary, Pelican 7.5 min. quadrangle, De Soto Parish, Louisiana. Lat 31°58.29′ N., long 93°33.06′ W. Samples are listed in stratigraphic order and are from the Naborton Formation unless otherwise indicated. Positions of palyniferous samples are shown in figure 2. In the Result column, A = analyzed for this report; B = barren or nearly so, or else palynomorph preservation was too poor for an analysis to be made.

Result	Paly-nology number	Field number	Lithology and location
A	R4875B	NF93LA-2	Clay, medium-dark-gray, silty, laminated; lowermost 3 cm overlying lignite bed. Dolet Hills Formation.
A	R4875W	NF93LA-23	Lignite, 4-10 cm below top of unit DH-2-4A.
A	R4875T	NF93LA-20	Lignite, 5 cm thick sample from middle of unit DH-2-3C.
A	R4875R	NF93LA-18	Lignite, 42-47 cm above base of unit DH-2-3B.
A	R4875P	NF93LA-16	Lignite, 21-26 cm above base of unit DH-2-3A.
B	R4875M	NF93LA-13	Shale, medium-brownish-gray, with vitrain streaks, 123-126 cm above base of lignite lentil, in middle part of unit DH-2-2.
A	R4875J	NF93LA-10	Lignite, 91-96 cm above base of lentil, in lower part of unit DH-2-1C.
B	R4875H	NF93LA-8	Lignite, 63-69 cm above base of lentil, in middle of unit DH-2-1B.
A	R4875E	NF93LA-5	Lignite, 0-10 cm above base of lentil, in unit DH-2-1A.
A	R4827	DH Blue Floor	Mudstone, floor of the "Blue Bed." Approximate sample location: lat 31°57.75′ N., long 93°31.39′ W.

Table 3. List of samples processed for palynomorphs from the Oxbow mine, N-C sec. 28, T. 12 N., R. 10 W., Harmon 7.5 min. quadrangle, Red River Parish, Louisiana. Lat 32°0.26′ N., long 93°23.93′ W. Samples are listed in stratigraphic order and are from the Naborton Formation unless otherwise indicated. Sample positions are shown in figure 2. In the Result column, A = analyzed for this report; B = barren or nearly so, or else palynomorph preservation was too poor for an analysis to be made.

Result	Paly-nology number	Field number	Lithology and location
	Subsection 1.		
A	R4878B	NF93LA-28	20-30 cm above top of 6-cm-thick flaser-bedded hard siltstone bed, whose base is 3.4 m above top of unit OX-2A. Mudstone, medium-light-gray, interlaminated with minor sandstone, medium-light-gray, fine-grained. Dolet Hills Formation.
A	R4878D	NF93LA-30	56-62 cm above top of unit OX-2A. Same lithology as sample 28. Dolet Hills Formation.
	Subsection 2, 57 ft (17 m) south of subsection 1; unit OX-P2 is 46 cm thick here.		
B	R4878Q	NF93LA-43	Lignite, unit OX-2A.
A	R4878 O	NF93LA-41	Shale, medium-dark-gray, with vitrain streaks; 7-12 cm above base of unit OX-P2 (claystone parting).
	Subsection 1.		
B	R4878M	NF93LA-39	Lignite, middle of unit OX-1D.
B	R4878K	NF93LA-37	Lignite, 54-59 cm above base of unit OX-1C.
B	R4878I	NF93LA-35	Lignite, 33-40 cm above base of unit OX-1B.
A	R4878G	NF93LA-33	Lignite, middle of unit OX-1A.
A	R4878F	NF93LA-32	Immediately below base of Chemard Lake Lignite Lentil. Mudstone, medium-dark brownish-gray, with vitrain streaks.

Table 4. Analyses of samples from the Dolet Hills mine. Sample order is up-section toward the right. X = present; P = probably present; Q = possibly present. Numbers are frequencies relative to total palynomorphs, to the nearest whole percent.

		R4875 samples						
	R4827	E	J	P	R	T	W	B
Coal (C) or detrital rock (D)-->	D	C	C	C	C	C	C	D
Spores								
Psilate monoletes		6	3	2	1			2
Psilate triletes		11	89	31	2	2		3
Cicatricosisporites spp.		Q	1					
Sphagnum spp.			1	12	2		17	1
Miscellaneous spores					6		15	2
Gymnosperm pollen								
Taxodiaceae-Cupressaceae-Taxaceae (TCT)	X	9		6	23	6	5	15
Bisaccate pollen	X							1
Ephedra voluta		1			1			
Angiosperm pollen								
Porate pollen								
Milfordia incerta					1			
Momipites tenuipolus group	X							1
Caryapollenites prodromus group	X							
Ulmipollenites tricostatus	X							
Miscellaneous triporates	X	1	1	22	60	85	60	43
Thomsonipollis magnificus	X	12		1				
Alnipollenites spp.	X							
Chenopodipollis spp.		P						
Monosulcate pollen								
Punctate to finely reticulate monosulcate pollen	P	1		2				2
Tricolpate and tricolporate pollen								
Choanopollenites discipulus	X							P
Choanopollenites sp. B of Tschudy (1973)						4	2	2
Nyssoid pollen								1
Holkopollenites chemardensis	X	3		2				
Finely reticulate prolate to spheroidal tricolpate to tricolporoidate pollen		9	1	2		1		3
Miscellaneous angiosperms	X	47	4	20	4	2	1	24
Reworked Carboniferous spore	X							
Probable freshwater plankters						1		1
Dinoflagellate cysts	X			1				

Table 5. Analyses of samples from the Oxbow mine. Sample order is up-section toward the right. X = present; Q = possibly present. Numbers are frequencies relative to total palynomorphs, to the nearest whole percent.

	R4878 samples				
	F	G	O	D	B
Coal (C) or detrital rock (D)-->	D	C	D	D	D
Spores					
Psilate monoletes	5		4	2	Q
Psilate triletes	2	2	7	2	Q
Cicatricosisporites spp.			1		
Sphagnum spp.				1	4
Miscellaneous spores			1	2	2
Gymnosperm pollen					
Taxodiaceae-Cupressaceae-Taxaceae (TCT)	12	2	15	54	50
Bisaccate pollen				3	11
Corollina sp.					1
Angiosperm pollen					
Porate pollen					
Momipites tenuipolus group	1		Q	1	
Miscellaneous triporates	3	1	21	1	6
Thomsonipollis magnificus		2	1		2
Monosulcate pollen					
Punctate to finely reticulate monosulcate pollen	6	2	1	2	
Tricolpate and tricolporate pollen					
Aesculiidites circumstriatus			1		
Bombacacidites sp.					1
Lanagiopollis cribellatus			1		
Holkopollenites chemardensis	1				
Finely reticulate prolate to spheroidal tricolpate to tricolporoidate pollen	9	20	3	18	15
Miscellaneous angiosperms	61	71	44	14	8

Table 6. List of additional samples processed for palynomorphs from northwestern Louisiana. In the Result column, A = analyzed for this report; P = palynomorph preservation was too poor for an analysis to be made.

Result	Paly-nology number	Field number	Lithology and location
P	R4876	NF93LA-24	Mudstone, medium-dark-gray, Dolet Hills railroad spur at Highway I-49. Probably SW 1/4 NW 1/4 sec. 1, T. 12 N., R. 12 W., Bayou Pierre Lake 7.5 min. quadrangle, De Soto Parish. Naborton Formation.
A	R4877A	NF93LA-25	Sand, light-gray, fine-grained, with laminae of mudstone, medium-gray. D. N. Bell property, sec. 7, T. 12 N., R. 12 W., Mansfield 15 min. quadrangle, lat 32°02.32′ N., long 93°38.16 W., old clay and gravel pit. Flaser(?) bedded strata below lignite bed, which probably is the "Yellow Bed." Cow Bayou Formation, perhaps 50 ft (15 m) above the Chemard Lake Lignite Lentil.
A	R4877B	NF93LA-26	Same locality as sample 25, lignite, weathered, probably the "Yellow Bed."

Table 7. Analyses of two samples from the Cow Bayou Formation in the Mansfield 15 min. quadrangle in northwestern Louisiana. At the sampled locality, the lignite bed (sample R4877B) overlies sand and mudstone (sample R4877A). P signifies that the taxon is probably present. Numbers are frequencies relative to total palynomorphs, to the nearest whole percent.

	R4877A	R4877B
	Sand and mudstone	Lignite
Spores		
Psilate monoletes	9	1
Psilate triletes	2	
Miscellaneous spores	2	1
Gymnosperm pollen		
Taxodiaceae-Cupressaceae-Taxaceae (TCT)	17	9
Bisaccate pollen	14	
Angiosperm pollen		
Porate pollen		
Ulmipollenites tricostatus	P	
Miscellaneous triporates	13	81
Alnipollenites spp.	1	
Monosulcate pollen		
Finely reticulate monosulcate pollen	2	
Tricolpate and tricolporate pollen		
Choanopollenites discipulus		1
Holkopollenites chemardensis	1	
Finely reticulate prolate to spheroidal tricolpate to tricolporoidate pollen	26	1
Miscellaneous angiosperms	13	6

Table 8. Analyses of two samples from Mississippi. Numbers are frequencies relative to total palynomorphs, to the nearest whole percent.

	R4879A Lignite	R4879B Lignite
Spores		
Psilate monoletes	5	3
Psilate triletes	7	3
Cicatricosisporites spp.	4	
Sphagnum spp.	2	3
Miscellaneous spores		1
Gymnosperm pollen		
Taxodiaceae-Cupressaceae-Taxaceae (TCT)	2	
Angiosperm pollen		
Porate pollen		
Carya <29µm		1
Miscellaneous triporates	37	44
Monosulcate pollen		
Finely reticulate monosulcate pollen	2	
Tricolpate and tricolporate pollen		
Holkopollenites chemardensis	2	
Nudopollis terminalis	2	
Favitricolporites baculoferus		4
Psilate to punctate fagaceous tricolpate and tricolporate pollen	4	4
Finely reticulate prolate to spheroidal tricolpate to tricolporoidate pollen	1	3
Miscellaneous angiosperms	32	34