Journal of the Arkansas Academy of Science

Volume 14 Article 9

1960

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APPLICATION OF PALYNOLOGY TO THE STUDY OF TERTIARY ROCKS OF THE COASTAL PLAIN OF ARKANSAS

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INTRODUCTION

Tertiary rocks representing the Eocene series of the Tertiary system crop out over large areas of the Coastal Plain in Arkansas. Of far lesser areal extent are rocks of the Paleocene series.

The Eocene section in Arkansas has been subdivided into the Wilcox group, lower Eocene; the Claiborne group, middle Eocene; and the Jackson group, upper Eocene in age. The Paleocene series is represented by the Midway group. All of these units are of considerable lateral extent, recognized in other states of the Coastal Plain. All dip generally to the southeast and thicken in the same direction.

Because of a paucity of distinctive fossil zones, and because of sharp vertical and lateral changes in lithology, these Tertiary rocks of the Coastal Plain pose stratigraphic problems. Boundaries between units are vague, often impossible to determine in field work. Subdivisions of the groups into formations, though accomplished in most states, is valid only in local areas. This is well illustrated by the recent work of Gordon, Tracey and Ellis (1958) in the Bauxite producing area of Arkansas. They were able, using lithology as the basis, to subdivide the Wilcox group into three formations. These units, the basal Berger formation, the overlying Saline formation and the upper unit, the Detonti sand, are restricted in areal distribution to parts of Saline and Pulaski Counties.

Problems are magnified in the subsurface where thickness of the Tertiary section increases and lithology changes laterally and vertically. The contact of the Wilcox and Midway groups in the area of outcrop in Arkansas is marked by a distinct unconformity. Down dip, the contact becomes apparently conformable and is impossible to select with certainty either from electric logs or from samples.

Equally acute is the problem of correlation of units from state to state. A prominent zone of Ostrea thirsae is present near the base of the Wilcox group in a number of states. It is often used as a basis for marking the base of the Eocene and for correlation. There is reason to believe that the zone is far from isochronous and is of questionable value in correlation.

E. W. Berry (1916, 1931) conducted studies of the abundant floras represented by leaf impressions in these predominantly continental rocks. His work, now often challenged as to validity, led the author to investigate the application of palynology, the study of spores and

pollen, to the stratigraphic problems present in the area.

APPLICATION OF PALYNOLOGY

Spores and pollen grains from plants preserved as fossils in sedimentary rocks can be used in the solution of stratigraphic problems of correlation and age determination in the same general way as the better known and more widely used invertebrate fossil groups. The plant microfossils also have value in the interpretation of paleoenvironmental conditions including climate and geography.

PREVIOUS WORK

Although spore and pollen analysis as a science dates back to 1916 according to Erdtman (1954), the first published account of its use as a stratigraphic tool was by Raistrick and Simpson (1933). They described the use of microspores in the correlation of coals in England. Since that date the use of spores and pollen in correlation has become general. Papers by Wilson (1946, 1959) and Kosanke (1950) illustrate the use of palynology in stratigraphic work in the United States. The application has been primarily to sections of Pennsylvania coal-bearing strata.

In addition to problems of correlation, spore and pollen analysis has been used in the interpretation of paleoclimates as is illustrated by the recent paper by Sears (1955). This application of palynology is of value in archeological as well as geological investigations as is shown in the paper by Wilson (1949).

The density of spores and pollen grains in sediments is also used by oil company palynological laboratories as indicators of former shore lines in directing exploration for oil and gas.

Although the results of palynological studies of Tertiary rocks of the Coastal Plain have not been published, results of investigations in other areas are available for comparison. The pollen from the Eocene Green River beds was described by Wodehouse (1932). Traverse (1935) studied the Brandon lignite, Tertiary in age. Wilson and Webster (1946) described a spore and pollen flora from a coal bed in the Fort Union group. An extensive study of plant microfossils from the Eocene Series in Germany was published by Potonie (1934). Simpson (1936) studied pollen from Tertiary coals in Scotland.

Earlier studies by Berry (1916, 1930) had been made of the Wilcox flora as represented by megascopic plant fossils, leaf impressions in particular.

AREA OF PRESENT STUDY

Outcroppings of Wilcox sediments in Saline County were selec-

ted as the section to be studied. The Wilcox in this area has a thick section of laminated dark, lignitic clays and fine to very fine, white sands. This is the Saline formation of Gordon, Tracey and Ellis (1958).

METHOD OF STUDY

Channel samples in 18-inch units were collected from exposures of the laminated Wilcox sediments in Saline County. Sections for sampling were selected to give a composite section representing as much as possible of the total thickness of the unit of laminated sediments.

These samples were then processed in the palynology laboratory at the University of Oklahoma.

The first step in the processing was the disaggregation of the material by crushing with mortar and pestle.

After disaggregation, the samples were immersed in hydrofluoric acid for 48 hours to remove siliceous materials. They were then washed in distilled water to remove excess acid.

The next step was to immerse them in concentrated ammonium hydroxide for 10 minutes and then to wash them in distilled water to remove excess ammonium hydroxide.

To remove additional inorganic debris, each sample was then centrifuged at low speed for 10 minutes in a zinc chloride solution having a density of 1.4, considerably higher than the spores and pollen grains contained in the samples, but lower than the inorganic detritus. The plant microfossils were then decanted from the centrifuge tube and washed to remove excess zinc chloride.

A part of the concentration of plant microfossils from each sample was then mounted on microscope slides for study.

Genera found by examination of the slides were described and their distribution through the section as well as their numerical distribution in each sample was recorded. Results were plotted as graphs and shown in Figure 1.

NATURE OF THE WILCOX MICROFLORA

An examination of the slides revealed at least 60 genera of plants represented by spores and pollen. Of the 60 genera, 10 were spores and the remainder pollen genera. Only one of the pollen types, Pinus, was a Gymnosperm. The others were Angiosperms. In addition to the spore and pollen flora, examples were found of Hystrichospherida. All of these appeared to belong to a single genus, Hystrichosphaeridium.

As shown by the statistics in Figure 1, the dominant element of the flora was Castanea. The density of other genera was quite variable. Common genera of the flora are shown in Plates I and II.

COMPARISON WITH OTHER SPORE AND POLLEN FLORAS

When compared with the floras from the Tertiary of other areas, the plant microfossils of the Wilcox of the Arkansas Coastal Plain were found to be almost the exact equivalent of those described by Potonie (1934). Nomenclature used by Potonie makes the comparison of generic names impossible. Of the 63 genera listed by Wodehouse (1932) from the Green River formation, only seven were found in the Wilcox. Wilson and Webster (1946) listed 15 genera of spores and pollen from a Fort Union coal. Of these, at least six are present in the Wilcox.

COMPARISON WITH THE WILCOX LEAF FLORA

Berry (1931) listed only 12 genera from the leaf impressions from Saline County, Arkansas, compared with some 140 genera for the Wilcox in the entire Coastal Plain. Of the 12, only two were represented in the spore and pollen flora. Ten additional genera represented by spores and pollen from the Saline County area were listed by Berry as being present in the leaf flora in other areas.

ECOLOGICAL SIGNIFICANCE

Berry (1916, 1931) considered the flora of the Wilcox to be tropical or sub-tropical in nature. Sharp (1951) made a series of comparisons of the flora as described by Berry and modified by more recent work with modern floras. He found the greatest correlation with the present flora of eastern Mexico where some 68% of Berry's genera are now present. Sharp noted two genera in the present Mexican flora not found in the lower Eocene of the Coastal Plain, Pinus and Quercus. These two genera are present in some sections of the laminated sediments of the Wilcox group. It appears, therefore, that the environmental conditions during the lower Eocene in the Coastal Plain of Arkansas are duplicated in eastern Mexico at present, an area that includes the eastern escarpments of the Central and San Cristobal Mesas and the adjoining coastal plain.

SUMMARY AND CONCLUSIONS

A limited study of the spore and pollen flora present in the laminated sediments of the Wilcox group in the Arkansas Coastal Plain indicates that the plant microfossils have stratigraphic and ecological significance.

Because of vertical changes in the nature of the spore and pollen flora, it appears possible to recognize distinct paleontological zones. The distinctive nature of the total flora, as well as individual zones, provides a basis for correlation of the lower Eocene section of Arkan-

sas with other areas.

Further application of palynological studies to other parts of the Tertiary system in the Coastal Plain should lead to a more definite subdivision of the section into stratigraphic units and aid in the solution of boundary problems, both in the surface and subsurface.

A comparison of the spore and pollen flora with that known from leaf impressions showed only minor correlation. This was expectable in view of the work done in other areas, such as that of Wodehouse (1932) on the Green River flora, where similar results were obtained in such a comparison.

The recognition of additional genera of plants through spores and pollen has aided in the interpretation of the lower Eocene depositional environment. Climatically, the area appears to have been comparable to eastern Mexico, an area of mesas and coastal plains.

GENUS	DISTRIBUTION EXPRESSED AS PERCENT OF TOTAL FLORA OF EACH SAMPLE		
Lygodium	.5%	.5%	1.4%
Athyrium	.0	.0	.5
Anemia	.5	.0	.2
Spore Type 1	.5	.5	.2
Pinus	.0	.0	10.5
Mauritia	.5	3.1	1.4
Acer	.5	.5	9.9
Anacardium	4.0	6.0	3.5
Betula	3.0	2.1	1.0
Carya	.5	2.1	1.9
Carpinus	.5	.0	.2
Castanea	58.0	51.0	41.0
Engelhardtia	6.2	1.8	3.1
Gordonia	1.0	1.4	4.8
Ilex	5.0	10.0	2.5
Juglans	.0	.7	.0
Nyssa	5.0	1.0	1.0
Typha	.5	1.0	.0
Ulmus	.0	.0	.2
Pollen Type 1	3.0	1.4	1.4
Pollen Type 2	.0	.0	1.1
Pollen Type 3	.0	1.4	.2
Pollen Type 4	1.0	1.4	1.0
Pollen Type 5	6.0	4.0	4.7
Hystrichosphaeridium	.0	2.1	.0
Position in Section	18' above base	12' above base	3' above base

Figure 1. Distribution of genera in Wilcox spore and pollen flora from laminated sediments exposed in road cut on State Highway 35, two miles south of Benton, Arkansas.

GENUS	VERTICAL DISTRIBUTION IN SECTION		
Lygodium	—	—	—
Athyrium	—		
Anemia	—		—
Spore Type 1	—	—	—
Pinus	—		
Mauritia	—	—	—
Acer	—	—	—
Anacardium	—	—	—
Betula	—	—	—
Carya	—	—	—
Carpinus	—	—	—
Castanea	—	—	—
Engelhardtia	—	—	—
Gordonia	—	—	—
Ilex	—	—	—
Juglans		—	
Nyssa	—	—	—
Typha		—	—
Ulmus	—		
Pollen Type 1	—	—	—
Pollen Type 2	—	—	—
Pollen Type 3	—	—	—
Pollen Type 4	—	—	—
Pollen Type 5	—	—	—
Hystrichosphaeridium		—	
Position in Section	3' above base	12' above base	18' above base

Figure 2. Distribution of genera in the Wilcox spore and pollen flora from laminated sediments exposed in road cut on State Highway 35, two miles south of Bentonville, Arkansas.

APPLICATION OF PALYNOLOGY TO THE STUDY OF TERTIARY ROCKS

TERTIARY SPORES AND POLLEN PLATE I

Lygodium

Athyrium

Anemia

Spore Type 1

Pinus

Mauritia

Acer (?)

Anacardium

Betula

Carya

Carpinus

TERTIARY SPORES AND POLLEN PLATE II

Castanea

Engelhardtia

Gordonia

Ilex

Juglans

Nyssa

Tilia

Typha

Ulmus

Pollen Type 1

Pollen Type 2

Pollen Type 3

Pollen Type 4

Pollen Type 5

Hystrichosphaeridium

Magnification of Illustrations X500

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