

IX

CENOZOIC FAUNA AND FLORA

By

JOSEPH KENT ROBERTS

THE CENOZOIC FAUNA AND FLORA IN KENTUCKY

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The Cenozoic era is represented in Kentucky by sediments of the Tertiary and Quaternary, but the sequence is not complete. Almost all of the sediments are limited to the Jackson Purchase area, that is, the region lying between the Tennessee and Mississippi Rivers, bounded on the north by the Ohio River and on the south by the State of Tennessee, though there are some deposits of sand, gravel, and loam between the Tennessee and Cumberland Rivers and to the east of the latter river. By far the greater portion of these sediments are unconsolidated, and like the Upper Cretaceous beds, they are not intruded by any forms of igneous rocks.

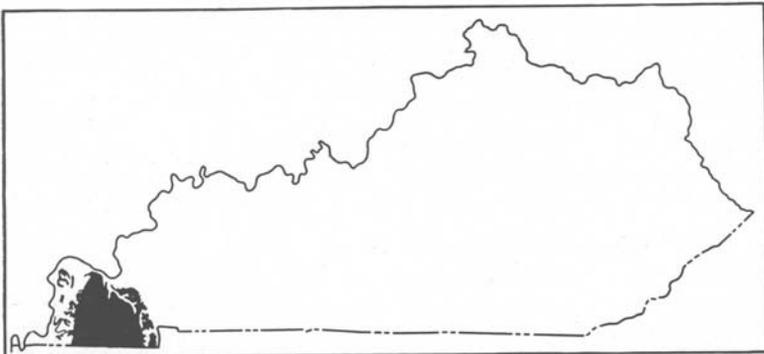


Fig. 32. Map of Kentucky showing outcrop of Cenozoic rocks.

The Tertiary sediments lie unconformably upon the Upper Cretaceous and from a standpoint of origin they represent marine, near shore, partly inland, and continental deposits. The Tertiary deposits cover much more territory than the Cretaceous. The time represented by the unconformity at the base of the Tertiary is of great length, as indicated by the changes in flora below and above the Cretaceous-Eocene contact shown in portions of the embayment area farther south in

Tennessee, Alabama, and Mississippi. Only a few floras survived this interval, and as the faunal record of the Tertiary is relatively nothing, little can be said of any faunal changes. The Tertiary beds become progressively younger towards the Mississippi River, and dip at a very low angle to the west in the southern part of the State, to the southwest near the middle, and almost south in the northern and northwestern portions. The structure is that of a gentle monocline. The Eocene beds are mostly covered by a blanket of sand and gravel of Plio-Pleistocene age, the so-called "Lafayette formation," and the Eocene members are only exposed in clay pits, a few streams, road and railroad cuts, and erosion exposures, thus making the study of the Eocene beds difficult. The Quaternary beds in addition to the Plio-Pleistocene sand and gravel consist of loess and a weathered phase of the loess, the loam, and the alluvial deposits of the Mississippi, Ohio, Tennessee, and the many smaller streams.

TERTIARY SYSTEM

The Tertiary sediments cover the region west of the Upper Cretaceous to the Mississippi river for the most part, involving the western portions of Calloway and Marshall counties, the southwestern portion of McCracken County, and most all of Ballard, Carlisle, Fulton, Graves, and Hickman counties. The Tertiary belt is an extension of the same belt of the embayment from Tennessee, and it disappears in McCracken and Ballard counties on the north beneath the Ohio river floodplain, but reappears in southern Illinois. A number of good plant localities are known over the region, particularly in Graves and Ballard counties. The sediments consist of clay, lignite, sand, gravel, and beds of consolidated clay, sand, and gravel, in which the consolidating agent is iron oxides, the latter beds being rather small in amount but large in extent.

As to age the sediments range from the Midway through the Wilcox to the Jackson, and most likely represented in the basal portions of the so-called "Lafayette" sand and gravel. The middle Eocene or Claiborne deposits are not represented in Kentucky nor in the surface exposures in Tennessee, so far observed. The deposits of Wilcox (Holly Springs and

Grenada) comprise the major portion of the Jackson Purchase region. The areal extent of the deposits of Jackson age is very small, as they outcrop only along the bluff of the Mississippi River in the vicinity of Hickman and Columbus.

Table of Tertiary Formations in Kentucky

EOCENE AGE	FORMATION	TYPE OF SEDIMENTS	COUNTIES WHERE EXPOSED
<i>Unconformity</i>			
JACKSON	Jackson	Sand, Clay, Lignite, Indurated clay	Fulton, Hickman, Carlisle
<i>Unconformity</i>			
WILCOX	Grenada	Sand, Clay, Lignite Indurated Sand & Clay	Hickman, Graves, Fulton
	Holly Springs	Sand, Clay, Lignite, Indurated Sand & Clay	Calloway, Marshall, McCracken, Graves, Ballard, Carlisle
<i>Unconformity</i>			
MIDWAY	Porters Creek	Clay, sand, with sandstone dikes	Calloway, Marshall, McCracken, Graves

The earliest reconnaissance report on the Tertiary of western Kentucky was that of Loughridge.¹ Loughridge recognized in the region the following formations or units:

Lagrange group (of Safford's Tennessee)

Lignitic (Safford's Porters Creek and Bluff Lignite)

Hickman (provisional)

He evidently confused what he termed the Hickman with the clay and sand of Jackson age, and such a confusion probably arose over the consolidated beds of clay which occur in the bluffs at Hickman and to the south of this town. He was also confused over the age of the Porters Creek and the so-called "Bluff Lignite" and placed them as of the same age. At present the Porters Creek is known to be lower Eocene, and the Bluff Lignite upper Eocene.

The Lagrange was used by the earlier geologists to embrace a vast thickness of sand, clay, and consolidated material, which at the present time is divided into the Grenada and Holly Springs. Safford's work in western Tennessee was used by

¹Loughridge, R. H., Report on the geological and economic features of the Jackson Purchase region: Kentucky Geol. Survey, Frankfort, 357 Pp. 21 figs, 3 maps, 1888.

Loughridge as a basis for his units in western Kentucky. The Lagrange as a term has been shown to cover too large a thickness in Tennessee and Mississippi. The use of this term in the early days of embayment studies was due to there being no fossil faunas in the Lagrange; though there were many fossil floras, and some were known to Safford, Owen, Loughridge, and others, yet such fossils were not studied and made use of as at present.

MIDWAY SERIES

The term, Midway, was proposed in 1896 by Harris² for the lower Eocene deposits farther south in the embayment region. In Kentucky the Midway is represented only by the Porters Creek clay with a small thickness of grayish sand at or near its top and numerous sandstone dikes, whereas in the southern portion of western Tennessee and Mississippi the Clayton (impure) limestone is present as its basal member.

The Porters Creek clay extends from the Tennessee line in a very broken manner through Calloway, Marshall, and McCracken counties. Alluvium and the Plio-Pleistocene deposits conceal it in many places, and while it is quite certain from well records that it occurs as a belt through Calloway, Marshall, McCracken, and Ballard counties, yet it has been mapped only where it is exposed on the surface. The Porters Creek belt is nowhere more than two and one-half to three miles wide, and only a small area of it occurs in Graves County in the extreme northeastern part.

The name, Porters Creek, was introduced by Safford during the sixties of last century from the occurrence of the clay along Porters Creek, west of Middleton, Hardeman County, Tennessee. This clay is very persistent in its lithologic character throughout Kentucky and Tennessee. It is known locally as "soapstone" from its greasy feel when dry. At the top of the Porters Creek clay in McCracken County there is a two-foot bed of sand, which carries marine pelecypoda and gastropoda.

The Porters Creek clay is a light gray to a dove color, the lighter color prevailing when it is dry. It is not indurated to any extent though it is very hard when dry and surprisingly light in weight. It is the easiest Tertiary unit to recognize

²Harris, G. D., The Midway Stage: Am. Pal., Bull., Vol. I, pp. 18-22, 1896.

in western Kentucky, from its conchoidal fracture, its hackly nature of weathering, color, and its field relations. It contains small muscovite flakes at times, but it is usually very fine grained and no particles except mica showing. It is of marine origin as shown by a few molluscs, foraminifera, and fish scales. Three miles south of Paducah, McCracken County near the old Paducah-Mayfield road the clay contains beautifully preserved fish scales, and casts of marine mollusca. A few plant remains have been found by L. C. Glenn near Middleton, Tennessee. The Porters Creek where the thickest exposure is known to occur, 2½ miles southeast of Elva, Marshall County, measures 35 feet. According to L. C. Glenn, the Porters Creek is as much as 150 feet thick³ at Wickliffe, Ballard County. The only contact of the Porters Creek clay and the overlying Holly Springs formation found in Kentucky is in the railroad cut of the Illinois Central new freight line between Fulton and Metropolis, in what is known as the Coleman Cut, southwestern part of McCracken County. Here the clay beds dip almost south and strike about east and west.

Section in Illinois Railway Cut, 2½ miles north of Graves County line,
McCracken County

	feet
Gray loam and soil, the loam grading downward into gray to white gravels of upwards one-half inch in diameter	6
Plio-Pleistocene gravel and sand; gravels for most part are rounded and flattened in lower portion coated with iron oxides, gravels composed of chert, numerous quartzite fragments of 15 inches or more; sand coarse to medium with clay pellets towards the base, cross bedded, and a number of thin indurated bed..	10-12
~~~~~ Unconformity ~~~~~	
Holly Springs formation:	
c. Yellowish red and gray sands interbedded, medium to fine texture, banded, and cross bedded at times .....	2-20
b. Light to medium gray clay, sandy in places, well bedded, with a few fairly well preserved plants .....	0-15
a. Yellowish brown sand, laminated, little indurated, composed chiefly of quartz .....	2- 5
~~~~~ Unconformity ~~~~~	
Porters Creek clay—dark to medium gray when wet, light gray when dry, few stem fragments, shaft of 28 feet sunk in the clay; exposed	10

WILCOX GROUP

The Wilcox in the embayment region farther south is composed of the Akerman, Holly Springs, and Grenada. The Akerman wedges out south of the Tennessee-Mississippi line, certainly it is not exposed in western Tennessee. The Grenada and Holly Springs extend from Tennessee into Kentucky.

³Glenn. L. C., Underground Waters of Tennessee and Kentucky west of Tennessee river and of an adjacent area in Illinois: Water Supply & Irrigation Paper 164, p. 31. 1906.

Among the earlier geologists this group was known as the Lagrange. The separation into the above units has been brought about within the last quarter of a century, chiefly through the paleobotanic studies of Berry, which will be referred to later. The name, Wilcox, takes its source from Wilcox County, Alabama, and was first used as a lithologic term for the Nanafolia, Tuscahoma, Bashi, and Hatchetigbee of Alabama by Crider⁴. The Holly Springs and Grenada were named after towns in Mississippi and were proposed in 1913 by Lowe⁵. The Holly Springs and Grenada have been mapped, and studied in western Tennessee by the writer and R. L. Collins⁶.

The Holly Springs sediments consist of coarse to fine sand and lenses of light and lignitic clay with all gradation of colors and several varieties of commercial clays, such as wad, sagger, and ball, which can be blended, and both the sand and clay may be consolidated by iron oxides. The sand is well rounded down to certain sizes and consists largely of quartz. Nowhere have any fossils been observed in the sand except a few fragments of silicified wood. The clay when free from sand is mined and shipped from six pits at present, five of which are located in Graves County and the sixth near Wickliffe, Ballard County.

The Holly Springs clay in certain beds abounds in leaf impressions a few fruits, cones, flower petals, and stem fragments. The massive ball clay does not show any leaf impressions to any extent. They are the most abundant in the yellowish gray clay and in the lighter varieties of the lignitic clay. A number of localities have been collected from as is shown in subsequent pages. The following localities have been examined and a great number of specimens collected during the summer of 1929, but as yet all these have not been determined and described by E. W. Berry:

LeCleade Christy clay pit, Wickliffe, Ballard County.

Abandoned clay pit south of Boaz, Graves County.

Pit of the Kentucky Clay Company, Viola, Graves County.

⁴Crider, A. F., *Geology and Mineral Resources of Mississippi*: U. S. Geol. Survey, Bull. 283, p. 25, 1906.

⁵Lowe, E. N., *Preliminary Report on the Iron Ores of Mississippi*: Mississippi Geol. Survey., Bull. 10, pp. 23-25, 1913.

⁶Roberts, Joseph K., and Collins, R. L., *The Tertiary of west Tennessee*: *Am. Jour. Sci.*, Vol. 12, pp. 235-243, 1926.

Roberts, Joseph K., *Tertiary Stratigraphy of west Tennessee*: *Geol. Soc. Am. Bull.*, Vol. 39, pp. 435-446, 1928.

Pit No.4, Ky.-Tenn. Clay Mining Co., Pryor, Graves County.

The Grenada consists of sand and clay and thin layers of indurated sand and clay. On the average, the sand of the Grenada is distinctly finer than that of the Holly Springs, and yields no fossils. The clay varies in color from a light gray and almost white to lignitic. In Kentucky the Grenada furnishes very few fossil floras. The clay is more of a hackly nature on weathering, and is difficult to differentiate from the Holly Springs clay.

The Wilcox beds are fairly thick, but no one section of either exposes the entire individual series. Sections have been recorded by Loughridge, Glenn, and Berry, and a number of well records are available. The total thickness of the Wilcox in western Tennessee is probably less than 2,000 feet, and the thickness in Kentucky is less than this.

Section in LeCleade-Christy Clay Pit, ¼ mile south of Wickliffe,

Viola, Graves County.

	Feet
Loam, medium gray when dry, porous, few rounded pebbles near the base -----	2-4
Plio-Pleistocene gravel and sand: gravels vary up to 2 inches in diameter and average around ½ inch, sand fills the pores and is a reddish brown, both sand and pebbles are iron stained, quartzite boulders up to 14 inches, mass little indurated -----	10-16
~~~~~ Unconformity ~~~~~	
Holly Springs formation:	
7. Gray, sandy clay, few leaf impressions -----	8
6. Sagger clay with abundant leaf impressions -----	6
5. Better grade of sagger clay, excellent leaves -----	4
4. Sandy clay with a six-inch ferruginous layer -----	1½
3. Ball clay, dark, lignitic, abundant leaves, carbonized leaves and stems -----	6
2. Wad clay with few leaves -----	5
1. Sand, gray to yellowish red, reached by auger.	

Section in Lecleade-Christy Clay Pit, ¼ mile south of Wickliffe,  
Ballard County.

	Feet
Loess, yellowish gray where weathered and medium gray where unweathered, numerous concretions, very few gastropods --	20
~~~~~ Unconformity ~~~~~	
Holly Springs formation:	
6. Yellowish, sandy clay -----	3
5. Lignitic clay, dark to black, some lignite -----	½
4. Gray clay, abundant plants -----	6¾
3. Black to dark brown clay, few carbonized forms ----	2¾
2. Dark gray clay, numerous leaves, iron concretions --	10½
1. Sand, gray color with layers of clay reach by auger.	

Section in Illinois Central Railway Cut, at Baltimore. Hickman County.

	Feet
Loam, light gray, gritty, very porous and full of cavities and root channels, close resemblance to loess, shows tendency to vertical weathering -----	2-8
Plio-Pleistocene gravel and sand; the gravel is contained in a sand matrix, upper gravel is gray and lower gravel reddish brown, the upper gravel smaller than lower; rounded and flattened, gravels orientated and bedded -----	3-20
~~~~~ <i>Unconformity</i> ~~~~~	
Grenada formation:	
c. Indurated layer of dark gray to blue clay resembling blue shale -----	1-10
b. Light gray sand, very quartzitic, rounded, cross-bedded, top surface very uneven when in contact with gravel ----	0-9
a. Clay, dark dove color when wet, finely laminated, lignitic, shows a few plant remains many of which are carbonized, a typical clay lens -----	0-15

List of fossil floras described by E. W. Berry⁷ collected at Wickliffe, Ballard County.

Anacardites metopifolia Berry  
 Banisteria pseudolaurifolia Berry  
 Banisteria wilcoxiana Berry  
 Banksia saffordi Berry  
 Banksia tenuifolia Berry  
 Carapa eolignitica Berry  
 Cassia fayettensis Berry  
 Cassia glenni Berry  
 Cassia marshallensis Berry  
 Cupanites eoligniticus Berry  
 Cupanites loughridgii Berry  
 Dryophyllum moorii Berry  
 Dryophyllum puryearensis Berry  
 Dryophyllum tennesseensis Berry  
 Engelhardtia ettingshauseni Berry  
 Exostema pseudocaribaeum Berry  
 Ficus denveriana Berry  
 Ficus wilcoxensis Berry  
 Inga wickliffensis Berry  
 Juglans berryi Berry  
 Juglans schimperi Berry  
 Mespilodaphne pseudoglaucia Berry  
 Mimosites variabilis Berry  
 Sapindus eoligniticus Berry  
 Sapindus formosus Berry  
 Sapindus linearifolius Berry  
 Sapindus mississippiensis Berry

As regards the age of the beds near Wickliffe from which these plants listed above were collected, Berry remarks as follows: "These species indicate a stratigraphic position at about the boundary between the Holly Springs sand or middle

⁷Berry, E. W., The Lower Eocene Floras of Southeastern North America: U. S. Geol. Survey, Prof. Paper 91, pp. 51-52, 1916.

Wilcox and the Grenada formation or upper Wilcox of the northern Mississippi section or slightly higher (younger).”

Somewhat prior to 1888, the date of the publication of the report by Loughridge, a collection was made at Wickliffe, Ballard County and another from Boaz Station, Graves County by Loughridge, and submitted to Lesquereux for determination. These forms are listed by Loughridge.⁸ Lesquereux determined these forms and later they were arranged by Knowlton and published in Volume 11 of the Proceedings of the U. S. National Museum, only two forms being figured. These forms are as follows given according to Lesquereux and according to Berry: (See Prof. Paper, op cit., pp. 23-24).

#### Flora from Wickliffe, Ballard County

##### LESQUEREUX'S BERRY'S DETERMINATIONS

Myrica elaeoides Lesq. _____	Myrica elaeoides Lesq.
Myrica copeana Lesq. _____	Cupanites loughridgii Berry
Ficus multinervis Herr _____	Ficus myrtifolius Berry
Sapindus falcifolius Herr _____	Ficus wilcoxensis Berry
Sapindus dubius Herr _____	Mixed forms: Engelhardtia ettingshauseni Exostema pseudocaribaeum Banisteria wilcoxiana Ficus wilcoxiana, and Carapa eolignitica
Sapindus angustifolius Lesq. ___	Sapindus mississippiensis Berry
Laurus californica? Lesq. _____	Mespilodaphne pseudoglauca Berry
Quercus saffordi Lesq. _____	Banksia saffordi Berry
Juglans rugosa Lesq. _____	Juglans schimperii Lesq.
Salix angusta Herr _____	Sapindus linearifolius Berry
Salix media Al Braun _____	Not recognized
Ailanthus leaf fragment _____	Not afterward referred to and lost

##### FROM BOAZ, GRAVES COUNTY

Sapindus falcifolius Herr _____	Ficus wilcoxensis Berry
Quercus nervifolia Al Braun _____	Banksia saffordi Berry
Quercus cuspidata Ung. _____	Dryophyllum tennesseensis Berry
Laurus californica Lesq. _____	Mespilodaphne pseudoglauca Berry
Ficus multinervis Herr _____	Ficus myrtifolius Berry

During July 1925, the writer and R. L. Collins made a collection of Holly Springs plants from the clay pit of the Bell City Pottery Company, at Bell City, southeastern Graves County; these plants have been determined by Professor E. W. Berry of the Johns Hopkins University, and very kindly furnished by him for this report.

⁸Loughridge, R. H., op. cit., App. II, p. 198.

List of Holly Springs plants from the pit of the Bell City Pottery,  
Graves County

Anacardites metopifolia Berry  
 Anacardites puryearensis Berry  
 Anoma robertsi Berry  
 Apocynophyllum sapinifolium Hollick  
 Aralia (?) semina Berry  
 Banksia tenuifolia Berry  
 Bombacites eocenicus Berry  
 Carpolithus kentuckyensis Berry  
 Cassia puryearensis Berry  
 Dryophyllum tennesseensis Berry  
 Glyptostrobus europaeus (Brongn.) Herr  
 Juglans schimperii Lesq.  
 Nyssa wilcoxiana Berry  
 Oreodaphne obtusifolia Berry  
 Oreodaphne pseudoguianensis Berry  
 Parrotia cuneata (Newb.) Berry  
 Rubiacites sphericus Berry  
 Sabalites grayanus Lesq.  
 Sterculia knowltoni Berry  
 Taxites sp.  
 Terminalia vera Berry  
 Ternstroemites ovatus Berry

JACKSON DEPOSITS

The name, Jackson, was proposed for beds of upper Eocene age occurring near Jackson, Mississippi, and was first used by Hilgard in 1860.⁹ The Jackson deposits or uppermost Eocene occur along the bluffs of the Mississippi River. These beds are of lower Jackson age as indicated by their floral content. In Mississippi the Jackson consists of two members namely, the Moody marl or basal member, and the Yazoo clay, and here the Jackson beds are conformable on the Claiborne and at their top with beds of Oligocene age. In Tennessee the Jackson deposits lie unconformably upon the Grenada, and presumably this holds true for Kentucky, though no actual contact was seen.

The age of the Jackson deposits was not recognized by the earlier geologists as has been pointed out. The first work of any note to be done was a result of the visit to the Columbus locality, Hickman County by Lesquereux in company with Sir Charles Lyell and D. D. Owen. After making a study of the collection of fossil floras found near Columbus, Lesquereux

⁹Hilgard, E. W., Report on the Geology and Agriculture of Mississippi: Mississippi State Geol. Survey, Report, pp. 107, 128-138, 1860.

assigned them to the Pleistocene.¹⁰ Later the deposits from which these plants were collected were given the name, Hickman group by Loughridge¹¹ and were regarded by him as the oldest of the Eocene sub-divisions.

In 1903 L. C. Glenn collected plants near Columbus, Hickman, and Wickliffe, and sent them to Knowlton for determination, and the latter assigned them to the Pliocene.¹² It remained for E. W. Berry to describe the plants from these beds in 1924 from collections made from a number of localities. These plants are described and figured in a recent publication.¹³

The beds of Jackson age have not been found to outcrop anywhere in Kentucky except in a broken manner along the Chickasaw Bluffs. The southernmost exposure begins about one mile south of the town of Hickman, Fulton County, extends through the town and about one-half mile north; the other exposure extends along the bluffs in Hickman County. To the east of the bluffs the Jackson does not appear exposed and it is covered by the Plio-Pleistocene deposits.

The sediments consist of sand, clays, and beds of considerable thickness of indurated clay; some lignite occurs in places, more so in Tennessee than in Kentucky. The sand is distinctly finer in texture than the sands of the Holly Springs and Grenada, and has a greenish color. It contains a great deal of clay and angular fragments of lignite. Lamination and cross bedding are very common. The clay is usually light gray, light brown to black, grading into lignite. The lignite is thin and quite impure. In Tennessee thick exposures of Jackson are found at Mayberry Leap, Richardson's Landing, Randolph, and Fulton, also north of Reelfoot Lake and at Lenox, and sections have been measured which attain as much as 120 feet. South of Hickman, Fulton County, the Jackson beds are between fifty and sixty feet in thickness and have about the same general sequence as in northwestern Tennessee.

¹⁰Lesquereux, L., On some fossil plants of Recent formations: *Am. Jour. Sci., Ser. 2*, Vol. 27, pp. 364-365, 1859.

¹¹Loughridge, R. H., *op. cit.*, pp. 37-41.

¹²Glenn, L. C., *op. cit.*, pp. 38-39, 1906.

¹³Berry, E. W., *The Middle and Upper Eocene Floras of southeastern North America*: U. S. Geol. Survey Prof. Paper, 92, 1924.

Section on the Chickasaw Bluff, 1 mile south of Hickman, Fulton  
County

	Feet
Soil weathered from the underlying loess -----	3-4
Loess, yellow towards the top, gray at the base, shows vertical weathering and jointing, abundant and large gastropods, and concretions -----	35
Plio-Pleistocene gravel and sand: gravel contained in a sand matrix, and grades upward into the loess, gravels contain Paleozoic corals, bryozoa, brachiopods, crinoid stems, gastropods; well rounded and flattened, coated with iron stain -----	20

~~~~~ *Unconformity* ~~~~~

| | |
|--|----|
| Jackson formation: | |
| 3. Shaly clay of light gray color, little indurated, fragments of leaves and stems ----- | 14 |
| 2. Highly indurated clay, gray, massive, exposed ----- | 10 |
| 1. Concealed by talus extending down to the Mississippi river floodplain ----- | 30 |

Section on the Mississippi river, 2½ miles south of Columbus, Hickman
County.

| | Feet |
|--|------|
| Soil and Loess mostly covered with vegetation, the loess shows a gray color ----- | 20 |
| Plio-Pleistocene gravel and sand; gravels rounded also flattened, coated with iron stain, with an average diameter of ½ inch, contained in a sand matrix; quartzite boulders as large as 14 inches in length ----- | 5-8 |

~~~~~ *Unconformity* ~~~~~

|                                                                                                                                        |       |
|----------------------------------------------------------------------------------------------------------------------------------------|-------|
| Jackson formation:                                                                                                                     |       |
| 2. Jackson clay, light to medium gray mostly covered with talus material -----                                                         | 18-28 |
| 1. Sand, fine texture, gray color, cross bedded, ripple marked, contains lenses of fossil clay which show fossil floras, exposed ----- | 16-20 |
| Concealed by slumped sand and clay -----                                                                                               | 10    |

List of fossil plants collected from near Columbus, Hickman County by Owen and Lesquereux, and determined by Lesquereux.¹⁴

- Quercus vireus Michx.
- Castanea nana, Muhl.
- Ulmus alata Michx.
- Ulmus minuta? Gopp.
- Planera gmelini, Michx. (P. Hickmanensis, Berry)
- Prinos integrifolia Ell.
- Caenothus americanus Lesq.
- Carya olivaeformis Mitt. (Hicoria jacksoniana, Berry)
- Gleditschia trecanthos Lesq.
- Acorus calamus Lesq.
- Alnus or Betula catkins

¹⁴Lesquereux, L. On some fossil plants from the Recent formation: Am. Jour. Sci., Ser. 2, vol. 27, pp. 359-366, 1859.

## List of Jackson floras from near Columbus.

(E. W. Berry, U. S. Geol. Survey Prof. Paper 92, pp. 107-110, 1924.)

*Hicoria jacksonia* Berry  
*Menispermites carolinaformis* Berry  
*Tecoma preradicans* Berry

## List of Jackson plants from Hickman.

(E. W. Berry, U. S. Geol. Survey Prof. Paper 92, pp. 107-110, 1924.)

*Palmocarpon* sp.  
 Palm rays  
*Hicoria jacksonia* Berry  
*Hicoria rostrataformis* Berry  
*Planera hickmanensis* Berry  
*Menispermites carolinaformis* Berry  
*Capparidocarpus sphericus* Berry  
*Bauhania wadii* Berry  
*Papilionites erythrinaformis* Berry  
*Lonchocarpus anceps* Berry  
*Liquidamber* sp.  
*Fagara catahoulensis coriacea* Berry  
*Fagara catahoulensis major* Berry  
*Rhamnites krugiodendroides* Berry  
*Grewiopsis wadii* Berry  
*Tecoma preradicans* Berry  
*Carpolithus bumeliaformis* Berry

## List of Jackson plants ½ mile north of Hickman.

(E. W. Berry, U. S. Geol. Survey Prof. Paper 92, pp. 107-110, 1924.)

*Taxodium dubium* (Sternb.) Herr?  
*Hicoria rostrataformis* Berry  
*Planera hickmanensis* Berry  
*Banksia jacksonensis* Berry  
*Liquidamber* sp.  
*Fagara catahoulensis coriacea* Berry  
*Fagara catahoulensis elongata* Berry  
*Burserites fayettensis* Berry  
*Grewiopsis wadi* Berry

## List of Jackson plants from 5 miles south of Hickman.

(E. W. Berry, U. S. Geol. Survey Prof. Paper 92, pp. 107-110, 1924.)

*Fagara catahoulensis elongata* Berry  
*Planera hickmanensis* Berry  
*Hicoria jacksoniana* Berry  
*Paliurus catahoulensis* Berry

The Jackson plants have been collected and described from 40 localities, from Georgia as far north as Kentucky, and west to the Rio Grande. These plants comprise 133 species of which 18 species have been found in Kentucky. These plants probably represent coastal plain forms, living around small ponds and bays of Jackson seas according to Berry.

No fossil faunas have been described from western Kentucky. The wing of a termite was found in the sandy clay,

2½ miles south of Columbus, Hickman County in July 1929. The Moody marl member of the Jackson in Mississippi contains well preserved fossils, and the Yazoo furnishes *Zeuglodon* remains. Something like 214 species of marine invertebrates have been found in the Jackson of Mississippi.

#### QUATERNARY SYSTEM

The Quaternary system is made up in part by the gravel and sand of Plio-Pleistocene age, the loess, and the alluvium. The writer regards the Columbia loam not as a separate formation but a weathered phase of the loess and more especially as an eastward extension of the loess, as it becomes coarser from the Mississippi river to the east and from the Ohio river to the south. A table of the Quaternary formations is as follows:

| Quaternary Formations |              |                                             |                                                                  |
|-----------------------|--------------|---------------------------------------------|------------------------------------------------------------------|
|                       | FORMATION    | TYPE OF SEDIMENTS                           | COUNTIES WHERE EXPOSED                                           |
| Quaternary            | Recent       | Alluvium: sand, gravel, muds, clays         | Found along streams of all eight counties                        |
|                       | Loess & Loam | Fine material with concretions and gravel   | Found in all the counties, best developed towards central region |
| Tertiary (in part)    | "Lafayette"  | Gravel, sand, and indurated gravel and sand | All counties                                                     |

#### PLIO-PLEISTOCENE (LAFAYETTE) DEPOSITS

The so-called Lafayette, which covers most of the Jackson Purchase region, constitutes by far the greatest unit of the areal geology. The name, Lafayette, was proposed in 1891 by McGee.¹⁵ McGee in his discussion in reference cited under the footnote remarks as follows: "The Lafayette formation, as now defined, was first discriminated in northern Mississippi in 1855 and 1856 by Dr. E. W. Hilgard, and was named by him after Lafayette County, in which it is typically developed."

¹⁵McGee, W. J., The Lafayette formation: U. S. Geol. Survey, 12th Ann. Rept., Part I, p. 497, 1891.

So, it appears that McGee revived the term, and placed it before the public to the extent that it was accepted.

These deposits consist of gravel and sand, reworked from the Tertiary, Cretaceous, and Paleozoic, in other words, from whatever material available at the time of the formation of the deposits. Since these deposits are found over the youngest of the Eocene beds, the Jackson, and immediately under the loess, which is regarded as Pleistocene, the writer is inclined to interpret their age as suggested in 1925 by E. W. Berry, namely that they are of Plio-Pleistocene age.

The gravels are well rounded and many are flattened. Most of them are coated with reddish brown iron oxides, but in western Graves County and the eastern portions of Hickman, and Carlisle Counties the gravels are a light gray to almost white. Their general average size is approximately one-half an inch, thus differing in size with the Tuscaloosa gravel as well as in the degree of rounding. The gravel is composed chiefly of chert with a few of quartzite. They are contained in a matrix of sand, which varies from coarse to medium and even fine, and usually colored to about the same tone as the gravels. The gravels when broken show typical Paleozoic fossils, such as crinoid stems, brachiopods, bryozoa, pelecypods, gastropods, echinoid spines, etc. One of the interesting features is the occurrence in the gravel of large quartzite boulders, some of which measure 52 inches in their major diameter, and are about 16 inches thick. These are found in the gravels as far south as 2½ miles north of Murray, Calloway County.

The gravels are often consolidated into a conglomerate, the cementing agent being iron oxides. The sand is composed of quartz, and broken masses of chert, and a few black, heavy minerals. Often the sand does not occur mixed with the gravel, but may overlie or underlie it. Cross bedding is quite common, and bedding and orientation are frequent.

These deposits can be found resting on every older member in the Jackson Purchase region, including the St. Louis chert and limestone. In fact, these deposits have been found by the writer far to the east in Crittenden County, and south of

Owensboro. There are no means or correlation except by lithology and stratigraphic position. Gravel and sand on the Atlantic Coastal Plain have been termed Lafayette by McGee, Fontaine, Ward, and others, but correlation with these deposits in the embayment area in the absence of fossils is impossible. It is not necessary to tabulate any sections of these gravels and sands, for their characters are much the same over the entire area, and any of the sections given above except the one in the clay pit at Wickliffe, Ballard County, will show gravels.

#### LOESS AND LOAM

The loess occurs over most of western Kentucky when the loam is considered to be a weathered and an eastern extension of the loess. Whenever the so-called loam is found on the Mississippi River bluffs it shows as nothing more than an upward gradation of the loess, being slightly more porous, full of cavities of fairly large size, root channels, and having more yellow tones. The loam thins to the east, and often is not more than one to two feet thick. The loess along the bluffs reaches as much as 40 feet in thickness, and is well exposed along the river edge wherever the river is undercutting the bluffs, otherwise on the abandoned bluffs.

The loess is usually a grayish color to a brown, but upon weathering it assumes a yellowish brown. Along the bluffs it shows the vertical jointing feature very well. It is thickest south of Hickman and in the vicinity of Columbus. Much of the soil of the four counties bordering on the Mississippi river and McCracken County on the Ohio River is of loess origin, and it forms a very fine soil. It is very easy to know when one is on loess roads either in dry weather or in rain on account of the immense amounts of dust or mud respectively.

The loam is found far to the east in the three counties of Graves, Calloway, and Marshall, and it is found lying upon the chert and limestone of Mississippian age. It may be Recent in part, but everywhere it is found lying upon the Plio-Pleistocene gravel and sand. It never contains any fossils so far observed, and its only resemblance to the loess is its lithology and stratigraphic position.

The loess contains great numbers of gastropods in some localities, but the variety is small. The writer has collected loess fossils from western Tennessee, and from the deposits along Crowley's Ridge near Madison and Forrest City, Arkansas, and the Kentucky forms show a less variety than any of the others. The Arkansas localities show two pelecypods, but the Kentucky forms are all gastropods. The forms reach as much as one inch in diameter, some with a deep, others with a shallow umbilicus. The fossils are limited to the deposits near the river, and do not occur more than three miles east of the river.

#### RECENT ALLUVIUM

The alluvium occurs along all the permanent and many of the intermittent streams, and is very extensive along the Tennessee, Ohio, and Mississippi Rivers. It consists of clays, muds, silts, sands, and gravels. A considerable amount of the area of the Jackson Purchase region is covered with alluvium due to the fact that the region is so flat, and has such a net work of streams, the majority of which are active much of the year.

#### BIBLIOGRAPHY

- Loughridge, R. H., Report on the geological and economic features of the Jackson Purchase Region.  
Ky. Geol. Survey, Report F, 1888, 357 pp. 21 Illus. 3 maps.
- Glenn, L. C., Underground waters of Tennessee and Kentucky west of the Tennessee River.  
U. S. Geol. Survey, Water Supply Paper 1640, 1906, 173 pp. 7 pls. 13 figs. 1 map.
- Roberts, Joseph K., and Collins R. L., The Tertiary of West Tennessee.  
Am. Jour. Sci., Vol. 12, 1926, pp. 235-243.
- Roberts, Joseph K., Tertiary Stratigraphy of West Tennessee.  
Geol. Soc. Am. Bull., Vol. 39, 1928, pp. 435-446. 2 tables.
- Roberts, Joseph K., Clays of the Jackson Purchase Region, Ky.  
Econ. Geol., Vol. 25, 1930, pp. 832-836.
- Roberts, Joseph K., Tertiary Deposits of Western Kentucky.  
Geol. Soc. Am., Bull., Vol. 402, 1931, pp. 523-526, 1 fig.

Explanation of **Plate LXIX**

## Wilcox Floras

1. *Juglans schimperi* Berry. Wickliffe, Kentucky. U. S. Geol. Surv., Prof. Paper 91., Pl. XIX, fig. 4.
2. *Myrica elaeagnoides* Lesquereux. Boaz, Kentucky. U. S. Geol. Surv., Prof. Paper 91, Pl. XVIII, fig. 2.
3. *Dryophyllum tennesseensis* Berry. Puryear, Tennessee. U. S. Geol. Surv., Prof. Paper 91, Pl. XXI, fig. 4.
4. *Mespilodaphne puryearensis* Berry. Puryear, Tennessee. U. S. Geol. Surv., Prof. Paper 91, Pl. LXXXVII, fig. 1.
5. *Sapindus formosus* Berry. Wickliffe, Kentucky. U. S. Geol. Surv., Prof. Paper 91, Pl. LXXVI, fig. 3.
6. *Carapa eolignitica* Berry. Wickliffe, Kentucky. U. S. Geol. Surv., Prof. Paper 91, Pl. LX, fig. 4.

**PLATE LXIX**



1



2



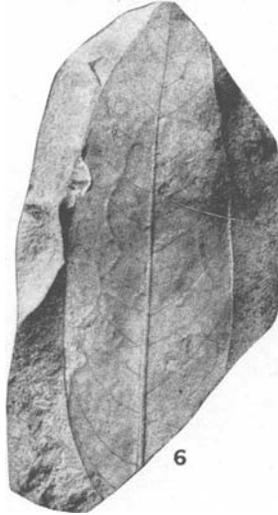
3



4



5



6

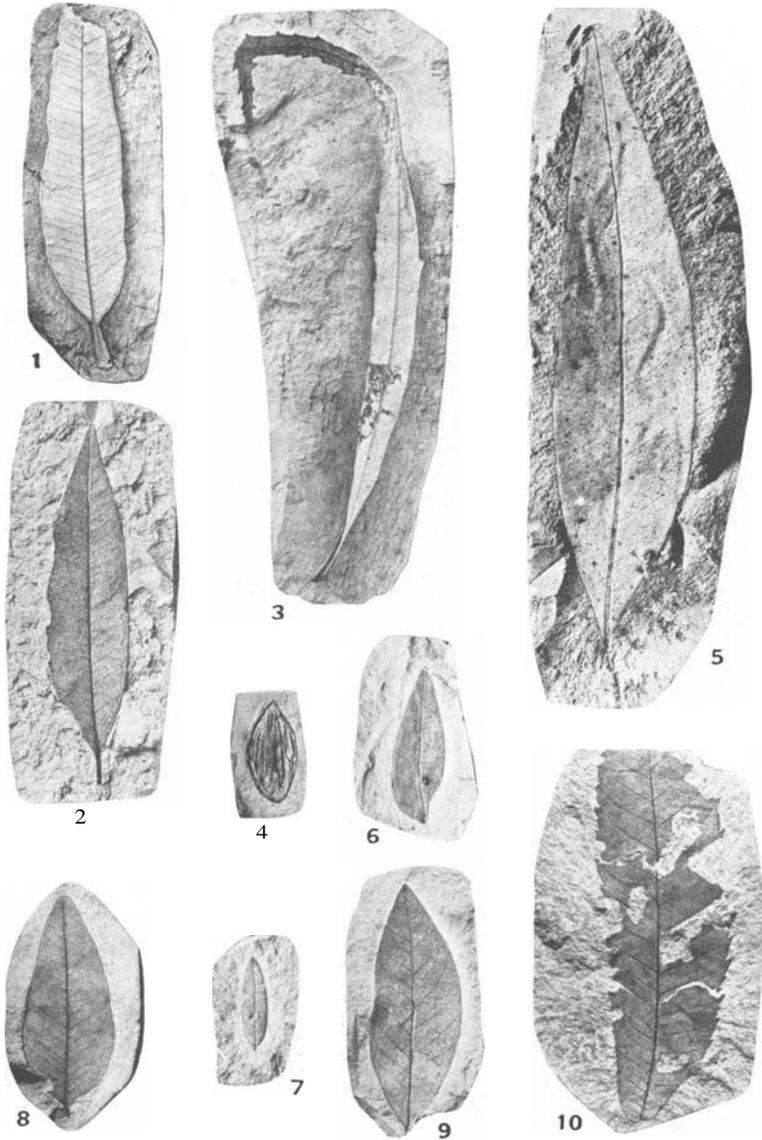
Plant Fossils of the Wilcox—Eocene

## Explanation of Plate LXX

## Wilcox Floras

1. *Ficus mytifolius* Berry. Holly Springs, Mississippi. U. S. Geol. Surv., Prof. Paper 91, Pl. XXX, fig. 1.
2. *Ficus wilcoxensis* Berry. Puryear, Tennessee. U. S. Geol. Surv., Prof. Paper 91, Pl. XXVII, fig. 6.
3. *Banksia saffordi* (Lesquereux) Berry. 1½ miles west of Grand Junction, Tennessee. U. S. Geol. Surv., Prof. Paper 91, Pl. XXXVI, fig. 5.
4. *Nyssa wilcoxiana* Berry. Puryear, Tennessee. U. S. Geol. Surv., Prof. Paper 91, Pl. XCIX, fig. 7.
5. *Sapindus mississippiensis* Berry. Wickliffe, Kentucky. U. S. Geol. Surv., Prof. Paper 91, Pl. LXIV, fig. 10.
6. *Inga wickliffensis* Berry. Wickliffe, Kentucky. U. S. Geol. Surv., Prof. Paper 91, Pl. L, fig. 8.
7. *Mimosites variabilis* Berry. Wickliffe, Kentucky. U. S. Geol. Surv., Prof. Paper 91, Pl. XLV, fig. 10.
8. *Anacardites metopifolia* Berry. Puryear, Tennessee. U. S. Geol. Surv., Prof. Paper 91, Pl. LVIII, fig. 7.
9. *Engelhardtia ettingshauseni* Berry. Holly Springs, Miss. U. S. Geol. Surv., Prof. Paper 91, Pl. XIX, fig. 3.
10. *Cupanites loughridgii* Berry. Wickliffe, Kentucky. U. S. Geol. Surv., Prof. Paper 91, Pl. LXXV, fig. 4.

PLATE LXX



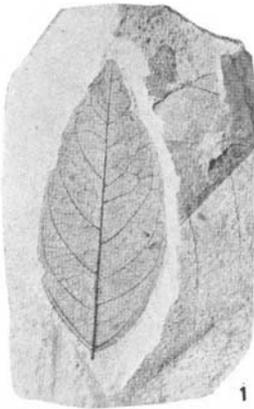
Plant Fossils of the Wilcox—Eocene

## Explanation of Plate LXXI

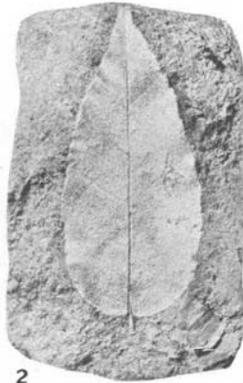
## Floras of Jackson Age

1. *Papilionites erythrinaformis* Berry. Fayette sandstone, Miraflores, Webb County, Texas. U. S. Geol. Surv., Prof. Paper 92, Pl. XXXIII, fig. 9.
2. *Burserites fayettensis* Berry. Catahoula (?) sandstone, Stryker, Texas. U. S. Geol. Surv., Prof. Paper 92, Pl. XLI, fig. 8.
3. *Planaria hickmanensis* Berry. Upper Jackson (?) age. 5 miles south of Hickman, Kentucky. U. S. Geol. Surv., Prof. Paper 92, Pl. L, fig. 4.
4. *Hicoria rostrataformis* Berry (a)-husk. (b)-part of the husk with nut inside Upper Jackson (?) age. Upper bluff, Hickman, Kentucky. U. S. Geol. Surv., Prof. Paper 92, Pl. L, figs. 6 and 9.
5. *Menispermities carolinaformis* Berry. Upper Jackson (?) age. Hickman, Kentucky. U. S. Geol. Surv., Prof. Paper 92, Pl. LI, fig. 1.
6. *Liquidamber incerta* Berry. Upper bluff, Hickman, Kentucky. U. S. Geol. Surv., Prof. Paper 92, Pl. LI, fig. 8.
7. *Fagara catahouleensis coriacea* Berry. Upper Jackson (?) age, north of Hickman, Kentucky. U. S. Geol. Surv., Prof. Paper 92, Pl. LI fig. 10.
8. *Fagara catahouleensis major* Berry. Upper (?) Jackson age. North of Hickman, Kentucky. U. S. Geol. Surv., Prof. Paper 92, Pl. LI, fig. 11.
9. *Rhammites krugiodendroides* Berry. Upper Jackson (?) age. Hickman, Kentucky. U. S. Geol. Surv., Prof. Paper 92, Pl. LII, fig. 2.
10. *Tecoma preradicans* Berry. Upper Jackson (?) age. (a) Single leaf; (b) Compound leaves. Hickman, Kentucky. U. S. Geol. Surv., Prof. Paper 92, Pl. LIV, figs. 1 and 2.

PLATE LXXI



1



2



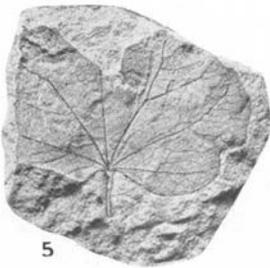
4 A



4 B



6



5



9



7



3



8



10 A



10 B

Plant Fossils of the Wilcox—Eocene