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UPPER CRETACEOUS FLORAS OF THE EASTERN GULF REGION IN TENNESSEE, MISSISSIPPI, ALABAMA, AND GEORGIA

BY

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CONTENTS.

ILLUSTRATIONS.

UPPER CRETACEOUS FLORAS OF THE EASTERN GULF REGION IN TENNESSEE, MISSISSIPPI, ALABAMA, AND GEORGIA.

By Edward Wilber Berry.

INTRODUCTION.

The eastern Gulf region discussed in this paper includes that part of the Atlantic Coastal Plain bordering on the Gulf of Mexico and lying south and west of the southern Appalachian province and east of Mississippi River. The area of outcrop of the Upper Cretaceous deposits borders the inland margin of the Coastal Plain (see Pl. I), and the belt from which determinable plant fossils have been collected extends from Benton County, in west-central Tennessee, southward and eastward to west-central Georgia. Most of the fossil plants come from the basal formation of the Upper Cretaceous series—the Tuscaloosa formation.

The overlying Eutaw, Selma, and Ripley formations, with their various members, are marine deposits with abundant molluscan faunas, which do not fall within the scope of the present contribution. A few fossil plants have been found in the basal beds of the Eutaw formation in Tennessee, Alabama, and Georgia, in the upper beds of the Eutaw formation in Tennessee, and a still smaller and more poorly preserved representation occurs in the shallow-water phases of the Ripley formation in Tennessee, eastern Alabama, and western Georgia.

As the bulk of the flora is from the Tuscaloosa formation and the representation of the Eutaw and Ripley floras is too meager to throw any considerable light upon their correlation or the physical conditions accompanying deposition, this contribution will be devoted principally to the elucidation of the Tuscaloosa flora and should be regarded simply as a preliminary report, for though it exhausts the present extensive collections, it should be remembered that both my own geologic work and that of my associates in this vast area was of a reconnaissance nature only. Later, when the abundant workable clays of the Tuscaloosa formation are developed for economic purposes many new localities will probably be discovered and it may be possible to recover additional representatives of the flora.

GENERAL RELATIONS OF THE CRETACEOUS DEPOSITS.

Both Lower and Upper Cretaceous deposits are represented in the eastern Gulf area, but the former are much less extensive and varied than in the middle Atlantic slope to the northeast or in the western Gulf area to the west in Texas and Mexico.

Lower Cretaceous sediments are present only in the eastern part of the area, where the southwesterly extension of the Potomac group of the Middle Atlantic States crosses Georgia along the fall line as an irregular belt of unfossiliferous cross-bedded arkosic sandy clays and light-colored kaolins 5 to 30 miles wide, extending westward into Alabama as a belt 4 to 8 miles wide that terminates in Elmore County.

The Upper Cretaceous is subdivided into the Tuscaloosa formation, the Eutaw formation, the Selma chalk, and the Ripley formation.

The Tuscaloosa is the basal formation of the eastern Gulf Coastal Plain from Elmore County, Ala., to Tishomingo County, Miss., where it gradually thins and is transgressed by the overlying Eutaw formation. The Tuscaloosa doubtless impinges on the Lower Cretaceous at the former's easternmost development, but both the Tuscaloosa and the Lower Cretaceous have been transgressed by the Eutaw and the details are obscured.

The Eutaw forms a belt of varying composition (sands, clays, and marls) extending from Taylor County, in western Georgia, to the southern part of Benton County, in western Tennessee, and as isolated remnants as

far north as Trigg County, Ky. In Georgia and eastern Alabama it rests with a marked unconformity on the Lower Cretaceous. Throughout the rest of Alabama it overlies the Tuscaloosa without apparent unconformity. Beyond the Tuscaloosa region in Tennessee, where it is represented by the Coffee sand member, the Eutaw constitutes the basal formation of the Coastal Plain, resting on the rocks of the Paleozoic floor, except where remnants of the Tuscaloosa are preserved.

The Selma chalk is a lithologic and not a chronologic unit, as it includes in the area of its greatest development equivalents of parts of the Eutaw and Ripley, as those formations are developed elsewhere. It extends from east-central Alabama to southern Benton County, Tenn., resting throughout without apparent unconformity on the Eutaw.

The deposits of the Ripley sea extend from Twiggs County, in central Georgia, to the head of the Mississippi embayment in southern Illinois and probably westward through the western Gulf region, although there is a wide interval in Missouri and Arkansas that was transgressed by Eocene deposits, large areas of which were subsequently removed by the action of Mississippi River during late Tertiary and Quaternary time.

These deposits of the Ripley sea do not constitute a single lithologic or formational unit, because in the eastern Gulf region those in the Chattahoochee basin are separated from those in northeastern Mississippi and the States northward by the western Alabama area, in which the Selma chalk continues to the top of the Upper Cretaceous.

The following list is a systematic arrangement of the plants found in the Upper Cretaceous of the Gulf region. In this list the species from the Tuscaloosa are denoted by the letter "T," and those from the Eutaw and Ripley by "E" and "R," respectively.

PHYLUM THALLOPHYTA.

Class Fungi.

Order Pyrenomycetes.

Sphaerites alabamensis Berry. T.

Class Algae (?).

Halymenites major Lesquereux. E, R.

PHYLUM BRYOPHYTA.

Class Hepaticae.

Order Jungermanniales.

Jungermannites cretaceus Berry. T.

PHYLUM PTERIDOPHYTA.

Order Equisetales.

Equisetum? sp. Berry. T.

Order Lycopodiales.

Lycopodium cretaceum Berry? T.
Lycopodites tuscaloosensis Berry. T.

Order Filicales.

Family Polypodiaceae.

Cladophlebis alabamensis Berry. T.
Dryopterites stephensoni Berry. T, R.
Asplenium dicksonianum Heer. T.

Family Cyatheaceae.

Dicksonia groenlandica Heer. T.

Family Gleicheniaceae.

Gleichenia delicatula Heer. T.

Family Marattiaceae (?).

Marattia cretacea Velenovsky? T.

PHYLUM SPERMATOPHYTA.

Class Gymnospermae.

Order Cycadales (?).

Podozamites marginatus Heer. T.
Cycadinocarpus circularis Newberry. T.

Order Coniferales.

Cephalotaxospermum carolinianum Berry. E.
Protophyllocladus subintegrifolius (Lesquereux) Berry. T.
Cunninghamites elegans (Corda) Endlicher. R.
Brachyphyllum macrocarpum formosum Berry. T, E.
Dammara borealis Heer. T.
Protodammara speciosa Hollick and Jeffrey. T.
Geinitzia formosa Heer. T.
Araucaria bladenensis Berry. E, R.
  jeffreyi Berry. E, R.
Androvettia carolinensis Berry. T.
  elegans Berry. E.
Abietites foliosus (Fontaine) Berry. T.
Sequoia reichenbachi (Geinitz) Heer. T, E.
  heterophylla Velenovsky. T.
  ambigua Heer. T, E.
  fastigiata (Sternberg) Heer. T.
Widdringtonites subtilis Heer. T.
  reichii (Ettingshausen) Heer. T.
Pinus raritanensis Berry. T.
Tumion carolinianum Berry? E.
Cupressinoxylon sp. E.

EXPLANATION

McNairy sand member
Coffee sand member
Tombigbee sand member
Ripley formation
Eutaw formation
Tuscaloosa formation

Selma chalk

Providence sand member
Cusseta sand member
Ripley formation

UPPER CRETACEOUS

Eutaw and Tuscaloosa formations, undifferentiated
(*Sands and gravels*)

(*UNCONFORMITY*)

LOWER CRETACEOUS

3 — *Liopistha protexta* subzone

2 — Lower limit of range of typical *Exogyra costata* and upper limit of range of typical *Exogyra ponderosa* (= dividing line between *Exogyra ponderosa* zone and *Exogyra costata* zone)

1 — *Mortoniceras* subzone

P — Lower limit of range of *Exogyra ponderosa*

FOSSIL PLANT LOCALITIES

Tuscaloosa formation:

1. 1⅝ miles east of Iuka, Miss.
2. Glen Allen, Ala.
3. Shirleys, Ala.
4. Around Tuscaloosa, Ala.
5. Cottondale, Ala.
6. Snow Plantation, Ala.
7. Sanders Ferry Bluff, Ala.
8. Whites Bluff, Ala.
9. Soap Hill and Centerville, Bibb County, Ala.
10. Mapleville, Ala.

Eutaw formation:

11. McBrides Ford, Ga.
12. Broken Arrow Bend, Ga.
13. Chimney Bluff, Ga.
14. Havana, Ala.
15. Coffee Bluff, Tenn.

Ripley formation:

16. Big Cut, Tenn.
17. Camden, Tenn.
18. Selmer, Tenn.
19. 13 miles northwest of Camden, Tenn.
20. Cowikee Creek, Ala.
21. 7 miles north of Eufaula, Ala.
22. 6 miles east of Buena Vista, Ga.
23. Central of Georgia Railway 1½ miles northeast of Byron, Ga.

MAP SHOWING AREAL DISTRIBUTION OF THE CRETACEOUS DEPOSITS OF THE EASTERN GULF REGION

The boundaries of the divisions have been compiled in part from the published maps of previous investigators and in part from the field notes of L. W. Stephenson and Bruce Wade

Scale 1/2,500,000

25 0 25 50 75 100 MILES

1919

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Class Angiospermae.

Subclass Monocotyledonae.

Order Liliales.

Doryanthites cretacea Berry. E, R.

Order Graminales.

Cyperacites sp. Hollick. T.
Phragmites prattii Berry. E.

Order Arecales.

Sabalites sp. Berry. R.

Subclass Dicotyledonae.

Order Piperales.

Family Piperaceae.

Piperites tuscaloosensis Berry. T.

Order Juglandales.

Family Juglandaceae.

Juglans arctica Heer. T, E.

Order Myricales.

Family Myricaceae.

Myrica emarginata Heer. T.
longa (Heer) Heer. T.
dakotensis minima Berry. T.
ripleyensis Berry. R.

Order Fagales.

Family Fagaceae.

Dryophyllum gracile Debey. R.

Order Salicales.

Family Salicaceae.

Salix flexuosa Newberry. T, E.
lesquereuxii Berry. T, E.
eutawensis Berry. E.
meekii Newberry. T.
Populus hyperborea Heer. T.
Populites tuscaloosensis Berry. T.

Order Urticales.

Family Moraceae.

Ficus krausiana Heer. T, E.
crassipes (Heer) Heer. T, E.
georgiana Berry. R.
daphnogenoides (Heer) Berry. T.
inaequalis Lesquereux. T.
shirleyensis Berry. T.
woolsoni Hollick. T.
ovatifolia Berry. E.
alabamensis Berry. T.
fontainii Berry. T.

Order Platanales.

Family Platanaceae.

Platanus asperaeformis Berry. T.
shirleyensis Berry. T.
latior (Lesquereux) Knowlton. T.
ripleyensis Berry. R.
sp. Berry. R.

Order Proteales.

Family Proteaceae.

Proteoides conospermaefolia Berry. T.
Persoonia lesquereuxii Knowlton. T.
lesquereuxii minor Berry. T.

Order Ranales.

Family Ranunculaceae (?).

Dewalquea smithi Berry. T.

Family Magnoliaceae.

Magnolia speciosa Heer. T.
capellinii Heer. T, E.
newberryi Berry. T.
obtusata Heer. T.
boulayana Lesquereux. T, E.
longipes Hollick. T.
lacoeana Lesquereux. T.
hollicki Berry. T.
Liriodendron meekii Heer. T.

Family Menispermaceae.

Cocculus cinnamomeus Velenovsky (?) T.
polycarpaefolius Berry. T.
problematicus Berry. T.
Menispermites trilobatus Berry. T.
integrifolius Berry. T.
variabilis Berry. E.

Order Papaverales.

Family Capparidaceae.

Capparites cynophylloides Berry. T.
orbiculatus Berry. T.

Order Rosales.

Family Mimosaceae.

Inga cretacea Lesquereux. T.

Family Caesalpiniaceae.

Hymenaea fayettensis Berry. T.
Bauhinia cretacea Newberry. T, E.
marylandica Berry. T.
alabamensis Berry. E.
ripleyensis Berry. R.
Palaeocassia laurinea Lesquereux. T.
Cassia vaughani Berry. T.

Family Papilionaceae.

Phaseolites formus Lesquereux. T
Colutea obovata Berry. T.
Liriodendropsis simplex (Newberry) Newberry. T.
angustifolia Newberry. T.
constricta (Ward) Hollick. T.

Leguminosae (position uncertain).

Leguminosites ingaefolia Berry. T.
omphalobioides Lesquereux. T.
shirleyensis Berry. T.
tuscaloosensis Berry. T.

Order Geraniales.

Family Rutaceae.

Citrophyllum aligerum (Lesquereux) Berry. T.

Family Euphorbiaceae.

Crotonophyllum panduraeformis Berry. T.
Manihotites georgiana Berry. E, R.

Order Sapindales.

Family Ilicaceae.

Ilex masoni Lesquereux. T.

Family Celastraceae.

Celastrophyllum decurrens Lesquereux. T.
shirleyensis Berry. T.
undulatum Newberry. T.
newberryanum Hollick. T.
grandifolium Newberry. T.
carolinensis Berry. T.
crenatum Heer. T.
crenatum ellipticum Berry. T.
alabamensis Berry. T.
brittonianum Hollick. T.
gymindaefolium Berry. T.
praecrassipes Berry. T.

Family Sapindaceae.

Sapindus variabilis Berry. T.
morrisoni Heer. T.

Order Rhamnales.

Family Rhamnaceae.

Zizyphus lamarensis Berry. T.
laurifolius Berry. E.
Paliurus upatoiensis Berry. E.
Eorhamnidium cretaceum Berry. T.
platyphylloides (Lesquereux) Berry. T.
Rhamnus tenax Lesquereux. T.

Family Vitaceae.

Cissites formosus Heer. T.
crispus Velenovsky. R.

Order Malvales.

Family Tiliaceae.

Grewiopsis formosa Berry. T.
tuscaloosensis Berry. T.

Family Sterculiaceae.

Pterospermites carolinensis Berry. T.
Sterculia snowii tennesseensis Berry. R.

Order Thymeleales.

Family Lauraceae.

Cinnamomum newberryi Berry. T, E.
heerii Lesquereux? E.
sp. R.
Persea valida Hollick. T.
Oreodaphne shirleyensis Berry. T.
alabamensis Berry. T.
Sassafras acutilobum Lesquereux. T.
Malapoenna cottondalensis Berry. T.
cretacea (Lesquereux) Knowlton. T.
falcifolia (Lesquereux) Knowlton. T.
horrellensis Berry. E.
Laurus plutonia Heer. T, E.
Laurophyllum nervillosum Hollick. T.
angustifolium Newberry. T.
elegans Hollick. E.

Order Myrtales.

Family Myrtaceae.

Eugenia tuscaloosensis Berry. T.
Eugenia (?) anceps Berry. R.
Eucalyptus latifolia Hollick. T.
geinitzi (Heer) Heer. T.
angusta Velenovsky. E.
Myrcia havanensis Berry. E, R.

Family Combretaceae.

Conocarpites formosus Berry. T.

Order Umbellales.

Family Araliaceae.

Aralia cottondalensis Berry. T.
eutawensis Berry. E.
Panax cretacea Heer. T.

Family Cornaceae.

Nyssa snowiana Lesquereux. T.
Cornophyllum vetustum Newberry. T.
obtusatum Berry. T.

Order Ericales (?).

Family Ericaceae.

Andromeda novaecaesareae Hollick. T, R.
grandifolia Berry. T.
parlatorii Heer. T, E.
wardiana Lesquereux. T, E.
cretacea Lasquereux ? E.
Dermatophyllites acutus Heer. T.
Kalmia brittoniana Hollick. T.

Order Primulales.

Family Myrsinaceae.

Myrsine gaudini (Lesquereux) Berry. T.
borealis Heer. T.

Order Ebenales.

Family Ebenaceae.

Diospyros primaeva Heer. T, E.
amboyensis Berry. T.
rotundifolia Lesquereux. T.

Family Sapotaceae.

Sapotacites ettingshauseni Berry. T.
shirleyensis Berry. T.
formosus Berry. T.

Order Gentianales.

Family Asclepiadaceae.

Acerates amboyensis Berry. T.

Order Polemoniales.

Family Borraginaceae.

Cordia apiculata (Hollick) Berry. T.

Position uncertain.

Tricalycites papyraceus Hollick. T.
Calycites sexpartitus Berry. T.
Carpolithus floribundus Newberry. T.
tuscaloosensis Berry. T.
Phyllites asplenoides Berry. E.
shirleyensis Berry. T.
pistiaeformis Berry. T.

TUSCALOOSA FORMATION.

HISTORICAL SKETCH.

The Tuscaloosa formation was named by Smith and Johnson [1] in 1887 after the city and the river (now usually known as the Warrior or Black Warrior River) of that name in Alabama. Earlier observers had noticed the presence of sands and clays below the recognized Cretaceous and above the Carboniferous. Lewis Harper,[2] the State geologist of Mississippi, mentioned them in print as early as 1856 and suggested that their age was perhaps Permian or even Triassic. The same year Alexander Winchell mentioned the mottled clays of Tuscaloosa, calling attention to the contained vegetable remains "appearing like the stems and leaves of dicotyledonous plants." He doubted their Triassic age and in his table of formations failed to assign a definite age to them. Meek and Hayden [3] in discussing the Alabama Mesozoic mentioned the presence of wood and leaves and correlated the lower part with the lowest Cretaceous of New Jersey and Nebraska. Their lithologic characterization clearly indicates that they are discussing the Tuscaloosa, and they say that although the weight of evidence favors the correlating of these beds with the Neocomian of the Old World, positive evidence is lacking that a part may not be older than Cretaceous. Subsequently E. W. Hilgard [4] described the beds in Mississippi beneath his Tombigbee sands as the Eutaw group and referred them to the Cretaceous. The following year Meek and Hayden restated their views and definitely correlated the beds in Alabama with the Dakota sandstone of the Western Interior.[5] Again in 1876 Meek [6] reaffirms his belief that the basal Cretaceous of Alabama is of the same age as the plastic clays of New Jersey and the Dakota sandstone of the Upper Missouri section.

All these geologists failed to discriminate the Tuscaloosa from the overlying, mostly unfossiliferous sands and laminated clays of what is now known as the Eutaw formation. The first reasonably complete account of the Tuscaloosa formation is that given by Smith and Johnson in the publication above referred to. From the attitude, lithologic character, and stratigraphic position of the beds they correlated the Tuscaloosa with the Potomac of the middle Atlantic slope which had just been named and briefly described by McGee.[7] This correlation was natural, because the Potomac as understood in the earlier days included beds which according to the opinions of different students were referred to various levels ranging from the Triassic to the Cretaceous and which subsequent study has shown constitute a series of well-marked formations, the oldest of Neocomian age and the youngest of Cenomanian age.

From 1883 to the present time Dr. E. A. Smith, the State geologist of Alabama, has added to our knowledge of these deposits, being assisted in the beginning by L. C. Johnson and D. W. Langdon, jr. The discovery of all the noteworthy localities for fossil plants is due to their efforts. In 1884 some leaf impressions collected by Langdon in Bibb County were

[1] Smith, E. A., and Johnson, L. C., Tertiary and Cretaceous strata of the Tuscaloosa, Tombigbee, and Alabama rivers: U. S. Geol. Survey Bull. 43, p. 95, 1887.

[2] Acad. Nat. Sci. Philadelphia Proc., vol. 8, pp. 126–128, 1856.

[3] Idem, vol. 9, pp. 117–133, 1857.

[4] Report on the geology and agriculture of the State of Mississippi, p. 61, 1860.

[5] Acad. Nat. Sci. Philadelphia Proc., vol. 13, pp. 419–421, 1861.

[6] Meek, F. B., A report on the invertebrate Cretaceous and Tertiary fossils of the Upper Missouri country: U. S. Geol. and Geog. Survey Terr. Rept., vol. 9, pp. 38–42, 1876.

[7] McGee, W J, [Geology of Washington and vicinity]: Report of the health officer of the District of Columbia for the year ending June 30, 1885, pp. 19–21, 23–35, 1886.

submitted to Leo Lesquereux, and among them he recognized a species of *Podozamites*, which he thought might indicate a pre-Cretaceous age. Lesquereux afterward determined a small collection of leaves from the Tuscaloosa formation at Tuscaloosa, but this list seems never to have been published.[1]

In 1886 Smith and Langdon discovered several localities for fossil plants in the vicinity of Tuscaloosa (Cottondale, Snow plantation, and Tuscaloosa) and the next year the United States Geological Survey sent W. M. Fontaine into the field. He made large collections of mostly fragmentary material from those outcrops as well as from one or two other outcrops near Tuscaloosa. In 1892 L. F. Ward visited Alabama and with Dr. Smith made extensive collections from Glen Allen and Shirleys Mill. These collections received a preliminary study by Ward, who furnished a list of 35 species which was published by Smith in 1894 in his report on the geology of the Coastal Plain of Alabama. This list enumerated the following forms:

Andromeda latifolia Newberry=Andromeda grandifolia Berry.
Andromeda novaecalcareae Hollick (novaecaesareae).
Andromeda parlatorii Heer.
Aralia wellingtoniana Lesquereux=Aralia cottondalensis Berry.
Carpolithus floribundus Newberry.
Celastrophyllum crenatum Heer.
undulatum Newberry.
Cinnamomum intermedium Newberry=Cinnamomum newberryi Berry.
Cladophlebis parva Fontaine=Cladophlebis alabamensis Berry.
Cycadinocarpus circularis Newberry.
Czekanowskia capillaris Newberry.[2]
Dewalquea groenlandica Heer.
Diospyros primaeva Heer.
Eucalyptus attenuata Newberry.[2]
nervosa Newberry.[2]
parvifolia Newberry.[2]
Ficus inaequalis Lesquereux.
lanceolato-acuminata Newberry.[2]
woolsoni Newberry.
Liriodendropsis angustifolia Newberry.
simplex Newberry.
Magnolia alternans Heer.[2]
auriculata Newberry.
glaucoides Newberry=Magnolia boulayana Lesquereux.
longifolia Newberry.
speciosa Heer.
Myrsine borealis Heer.
Populus apiculata Newberry=Cordia apiculata Berry.
Proteoides daphnogenoides Heer=Ficus daphnogenoides Berry.
Pterospermites modestus Lesquereux.[2]
Sequoia gracillima Lesquereux, Newberry=Widdringtonites reichii (Ettingshausen) Heer.
heterophylla Velenovsky.
reichenbachii (Geinitz) Heer.
Tricalycites papyraceus Newberry.
Widdringtonites reichii (Ettingshausen) Heer.

I spent the field season of 1909 revisiting all of the known plant localities in Alabama and making extensive collections in preparation for this report. Accompanied by L. W. Stephenson I studied the Black Warrior and Tombigbee river sections during a trip down those rivers in a launch from Tuscaloosa, Ala., to the Eocene contact at Moscow, Ala.; I traversed Coosa and Alabama rivers from Wetumpka to Montgomery, Ala., Chattahoochee River from Columbus to Gainesville, Ga., and upper Tombigbee River in Mississippi, and visited localities in Tishomingo, Prentiss, and Itawamba counties, Miss. I have also used the collections and notes made by Mr. Stephenson in his extensive field and office studies on the stratigraphy and paleontology of the Cretaceous of the eastern Gulf area.

AREAL DISTRIBUTION.

The Tuscaloosa formation outcrops as a belt of varying width along the southwestern border of all four of the physiographic divisions of the southern Appalachian province. These divisions are, in order from northwest to southeast, the Interior Lowlands, the Cumberland Plateau, the Appalachian Valley, and the Piedmont Plateau. This area of outcrop, which amounts to about 6,500 square miles, is almost exactly lunate in outline, one horn terminating at the Tennessee boundary in northeastern Mississippi and the other near Montgomery in east-central Alabama. Its length is about 250 miles, and the chord of the arc is almost exactly at right angles with the axis of the Appalachian Mountains.[3]

LITHOLOGIC CHARACTER.

The materials are predominantly sandy and give rise to the broken, uneven topography of the present day. These sands are usually

[1] Smith, E. A., Geological map and explanatory chart of Alabama, Alabama Geol. Survey, 1894.
[2] Not recognized by me.
[3] Undifferentiated Tuscaloosa or Eutaw deposits are shown on the map to extend across Tennessee and into western Kentucky.

light in color, cross-bedded, and micaceous and contain in places, particularly landward and northward, considerable gravel and pebble beds, made up of both well-rounded quartz and angular chert in about equal proportions. In disconnected and interbedded lenses there is a large amount of argillaceous material which is in places massive and in places laminated. Seams of lignite of inconsiderable thickness are present at various levels, for example, 2 miles east of Tuscaloosa near the base of the Tuscaloosa formation a seam occurs several inches thick; and toward the top of the Tuscaloosa, in Itawamba County, Miss., lies a persistent bed of lignite, nearly 2 feet thick, which in the earlier days of the county led to the formation of a coal company. Very lignitic clays are seen in many sections, a layer in the section at Big Gully, southwest of Tuscaloosa, being filled with prostrate logs of large size. Pyrite and ferruginous oxide forming locally indurated sandstones are generally distributed. The lignite beds or lignitic clays commonly contain globules of amber, and finely disseminated gypsum crystals are seen at various levels.

The clays of the lower part of the Tuscaloosa are more extensive, more massive, and thicker than in the corresponding Upper Cretaceous from Cape Cod to Texas except in the Raritan formation of Middlesex County, N. J. Like the Raritan they represent nonmarine sediments although marine waters were near by. This fact is attested by temporary incursions of marine faunas in the Raritan and by the presence of glauconite and gypsum in the Tuscaloosa. Some of this gypsum seems unquestionably to be secondary in origin as in the large radiating crystals so abundant in the gully on the Snow plantation, but the finely disseminated needles of gypsum, as in the Sanders Ferry Bluff section, are usually regarded as of primary and not of secondary origin. Continental deposits have probably helped to make up the thickness of the Tuscaloosa. The great bulk of the Tuscaloosa flora comes from western Alabama in the area from Cottondale northwest to Glen Allen. East of Cottondale identifiable plant remains are sporadic in their occurrence, but northwest of Glen Allen they are practically absent and the few plants found in northeastern Mississippi prove that the base of the Tuscaloosa is progressively younger toward the head of the embayment. A reasonable explanation is furnished by the delta type of sediments and the probable Cretaceous drainage lines southwestward in the structural lines of the folded Carboniferous rocks. This view of the Cretaceous physiography is by no means new, having been elaborated by Hayes [1] in 1899.

The basal purplish clays around Tuscaloosa seem to be replaced by basal sands in northern Fayette County. These sands are coarse, with large and small pebbles, in places with well-rounded quartz cobbles and angular cobbles of Carboniferous sandstone. About half the pebbles are rounded quartz, and the remainder are angular chert. In places the sands are filled with fragments of chert the size of buckshot. The Carboniferous surface is undulating and in places approaches close to the surface. It is exposed in the stream channels and rises to form the cores of many of the hills between Fayette and Glen Allen. These hills were probably in existence during Tuscaloosa time. The local lithologic variations will not be described in the present connection as they have been discussed at length by Smith and more recently by Stephenson, and they are sufficiently illustrated in the sections carrying plant remains which are subsequently discussed (pp. 15–22).

The strike of the beds is parallel with the shore line of the old land mass which they skirt, and their dip conforms to the gently warped surface of the Cumberland peneplain. Their total thickness in western Alabama is estimated by Smith to be about 1,000 feet, but they become thin in a short distance north.

In northeastern Mississippi their maximum thickness, as determined by the city waterworks well at Corinth, is about 270 feet, and although they probably were transgressed by the overlying Eutaw in this northern area, they have not been recognized north of the Tennessee-Mississippi boundary in either surface outcrops or well borings, except as sands or gravels which have been mapped as undifferentiated Tuscaloosa and Eutaw and which are interpreted as a series of coarse sediments resulting from physiographic changes covering an interval extending from Tuscaloosa into Eutaw time. These changes are discussed on pages 26–29.

[1] Hayes, C. W., Physiography of the Chattanooga district, in Tennessee, Georgia, and Alabama: U. S. Geol. Survey Nineteenth Ann. Rept., pt. 2, pp. 1–58, 1899.

STRATIGRAPHIC RELATIONS.

In the easternmost part of their outcrop the Tuscaloosa deposits may rest upon the Lower Cretaceous sediments that enter eastern Alabama from Georgia and disappear in the longitude of Montgomery, particularly as these Lower Cretaceous sediments are supposed to have once been continuous with those of the western Gulf region. However, the unlithified and unfossiliferous character of all the deposits at this point has thus far prevented a determination of their precise limitation and relations.

From the western part of Elmore County northwestward to the central part of Chilton County, a distance of about 40 miles, the Tuscaloosa rests upon the crystalline igneous and metamorphic rocks of the Piedmont Plateau. From Chilton County northwestward to their disappearance as continuous beds in northeastern Mississippi, the Tuscaloosa sediments rest on the limestones, shales, and sandstones of the Mississippian and Pennsylvanian series of the Carboniferous. They are overlain throughout their extent by the somewhat similar shallow-water sediments forming the basal part of the Eutaw formation.

LOCAL SECTIONS CONTAINING PLANT REMAINS.

The detailed areal distribution and lithology of the Tuscaloosa formation will probably be fully discussed in a subsequent Survey publication by L. W. Stephenson in connection with his Cretaceous faunal studies, so that any extended discussion is not necessary in this report. Therefore only a few of the more important outcrops where fossil plants have been collected will be described in the following pages.

NEAR IUKA, MISS.

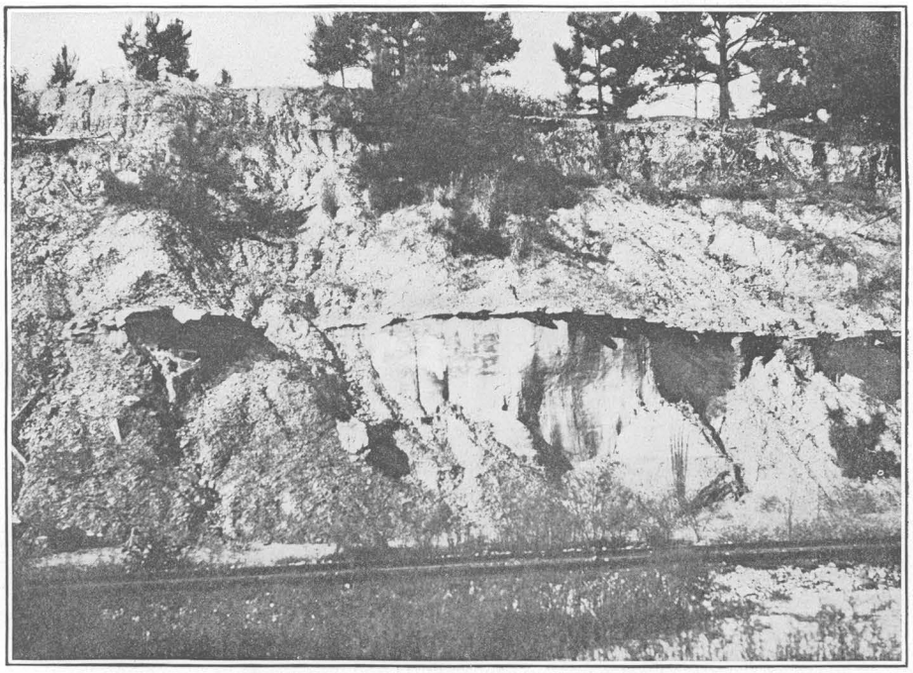
The most northerly plant-bearing outcrop of the Tuscaloosa formation is that in the cut of the Southern Railway 1⅝ miles east of Iuka, in Tishomingo County, Miss. (See Pl. III, *B*.) The exposure is not extensive but shows, according to Stephenson, a basal conglomerate overlain by lignitic, argillaceous, very micaceous sands. An interesting feature of this and other outcrops in northeastern Mississippi is the abundance of amber, which occurs in pieces ranging from tiny globules to pellets about the size of marbles, that found near Iuka showing distinct evidence of having been rolled and waterworn. The fossil plants found at this locality are few in number and poorly preserved. They include the four forms *Andromeda wardiana*, *Androvettia carolinensis*, *Phyllites pistiaeformis*, and *Sequoia reichenbachi*, of which the last is typical and very abundant. These forms are all significant in their bearing on the relative age of the deposit, and though the *Andromeda* and *Phyllites* occur in the Alabama Tuscaloosa, both are rare, and usually the rare plants are not found at localities where the representation of the flora is small. The *Androvettia* is common to the Black Creek formation of North Carolina, and though the *Sequoia* occurs in the Alabama Tuscaloosa as well as in the New Jersey Raritan, it is rare in both, becoming exceedingly abundant in the Magothy, Black Creek, and Eutaw formations. It seems evident that the northward extension of the Tuscaloosa in Mississippi is younger than the main body of the deposits in Alabama and represents the upper 200 or 300 feet of the Tuscaloosa as developed in west-central Alabama.

Plant remains are recorded by Smith, on the authority of L. C. Johnson, from Itawamba County, Miss., and this is the only locality in northeastern Mississippi where they have been found, as an extended search in the lignitic clays of that county failed to reveal any identifiable plants.

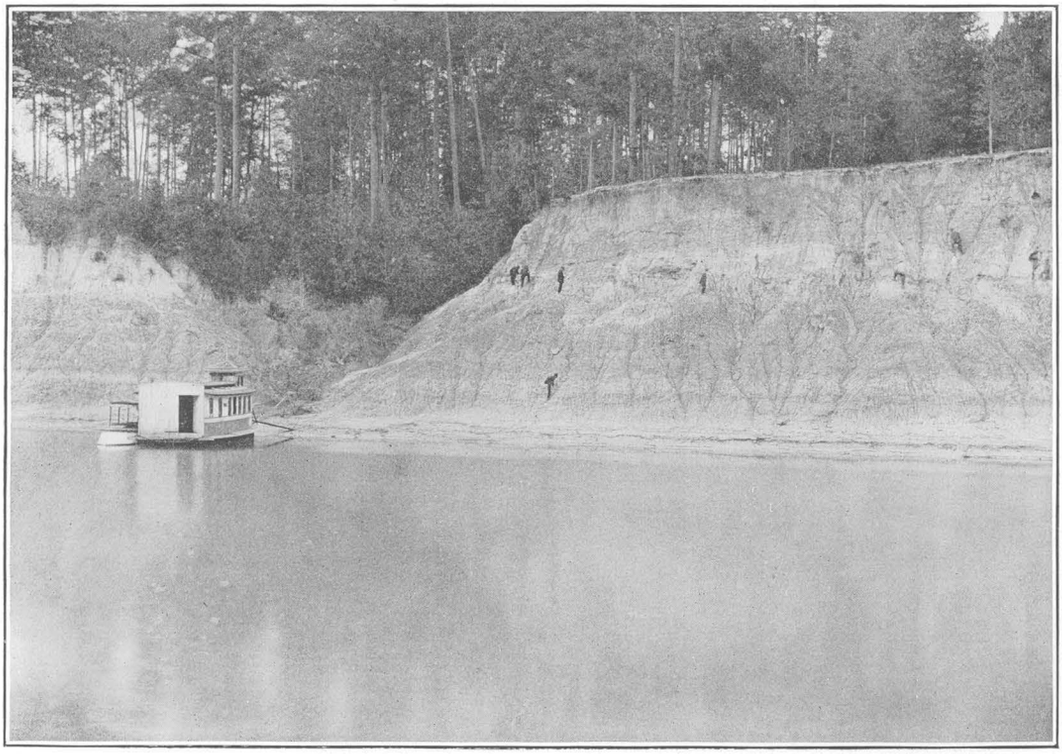
GLEN ALLEN, ALA.

The most northern plant locality known in the Alabama area is in a cut along the St. Louis-San Francisco Railway about a quarter of a mile east of Glen Allen, near the northern boundary of Fayette County. (See Pl. II, *A*.) This locality was discovered by the Geological Survey of Alabama about 25 years ago, and extensive collections were made here by E. A. Smith and L. F. Ward in 1892. These were supplemented by collections made by Berry and Stephenson in 1909. This locality is the one erroneously stated by Smith to be in Marion County.[1] The outcrop extends about 150 yards on both sides of the track and is shown diagrammatically in figure 1. An examination of material obtained from dug wells

[1] Smith, E. A., Langdon, D. W., jr., and Johnson, L. C., On the geology of the Coastal Plain of Alabama, Cretaceous, Tertiary, and post-Tertiary formations, p. 331, Alabama Geol. Survey, 1894.



A. CUT IN THE TUSCALOOSA FORMATION NEAR GLEN ALLEN, ALA., ALONG THE ST. LOUIS-SAN FRANCISCO RAILWAY, SHOWING SANDS BELOW THE FERRUGINOUS LEDGE AND LEAF-BEARING CLAYS ABOVE.



B. WHITES BLUFF, BLACK WARRIOR RIVER, ALA., SHOWING SANDS AND LEAF-BEARING CLAYS OF THE TUSCALOOSA FORMATION.

and near-by exposures shows the leaf-bearing stratum to be about 90 feet above the Paleozoic floor. The beds represented by this thickness are predominantly sandy and extensively current-bedded. Above a ferruginous ledge there is a dark, tough plastic clay, rather massively bedded at the base and becoming laminated above. This is the leaf-bearing horizon, and the best materials were collected from the lower half of the member. The following 39 species have been recognized:

Andromeda grandifolia Berry.
novaecaesareae Hollick.
parlatorii Heer.
Bauhinia marylandica Berry.
Cassia vaughani Berry.
Cinnamomum newberryi Berry.
Cissites formosus Heer.
Cocculus problematicus Berry.
Conocarpites formosus Berry.
Cordia apiculata (Hollick) Berry.
Cornophyllum vetustum Newberry.
Cycadinocarpus circularis Newberry.
Diospyros primaeva Heer.
rotundifolia Lesquereux.
Ficus daphnogenoides (Heer) Berry.
krausiana Heer.
woolsoni Newberry.
Ilex masoni Lesquereux.
Leguminosites ingaefolia Berry.
Liriodendropsis simplex Newberry.
Lycopodites tuscaloosensis Berry.
Lycopodium cretaceum Berry.
Magnolia lacoeana Lesquereux.
newberryi Berry.
speciosa Heer.
Marattia cretacea Velenovsky?
Myrica dakotensis minima Berry.
Myrsine borealis Heer.
gaudini (Lesquereux) Berry.
Persoonia lesquereuxii minor Berry.
Phyllites pistiaeformis Berry.
Populites tuscaloosensis Berry.
Pterospermites carolinensis Berry.
Salix lesquereuxii Berry.
Sapindus variabilis Berry.
Sphaerites alabamensis Berry.
Tricalycites papyraceus Newberry.
Widdringtonites reichii (Ettingshausen) Heer.
Zizyphus lamarensis Berry.

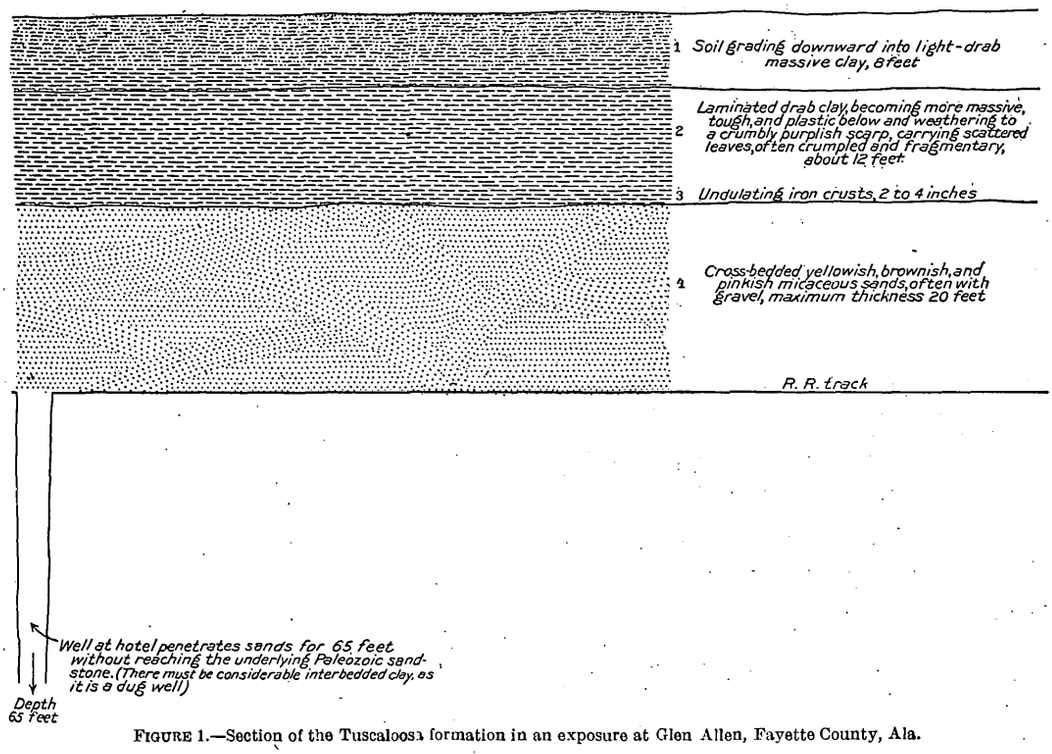


FIGURE 1.—Section of the Tuscaloosa formation in an exposure at Glen Allen, Fayette County, Ala.

This outcrop is between 20 and 25 miles directly north of the Shirleys Mill locality and is about the same distance above the base of the formation as the exposure at Shirleys Mill. Notwithstanding its proximity and similar stratigraphic position, 14 of the 39 species do not occur in the larger collections from the latter locality. The significant lithologic features of this and near-by sections are the coarseness of the sands and their current bedding, the abundance of gravels, pebbles, and cobbles, the quartz cobbles being well

rounded and those of Carboniferous sandstone rather angular. The sands, gravels, and pebbles are estimated to be about half angular chert and half well-rounded quartz, showing that Carboniferous elements in the Tuscaloosa were not transported very far.

SHIRLEYS MILL, ALA.

About 25 miles south of Glen Allen, in the southern part of Fayette County, Davis Creek, a small branch of Sipsey River, has cut its valley nearly through the Tuscaloosa mantle. The plant-bearing clays outcrop along the old underlying Paleozoic floor there is a stratum of about 15 feet of brownish, thickly laminated, rather pure clay with thin films of fine white sand, which carries an abundance of leaves, the best material coming from the basal 4 or 5 feet. The leaves are the best preserved of any that I have found in the Tuscaloosa. They are not in matted layers but evenly distributed, most of them lying flat, with petioles attached and the dripping points of the long slender leaves unbroken. The prevailing fineness of the sediments and the lack of any evidence of trituration of the fossils show that the waters

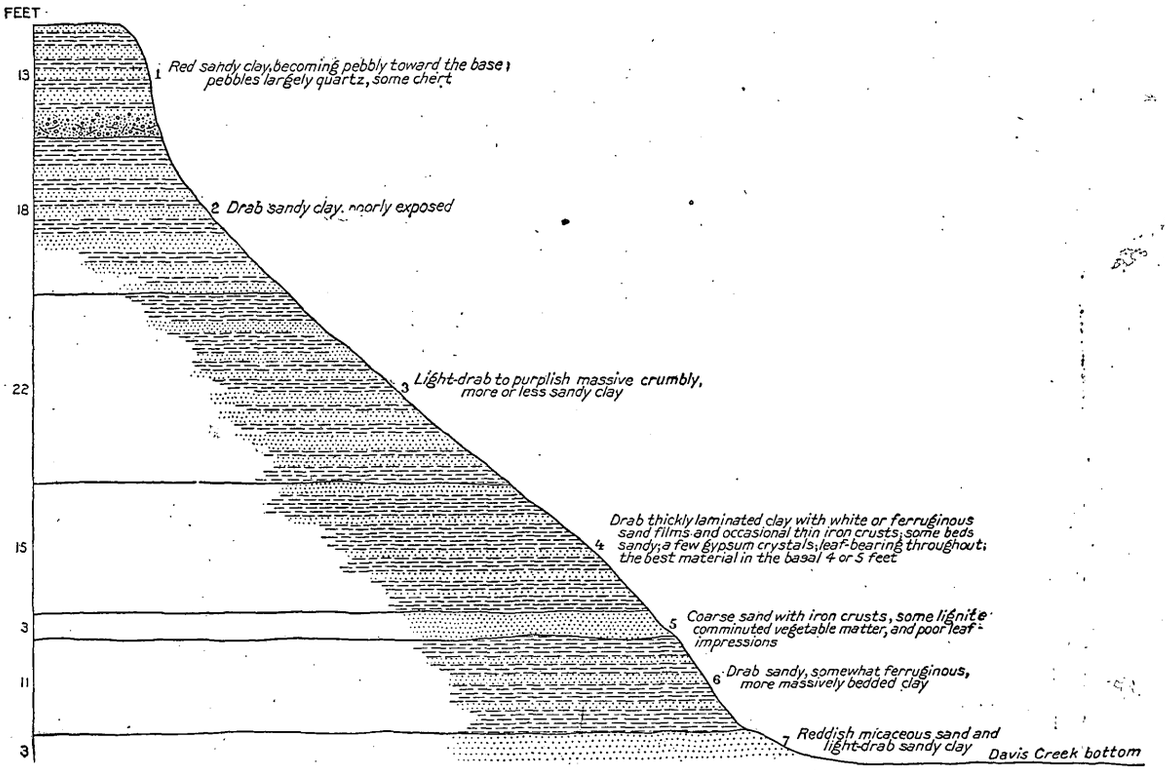
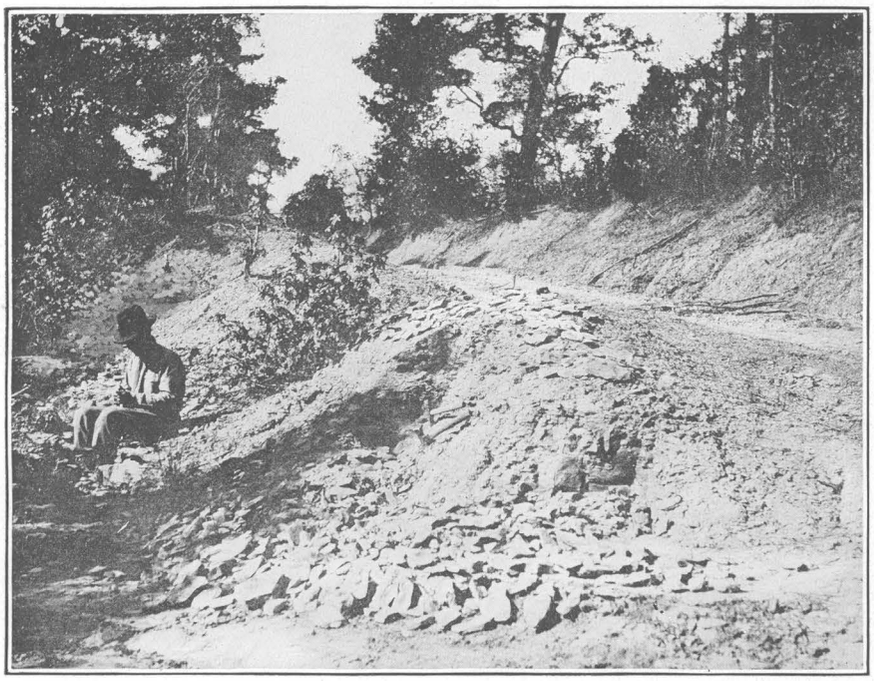


FIGURE 2.—Section of the Tuscaloosa formation (beds Nos. 2 to 7, inclusive), in an exposure near Shirleys Mill, 10 miles southeast of Fayette, Fayette County, Ala.

Fayette-Tuscaloosa coach road about 10 miles southeast of Fayette courthouse, where the road dips sharply to Davis Creek bottom. (See Pl. III, *A*.) This locality was discovered by the Geological Survey of Alabama and collections were made from it in 1892 by Smith and Ward. A larger amount of better-preserved material was obtained by Berry and Stephenson in 1909. The section is shown graphically in figure 2.

Argillaceous materials predominate throughout nearly the entire section, although the clays are often sandy. About 20 feet above the base of the section and not far above the were quiet and that the plants grew near shore. The regular vertical distribution and lack of closely packed layers indicate no less clearly that the leaves were not deciduous, but that they dropped one by one throughout the year into what was a quiet delta lake or sluggish bayou, whose shores were mantled with a varied arborescent flora. In a collecting experience in the Coastal Plain Cretaceous extending from Long Island to Texas I know of no localities as satisfactory as this one. Some of the clays of the Middendorf arkose member of the Black Creek formation in South Caro-



A. ROADSIDE WASH IN THE TUSCALOOSA FORMATION NEAR SHIRLEYS MILL, ALA., EXPOSING HIGHLY FOSSILIFEROUS CLAYS.

B. VIEW SHOWING BASAL GRAVEL OVERLAIN BY LAMINATED CLAYS OF THE TUSCALOOSA FORMATION, BEARING LEAVES, LIGNITE, AND AMBER, 1½ MILES EAST OF IUKA.

lina carry equally good material, but it is neither so abundant nor so varied. I have identified the following 98 different species from this outcrop:

Acerates amboyensis Berry.
Andromeda grandifolia Berry.
novaecaesareae Hollick.
parlatorii Heer.
wardiana Lesquereux.
Asplenium dicksonianum Heer.
Bauhinia cretacea Newberry.
marylandica Berry.
Brachyphyllum macrocarpum formosum Berry.
Capparites cynophylloides Berry.
orbiculatus Berry.
Carpolithus floribundus Newberry.
Celastrophyllum brittonianum Hollick.
crenatum ellipticum Berry.
decurrens Lesquereux.
grandifolium Newberry.
gymindaefolium Berry.
newberryanum Hollick.
praecrassipes Berry.
shirleyensis Berry.
Cinnamomum newberryi Berry.
Citrophyllum aligerum (Lesquereux) Berry.
Colutea obovata Berry.
Cordia apiculata (Hollick) Berry.
Crotonophyllum panduraeformis Berry.
Dammara borealis Heer.
Dermatophyllites acutus Heer.
Dewalquea smithi Berry.
Dicksonia groenlandica Heer.
Diospyros amboyensis Berry.
primaeva Heer.
rotundifolia Lesquereux.
Eorhamnidium cretaceum Berry.
Eugenia tuscaloosensis Berry.
Ficus alabamensis Berry.
daphnogenoides (Heer) Berry.
fontainii Berry.
inaequalis Lesquereux.
krausiana Heer.
shirleyensis Berry.
woolsoni Newberry.
Geinitzia formosa Heer.
Gleichenia delicatula Heer.
Grewiopsis formosa Berry.
tuscaloosensis Berry.
Hymenaea fayettensis Berry.
Inga cretacea Lesquereux.
Juglans arctica Heer.
Jungermannites cretaceus Berry.
Kalmia brittoniana Hollick.
Laurophyllum nervillosum Hollick.
Laurus plutonia Heer.
Leguminosites ingaefolia Berry.
omphaloboides Lesquereux.
shirleyensis Berry.
tuscaloosensis Berry.
Liriodendropsis angustifolia Newberry.
constricta Ward.
simplex Newberry.
Lycopodites tuscaloosensis Berry.
Lycopodium cretaceum Berry.
Magnolia boulayana Lesquereux.
hollicki Berry.
lacoeana Lesquereux.
longipes Newberry.
obtusata Heer.
speciosa Heer.
Malapoenna falcifolia (Lesquereux) Knowlton
Menispermites trilobatis Berry.
Myrica emarginata Heer.
Myrsine borealis Heer.
Nyssa snowiana Lesquereux.
Oreodaphne shirleyensis Berry.
Palaeocassia laurinea Lesquereux.
Panax cretacea Heer.
Persoonia lesquereuxii Knowlton.
lesquereuxii minor Berry.
Phaseolites formus Lesquereux.
Phyllites shirleyensis Berry.
Piperites tuscaloosensis Berry.
Platanus asperaeformis Berry.
shirleyensis Berry.
Proteoides conospermafolia Berry.
Protodammara speciosa Hollick and Jeffrey.
Pterospermites carolinensis Berry.
Rhamnus tenax Lesquereux.
Salix flexuosa Newberry.
lesquereuxii Berry.
meekii Newberry.
Sapindus variabilis Berry.
Sapotacites ettingshauseni Berry.
formosus Berry.
shirleyensis Berry.
Sequoia heterophylla Velenovsky.
Sphaerites alabamensis Berry.
Tricalycites papyraceus Newberry.
Widdringtonites reichii (Ettingshausen) Heer.
subtilis Heer.

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TUSCALOOSA, ALA.

Following a strictly geographic order there are several localities in and immediately around the town of Tuscaloosa to be briefly considered. The sections exposed are not extensive nor of especial significance and will not be discussed. The plants also are few and as a rule not especially well preserved. Two of these localities are on the university grounds and one on the site of the hydraulic laboratory, from which specimens were collected many years ago that bear the labels "Bathhouse, university grounds." A few plants have also been collected by E. A. Smith in a railroad cut just east of Tuscaloosa and from the banks of

Black Warrior River in the town. A light-colored, thinly laminated clay with rather well preserved leaves of little variety outcrops in a ravine leading down to Black Warrior River. Fontaine made a collection from this outcrop in 1887 and the locality is stated as "Back of Menges livery stables near Lynch House," referring to two establishments that have since disappeared. An additional locality is a roadside outcrop a few miles southwest of Tuscaloosa from which Fontaine collected specimens in 1887. This locality is referred to in the systematic chapter as "southwest of Northport." The plants from all of these localities are grouped under "Tuscaloosa" in the table of distribution.

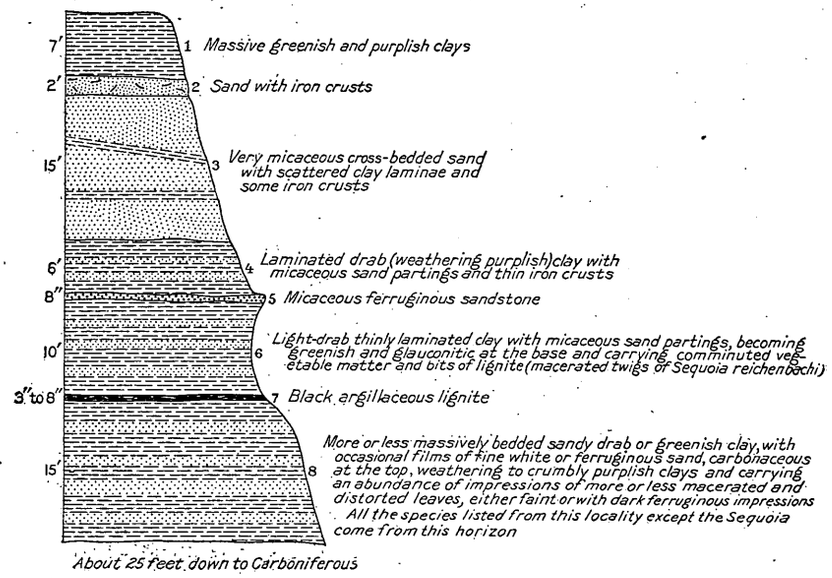


FIGURE 3.—Section of the Tuscaloosa formation in an exposure near Cottondale, Tuscaloosa County, Ala.

COTTONDALE, ALA.

A richly fossiliferous stratum outcrops along the public road about 10 miles east of Tuscaloosa and 2 miles southeast of Cottondale. This locality is referred to as Cottondale in the general discussions and in the systematic chapter. The materials, which are argillaceous below and arenaceous above, are near the base of the formation. Carboniferous (Pottsville) sandstones outcrop in the bed of a small branch of Hurricane Creek, a short distance west of the exposure. The leaf-bearing stratum is estimated to be about 25 feet above this Paleozoic floor. The section is shown diagrammatically in figure 3. The lithology is of considerable interest, as about 15 or 20 feet above the base of the section and 50 feet or more above the base of the formation there is an extensive seam of lignite several inches thick, above which is thinly laminated clay with more or less glauconite, carrying traces of *Sequoia reichenbachi*, a species which, though not positively diagnostic of any one horizon, is entirely absent in the basal plant-bearing beds at the localities which have furnished the bulk of the Tuscaloosa flora, a species which is moreover especially prominent in the flora of the Eutaw formation. The lignite seam is too thin and argillaceous to mark a swamp surface, and sedimentation is believed not to have been interrupted. The total number of identified species from the clays at the base of this section is 47, the following forms being present:

Andromeda parlatorii Heer.
Aralia cottondalensis Berry.
Bauhinia cretacea Newberry.
marylandica Berry.
Celastrophyllum crenatum Heer.
grandifolium Newberry.
undulatum Newberry.
Cinnamomum newberryi Berry.
Citrophyllum aligerum (Lesquereux) Berry.
Cocculus cinnamomeus Velenovsky?
polycarpaefolius Berry.
Cordia apiculata (Hollick) Berry.
Cornophyllum obtusatum Berry.
Diospyros primaeva Heer.
Eorhamnidium cretaceum Berry.
platyphylloides (Lesquereux) Berry.
Eugenia tuscaloosensis Berry.

Ficus daphnogenoides (Heer) Berry.
fontainii Berry.
inaequalis Lesquereux.
krausiana Heer.
woolsoni Newberry.
Geinitzia formosa Heer.
Ilex masoni Lesquereux.
Juglans arctica Heer.
Laurus plutonia Heer.
Liriodendron meekii Heer.
Magnolia capellinii Heer.
longipes Newberry.
speciosa Heer.
Malapoenna cottondalensis Berry.
cretacea (Lesquereux) Knowlton.
Menispermites integrifolia Berry.
Myrica emarginata Heer.
Mysine gaudini (Lesquereux) Berry.

numbers 151 species, and although this combined list includes many forms which range through the entire thickness of the Tuscaloosa and into the basal beds of the Eutaw it also contains a number of distinctive forms and as a whole may be considered as giving a representative picture of the flora which clothed the southern Appalachian land area at the time that Tuscaloosa sedimentation began.

SNOW PLANTATION NEAR TUSCALOOSA, ALA.

Two outcrops on the Snow plantation on the west bank of Black Warrior River, about 9 miles southwest of Tuscaloosa, have yielded many fossil plants, extensive collections having been made from them in 1887 by Fontaine and smaller collections by Berry and Stephenson in 1909. These outcrops are referred to on the labels as "Upper ravine" and "Big gully, Snow place." Erosion has eaten into the upland along the west bank of the river and the largest gully, which shows the following noteworthy section, is known locally as Catamount Bluff. There is an almost sheer drop of nearly 100 feet at the head of the gully and its top is about 300 feet above the bottom land of Black Warrior River. The section is shown diagrammatically in figure 4. It

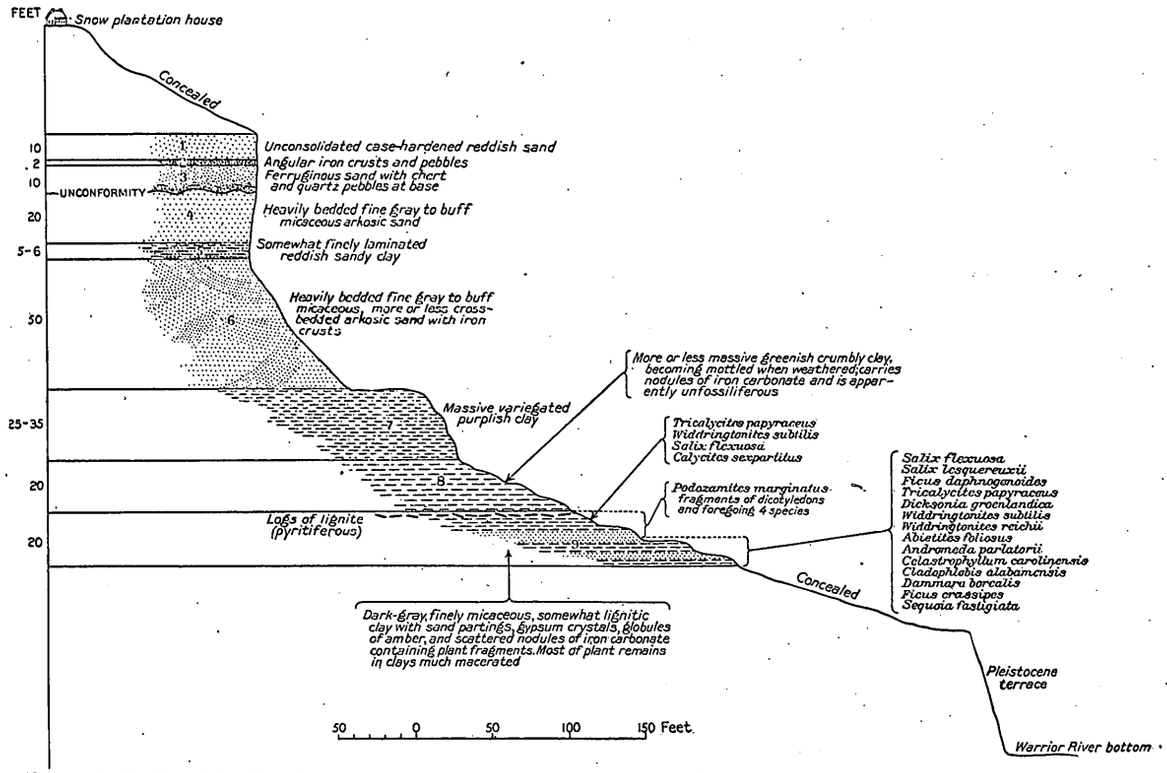


FIGURE 4.—Section of the Tuscaloosa formation in an exposure in a gully on the Snow plantation, 9 miles southwest of Tuscaloosa, Ala.

Oreodaphne alabamensis Berry.
Persea valida Hollick.
Phaseolites formus Lesquereux.
Pinus raritanensis Berry.
Platanus latior (Lesquereux) Knowlton.
shirleyensis Berry.
Populus hyperborea Heer.
Protophyllocladus subintegrifolius (Lesquereux) Berry.
Pterospermites carolinensis Berry.
Salix lesquereuxii Berry.
Sassafras acutilobum Lesquereux.
Sequoia reichenbachii (Geinitz) Heer?

This list and that from Glen Allen and Shirleys Mill together contain 131 species of the known flora of the Tuscaloosa, which

differs from the other sections reproduced in several particulars. The plant remains are much macerated, but the bedding throughout is principally massive and cross-bedding is not prominent. The upper sands carry many arkosic grains, and there is much secondary gypsum disseminated through the clays. No extensive ferruginous ledges are developed and all of the materials are unlithified, but iron is abundant in the form of oxide, sulphide, and carbonate. Nodules of the carbonate containing vegetable matter were found. Fossil plants occur throughout the basal 20 feet of the exposure, being most plentiful in the basal 10 feet, where the clays are somewhat lignitic and carry globules of amber. Above this point there is an interval of about 10 feet in which *Podozamites* leaflets greatly predominate, associated with a single gymnosperm and two or three species of dicotyledons. At this level (20 feet above the base) lies a pyritiferous clay stratum filled with large prostrate lignified logs above which the clays become more massive and apparently unfossiliferous. Twenty-six species have been identified from this outcrop and four from the near-by "upper ravine," where they come from the same horizon. These sections are between 300 and 400 feet above the base of the Tuscaloosa, and yet it was the Fontaine collections from here that suggested that the Tuscaloosa was perhaps Lower Cretaceous. The only forms suggesting a Lower Cretaceous age are *Abietites foliosus* and *Sequoia ambigua*. The latter occurs in both the Eutaw and Magothy formations and the former is associated at this outcrop with *Dryopterites stephensoni*, which was described from the much younger Ripley formation in Georgia. Although 13 or 14 species of this level are common to the basal beds, no traces of *Abietites* have been found in the latter, either here or at other localities. Seven of the species survive into the Eutaw but these are wide-ranging forms. Among them *Ficus crassipes* tends to synchronize the leaf-bearing horizon in this section with the post-Raritan of the Middle Atlantic Coastal Plain. Combining the species listed from the upper ravine with those from the Big Gully we have the following 30 forms from this locality:

Abietites foliosus (Fontaine) Berry.
Andromeda grandifolia Berry.
Andromeda novaecaesareae Hollick.
Andromeda parlatorii Heer.
Calycites sexpartitus Berry.
Carpolithus tuscaloosensis Berry.
Celastrophyllum carolinensis Berry.
crenatum Heer.
Cladophlebis alabamensis Berry.
Dammara borealis Heer.
Dicksonia groenlandica Heer.
Dryopterites stephensoni Berry.
Eucalyptus geinitzi (Heer) Heer.
latifolia Hollick.
Equisetum? sp.
Ficus crassipes (Heer) Heer.
daphnogenoides (Heer) Berry.
krausiana Heer.
Laurophyllum angustifolium Newberry?
Myrica emarginata Heer.
Myrsine borealis Heer.
Podozamites marginatus Heer.
Salix flexuosus Newberry.
lesquereuxii Berry.
Sequoia ambigua Heer.
fastigiata (Sternberg) Heer.
reichenbachi (Geinitz) Heer.
Tricalycites papyraceus Newberry.
Widdringtonites reichii (Ettingshausen) Heer.
subtilis Heer.

SANDERS FERRY BLUFF, ALA.

This notable exposure is formed by the next meander of Black Warrior River below the preceding section. It is about 2 miles farther southwest of Tuscaloosa by air line but of course much farther by the river. The section is remarkable for its predominantly argillaceous character, the only sand seen being at the base, where there is about 15 feet of cross-bedded, somewhat glauconitic sand. A stratum 38 feet thick begins about 40 feet above the base of the section and is made up of extremely compact, thinly laminated clay with partings of micaceous glauconitic sand. Near the middle of the stratum there is an abundance of disseminated needles of gypsum which I regard as primary, and toward the top leaves with their cuticles preserved are common. The following five species have been identified: *Acerates amboyensis* Berry, *Ficus crassipes* (Heer) Heer, *Ficus krausiana* Heer, *Salix flexuosa* Newberry, and *Salix lesquereuxii* Berry. All but the first of these also occur in the outcrops on the Snow plantation.

Above the fossiliferous stratum there is about 50 feet of massively bedded unfossiliferous clay. The section is shown diagrammatically in figure 5.

WHITES BLUFF, ALA.

Whites Bluff is in the northeastern part of Greene County, on the right bank of Black Warrior River, 309 miles above Mobile.

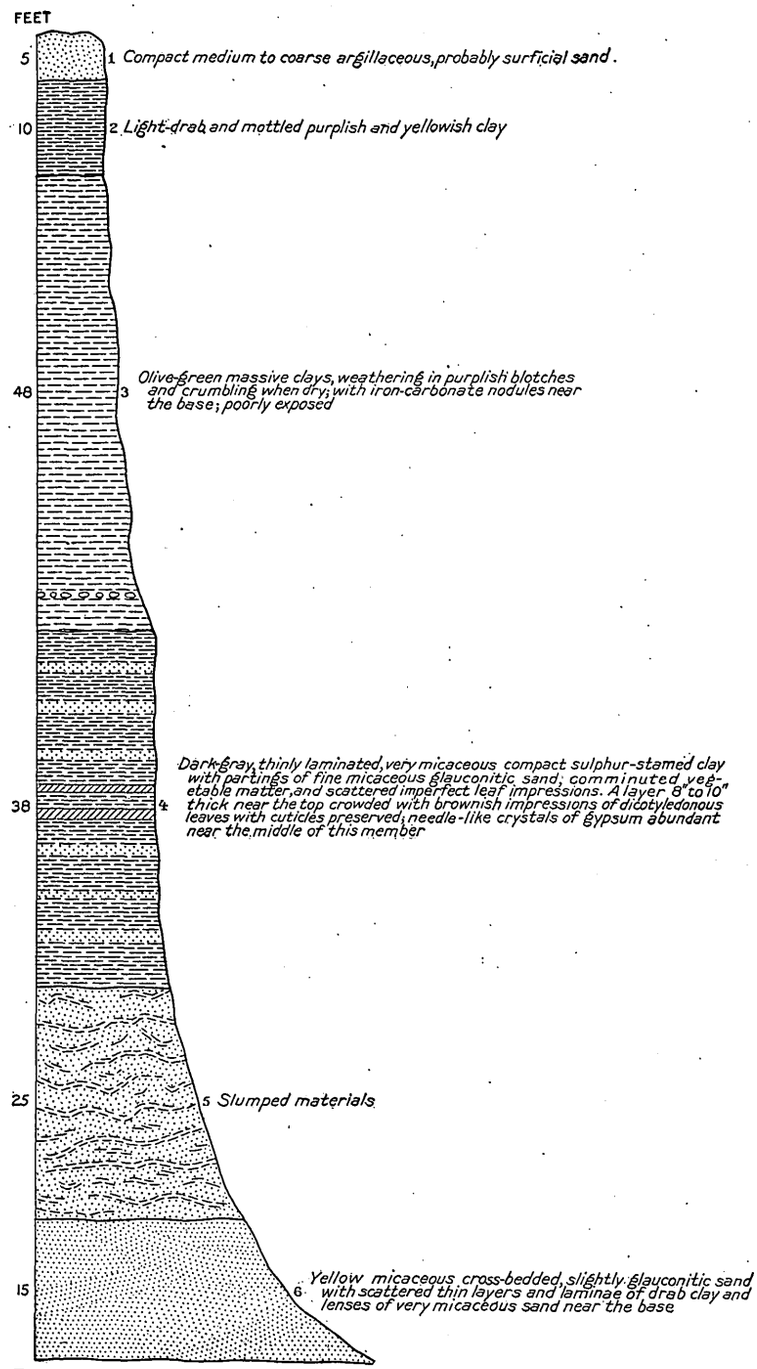


FIGURE 5.—Section of the Tuscaloosa formation in an exposure at Sanders Ferry Bluff, on Black Warrior River, 12 miles below Tuscaloosa, Ala.

The outcrop is very near the top of the Tuscaloosa and fortunately it carries fossil plants, although they are neither abundant nor varied. The section is shown diagrammatically in figure 6. The materials are variable horizontally, the only persistent stratum being the 27 feet of blotched sandy, massive clay at the base. (See Pl. II, *B*, p. 14.) The following plants have been identified from this outcrop:

Brachyphyllum macrocarpum formosum Berry.
Dewalquea smithi Berry.
Salix flexuosa Newberry.
Sequoia heterophylla Velenovsky.
reichenbachi (Geinitz) Heer.
Widdringtonites reichii (Ettingshausen) Heer.

All these plants occur in the basal part of the Tuscaloosa and all except *Sequoia heterophylla* and *Widdringtonites reichii* are common in the overlying Eutaw. The most remarkable form is the abundant *Dewalquea smithi*, which occurs also in the Middendorf arkose member of the Black Creek formation of South Carolina.

None of these plants can be regarded as distinctly Eutaw species, and they serve to emphasize the fact that the flora shows but slight changes from the base to the top of the Tuscaloosa.

The flora is thus about as well represented as that of the Raritan formation or the Magothy formation, with both of which it agrees in its general facies and the types of plants represented. The Tuscaloosa flora therefore presents nothing especially new, the forms represented being just such types as in general might be expected to occur in a flora of this age. There are some new forms that may reflect its more southern position, but I imagine these are really explained by the more careful comparisons instituted with the existing flora of

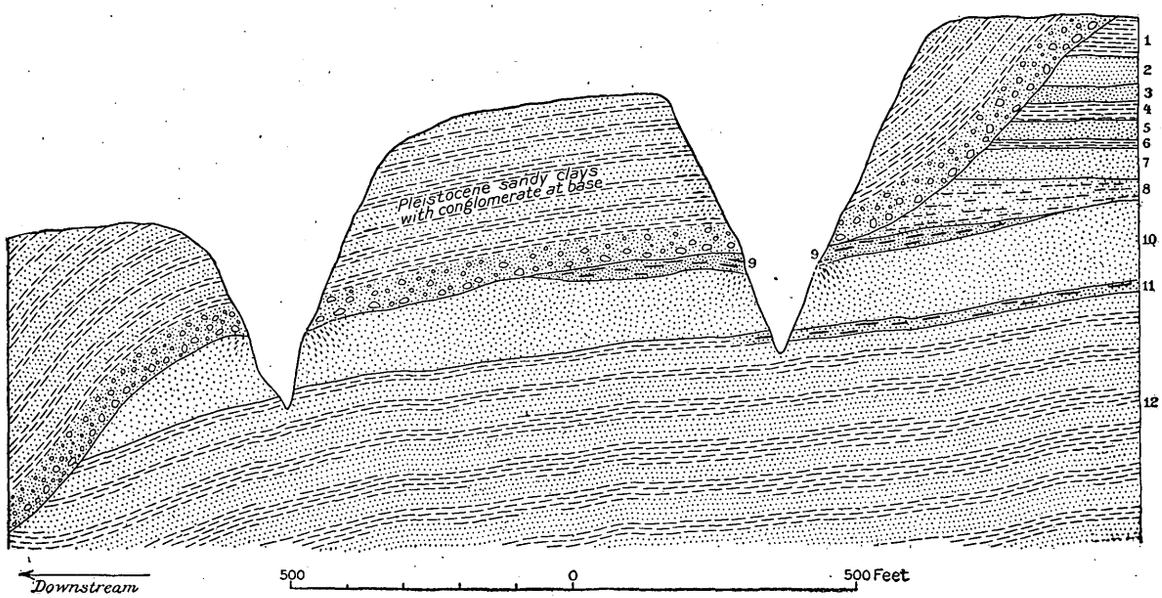


FIGURE 6.—Section of the Tuscaloosa formation in an exposure at Whites Bluff, Black Warrior River, 52¾ miles below Tuscaloosa, Ala. 1, Finely micaceous and arenaceous reddish and purplish blotched clays, 4 feet; 2, light-drab, finely micaceous and argillaceous laminated sand, 3 feet 3, greenish-gray fine micaceous massive sand, 2 feet; 4, gray, finely arenaceous clay, 2 feet; 5, greenish-gray fine micaceous massive sand, 2 feet; 6, gray arenaceous massive clay, 1 foot; 7, greenish-gray compact micaceous massive argillaceous sand, 3 feet; 8, blotched purplish massive sandy ferruginous clay, 2½ feet; 9, very argillaceous sand with leaf impressions, lignite (some specimens bored by the teredo, *Feistmantellia*), and amber, a thin film to 2 feet; 10, greenish-gray or yellow, compact fine sand, 8 feet; 11, coarse gray sand and drab clay with lignite, leaf fragments, and amber, 1 foot: 12, purplish-blotched massive sandy clay, 27 feet.

COMPOSITION, ORIGIN, AND EVOLUTION OF THE TUSCALOOSA FLORA.

The Tuscaloosa flora as described in the systematic chapter embraces 151 species. The present treatment is conservative, as a considerable number of additional forms represented in the collections by incomplete material have been left uncharacterized. Unidentifiable seeds representing about a score of forms are also in the collections. Later, when the area in which the Tuscaloosa outcrops shall have been examined in detail, doubtless many new forms will be brought to light.

tropical and subtropical America and fortified by a prolonged study of the subtropical floras of our Gulf Tertiary.

The 151 described species from the Tuscaloosa formation represent 87 genera, of which the following are not represented in existing floras: *Sphaerites, Jungermannites, Lycopodites, Cladophlebis, Dryopterites, Podozamites, Cycadinocarpus, Cephalotaxospermum, Protophyllocladus, Brachyphyllum, Protodammara, Geinitzia, Androvettia, Abietites, Widdringtonites, Cyperacites, Sabalites, Piperites, Populites, Proteoides, Dewalquea, Menispermites, Laurophyllum, Capparites, Palaeocassia, Phaseolites, Lirio-*

dendropsis, *Leguminosites*, *Citrophyllum*, *Crotonophyllum*, *Manihotites*, *Celastrophyllum*, *Cissites*, *Eorhamnidium*, *Grewiopsis*, *Pterospermites*, *Conocarpites*, *Cornophyllum*, *Dermatophyllites*, *Sapotacites*, *Tricalycites*, *Calycites*, *Carpolithus*, and *Phyllites*.

Thus 44 genera, or about half of the entire number described, are not represented, but it should be remembered that many of these are form genera, like *Laurophyllum*, *Capparites*, and *Leguminosites*, that reflect our ignorance of the exact affinities of the plants discussed. All the species are of course extinct, none surviving in the abundant lower Eocene floras of the Mississippi embayment. Many of the genera, however, are represented in the Eocene, the striking difference, in addition to the great modernization of the Eocene forms, being the dropping out of the Mesozoic gymnospermous types like *Androvettia*, *Abietites*, *Brachyphyllum*, *Protophyllocladus*, *Widdringtonites*, *Podozamites*, *Protodammara*, and *Geinitzia*.

The 87 genera represented are segregated into 48 families in 31 orders, the most abundant orders being the Ranales with 15 species, the Rosales with 15, the Sapindales with 15, the Coniferales with 14, and the Urticales with 8. The largest single genera are *Celastrophyllum* with 12 species, *Magnolia* with 8, and *Ficus* with 8. The additional genera that are represented by more than 2 species are *Myrica*, *Salix*, *Cocculus*, *Malapoenna*, *Bauhinia*, *Liriodendropsis*, *Diospyros*, and *Sapotacites* with 3 each, and *Sequoia*, *Leguminosites*, and *Andromeda* with 4 each.

In common with most Upper Cretaceous and later floras the bulk of the flora is made up of seed plants (Spermatophyta) and a large majority of these are dicotyledonous angiosperms.

The three numerically great modern phyla, the Thallophyta, Bryophyta, and Pteridophyta, are represented by only 11 recognizable forms, the first by a single species of leaf-spot fungus, the second by an inconclusively identified foliose liverwort, and the third by a single fragment of an *Equisetum*, two lycopodiaceous species, and six species of ferns. The Pteridophyta, which are so abundant in earlier floras, constituting about 30 per cent of the whole flora of the Potomac group of the Atlantic Coastal Plain, had dwindled to a meager 4 per cent in the Tuscaloosa flora, although they are somewhat more abundant in the nearly contemporaneous flora of the Atane beds of West Greenland, where they constitute 11 per cent of the known flora. Three species are referred to the family Polypodiaceae, a doubtfully determined *Marattia*, a *Dicksonia*, and a *Gleichenia* first recorded in the Lower Cretaceous of Greenland. If this *Gleichenia* originated in Greenland it must have covered more than 3,000 miles between the Nugsuak Peninsula (West Greenland) and Alabama in the interval between the Barremian and the Cenomanian, a period represented by the Aptian and Albian stages of European geology, during which this widespread species also reached Bohemia in Central Europe. *Asplenium dicksonianum* Heer and the two coniferous species, *Sequoia ambigua* and *Sequoia reichenbachii*, have a like distribution, but the *Sequoias* are both present in the Lower Cretaceous floras of Maryland and Virginia. The Gleicheniaceae are more abundant in most of the Upper Cretaceous floras than they are in the Tuscaloosa and still survive in tropical America.

Cycad-like plants, so abundant in Lower Cretaceous and older Mesozoic floras, are represented by a single species of *Podozamites*, on the assumption that *Podozamites* is really cycadaceous—an assumption questioned by many students. It is individually very abundant at the two localities in the Tuscaloosa where it has been found, and is another type whose range extends northward to Greenland. A second cycadaceous type is represented by the fruits referred to *Cycadinocarpus*, which are of rare occurrence in the Tuscaloosa deposits. Six species of Cycadophytes have been recorded from the Raritan formation of New Jersey.

The Coniferales of the Tuscaloosa flora are of exceptional interest, although they are represented by only 14 species as against 16 in the Raritan flora of New Jersey. They include modern types of *Pinus*, *Dammara*, and *Sequoia*, and the curious extinct phylloclad type *Androvettia*, as well as *Protophyllocladus*, *Brachyphyllum*, *Protodammara*, and *Geinitzia*. A species of *Abietites* survives from the Lower Cretaceous and represents an early abietineous form with a large and indeterminate number of leaves in each fasicle. Two species of *Widdringtonites* are abundant, one being represented by characteristic fruits. They are wide-

ranging, almost cosmopolitan types in the earlier part of the Upper Cretaceous. The genus *Moriconia*, so characteristic and abundant in the Upper Cretaceous floras of the Atlantic Coastal Plain from Marthas Vineyard to South Carolina and found also in Greenland and western Europe at this time, is conspicuously absent in the Tuscaloosa flora.

Only three of the Coniferales appear to have survived into the overlying Eutaw deposits and these are all wide-ranging and persistent forms.

The angiosperms constitute the major part of the Tuscaloosa flora in common with all known Upper Cretaceous floras. It may be noted that the monocotyledons are represented by a single fragmentary and rare grass-like form referred to the form genus *Cyperacites*. There are many excellent reasons for the derivation of the monocotyledons from the dicotyledons, but on account of the scarcity of monocotyledons in fossil floras little light is thrown on the subject by paleobotanic studies. This scarcity of monocotyledons is largely due to the fact that the lack of differentiation of their foliage into lamina and petiole precludes the regular shedding of their leaves, which therefore hang on and are flayed by the wind until they become almost unrecognizable. This fact is well illustrated by their unimportant place in the subtropical floras of the early Tertiary in the Gulf region, where they must have been abundant but are only represented by forms like the palms and cannas, in which the leaves are differentiated into blade and stalk, and even the coriaceous-leafed palms are commonly represented by deposits packed with masses of frayed and detached rays.

The Dicotyledonae of the Tuscaloosa number 123 species, well distributed among 34 still existing families in 21 still existing orders. As might be expected, 107 of the dicotyledonous plants belong to the division Choripetalae and only 16 are referred to the essentially later and more specialized Gamopetalae. Of the forms referred to the Choripetalae 24 belong to the more or less artificial group of Apetalae and 77 to the Polypetalae. Ten species are referred to the so-called amentiferous families.

The order Ranales, which includes 15 species, has one supposed species of Ranunculaceae referred to the genus *Dewalquea*. This species is represented in abundance by satisfactory remains and constitutes a curious type which appeared with apparent suddenness in the Atane beds of Greenland, the Raritan formation of New Jersey, the Tuscaloosa formation of Alabama, and the Cenomanian of Bohemia, survived in some of these areas through the remainder of the Upper Cretaceous, and was last seen in the Paleocene of western Europe.

The Ranales include 9 species of Magnoliaceae, perhaps unduly enlarged by a too great differentiation of the leaves referred to *Magnolia*, and 5 species of Menispermaceae.

The prominence of the orders Rosales and Sapindales is explained largely by the fact that so many of their species are coastal types, which stand a much better chance of preservation than do forms of other habitats. In many ways the most interesting plants in the order Rosales are the striking new species of *Hymenaea* and the two diverse species of *Bauhinia*, a genus which in the existing flora is an inhabitant of the Tropics. Its curious bilobate, butterfly-like leaves are very characteristic in both their outline and venation and could scarcely be confused with any other type. The large Tuscaloosa form occurs also in the Raritan formation of New Jersey and the small form is found in the Magothy formation of Maryland. Three species of *Liriodendropsis* are referred to the family Papilionaceae. The chief genus of the Sapindales, as these forms are usually interpreted, is *Celastrophyllum*, which has 13 forms in the Tuscaloosa flora. *Celastrophyllum* makes a remarkable display in the late Lower Cretaceous (Patapsco formation) of the Atlantic Coastal Plain, and the Tuscaloosa shares with the Raritan and Dakota in an abundant and varied display of forms, not one of which is known to survive in the overlying Eutaw deposits. Similarly none are found in the deposits of the Montana group in the Rocky Mountain province, but two or three survive Raritan time and occur in the Magothy formation of the New Jersey-Maryland area and in the Black Creek formation of the Carolinas.

The order Urticales has 8 species, all referred to the genus *Ficus* of the family Moraceae, and most of them are very abundant individually. Both the palmate and pinnately veined types are represented, most of the species being widely distributed and largely coastal forms, which, combined with the coriaceous nature of

the leaves of many of the species, explains their abundance in all fossil floras that flourished where the climate was not intolerant.

The order Proteales, no longer represented in North America and largely antipodean in the existing flora, is represented by a species of *Proteoides* and two species of *Persoonia*. It is thus somewhat less prominent than in most Upper Cretaceous floras.

The remaining elements in the flora need not be enumerated in the present connection, as they would contribute nothing of especial significance to the discussion.

The origin of this flora, particularly of its large dicotyledonous element, is one of surpassing interest to both the geologist and botanist. The place and manner of evolution of this type of plant, which so quickly replaced all others in the struggle for possession of the soil, are still uncertain. They appear with apparent suddenness at the close of the Lower Cretaceous in America, Europe, and the Arctic region. Like so many other plant and animal types, they must have had a long antecedent period of evolution, extending back, perhaps, well into the Jurassic. The fact that so many of them, and a number of them forms of identical species, are first recorded at about the same time in Greenland, North America, and Europe is capable of several interpretations. The late Lower and early Upper Cretaceous floras of Asia are practically unknown, and it is quite possible that Asia was the theater of their evolution, from which continent they may have spread eastward into North America and westward into Europe. It seems to be established that they were more abundant in America than in Europe during the earlier recorded stages of their history, and there are quite a number of forms whose appearance in North America seems to have preceded their appearance in Europe by an appreciable though slight time interval. This suggests that North America was nearer their center of radiation. I do not regard the Southern Hemisphere as at all likely to have been their original home. I have plotted the Mesozoic and Cenozoic distribution of a large number of the genera, and there is always a consistent progressive southward migration.

Theoretically the eastern part of North America, during the long interval of emergence and erosion covered by the Jurassic period, offers many potential possibilities. North America may have been the original home of the Mesozoic and Cenozoic floras, but this is not substantiated by the records, and our records of the Mesozoic land flora are far more representative and complete at the present time than those of any other country. At present there is absolutely no evidence of their having originated in the European area. A remaining alternative is that of regarding the Arctic area as the scene of their evolution and dispersal. This theme has been dwelt upon by more than one student of both floras and terrestrial faunas. The facts available, though suggestive, are not conclusive, but thus far they are more in accord with the theory of Arctic origin than with any others, so that at least tentatively we may picture successive waves of migration sweeping southward from the North Polar region during the late Lower and early Upper Cretaceous. The Upper Cretaceous floras indicate somewhat cooler climatic conditions than those of the Lower Cretaceous, and these conditions may have been a prominent factor in causing such migrations.

These floras show but slight evidence of rapid generic evolution during the Upper Cretaceous, although specific evolution seems to have been accentuated at times. The records, however, fail to show any large number of synthetic types, most of the generic types being well differentiated from the beginning of the record down to the present time. A more or less well defined change in facies separates the Cenomanian from the Turonian and Senonian floras, but this change seems to be largely a reflection of migrations which are but little understood and which are due to changes in habitat and climate rather than to evolutionary processes. The principal types were chiefly long lived and wide ranging, and there are many single forms which are found from West Greenland to Alabama and extend chronologically from the base of the Raritan through the Tuscaloosa into the basal beds of the Eutaw. The first appearance of some of these types in the upper part of the Lower Cretaceous suggests a longer time interval, but they are too few to be relatively significant.

ECOLOGIC CONDITIONS INDICATED BY THE TUSCALOOSA FLORA.

Any attempt to reconstruct the details of the physical conditions under which the Tuscaloosa flora flourished is beset with the greatest uncertainties. The flora is not only too remote from the present time for accurate comparisons, but exact knowledge of the finer reactions of recent plants to their environment is lacking, and most of the current ideas on this subject are largely empirical. In all but desert areas the interrelation of diverse factors is almost infinitely complex.

Some general statements, however, can be deduced, and from a study of the sediments and the present topography of this and adjoining areas we can get a more or less accurate even if faint picture of the physical geography of the Tuscaloosa time.

During the enormous interval of time represented in other parts of the world by marine sediments of Pennsylvanian, Permian, Triassic, Jurassic, and Lower Cretaceous age the southern Appalachian region was above sea level. Physiographically the southern half of this region is segregated at the present time into the Piedmont Plateau, the Appalachian Mountains (which die out in northwestern Georgia), the Appalachian Valley, the Cumberland Plateau, and the Interior Lowlands. Its area south of Ohio River is over 160,000 square miles and the actual area of this land mass during the interval from the Carboniferous to the Upper Cretaceous must have been very much greater than this, for nowhere along the margins of this massif have marine sediments of these ages been deposited near enough to its present limits to be reached by deep borings near the margin of the present Coastal Plain.

The region of the southern Appalachians has long interested physiographers. Hayes and Campbell, the chief contributors,[1] have recognized three base-levels or peneplains, which they term in the order of their age the Cumberland, the Highland Rim, and the Coosa. They consider that the original Tennessee River, which they term Appalachian River, flowed southwestward by way of the valley of Coosa River throughout the Upper Cretaceous and the major portion of the Tertiary until it was diverted by stream capture due to the working back across Walden Ridge of a stream in the Sequatchie Valley to the west of that ridge. This spectacular river capture has been disputed by Johnson,[2] who, it seems to me, conclusively demonstrates that the present course of Tennessee River across Walden Ridge in a winding gorge is imposed from meanders inherited from the period of earliest complete base-leveling in this area, namely, from the Cumberland peneplain.

The character of the Upper Cretaceous sediments of the eastern Gulf area throws considerable light on the physical history which has interested me chiefly in connection with the interpretation, in terms of geologic history, of the extensive fossil floras that have been found in the earliest Upper Cretaceous or Tuscaloosa formation of this region.

The Tuscaloosa formation in the area around Tuscaloosa, Ala., and for some distance to the northwest consists of a great thickness of predominantly sandy materials which give the country its present broken topography. These sands are generally light in color, cross-bedded and micaceous; in some places there are traces of glauconitic layers. There are heavy beds of gravel made up of well-rounded quartz and subangular chert pebbles in about equal proportions in places, especially toward the landward margin of the deposits and northward along the strike. In disconnected and interbedded lenses there is a considerable amount of argillaceous material—locally massive or heavy bedded but generally laminated. Thin seams of lignite are present at various levels, but these are generally only a few inches or less in thickness. The clays are commonly oxidized and mottled in color, but they are as commonly very carbonaceous and dark in color. In some sections, as in the section in the Big Gully southwest of the town of Tuscaloosa, there are layers filled with prostrate logs of trees of large size. Pyrite and ferruginous oxide, forming locally indurated sandstones and gravels, are generally distributed, and finely disseminated crystals of gypsum are very common.

No fossils other than the remains of land plants have been found in the Tuscaloosa

[1] Hayes, C. W., and Campbell, M. R., The geomorphology of the southern Appalachians: Nat. Geog. Mag., vol. 6, pp. 63-126, 1894. Hayes, C. W., The physiography of the Chattanooga district: U. S. Geol. Survey Nineteenth Ann. Rept., pt. 2, pp. 1-58, 1899.

[2] Johnson, D. W., The Tertiary history of the Tennessee River: Jour. Geology, vol. 13, pp. 194-231, 1905.

deposits. Usually the plant remains are much macerated and broken by water transportation and deposited in films of broken fragments in the laminated beds. Drift logs are common, and these occasionally brought down cobbles embedded in their roots, as is shown by specimens of lignitized tree roots that have been collected. There appear to have been areas of quiet waters at certain localities where the leaf remains in the clays are abundant and in a state of preservation indicating that they grew in the immediate vicinity.

The outcrop of the Tuscaloosa formation, as shown in the sketch map (fig. 7), is roughly lunate in outline with the southeastern horn terminating near Montgomery, Ala., and the other extending as an attenuated band across western Tennessee. As shown in the sketch map, the greatest width of outcrop coincides with the maximum thickness of sediments in a belt about 125 miles in length which is at right angles to the axis of the Appalachian land mass. Toward the north the deposits become thinner, are prevailingly gravels, and are shown by the fossil plants to be somewhat younger than the main body of the deposits.

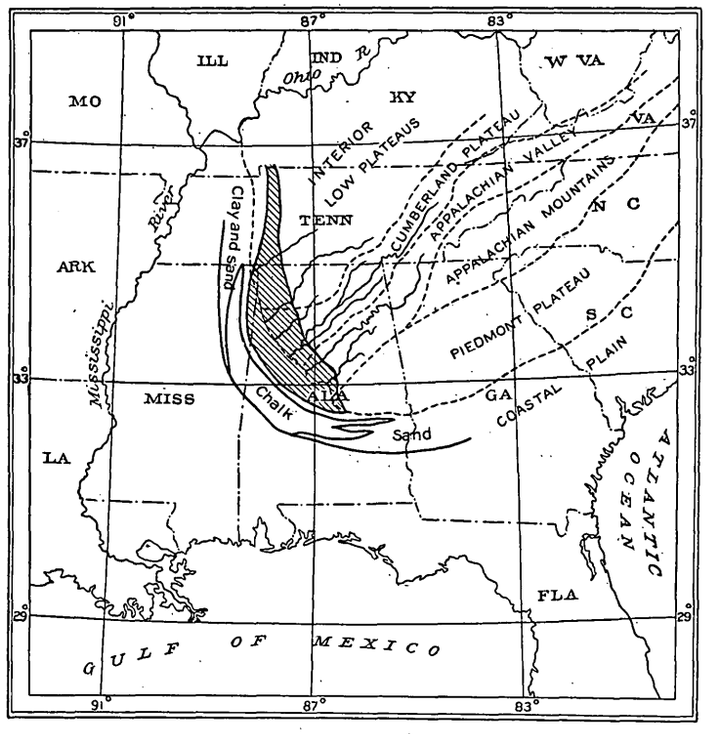


FIGURE 7.—Sketch map showing the Tuscaloosa drainage and its subsequent history.

The delta-like character of the Tuscaloosa deposits, with their gravels and compound oblique cross-bedded sands, their local traces of glauconite, and their abundance of driftwood, can not fail to be noticed. We are now fairly familiar with the main features of delta deposits in different parts of the world,[1] and Grabau[2] and Barrell[3] have recently made considerable contributions toward the interpretation of Paleozoic delta deposits. In the Tuscaloosa region no sediments later than the Pottsville were laid down until the deposition of the Tuscaloosa in the earlier Upper Cretaceous. This long interval resulted in the nearly complete base-level known as the Cumberland peneplain. There must have been some regional uplift or warping at the beginning of Tuscaloosa time to account for the sudden augmentation in river action and the beginning of the large delta or series of deltas along the southwestern margin of the land mass. There is no evidence in the sediments that an Appalachian river flowed southwestward through the Coosa Valley. Such a river would have brought the bulk of the sediments farther eastward than the region where they now occur. Though I regard Johnson's evidence[4] as conclusive for the course of Tennessee River across Walden Ridge, I can not help believing that the Cretaceous ancestor of this stream at the beginning of Tuscaloosa time, instead of making the sharp turn to the northwest at Guntersville, Ala., which it does at present, continued southwestward down either Brown or Big Spring valleys and reached the sea through either Mulberry or Locust Fork of Black Warrior River. This, however, is not an essential part of my argument for the delta character of the Tuscaloosa formation, for there was obvi-

[1] Credner, G. R., Die Deltas: Petermanns Mitt., Ergänzungsheft 56, pp. 1-74, pl. 3, 1878.

[2] Grabau, A. W., Early Paleozoic delta deposits of North America: Geol. Soc. America Bull., vol. 24, pp. 399-528, 1913.

[3] Barrell, Joseph, Geol. Soc. America Bull., vol. 23, pp. 377-446, 1912.

[4] Johnson, D. W., op. cit.

ously at that time a stream or a series of streams draining to the southwest and engaged in removing the débris of the long-weathered land mass.

I do not ignore the fact that some of the Tuscaloosa deposits are subaerial and that originally the delta deposits probably continued inland up the valley or valleys for considerable distances as continental deposits of channels, flood plains, and lakes. The antecedent meanders of the present streams give clear evidence of conditions that prevailed on the Cumberland peneplain that were suitable for the formation of oxbow lakes. There must have been quiet waters in the delta itself in certain bayous or possibly lakes like Lakes Salvador, Pontchartrain, and Borgne of the present Mississippi Delta region. Certainly the leaf-bearing clays near Glen Allen and Shirleys Mill, in Fayette County, Ala., were formed in such quiet bodies of water with densely wooded shores.

that is, southwest of the axis of the Appalachian land mass. In this area the Selma chalk continues upward to the Eocene contact. Its outcrop, as shown in the sketch map (fig. 7), is almost perfectly lunate, and at its horns both to the east and the north it passes over into sands. The Selma, as shown by its abundance of Ostracea and other Mollusca, is a shallow-water deposit. So far as my observation goes, it is entirely destitute of driftwood, lignite, or any considerable sandy beds in the area of its greatest thickness, and I wish to make clear that the southwestern drainage, which explains the character of the Tuscaloosa sediments, must have been reduced to a minimum or become practically nonexistent before the deposition of the Selma chalk. The prevailing direction of the drainage during Selma time must have been to the southeast and northwest in order to account for the Ripley sands in those regions and the absence of any except the finest terrigenous materials in the main body of the Selma chalk.

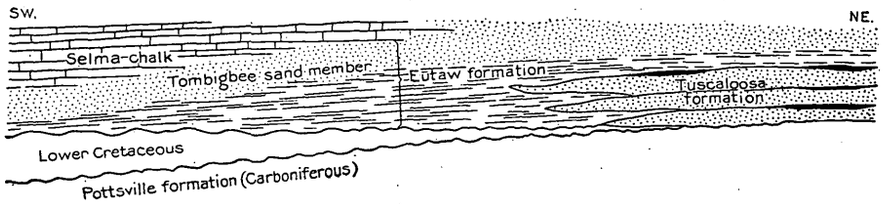


FIGURE 8.—Hypothetical section illustrating the interrelationship of the Upper Cretaceous types of sedimentation from Tuscaloosa to lower Selma.

The relations of the Tuscaloosa formation emphasize its delta character. (See figs. 7, 8.)

The Tuscaloosa sands grade seaward into the glauconitic sands and thinly laminated clays of the Eutaw formation, which contains a sparing representation of the marine life of the time and which must have been in part at least contemporaneous with the Tuscaloosa. A few plants in the near-shore transgressing phase have been collected from the vicinity of Havana, Hale County, Ala. The upper Eutaw, or Tombigbee sand member, I regard as a transgressing deposit, and in conformity with this interpretation it contains a much better marine fauna than the earlier Eutaw deposits. Overlying the Eutaw formation is the Selma chalk—an argillaceous limestone or calcareous clay, which reaches its maximum thickness in the same region as the Tuscaloosa sands—

Inferentially, if the Cretaceous Tennessee River was a factor in the building of the Tuscaloosa Delta, local warping must have broken its continuity with the Black Warrior drainage and started it toward the northwest before the deposition of the Selma chalk. It is possible that this may have been accomplished without local warping by the simple clogging of its distributaries as a result of their own loads combined with decreased run-off. This set of factors, combined with the westward tilting that resulted in the Ripley Cretaceous and Midway Eocene seas penetrating up the Mississippi Valley as far as southern Illinois, is sufficient to account for such a change in course. This change in the direction of the drainage may be compared to the shifting of the present Mississippi Delta toward the east by marine currents.

The remnants of heavy gravels of Tuscaloosa age that have been traced by Wade[1] across Tennessee and into Kentucky appear to represent the gradual migration or shifting northward of such a stream. That the western Highland Rim of Tennessee has resulted from a middle or late Tertiary planation of prevailingly siliceous rocks by Tennessee River in its lower northward course is probably true, but the discussion of this feature hardly falls within the scope of this paper.

A feature that makes the Tuscaloosa flora of especial interest is the fact that the plants whose fragmentary remains are preserved in the clays of the Tuscaloosa formation grew on soils derived from Paleozoic sediments, and that all of the heretofore known Cretaceous floras of the Coastal Plain grew on soils of the Piedmont type, which were derived from igneous or highly metamorphosed rocks, the only possible exception being the Raritan flora of New Jersey, which is in deposits resting directly upon the Triassic sandstones and shales. However, even the Raritan materials show no apparent evidence that these rocks contributed to the Raritan sediments, and the theory has been advanced that the only emerged Triassic rocks in Raritan time in the area of their development were diabase and basalt.

Plant geographers have long noticed the differences in the vegetation of areas of calcareous rocks and those of basic igneous rocks, but the laws governing these differences seem to be as yet unformulated. I can see nothing in the facies of the Tuscaloosa flora that can be attributed to the character of the soil. The flora is essentially the same familiar early Upper Cretaceous flora that is found in the late Raritan and in the Magothy formation from Marthas Vineyard to Potomac River, and that reappears in the earlier beds of the Black Creek formation in the Carolinas and in the Woodbine sand of Texas. Its essential elements are present in West Greenland and in Europe at Niederschoena, Saxony, in Bohemia, or wherever floras of this age have been preserved.

In general, the flora is of a lowland coastal type. The only plant, judging from its occurrence and condition of preservation, that may have come from a region removed from the coast is *Androvettia carolinensis*. I doubt very much if there remained at that time any considerable area of greatly elevated land in the southern Appalachian province. A number of the Tuscaloosa plants, judging by their modern relatives, were distinctly strand types. To this class probably belonged the myricas, the figs, and several of the Lauraceae, Leguminosae, and Celastraceae. The Sapindaceae and Rhamnaceae are also in general strand types. This seems to have been especially true of the genus *Eorhamnidium*, which clearly shows, not only in the Tuscaloosa flora but in the succeeding Tertiary, that its habits of growth are comparable with those of the monotypic existing genus *Krugeodendron* of the American tropical strand flora. The members of the Myrtales also were probably dwellers in the dry or wet strand, as are so many modern species of *Eugenia* and *Myrcia*. The supposed Ericaceae were probably strand types, and the Sapotaceae almost certainly were, as well as the genus *Conocarpites*.

With regard to the elements that made up the Tuscaloosa climate the data are not exact. It would seem from the coarseness of the sediments that the run-off was great. Many of the plants demand a heavy rainfall. This is also indicated by the development of the so-called dripping points in many unrelated Moraceae, Lauraceae, Leguminosae, Sapindaceae, and Ericaceae?. Several of these forms range northward to Greenland, and they become much more elongated and acuminate toward the southern limit of their range. Finally the mingling of types whose descendants characterize tropical and temperate climes is only paralleled by a similar mingling in those modern areas known as warm-temperate rain forests. Such areas as southern Japan or northern New Zealand offer many points of comparison with the Upper Cretaceous floras of the Coastal Plain, as I have insisted in several previous publications. With regard to actual temperatures during Tuscaloosa time, specific data can not be expected. The climate, to judge by modern standards, appears to have been cooler than that of the Lower Cretaceous. However, it should be remembered that the numerous cycadophytes and tree ferns of the Lower Cretaceous were the dominant types of the older Mesozoic, with a cosmopolitan range which, from numerous analogies, would be expected to have become adapted to a wide

[1] Wade, B., Johns Hopkins Univ. Circ., March, 1917, pp. 102-106.

range of physical conditions. The flora of the Tuscaloosa is certainly less clearly indicative of tropical conditions than are some of our southern Tertiary floras. Among the Tuscaloosa plants whose modern representatives are strictly subtropical types I might mention the genera *Gleichenia, Piperites, Cocculus, Oreodaphne, Capparites, Inga, Bauhinia, Citrophyllum, Crotonophyllum, Sapindus, Grewiopsis, Zizyphus, Eorhamnidium, Pterospermites, Eugenia, Conocarpites, Myrsine, Sapotacites,* and *Cordia.*

One feature that stands out very clearly is the manner in which this Upper Cretaceous flora preserves its integrity when traced northward. A comparison between the flora of Alabama and New Jersey shows but slight differences, and none which can be directly correlated with climatic conditions. Even when comparisons are made with such remote northern regions as Disko Island, in latitude 70° N., similar results are obtained, the difference of 38° of latitude being apparently of slight importance, the extreme northern area being much richer in ferns and cycadophytes than the extreme southern area and including such strictly tropical forms of the modern flora as *Artocarpus,* which is represented by both characteristic leaves and fruit in Greenland.

These considerations lead to the conclusion that Upper Cretaceous climate during Tuscaloosa time was much more uniform both secularly and seasonally over wide areas and was very different in this respect from modern climates. A consideration of all ancient climates based on floras and marine faunas of all ages unmistakably points to the conclusion that existing climates are exceptional, and that during the long history of the globe the rule has been one of comparatively uniform climatic conditions from the Equator to the Poles, with a lack of marked differentiation into seasons. At times of maximum land emergence climatic conditions have become diversified and more or less extensive glaciations have resulted, but these periods form a very small fraction of the total geologic time.

In conclusion it may be postulated that the Tuscaloosa flora occupied a low coastal land of rather uniform topography—a land favored with an abundant and well-distributed rainfall, with equable temperatures within the limits embraced between warm temperate and subtropical, and with slight seasonal changes.

EUTAW FORMATION.

HISTORICAL SKETCH.

The name Eutaw was proposed by Dr. E. W. Hilgard [1] in 1860 for deposits in northeastern Mississippi described as "bluish-black or reddish laminated clays, often lignitic, alternating with and usually overlaid by noneffervescent sand, mostly (though not always) poor in mica, and of a gray or yellow tint." The name was chosen because these beds were first studied and recognized as of Cretaceous age by Tuomey [2] near Eutaw, Ala., where they are typically developed.

Smith and Johnson,[3] in their study of the Alabama Coastal Plain, adopted the term Eutaw and extended its upper limits to include the Tombigbee sand of Hilgard, differentiating the Tuscaloosa below, the Mississippi representative of the Tuscaloosa being included in the Eutaw as the term was used by Hilgard. It is not worth while in a study of the floras to go into the details of the history of the study of these deposits but merely to state that the recent areal and faunal studies of L. W. Stephenson have shown that the Eutaw is represented in western Tennessee by the Coffee sands of Safford, as Glenn [4] announced in 1906. The history of the study of the flora of the Eutaw formation can be summed up in a single brief paragraph, for though different students mention lignite in the formation the only reference to leaf impressions is a line in Langdon's general section of Chattahoochee River, where, in referring to the outcrop at Chimney Bluff, he mentions, "Yellow sands and gray clay, containing bits of leaves." [5] The plant locality near Havana, in Hale County, Ala., was discovered by Prouty and Stephenson in 1908 and a small collection was made. This represents the only collection of the Eutaw flora prior to the present study, which is based on collections made by me in company with Stephenson in 1909, supplemented by later collections made by Bruce Wade.

[1] Hilgard, E. W., Report on the geology and agriculture of Mississippi, pp. 61–68, 1860.

[2] Tuomey, Michael, Alabama Geol. Survey First Bienn. Rept., pp. 118–120, 1850.

[3] Smith, E. A., and Johnson, L. C., Tertiary and Cretaceous strata of the Tuscaloosa, Tombigbee, and Alabama rivers: U. S. Geol. Survey Bull. 43, pp. 71–136, 1887.

[4] Glenn, L. C., Underground waters of Tennessee and Kentucky west of Tennessee River and of an adjacent area in Illinois: U. S. Geol. Survey Water-Supply Paper 164, p. 23, 1906.

[5] Smith, E. A., Langdon, D. W., jr., and Johnson, L. C., On the geology of the Coastal Plain of Alabama, p. 440, Alabama Geol. Survey, 1894.

A preliminary account [1] of the flora of the Eutaw in the Georgia area was published in 1910 and a complete account [2] has been published by the United States Geological Survey. Lists of plant species quoted from the preliminary account and from the manuscript of the completed report were given by Stephenson [3] in 1911.

AREAL DISTRIBUTION.

The Eutaw formation, consisting of sands, clays, and marls, outcrops in a belt of varying width extending from Taylor County, in western Georgia, to the southern part of Benton County, in western Tennessee, a distance between 400 and 450 miles. Scattered remnants containing *Halymenites* and found as far north as Trigg County, Ky., are believed to represent a former more northerly extent of this formation. Along Chattahoochee River this belt is about 10 miles wide, across Alabama it ranges from 5 to 15 miles, across northeastern Mississippi it is from 5 to 12 miles, and in western Tennessee it is from 2 to 8 miles, averaging somewhat less than 4 miles.

LITHOLOGIC CHARACTER.

The Eutaw is predominantly composed of sand, but the materials vary through wide limits. Along Chattahoochee River the base is an arkosic, micaceous sand with pebbles and small intercalated lenses of laminated carbonaceous and lignitic clay. The clays in places carry fossil plants and were apparently deposited in shallow marine waters. Overlying the basal bed, which is not very thick, is about 50 feet of typically marine, fine, more or less micaceous and calcareous fossiliferous sands and clays. Above this is several hundred feet of variable, mostly shallow-water materials. These are predominantly cross-bedded to massive micaceous sands and dark laminated lignitic clays. Overlying this material is about 120 feet of massive marine irregularly bedded sands and clays, constituting the Tombigbee sand member (included by Langdon in the Ripley and forming a part of the Blufftown marl of Veatch). All the fossil plants come from the beds below the Tombigbee sand member. In passing eastward from Chattahoochee River even the Tombigbee member of the Eutaw becomes littoral in character, the materials being progressively coarser and more irregularly bedded.

In western Alabama the Eutaw materials are exceedingly variable and are predominantly sands. The sands are light colored and much cross-bedded and are interbedded with thinly laminated dark clays, strongly suggestive of the similar laminated clays of the Black Creek formation of the Carolinas. None of the lower beds of the Eutaw are persistent for any distance, but the upper calcareous Tombigbee sand preserves its identity fairly well across the State. A similar variable lithology characterizes the Eutaw across northeastern Mississippi and in western Tennessee.

The strike of the Eutaw is northeast in Georgia; it becomes more nearly east across Alabama, turns to the northwest in the western part of the State, and gradually becomes north through most of its extent in Mississippi and in Tennessee. It dips between 20 and 30 feet to the mile. In its area of maximum development from Chattahoochee River westward across Alabama it is between 500 and 600 feet thick. The materials become coarser, and eastward in Georgia, where the deposits become thinner, they show increasing evidence of shallow-water deposition. In the northwestern part of its outcrop in Mississippi and Tennessee the Eutaw also becomes thinner, being there between 300 and 400 feet thick.

STRATIGRAPHIC RELATIONS.

In Georgia and eastern Alabama the Eutaw rests with a marked unconformity on the Lower Cretaceous. From Alabama River to the Mississippi-Tennessee boundary it rests without apparent unconformity on the Tuscaloosa. From the Tennessee boundary until it disappears, it overlies the Paleozoic rocks which constitute the floor of the embayment.

Except for the Pleistocene deposits, the Eutaw is overlain throughout its extent in eastern Alabama and in Georgia, without apparent unconformity, by the marine sands of the Ripley formation. From Macon County, Ala., westward and northward throughout its outcrop, it is overlain almost continuously by the Selma chalk. As I have explained elsewhere (p. 37), the Selma chalk is a lithologic and not a

[1] Berry, E. W., Contributions to the Mesozoic flora of the Atlantic Coastal Plain; VI, Georgia: Torrey Bot. Club Bull., vol. 37, pp. 503–511, 1910.

[2] Berry, E. W., The Upper Cretaceous and Eocene floras of South Carolina and Georgia: U. S. Geol. Survey Prof. Paper 84, 200 pp., 1914.

[3] Veatch, Otto, and Stephenson, L. W., Preliminary report on the geology of the Coastal Plain of Georgia: Georgia Geol. Survey Bull. 26, 466 pp., 1911.

chronologic unit and represents, in the region of its maximum development, a part of the upper Eutaw and all of the Ripley.

LOCAL SECTIONS CONTAINING PLANT REMAINS.

Numerous local sections of the Eutaw formation have been published in recent years, to which the reader in search of details is referred, as only those few sections containing fossil plants will be discussed in this report.

McBRIDES FORD, GA.

About 11 miles southeast of Columbus, in Chattahoochee County, Ga., an interesting fossiliferous section discovered by Stephenson and visited by Stephenson and me, is exposed just above McBrides Ford on Upatoi Creek.

Section just above McBrides Ford, Ga.

	Feet.
Pleistocene:	
Sand with gravel at base, about	10
Unconformity.	
Eutaw formation (Upper Cretaceous):	
More or less pebbly, coarse cross-bedded sands with small lenses of lignitic carbonaceous clay, one of which contains the plants listed from this locality	10–15
Unconformity.	
Lower Cretaceous:	
Light-colored coarse arkosic sands	0–5

The leaf-bearing lens of almost black carbonaceous clay was only about 15 inches in maximum thickness and only a few feet in lateral extent. This lens and the other little clay lenses represent small shallow basins in the sandy bottom of the Eutaw sea that accumulated vegetable material drifted from the nearby shores. The following 19 species have been recognized from this clay lens:

Andromeda cretacea Lesquereux?
wardiana Lesquereux.
Androvettia elegans Berry.
Aralia eutawensis Berry.
Brachyphyllum macrocarpum formosum Berry.
Cinnamomum heerii Lesquereux?
newberryi Berry.
Eucalyptus angusta Velenovsky.
Ficus ovatifolia Berry.
Inga cretacea Lesquereux.
Magnolia boulayana Lesquereux.
capellinii Heer.
Manihotites georgiana Berry.
Menispermites variabilis Berry.
Paliurus upatoiensis Berry.
Salix flexuosa Newberry.
Sequoia reichenbachi (Geinitz) Heer.
Tumion carolinianum Berry?
Zizyphus laurifolius Berry.

BROKEN ARROW BEND, GA.

At Broken Arrow Bend, on Chattahoochee River about 10½ miles below Columbus, good sections are exposed along both banks of the river. That containing plant remains is on the left bank in Chattahoochee County, Ga., about 100 yards below the section on the Alabama side. The following materials are exposed:

Section at Broken Arrow Bend, Ga.

	Feet.
Eutaw formation (basal beds):	
Gray calcareous micaceous sand with nodules of impure limestone, carrying a marine invertebrate fauna	15
Coarse cross-bedded sand, in part evidently reworked Lower Cretaceous materials with gravel and much lignite and thin lenses of compact dark-drab clay near the base carrying plant remains	2–15
Unconformity.	
Lower Cretaceous:	
Coarse gray arkosic cross-bedded sands with subordinate argillaceous materials	0–5

The fossil plants collected at this locality are few in number and much macerated and were evidently in the water some time before fossilization. The following species have been recognized:

Malapoenna horrellensis Berry.
Phragmites pratti Berry.
Salix eutawensis Berry.
Salix flexuosa Newberry.
Sequoia reichenbachi (Geinitz) Heer.

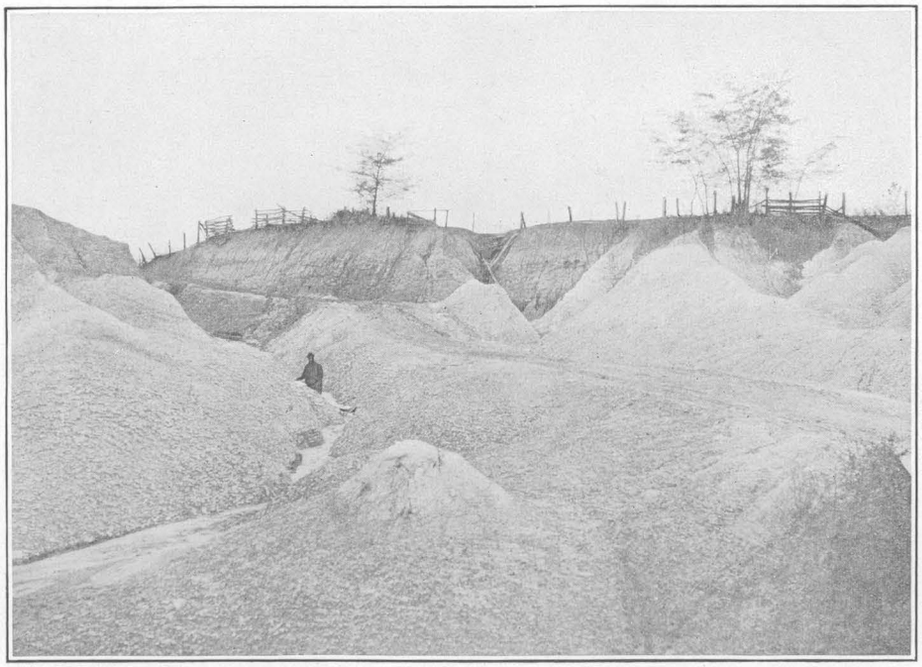
This is exactly the same horizon from which fossil plants were collected at McBrides Ford.

CHIMNEY BLUFF, GA.

At Chimney Bluff, on the left bank of Chattahoochee River, in Chattahoochee County, Ga., 22 miles below Columbus, the following section is exposed:

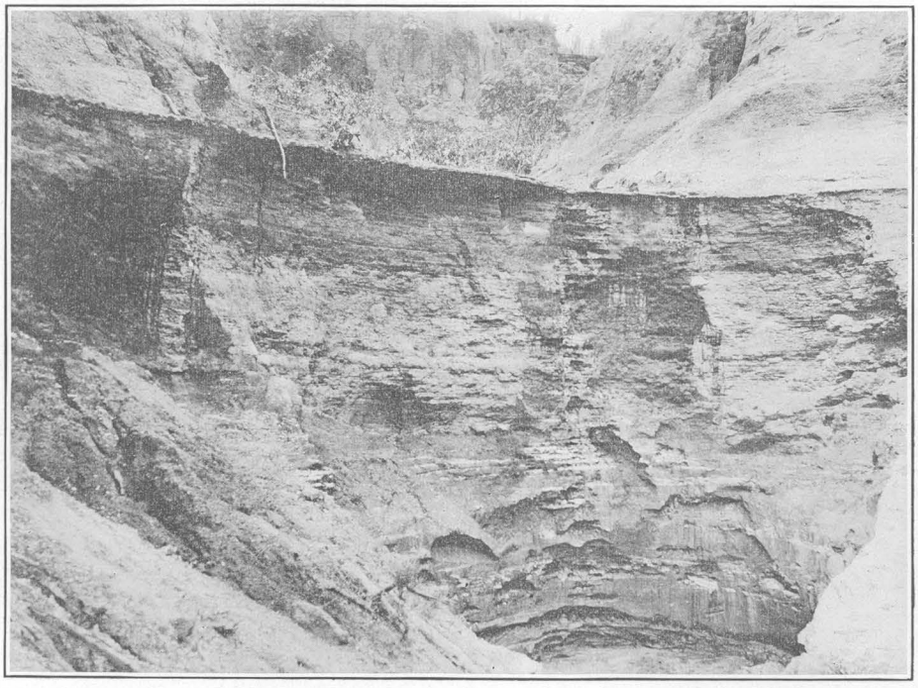
Section at Chimney Bluff, Ga.

	Feet.
Eutaw formation:	
Greenish (weathering yellowish) fine sandy clay with casts of marine invertebrates (Tombigbee sand member), about	50
Fine white loose, somewhat cross-bedded micaceous sand (lens), exposed	8–15
Irregularly bedded, laminated, cross-bedded, very lignitic pyritiferous sands and clay with pellets of amber and many large teredo-bored logs of lignite, the largest 2 or 3 feet in diameter, with small lenses of dark plastic clay carrying rather friable plant remains, about	25



A. VIEW SHOWING THE ARGILLACEOUS LEAF-BEARING SANDS OF THE RIPLEY FORMATION, 13 MILES NORTHWEST OF CAMDEN, TENN.

Photograph by L. W. Stephenson.



B. VIEW SHOWING THE CHARACTER OF THE BEDDING OF THE BASAL SANDS AND CLAYS OF THE EUTAW FORMATION, 2 MILES SOUTHEAST OF HAVANA, ALA.

Photograph by L. W. Stephenson.

The lower part of this section, which is in the lower part of the Eutaw, represents an accumulation of drifting vegetable matter and fine sediment behind some temporary bar or in some shallow water or eddy near the shore, possibly in the estuary of some Eutaw river. The plants show evidence of considerable immersion and transportation, only coriaceous forms which withstood maceration being in a recognizable condition.

The following species have been recognized:

Araucaria bladenensis Berry (leaf-bearing twigs).
jeffreyi Berry (cone scales).
Ficus crassipes (Heer) Heer.
krausiana Heer.
Salix flexuosa Newberry.
lesquereuxii Berry.
Sequoia reichenbachi (Geinitz) Heer (twigs).

The most abundant form is *Araucaria bladenensis*, represented by some large foliage-bearing twigs and numerous detached leaves.

HAVANA, ALA.

Between 1½ and 2 miles southeast of Havana, in the north-central part of Hale County, Ala., extensive gullies have been eroded in the basal sands of the Eutaw formation. The lithology varies from gully to gully, and in only one have fossil plants been found. (See Pl. IV, *B*.) The section shown diagrammatically in figure 9 is exposed in this gully.

In common with the preceding Eutaw sections the fossil plants come from the basal beds of the formation. These basal sands and thinly laminated clays are more or less cross-bedded and carry considerable glauconite, which is perhaps the source of the numerous iron crusts. They are also micaceous and lignitic, carrying pellets of amber and much comminuted vegetable matter. The fossil plants are for the most part much macerated, some of the sand films between clay laminae being crowded with the detached leaves of *Sequoia reichenbachi*. The following 14 species have been identified from this outcrop:

Andromeda parlatorii Heer.
Araucaria bladenensis Berry.
Bauhinia alabamensis Berry.
cretacea Newberry.
Brachyphyllum macrocarpum formosum Berry.
Cephalotaxospermum carolinianum Berry.
Diospyros primaeva Heer.
Doryanthites cretacea Berry.
Ficus krausiana Heer.
Laurus plutonia Heer.
Malapoenna horellensis Berry.
Myrcia havanensis Berry.
Sequoia ambigua Heer.
reichenbachi (Geinitz) Heer.

The commonest form is *Araucaria bladenensis*. Next in abundance are *Doryanthites*, the two species of *Sequoia*, and the two coriaceous, lanceolate species of *Ficus*.

COFFEE BLUFF, TENN.

Coffee Bluff, which was described originally by Safford[1] in 1884, is on the west bank of Tennessee River in Hardin County, Tenn., and is the type locality of the Coffee sand, the uppermost member of the Eutaw formation. The river washes the bluff for nearly 2 miles, exposing the highly variable littoral materials that characterize the formation in this area. The following section is quoted from Glenn:[2]

Section at Coffee Bluff, Tenn.

	Feet.
1. Half a mile inland from the edge of the bluff, red and yellow chert gravels with overlying reddish sandy clay	15
2. Along descending slope of road to edge of bluff are poorly exposed light-colored sands and lead-colored clays interbedded in thin layers, which are usually minutely laminated	120
3. Top of bluff, light-colored sands similar in color, texture, and structure to those of the following member	12
4. Dark slate-colored clay in thin laminae, generally pure but in places has thin sandy layers; contains fragments of plants and locally shows an unconformity with the underlying beds	25
5. Fine gray sand interbedded with slaty or lead-colored clay in fissile papery laminae. The sand and clay are commonly interlaminated and more or less cross-bedded; in places a relatively pure bed of sand or clay several feet thick grades over along the bedding plane into the other within a few yards. On the surface of the thin fissile shales are leaf impressions. The sand and clay alike carry more or less lignitized wood, which is in small pieces except in the lower part of the bed, where logs of it are found. Decomposing pyrite is associated with the lignite. Two logs of petrified wood projected from this sand at the time Safford measured this section. In places a tendency to induration is noticeable in the sands, though generally they are rather soft. The cross-bedding is invariably on a small scale and frequent reversals of direction occur in many places.	40
6. Sand varying in color from light gray to canary yellow, micaceous	3
7. Sand, gray and lignitic, with much decomposing pyrite, to the water's edge	15

[1] Safford, J. M., Am. Jour. Sci., 2d ser., vol. 37, pp. 360-372, 1864; Geology of Tennessee, p. 412, 1869.

[2] Glenn, L. C., U. S. Geol. Survey Water-Supply Paper 164, pp. 24-25, 1906.

Petrified wood collected by Wade from the beds included in No. 5 of the section represents a silicified species of *Cupressinoxylon* which is too poorly preserved for specific description. Pellets of amber are scattered in the lignitic clays, and one of these, discovered by Wade, contained the remains of an insect, which is, I believe, the first amber insect to be described from North America.[1] Fossil plants are not uncommon throughout the argillaceous portions of the section, but they are usually much broken and poorly preserved in the prevailingly sandy clays. During his mapping of Hardin County for the Tennessee Geological Survey, Wade made large collections of these plant fossils, which were referred to me, and the results of their study are incorporated in this report. A considerable portion of the collected material was too poorly preserved to be determinable, but a number of specimens, though most of them are fragmentary, have been satisfactorily identified. These are:

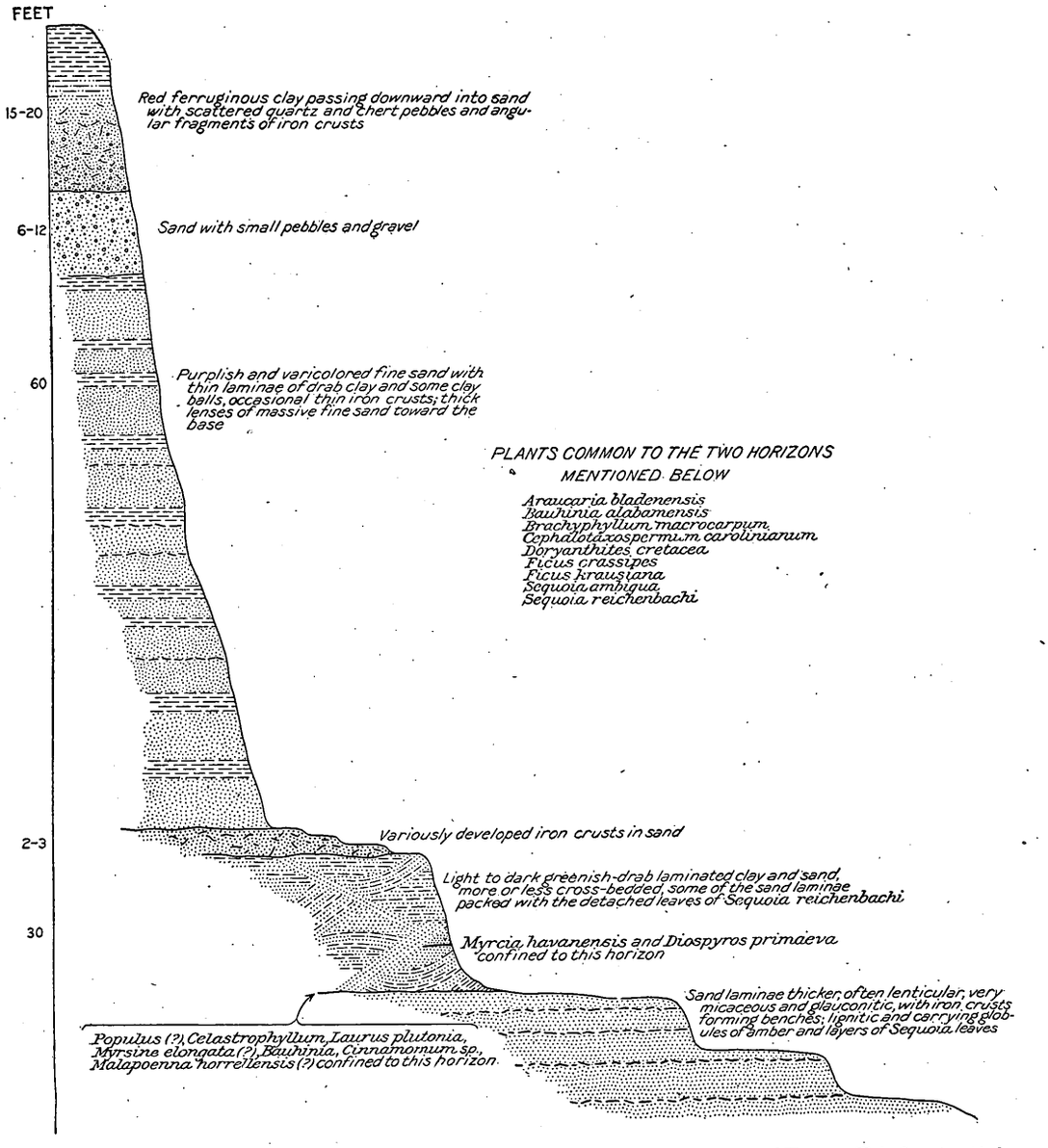


FIGURE 9.—Section of the Eutaw formation exposed in one of the deep gullies 2 miles southeast of Havana, Hale County, Ala.

Andromeda wardiana Lesquereux.
novaecaesareae Hollick.
Cinnamomum heeri Lesquereux.
Cupressinoxylon sp.

[1] Cockerell, T. D. A., U. S. Nat. Mus. Proc., vol. 51, pp. 98-99, fig. 6, 1916.

Dewalquea smithi Berry.
Diospyros primaeva Heer.
Ficus crassipes Heer.
krausiana Heer.
ovatifolia Berry.
Halymenites major Lesquereux.
Laurophyllum elegans Hollick.
Manihotites georgiana Berry.
Phragmites prattii Berry.
Phyllites asplenioides Berry.
Pterospermites carolinensis Berry.
Salix eutawensis Berry.

COMPOSITION AND ECOLOGIC CONDITIONS INDICATED BY THE EUTAW FLORA.

The Eutaw flora is far from representative of the flora that flourished during the deposition of the sediments of the Eutaw formation, as the majority of the plants that have been found came from the basal beds of the formation, in which the flora had not undergone any marked changes from that which lived in late Tuscaloosa time. It is, furthermore, not representative of the flora of early Eutaw time, because most of the plant remains had undergone much maceration, the consequent trituration having weeded out nearly all but the more coriaceous forms.

The known flora numbers but 43 species. No thallophytes (except the doubtful *Halymenites*) or bryophytes are represented; there is 1 fern, 9 gymnosperms, 2 monocotyledons, and 30 dicotyledons. The gymnosperms, although few in number, are of especial interest in the variety of forms represented. *Cephalotaxospermum* is represented by fruits very similar to those of the existing genus *Cephalotaxus*. *Brachyphyllum* is an older Mesozoic type without any close modern relatives. The *Sequoia* is the well-known and wide-ranging *Sequoia reichenbachi*, which appears to have been much more abundant in the Eutaw than in the Tuscaloosa. The *Tumion* is poorly represented. By far the most abundant type is *Araucaria bladenensis*, a form very abundant in the Black Creek formation and one scarcely distinguishable from the existing broad-leafed *Araucaria bidwilli*. Characteristic modern-appearing cone scales are represented by *Araucaria jeffreyi*. Perhaps the most remarkable type is the fernlike *Androvettia elegans*, a form without any nearly allied existing representatives.

The Monocotyledonae are of slight botanic interest. The *Phragmites* represents some Eutaw sedge or grass and the *Doryanthites* represents a large parallel-veined species of unknown affinity.

The 30 dicotyledons represent 11 orders of which the largest is the Thymeleales, with 5 species. There are 3 species each of Salicales, Urticales, Ranales, and Ericales; 2 each of Rosales, Rhamnales, and Myrtales; and 1 each of Juglandales, Geraniales, Umbellales, and Ebenales. Thus 23 belong to the Choripetalae and 4 to the Gamopetalae, the former being divided into 7 Apetalae and 16 Polypetalae. The order Sapindales, which had 15 species in the Tuscaloosa, the most important genus being *Celastrophyllum*, is entirely unrepresented.

The dicotyledonous families have 30 representatives, of which the largest is the Lauraceae with 5 species. The Salicaceae, Moraceae, and Ericaceae? have 3 species each; the Magnoliaceae, Caesalpiniaceae, Rhamnaceae, and Myrtaceae have 2 species each, and the Juglandaceae, Menispermaceae, Euphorbiaceae, Araliaceae, and Ebenaceae have 1 each. The most remarkable dicotyledon of the Eutaw is *Manihotites georgiana*, which had irregularly lobed subpeltate leaves 48 centimeters in diameter.

The Eutaw flora is far too small to serve for any conclusive deductions regarding ecologic or other physical conditions, and what has been said regarding this feature of the much more extensive Tuscaloosa flora applies equally well to the Eutaw. The basal Eutaw materials are evidently shallow-water sediments, but they do not show evidence of current bedding greater than that shown by the Tuscaloosa. It is in the clays that we see the differences both in lithology and in the contained flora. This clearly indicates one of two conditions. Either the Eutaw coast line lacked the estuaries with their bars, lagoons, or bayous of quiet waters and their mud flats which offer such exceptional opportunities for the preservation of plant foliage, or such deposits if formed have been subsequently destroyed by erosion. The Eutaw coast line was probably less broken than that of the Tuscaloosa, and doubtless some of the phytologic records of the Eutaw have been eroded; certainly vegetable matter was abundant in the Eutaw sea. This abundance is indicated by the lignitic character of many of the lower sands and by

the dark carbonaceous clays. All that I have seen, however, was evidently subject to the action of the water a long time before entombment. The logs are thoroughly bored by some Eutaw representative of the modern Teredo. A calcified log 6 or 7 inches in diameter, found at Broken Arrow Bend, was thickly covered on one side with a fine set of nearly adult individuals of *Ostrea cretacea*, indicating the shallowness of the waters, because the spat of the Ostreidae do not set in deep water.

An effort to picture accurately the environment of this flora is beset with unusual difficulties, as may be imagined from what has already been said. It is safe to assume that the climate was mild and humid, the latter being probably the most important factor aside from the absence of frost. That the temperature was not tropical in character we may assume from the manner in which this flora preserves its integrity if traced northward over at least 10° of latitude. Judged by the facts of the present-day geographic distribution of plants, this flora presents an antipodean facies with its abundant Araucarieae, but this is only another way of emphasizing its Mesozoic character, as the abundant evidence at our command shows that these types were practically cosmopolitan in the Mesozoic. Another feature which seems strange to modern plant geographers is the curious mingling of forms, which in the existing flora are to a greater or less extent climatically segregated. Willows and walnuts growing with figs, laurels, and araucarias would indeed be anomalous in the present flora, but this and similar associations are familiar enough in fossil floras not only during the Mesozoic but well into the Cenozoic.

Even though no close comparisons with modern ecologic groups are possible, it would seem that the Eutaw flora, like that of the Tuscaloosa, if it were living at the present time, would be included by ecologic botanists under that somewhat elastic head which Schimper calls "temperate rain forests." In no other modern plant associations do we find that commingling of temperate and tropical types that we find in certain present-day temperate rain forests, as for example those of southern Chile, southern Japan, northern Australia, and New Zealand. In the last-mentioned country we find aralias, laurels, *Cinnamomum*, *Magnolia*, and *Sterculia* associated with *Quercus*, *Fagus*, *Gleichenia*, *Dryopteris*, *Dicksonia*, and other forms. In some respects this type in New Zealand is the most tropical in its facies and more like our eastern American Upper Cretaceous floras than any other existing flora. In New Zealand conifers are abundant and include forms with reduced leaves like *Libocedrus* and *Dacrydium*, as well as forms with broad leaves like *Dammara*, *Podocarpus*, and *Phyllocladus*. Dicotyledonae are numerous and varied, including between 100 and 150 species, among which forms of Myrtaceae, Lauraceae, Proteaceae, etc., with coriaceous leaves are prominent. The undergrowth is rich in tree ferns and various genera of Araliaceae.

When this modern flora is compared element for element with the eastern Gulf Cretaceous floras naturally many differences become apparent, but the resemblance between the two is remarkable. In the eastern Gulf Cretaceous floras *Sequoia*, *Brachyphyllum*, and *Widdringtonites* represent the narrow or scale-leaved conifers, *Dammara* and *Araucaria* the broad-leaved araucarias, and *Androvettia* and *Protophyllocladus* the modern *Phyllocladus*. The dicotyledons are numerous and varied, with a mixing of temperate and tropical types and with numerous coriaceous forms belonging to a number of the same families as do the New Zealand plants. Aralias are common in both the eastern Gulf Cretaceous and the modern floras. That the Cretaceous rainfall was plentiful may be inferred not only from the species of plants preserved but also from the formation of dripping points on various leaves, this feature being especially emphasized in the Tuscaloosa flora.

SELMA CHALK.

It is not within the province of this report to discuss the strictly marine and non plant-bearing deposits known as the Selma chalk. A brief statement is demanded, however, in order not to leave a hiatus in the discussion.

The Selma chalk is one of the most persistent lithologic units in the entire Coastal Plain and consists for the most part of massively bedded, usually lithified calcareous clay or argillaceous limestone.

The Selma chalk, long known as the "Rotten limestone," outcrops from east-central Ala-

bama to the southern part of Benton County, in west Tennessee, forming the so-called Black Prairie country. In the area of its maximum development along Tombigbee River in west-central Alabama it outcrops as a broad belt and attains a thickness of at least 1,000 feet, extending to the extreme top of the Upper Cretaceous. It is a moderately shallow water deposit, as is shown by the abundance of fossil Ostreidae, and seems to owe its peculiar character to the absence of terrigenous materials. As I have previously stated, it is a lithologic and not a chronologic unit, the careful faunal studies of Stephenson having shown that it is partly the equivalent of the Eutaw and largely the equivalent of the Ripley. The various faunal lines have been traced successfully from the sands and clays of the Chattahoochee basin through the chalk to the sands and clays of northeastern Mississippi. The bearing of the Selma chalk on the Upper Cretaceous physiography has been mentioned in discussing the delta character of the Tuscaloosa deposits.

RIPLEY FORMATION.

HISTORICAL SKETCH.

The Ripley formation was named in 1860 by E. W. Hilgard[1] after the town of Ripley, in Tippah County, Miss., which is 3 miles southwest of the classic fossiliferous Ripley deposits exposed along Owl Creek.

The limits of the Ripley have been indefinite for more than half a century, any fossiliferous Upper Cretaceous sand being usually considered Ripley until the studies of Stephenson previously mentioned. The history of the study of these deposits need not concern us further, the literature containing absolutely no reference to fossil plants except a brief preliminary report on the Cretaceous flora of Georgia which I published in 1910.[2]

AREAL DISTRIBUTION.

The beds to which the name Ripley formation has been applied outcrop from Twiggs County, in central Georgia, to central Alabama where they are interrupted by the synchronous deposits of the upper part of the Selma chalk. The Selma chalk forms the top of the Upper Cretaceous for most of the distance between central Alabama and Houston County, Miss. From that point to the head of the Mississippi embayment the Ripley deposits are continuous. In Georgia the outcrop is from 10 to 15 miles wide, westward in Alabama to where it passes into the chalk phase it is from 25 to 30 miles, and beyond the chalk in northeastern Mississippi it lessens to about 12 miles at the Mississippi-Tennessee boundary. It has narrowed to about 6 miles at the Tennessee-Kentucky boundary, which width it maintains across Kentucky and southern Illinois.

LITHOLOGIC CHARACTER.

The Ripley materials are predominantly marine sands massively bedded, dark gray to greenish black in color, more or less calcareous, micaceous, pyritiferous, glauconitic, and argillaceous, according to the conditions of sedimentation in different parts of the Ripley sea. They are usually fossiliferous, sometimes enough so to constitute shell marls. Ledges of sandy limestone are developed locally. Some distance east of the Selma chalk, as in the Chattahoochee basin, the Ripley has been estimated to be about 1,000 feet thick, getting thinner eastward in Georgia, where it becomes more definitely a deposit of littoral sands. It also is thinner in the upper embayment, having a reported thickness of 400 feet at Wickliffe, Ky.; 54 feet at Cairo, Ill.; and 204 feet at Paducah, Ky.

STRATIGRAPHIC RELATIONS.

The Ripley formation rests without apparent unconformity on the somewhat similar sands of the upper part of the Eutaw in the Chattahoochee basin. Eastward in Georgia it lies unconformably on the Lower Cretaceous. Westward across most of Alabama and Mississippi it is developed above the chalk phase (Selma chalk) which underlies it as far as the southern part of Benton County, in west Tennessee. From this point to the head of the embayment it rests on the embayment floor of Paleozoic rocks. It is overlain throughout its extent by the unconformable deposits of the Eocene.

PLANT LOCALITIES.

Small collections of fossil plants have been made at seven or eight localities in the Ripley,

[1] Hilgard, E. W., Report on the geology and agriculture of Mississippi, pp. 62, 83-95, 1860.

[2] Berry, E. W., Contributions to the Mesozoic flora of the Atlantic Coastal Plain; VI, Georgia: Torrey Bot. Club Bull., vol. 37, pp. 503-511, 1910.

and I have seen undeterminable fragments at numerous other outcrops. At the Big Cut on the Southern Railway 1½ miles west of Cypress, Tenn., a lens of carbonaceous clay at the base of the western end of the exposure is full of leaf fragments, and they are also present in the iron crust capping the clay. I failed to obtain anything identifiable at this outcrop, but there is a specimen of *Myrcia havanensis* Berry in the National Museum collections, and Wade collected 2 additional species from this locality. I have seen fragments of what may have been this species at the base of Chalk Bluff on Ohio River 2½ miles above Caledonia Landing, Pulaski County, Ill. Extended search at this outcrop failed to yield any positively determinable material. Glenn made a small collection east of Benton, in Marshall County, Ky.[1] I have examined this collection and visited the outcrop without being able to determine any of the plant fragments.

In the northwestern part of Benton County, Tenn., L. W. Stephenson collected a few fossil plants from exposures along the Camden-Paris public road. (See Pl. IV, *A*.) I have been able to recognize *Myrcia havanensis* Berry, *Myrica ripleyensis* Berry, and *Sabalites* sp.

Just above the mouth of Cowikee Creek, in Barbour County, Ala., there is an exposure of 30 to 40 feet of massive, compact glauconitic, argillaceous, micaceous sand carrying plant fragments associated with invertebrates of the genera *Nucula*, *Ostrea*, *Cymella*, *Liopistha*, and *Leptosolen*.[2] The plants are fragmentary and bear evidence of having been in the water a long time before fossilization. The following forms have been recognized:

Bauhinia ripleyensis Berry.
Fern, undeterminable.
Laurus? sp.
Platanus sp.
Salix? sp.
Sapindus? sp.

I have been unable to identify any of these with previously known forms and they are so inconclusive that only the *Bauhinia* and the *Platanus* are included in the systematic descriptions that follow.

There are two localities in Georgia from which Ripley plants have been collected, one 6 miles east of Buena Vista on the Buena Vista-Tazewell Road, in Marion County, where the following section is exposed:[3]

Section on the Buena Vista-Tazewell Road, Marion County, Ga.

Ripley formation:	Feet.
Marine member (brownish weathered sands).....	70
Cusseta sand member (coarse light-colored cross-bedded arkosic sand locally with iron concretions and both light and dark clay lenses; from a lens of black clay near the base fossil plants were collected).....	50

The following 6 species, collected by Stephenson, have been determined from this outcrop:

Andromeda novaecaesareae Hollick.
Araucaria bladenensis Berry.
Doryanthites cretacea Berry.
Eucalyptus angusta Velenovsky.
Ficus georgiana Berry.
Manihotites georgiana Berry.

The most abundant form is the curious monocotyledon *Doryanthites cretacea*.

The second Ripley plant locality in Georgia is in a cut along the Central of Georgia Railway 1½ miles northeast of Byron, in Houston County. The materials as described by Stephenson[4] are light cross-bedded sands of the Cusseta sand member underlain by drab clays with sand lenses, and a layer of dark carbonaceous clay 6 feet thick in the lower part of the section yielded the following plants: *Araucaria jeffreyi* Berry, *Cunninghamites elegans* (Corda) Endlicher, and *Dryopterites stephensoni* Berry.

The most extensive known collection of plants from the Ripley formation is that which was made by Bruce Wade from a small clay lens near the base of the McNairy sand member of the Ripley formation 2½ miles southwest of Selmer, in McNairy County, Tenn. Because of the exceptionally extensive fauna preserved in the Upper Cretaceous deposits of this region I have introduced a diagrammatic section (fig. 10) showing the lithology and the relative geologic and geographic relations of the plant localities at Selmer and Big Cut to those which have furnished the marine faunas of Coon Creek, Sand Hill, and Trims Mill.

The following species of plants have been identified from the McNairy sand member of the Ripley formation from the locality near Selmer:

Bauhinia ripleyensis Berry.
Cinnamomum sp.

[1] Glenn, L. C., Underground waters of Tennessee and Kentucky west of Tennessee River and of an adjacent area in Illinois: U. S. Geol. Survey Water-Supply Paper 164, p. 27, 1906.

[2] Stephenson, L. W., Georgia Geol. Survey Bull. 26, pp. 172, 173, 1911.

[3] Idem, p. 163.

[4] Idem, pp. 170–171.

Cissites crispus Velenovsky.
Dryophyllum gracile Debey.
Eugenia? anceps Berry.
Magnolia capellini Heer.
Malapoenna horrellensis Berry.
Manihotites georgiana Berry.
Myrcia havanensis Berry.
Myrica ripleyensis Berry.
Sabalites sp.
Sterculia snowii tennesseensis Berry.

The fossil plants of the Ripley are so few in number and in the main so poorly preserved that any discussion of the general character of the Ripley flora or of the ecologic conditions which it indicates is out of the question.

Grewiopsis formosa.
tuscaloosensis.
Hymenaea fayettensis.
Jungermannites cretaceus.
Leguminosites ingaefolia.
shirleyensis.
tuscaloosensis.
Lycopodites tuscaloosensis.
Malapoenna cottondalensis.
Menispermites integrifolius.
trilobatus.
Myrica dakotensis minima.
Oreodaphne shirleyensis.
Persoonia lesquereuxii minor.
Phyllites shirleyensis.
pistiaeformis.

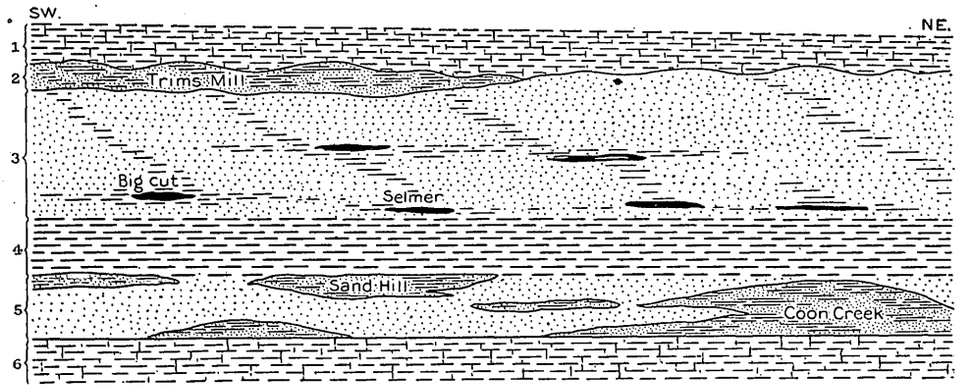


FIGURE 10.—Diagrammatic section of the Ripley formation in McNairy County, Tenn., from northeast to southwest. No. 1 is chalky clay of Midway age. Nos. 2 to 5, inclusive, belong to the Ripley formation. No. 2, consisting of sandy fossiliferous marl, is the northeastern extension of the Owl Creek beds of Lowe; No. 3 is the McNairy sand member; No. 4, ferruginous clay; and No. 5, sand with fossiliferous marl lenses and *Halymenites*-bearing sands, being the fossiliferous horizon of Coon Creek. No. 6 (chalky clay) is the Selma chalk. Localities named indicate positions of faunas and floras.

BEARING OF THE FLORAS ON CORRELATION.

CORRELATION OF THE TUSCALOOSA FLORA.

The following 47 Tuscaloosa species are new and have no known outside distribution:

Aralia cottondalensis.
Calycites sexpartitus.
Capparites cynophylloides.
orbiculatus.
Carpolithes tuscaloosensis.
Cassia vaughani.
Celastrophyllum alabamensis.
crenatum ellipticum.
gymindaefolium.
precrassipes.
shirleyensis.
Cladophlebis alabamensis.
Cocculus polycarpaefolius.
problematicus.
Conocarpites formosus.
Eorhamnidium cretaceum.
Equisetum? sp.
Eugenia tuscaloosensis.
Ficus alabamensis.
fontainii.
shirleyensis.
Piperites tuscaloosensis.
Platanus asperaeformis.
shirleyensis.
Populites tuscaloosensis.
Proteoides conospermaefolia.
Sapindus variabilis.
Sapotacites ettingshauseni
formosus.
shirleyensis.
Sphaerites alabamensis.

These species are obviously of slight value in exact correlation, nevertheless, with the exception of the new genera *Capparites*, *Conocarpites*, *Eorhamnidium*, and *Piperites* and the two genera *Grewiopsis* and *Platanus*, all the genera are characteristic of the flora of the Dakota sandstone of the Rocky Mountain region, the Raritan and Magothy formations of the northern Coastal Plain, and the Cenomanian of Europe. Two of the varieties are varieties of well-known Dakota forms. The variation shown by *Celastrophyllum* finds its parallel in the Dakota and Raritan and nowhere else. This genus has 12 species in the

Tuscaloosa, nearly as many in the Dakota and Raritan, and some in the Magothy of New Jersey, and the Black Creek formation of the Carolinas, but not a single species in the Eutaw formation, in the abundant flora of the Montana group, or in the extensive Senonian floras of Europe. The genus is moreover abundant in the Patapsco formations, at the top of the Lower Cretaceous, and is of the greatest importance in fixing the age of the Tuscaloosa. The new species of *Hymenaea* is related to a Dakota sandstone form, as is the *Aralia*, and *Cladophlebis* is distinctly a survivor from the Lower Cretaceous.

The following 6 Tuscaloosa plants have been recorded from the Lower Cretaceous:

Abietites foliosus.
Asplenium dicksonianum.
Celastrophyllum brittonianum.
Gleichenia delicatula.
Sequoia ambigua.
reichenbachi.

The only one of these that is a characteristic Lower Cretaceous species is *Abietites foliosus*, and it is probably allied to the structural material referred to *Prepinus* from the Raritan formation of the Upper Cretaceous. *Asplenium dicksonianum* occurs in both the Raritan and the Dakota, the *Celastrophyllum* in the Raritan of New Jersey and the Patoot beds of Greenland, *Sequoia ambigua* in the Magothy, and *Sequoia reichenbachi* through the entire Cretaceous. Without further discussion the suggestion that any part of the Tuscaloosa formation is of Lower Cretaceous age is dismissed as an impossibility.

The relation of the Tuscaloosa flora to other Upper Cretaceous floras may next be considered. Sixteen Tuscaloosa species are found in the basal beds of the Eutaw formation in Alabama and Georgia and others are represented by closely allied forms, showing that the Tuscaloosa flora and that of the basal Eutaw are very closely related. The total number of plants known from the Eutaw is 41, of which 50 per cent are survivors from the Tuscaloosa. With the still younger Ripley flora the resemblance is slight. Only 20 identifiable forms have been found in the Ripley and of these only *Andromeda novaecaesareae* and *Dryopterites stephensoni* occur in the Tuscaloosa.

A considerable flora has been recorded from the Black Creek formation in North and South Carolina. Twenty-eight Tuscaloosa forms are found in the typical Black Creek and 9 additional in the Middendorf arkose member of South Carolina, which is a basal lithologic phase of the Black Creek. The Black Creek is several hundred feet thick and carries a considerable marine fauna in its upper beds, which fauna, according to the studies of Stephenson, shows affinities with the Eutaw and basal Ripley faunas. Though a majority of the species common to the Tuscaloosa and the Black Creek (including the Middendorf member) formations are found in the lower beds of the Black Creek either at Court House Bluff, on Cape Fear River, or in the Middendorf member of South Carolina, the Black Creek flora is essentially a unit, the species diagnostic of the Eutaw in Alabama being common to the upper and lower parts of the Black Creek.

The relation of the Tuscaloosa flora to that of the northern Coastal Plain from Marthas Vineyard to Maryland as developed in the floras of the Raritan and Magothy formations is exceedingly close. There are 63 species common to the Tuscaloosa and Raritan and 62 common to the Tuscaloosa and Magothy. Of the 63 species common to the Raritan 14 are from the upper part of the Raritan and several additional are from unknown localities. A marked difference exists between the flora of the upper and lower parts of the Raritan, as I have shown in a recent publication devoted to the Raritan flora.[1] Fifty per cent of the upper Raritan flora does not occur in the more abundant lower Raritan flora, and the upper Raritan flora is closely allied to that of the overlying Magothy. For these reasons I consider that the lower Raritan is older than any part of the Tuscaloosa and that the basal part of the Tuscaloosa is the equivalent of the upper part of the Raritan.

The relation of the Tuscaloosa flora to that of the Magothy is very close, more than 41 per cent of the Tuscaloosa species being found in the Magothy. Obviously the two are nearly synchronous, although their lower limits do not correspond, because the upper part of the Raritan is considered to correspond with the lower part of the Tuscaloosa. Their upper limits are also probably not identical, as the Magothy formation is much thinner than the Tuscaloosa. The uppermost Tuscaloosa may correspond to

[1] Berry, E. W., New Jersey Geol. Survey Bull. 3, 1911.

more or less of the Matawan, because the few fossil plants found in the Matawan, comprising only 2 or 3 species, all are Magothy survivors. However, I am disposed to think that this resemblance is not important, as a considerable element of the Tuscaloosa flora survives in the Eutaw and as the invertebrates of the Eutaw are mainly Magothy and Matawan types, so that probably the Matawan is mainly to be correlated with the Eutaw, and possibly with the lower part of the Ripley as developed in the Chattahoochee region.

On turning to the western Gulf area we find in the scanty flora of the Woodbine sand of southern Texas 19 Tuscaloosa species, clearly indicating the substantial synchroneity of these two formations on opposite sides of the Mississippi embayment. Recently a small flora of 28 species has been collected by H. D. Miser from the Bingen formation in Pike and Howard counties, Ark.[1] Of these species 18 are common to the Tuscaloosa formation. Mr. Miser proposes to separate the Bingen formation into a lower and an upper member, and it is significant that the flora of the lower member is more closely related to that of the Tuscaloosa formation, whereas the flora of the upper member is more like that found in the Eutaw formation of the eastern Gulf area.

The floras of the Western Interior or Rocky Mountain province show the initial deposits of the Upper Cretaceous cycle of sedimentation, the Dakota sandstone, to be rich in fossil vegetation. Forty-eight Tuscaloosa plants are recorded from the Dakota and in addition nearly all the genera are common to the two areas with closely related species in both. To what extent the Dakota flora survived in Colorado time is unknown, so that comparisons between the East and the West lack precision. There are only four Tuscaloosa species recorded from the Montana group, one the widespread *Sequoia reichenbachi*, which because of its wide range is lacking in significance; another is *Sequoia heterophylla*, which ranges from the Cenomanian to the Emscherian in Europe; a third is *Geinitzia formosa*, whose later occurrence in both the Montana and the Senonian of Europe is to be regarded as an instance of survival; and the fourth *Gleichenia delicatula*, a survivor from the Lower Cretaceous that is said to occur in a disputed area in Wyoming, in rocks which may be Colorado instead of Montana in age. Moreover a large number of the genera represented in the flora of the Montana group are unrepresented in the Tuscaloosa, Raritan, or Magothy of the East. In consequence the facies is very different, and I have no hesitation in considering these eastern floras older than the known flora of the Montana group, an opinion which has been consistently held by all paleobotanic students who have examined the question.

To consider briefly the European Upper Cretaceous floras it is remarkable that 18 identical species should be found in the European Cenomanian, 2 in the florally poor Turonian, and 4 in the Senonian, 1 being the ubiquitous *Sequoia reichenbachi*, which is without significance, and none of the other three being angiosperms; two are conifers with an identical range in this country and the third is an *Asplenium* which survived from the Lower Cretaceous. Hence the evidence of the floras is overwhelmingly in favor of the pre-Senonian and pre-Montana age of the Tuscaloosa and allied floras. Thirty Tuscaloosa species are found in the Atane beds of Greenland and ten in the Patoot beds of Greenland, a distribution significantly in accord with the preceding statements.

The details of the range of the different elements of the Tuscaloosa flora both within the formation and elsewhere are shown in the tables of distribution which accompany this chapter.

CORRELATION OF THE EUTAW FLORA.

Four of the five localities are in the lower part of the Eutaw formation, which, in the Chattahoochee section, is estimated to be 400 or 450 feet thick, and the flora, which numbers 41 species, may be discussed as a unit.

The following species are new to science and are known only from these deposits. They are therefore of but slight value for purposes of precise correlation.

Androvettia elegans Berry.
Bauhinia alabamensis Berry.
Cupressinoxylon sp.
Menispermites variabilis Berry.
Paliurus upatoiensis Berry.
Zizyphus laurifolius Berry.

The *Androvettia* is closely related to a similar species found in the upper part of the Tuscaloosa formation in Mississippi and in the Black

[1] Berry, E. W., Torrey Bot. Club Bull., vol. 43, pp. 167–190, pl. 7, 1917.

Creek formation in North Carolina. The other new species are without special significance except that they are referred to genera found in the Dakota and Magothy formations, and only the genus *Bauhinia* is found in the younger Ripley formation of the eastern Gulf area, and none, so far as I know, are represented in the flora of the Montana group of the Rocky Mountain province.

Of the Eutaw species 20 are survivors from the Tuscaloosa and 9 continue into the overlying Ripley; 8 of these make their appearance in the Eutaw and serve to give it a distinct floral facies. These 8 species are *Malapoenna horrellensis, Eucalyptus angusta, Halymenites major, Manihotites georgiana, Araucaria bladenensis, Araucaria jeffreyi, Doryanthites cretacea,* and *Myrcia havanensis.* All of these except the *Myrcia* and *Halymenites* are common to the Black Creek formation, and two of them, *Araucaria bladenensis* and *Doryanthites cretacea,* are found in the Magothy formation.

The Eutaw has 4 species common to the Woodbine sand of Texas, 6 to the Bingen formation of Arkansas, 15 to the Dakota sandstone of the West, 12 to the Raritan formation of the northern Coastal Plain, 15 to the Magothy formation of the northern Coastal Plain, 20 to the Black Creek formation of the Carolinas and 2 additional in its Middendorf member, 9 in the Atane beds of Greenland, 3 in the Patoot beds of Greenland, and 6 in the Cenomanian of Europe. One species, *Sequoia reichenbachi,* is common to the Montana group of the West and to the European Turonian and Senonian, and this is a species, as I have previously pointed out, that is without significance because of its wide geologic range. The parallelism between the Eutaw formation, the Black Creek formation of the Carolinas, and the Magothy formation of the northern Coastal Plain is even closer than the mere percentages would indicate, as it is based upon peculiar forms, such as the two species of *Araucaria,* the *Cephalotaxospermum,* and the *Doryanthites,* and not upon wide-ranging species. I consider that the basal plant-bearing portion of the Eutaw formation is synchronous with a large part of the Black Creek formation and with all of the Magothy formation. Because of the thinness of the Magothy it is probable that at least the basal part of the Matawan formation, which overlies the Magothy in the northern Coastal Plain, is also to be correlated with the Eutaw formation, as I understand the invertebrate faunas also indicate.

Comparisons between the Eutaw flora and that of the Upper Cretaceous of Texas, Kansas, and the Rocky Mountain province are more vague. The Eutaw is obviously younger than the Woodbine, as the comparison of the Woodbine with the Tuscaloosa has clearly indicated. (See p. 41.) The Eutaw undoubtedly represents a part of the Dakota flora, but beyond this statement the evidence is not specific enough. One fact stands out very clearly—the Eutaw flora has nothing in common with and is decidedly older than the Montana floras of the Rocky Mountain province, the stratigraphic succession necessitating a suggested synchronism with part of the Dakota sandstone and part of the Colorado group of the West.

The Eutaw flora also has nothing in common with the abundant Senonian floras of Europe, and whatever may be the conclusions drawn from a study of the invertebrate faunas of the overlying beds of the Eutaw, I have no hesitation in affirming that the flora found in its basal beds is pre-Senonian in age.

CORRELATION OF THE RIPLEY FLORA.

The flora found in the Ripley formation is so scanty, including only 21 identifiable species, of which 8 are new and confined to these beds, that accurate correlation is impossible.

The following 8 species, *Araucaria bladenensis, Araucaria jeffreyi, Halymenites major, Malapoenna horrellensis, Eucalyptus angusta, Doryanthites cretacea, Myrcia havanensis,* and *Manihotites georgiana,* are survivors from the Eutaw, and all of these but the *Myrcia, Halymenites,* and *Eucalyptus* are common to the Black Creek formation of the Carolinas, and two of them *Araucaria bladenensis* and *Doryanthites cretacea,* occur in the Magothy formation of the northern Coastal Plain.

The following species come from the lower beds of the Ripley formation:

Andromeda novaecaesareae Hollick.
Araucaria bladenensis Berry.
Araucaria jeffreyi Berry.
Cunninghamites elegans (Corda) Endlicher.
Doryanthites cretacea Berry.
Dryopterites stephensoni Berry.
Eucalyptus angusta Velenovsky.
Ficus georgiana Berry.
Manihotites georgiana Berry.

This list is of considerable significance, because all but the new species of *Dryopterites* and *Ficus* occur in the Black Creek formation, the first, second, and fourth are common to the Magothy formation, the first and sixth occur in the Tuscaloosa formation, and the first and seventh go back as far as the uppermost part of the Raritan.

The flora of the upper beds of the Ripley formation, though it consists of only *Dryophyllum gracile*, *Cissites crispus*, *Sterculia snowii tennesseensis*, *Cinnamomum* sp., *Malapoenna horrellensis*, *Eugenia? anceps*, *Halymenites major*, *Manihotites georgiana*, *Bauhinia ripleyensis*, *Myrcia havanensis*, *Myrica ripleyensis*, *Platanus* sp., and *Sabalites* sp., has little in common with the flora of the lower Ripley, and only three of these species afford a point of contact with older floras, the *Manihotites*, *Myrcia*, and *Malapoenna* making their appearance in the Eutaw.

Still another element of contrast is furnished by the presence in the upper Ripley of Cowikee Creek of the representatives of four other species, not specifically determinable but apparently unlike any of the older floras with which I am familiar. These were designated as *Fern* (undeterminable), *Laurus?* sp., *Salix?* sp., and *Sapindus?* sp.

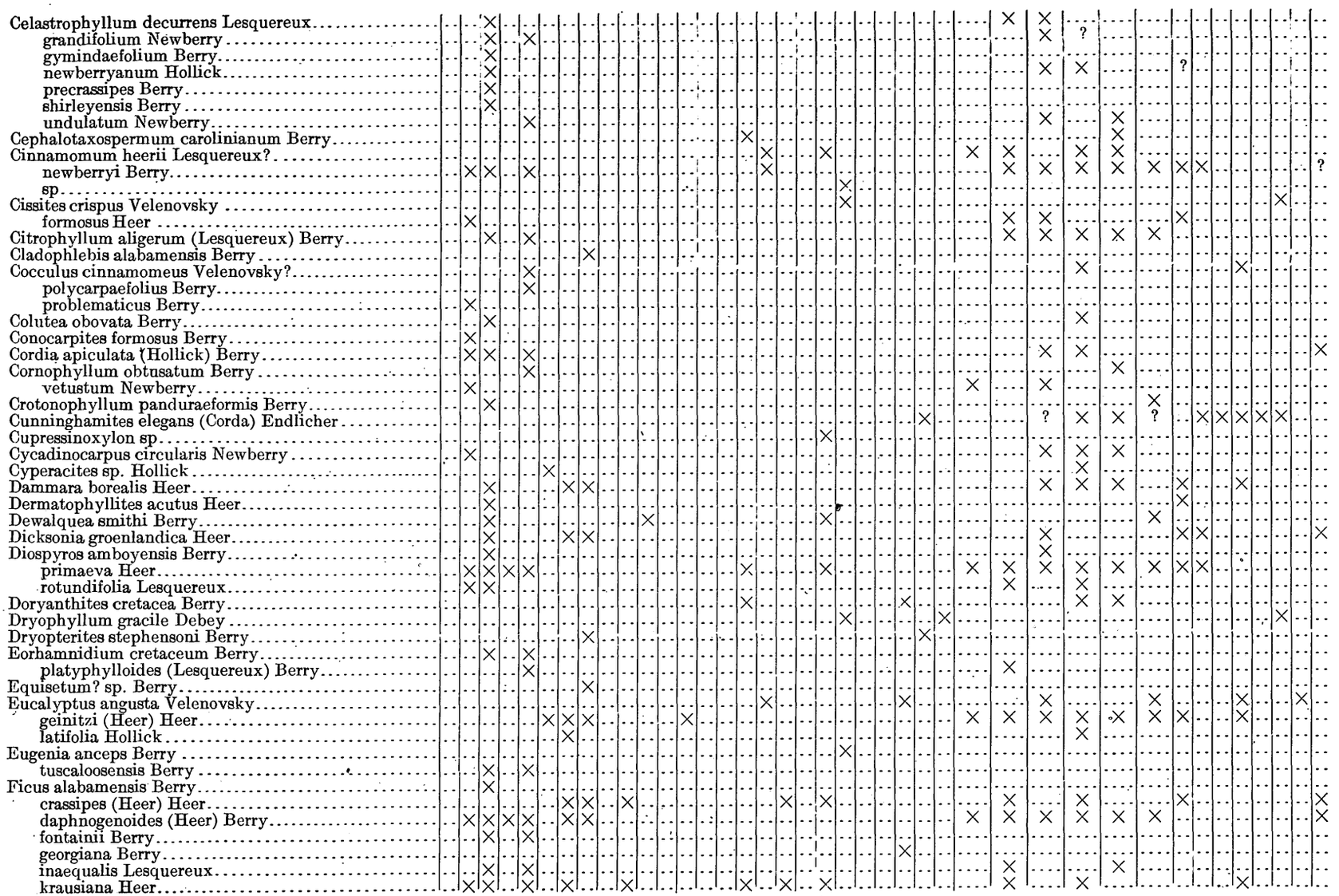
It seems evident, in spite of the meager paleobotanic data, that the striking change in our eastern Upper Cretaceous floras, if there really was a striking change, which may well be questioned, took place after the deposition of the Cusseta sand member of the Ripley formation. It might perhaps be clearer to say that in the flora of the Ripley deposits above the Cusseta sand member all close similarities with earlier Cretaceous floras had been eliminated. One of the Ripley species, *Cunninghamites elegans*, and the dubious *Halymenites major*, are present in the flora of the Montana group of the West.

DISTRIBUTION OF THE TUSCALOOSA, EUTAW, AND RIPLEY FLORAS.

Details of distribution both within and outside the eastern Gulf area for all the units of the Tuscaloosa, Eutaw, and Ripley floras are assembled in the appended table.

Distribution of species contained in the Tuscaloosa, Eutaw, and Ripley floras.

	Tuscaloosa formation.																									Eutaw formation.						Ripley formation.							Woodbine sand, Tex.	Dakota sandstone, Western Interior.	Raritan formation, northern Coastal Plain.	Magothy formation, northern Coastal Plain.	Typical deposits of Black Creek formation, North Carolina and South Carolina.	Middendorf arkose member of Black Creek formation, South Carolina.	Atane beds, Greenland.	Patoot beds, Greenland.	Montana group, Western Interior.	Cenomanian, Europe.	Turonian, Europe.	Senonian, Europe.	Lower Cretaceous.	Bingen formation of Arkansas.
	Near Iuka, Miss.	Glen Allen, Ala.	Shirleys Mill, Ala.	Tuscaloosa, Ala.	Cottondale, Ala.	Southwest of Northport, Ala.	Upper ravine, Snow place, Ala.	Big gully, Snow place, Ala.	Robertsons Landing, Ala.	Sanders Ferry Bluff, Ala.	Whites Bluff, Ala.	Soap Hill, Ala.	Near Mapleseville, Ala.	Jones Ferry, Ala.	Near Centerville, Ala.	Near Havana, Ala.	McBrides Ford, Ga.	Chimney Bluff, Ga.	Broken Arrow Bend, Ga.	Coffee Bluff, Tenn.	Near Selmer, Tenn.	Near Camden, Tenn.	Cowikee Creek, Ala.	Near Buena Vista, Ga.	Near Byron, Ga.	Cypress, Tenn.																									
Abietites foliosus (Fontaine) Berry							×	×																																									
Acerates amboyensis Berry										×							×																																
Andromeda cretacea Lesquereux?			×	×			×																																										
grandifolia Berry																																																
novaecaesareae Hollick			×	×			×	×																																								
parlatorii Heer			×	×	×	×	×	×									×																															
wardiana Lesquereux			×	×																																												
Androvettia carolinensis Berry																	×																															
elegans Berry																	×																															
Aralia cottondalensis Berry					×																																											
eutawensis Berry																																																
Araucaria bladenensis Berry																×		×																														
jeffreyi Berry																																																
Asplenium dicksonianum Heer																																																
Bauhinia alabamensis Berry																×																															
cretacea Newberry																×																															
marylandica Berry																																															
ripleyensis Berry																																															
Brachyphyllum macrocarpum formosum Berry																																															
Calycites sexpartitus Berry																																															
Capparites cynophylloides Berry																																															
orbiculatus Berry																																															
Carpolithus floribundus Newberry																																															
tuscaloosensis Berry																																															
Cassia vaughani Berry																																															
Celastrophyllum alabamensis Berry																																															
brittonianum Hollick																																															
carolinensis Berry																																															
crenatum Heer																																															
crenatum ellipticum Berry																																															


Celastrophyllum decurrens Lesquereux
grandifolium Newberry
gymindaefolium Berry
newberryanum Hollick
precrassipes Berry
shirleyensis Berry
undulatum Newberry
Cephalotaxospermum carolinianum Berry
Cinnamomum heerii Lesquereux?
newberryi Berry
sp
Cissites crispus Velenovsky
formosus Heer
Citrophyllum aligerum (Lesquereux) Berry
Cladophlebis alabamensis Berry
Cocculus cinnamomeus Velenovsky?
polycarpaefolius Berry
problematicus Berry
Colutea obovata Berry
Conocarpites formosus Berry
Cordia apiculata (Hollick) Berry
Cornophyllum obtusatum Berry
vetustum Newberry
Crotonophyllum panduraeformis Berry
Cunninghamites elegans (Corda) Endlicher
Cupressinoxylon sp
Cycadinocarpus circularis Newberry
Cyperacites sp. Hollick
Dammara borealis Heer
Dermatophyllites acutus Heer
Dewalquea smithi Berry
Dicksonia groenlandica Heer
Diospyros amboyensis Berry
primaeva Heer
rotundifolia Lesquereux
Doryanthites cretacea Berry
Dryophyllum gracile Debey
Dryopterites stephensoni Berry
Eorhamnidium cretaceum Berry
platyphylloides (Lesquereux) Berry
Equisetum? sp. Berry
Eucalyptus angusta Velenovsky
geinitzi (Heer) Heer
latifolia Hollick
Eugenia anceps Berry
tuscaloosensis Berry
Ficus alabamensis Berry
crassipes (Heer) Heer
daphnogenoides (Heer) Berry
fontainii Berry
georgiana Berry
inaequalis Lesquereux
krausiana Heer

Distribution of species contained in the Tuscaloosa, Eutaw, and Ripley floras—Continued.

	Tuscaloosa formation.	Eutaw formation.	Ripley formation.
	Near Iuka, Miss.		
	Glen Allen, Ala.		
	Shirleys Mill, Ala.		
	Tuscaloosa, Ala.		
	Cottondale, Ala.		
	Southwest of Northport, Ala.		
	Upper ravine, Snow place, Ala.		
	Big gully, Snow place, Ala.		
	Robertsons Landing, Ala.		
	Sanders Ferry Bluff, Ala.		
	Whites Bluff, Ala.		
	Soap Hill, Ala.		
	Near Maplesville, Ala.		
	Jones Ferry, Ala.		
	Near Centerville, Ala.		
		Near Havana, Ala.	
		McBrides Ford, Ga.	
		Chimney Bluff, Ga.	
		Broken Arrow Bend, Ga.	
		Coffee Bluff, Tenn.	
			Near Selmer, Tenn.
			Near Camden, Tenn.
			Cowikee Creek, Ala.
			Near Buena Vista, Ga.
			Near Byron, Ga.
			Cypress, Tenn.
Ficus ovatifolia Berry			
shirleyensis Berry			
woolsoni Newberry			
Geinitzia formosa Heer			
Gleichenia delicatula Heer			
Grewiopsis formosa Berry			
tuscaloosensis Berry			
Halymenites mayor Lesquereux			
Hymenaea fayettensis Berry			
Ilex masoni Lesquereux			
Inga cretacea Lesquereux			
Juglansarctica Heer			
Jungermannites cretaceus Berry			
Kalmia brittoniana Hollick			
Laurophyllum angustifolium Newberry?			
elegans Hollick			
nervillosum Hollick			
Laurus plutonia Heer			
Leguminosites ingaefolia Berry			
omphalobioides Lesquereux			
shirleyensis Berry			
tuscaloosensis Berry			
Liriodendron meekii Heer			
Liriodendropsis angustifolia Newberry			
constricta Ward			
simplex Newberry			
Lycopodites tuscaloosensis Berry			
Lycopodium cretaceum Berry			

Woodbine sand, Tex.
Dakota sandstone, Western Interior.
Raritan formation, northern Coastal Plain.
Magothy formation, northern Coastal Plain.
Typical deposits of Black Creek formation, North Carolina and South Carolina.
Middendorf arkose member of Black Creek formation, South Carolina.
Atane beds, Greenland.
Patoot beds, Greenland.
Montana group, Western Interior.
Cenomanian, Europe.
Turonian, Europe.
Senonian, Europe.
Lower Cretaceous.
Bingen formation of Arkansas.

Magnolia boulayana Lesquereux			X														X										X	X	X	X										
capellinii Heer					X												X				X							X	?	X	X		X			X				
hollicki Berry			X																										X	X										
lacoeana Lesquereux		X	X																									X	X	X										
longipes Newberry			X		X																								X	X										
newberryi Berry		X																											X	X	X									
obtusata Heer			X																									X		X			X							
speciosa Heer		X	X	X	X																						X	X	X	X						X				
Malapoenna cottondalensis Berry					X																																			
cretacea (Lesquereux) Knowlton					X																							X												
falcifolia (Lesquereux) Knowlton			X																								X	X		X										
horrellensis Berry																X			X		X	X				X					X									
Manihotites georgiana Berry																	X			X	X			X							X									X
Marattia cretacea Velenovsky?		X																																		X				
Menispermites integrifolius Berry					X																																			X
trilobatus Berry			X																																					
variabilis Berry																	X																							
Myrcia havanensis Berry																X					X	X				X														
Myrica dakotensis minima Berry		X																																						
emarginata Heer			X		X																						X	X	X				X							
longa (Heer) Heer							X	X																			X	X		X			X	X						X
ripleyensis Berry																					X	X																		
Myrsine borealis Heer		X	X					X																				X	X	X	X		X							
gaudini (Lesquereux) Berry		X			X	X																						X	X	X	X									
Nyssa snowiana Lesquereux			X																									X												
Oreodaphne alabamensis Berry					X																						X													
shirleyensis Berry			X																																					
Palaeocassia laurinea Lesquereux			X																								X	X												
Paliurus upatoiensis Berry																	X																							
Panax cretacea Heer			X																											X			X							
Persea valida Hollick					X																									X										
Persoonia lesquereuxii Knowlton			X																									X	X	X										
lesquereuxii minor Berry		X	X																																					
Phaseolites formus Lesquereux			X		X																							X			X					X				
Phragmites pratti Berry																			X	X											X									
Phyllites asplenioides Berry																				X																				
pistiaeformis Berry	X	X																																						
shirleyensis Berry			X																																					
Pinus raritanensis Berry					X																								X	X		X								
Piperites tuscaloosensis Berry			X	X																																				
Platanus asperaeformis Berry			X																																					
latior (Lesquereux) Knowlton					X																							X												
shirleyensis Berry			X		X																																			
sp. Berry																							X																	
Podozamites marginatus Heer								X				X																	X	X			X			?				X
Populites tuscaloosensis Berry		X		X																																				
Populus hyperborea Heer					X																							X					X							
Proteoides conospermaefolia Berry			X																																					
Protodammara speciosa Hollick and Jeffrey			X																										X											
Protophyllocladus subintegrifolius (Lesquereux) Berry					X																							X	X	X			X							
Pterospermites carolinensis Berry		X	X		X															X											X									
Rhamnus tenax Lesquereux			X																								X	X												
Sabalites sp. Berry																					X	X																		

Distribution of species contained in the Tuscaloosa, Eutaw, and Ripley floras—Continued.

		Salix eutawensis Berry	flexuosa Newberry	lesquereuxii Berry	meekii Newberry	Sapindus morrisonii Heer	variabilis Berry	Sapotacites ettingshauseni Berry	formosus Berry	shirleyensis Berry	Sassafras acutilobum Lesquereux	Sequoia ambigua Heer	fastigiata (Sternberg) Heer	heterophylla Velenovsky	reichenbachi (Geinitz) Heer	Sphaerites alabamensis Berry	Stercullia snowii tennesseensis Berry	Tricalycites papyraceus Newberry	Tumion carolinianum Berry?	Widdringtonites reichii (Ettingshausen) Heer	subtilis Heer	Zizyphus lamarensis Berry	laurifolius Berry
Tuscaloosa formation.	Near Iuka, Miss.														×								
	Glen Allen, Ala.		×				×									×		×		×		×	
	Shirleys Mill, Ala.	×	×	×	×		×	×	×	×	×			×		×		×		×	×		
	Tuscaloosa, Ala.	×	×													×							
	Cottondale, Ala.		×								×				?								
	Southwest of Northport, Ala.				×																		
	Upper ravine, Snow place, Ala.	×										×											
	Big gully, Snow place, Ala.	×	×									×	×		×			×		×			
	Robertsons Landing, Ala.	×																					
	Sanders Ferry Bluff, Ala.	×	×																				
	Whites Bluff, Ala.	×												×	×					×			
	Soap Hill, Ala.																						
	Near Mapleseville, Ala.	×																					
	Jones Ferry, Ala.																						
	Near Centerville, Ala.																						
Eutaw formation.	Near Havana, Ala.											×			×								
	McBrides Ford, Ga.	×													×					×			×
	Chimney Bluff, Ga.	×	×												×								
	Broken Arrow Bend, Ga.	×	×												×								
	Coffee Bluff, Tenn.																						
Ripley formation.	Near Selmer, Tenn.																×						
	Near Camden, Tenn.																						
	Cowikee Creek, Ala.																						
	Near Buena Vista, Ga.																						
	Near Byron, Ga.																						
	Cypress, Tenn.																						
Woodbine sand, Tex.						×												×			×		
Dakota sandstone, Western Interior.		×	×	×	×						×		×		×					×			
Raritan formation, northern Coastal Plain.		×	×	×	?						×			×	×			×		×	×		
Magothy formation, northern Coastal Plain.		×	×	×	×						×	×		×	×			×	×	×	×		
Typical deposits of Black Creek formation, North Carolina and South Carolina.		? ×		×										×	×				×				
Middendorf arkose member of Black Creek formation, South Carolina.		×	×		×										×						×		
Atane beds, Greenland.					×							×	×		×					×	×		
Patoot beds, Greenland.					×								×							×			
Montana group, Western Interior.															×								
Cenomanian, Europe.											×		×	×	×					×			
Turonian, Europe.															×								
Senonian, Europe.															×								
Lower Cretaceous.												×			×								
Bingen formation of Arkansas.		×	×		×										×					×			

THE FLORAS.

Phylum THALLOPHYTA.

Class FUNGI.

Order PYRENOMYCETES.

Genus SPHAERITES Unger.

[Genera et species plantarum fossilium, p. 37, 1850.]

Sphaerites alabamensis Berry, n. sp.

Plate V, figure 1.

When viewed megascopically these remains appear as elliptical or circular spots from 1 to 1.5 millimeters in diameter, each containing several darker dots which represent the spore groups. The margins of the leaf spots are well marked and not diffuse.

Sphaerites alabamensis was found in abundance upon various leaves, including those of *Platanus shirleyensis* Berry. It is plainly congeneric with the forms usually referred to this genus and very similar to *S. problematicus* (Knowlton) Knowlton from the Dakota sandstone of Kansas and *S. raritanensis* Berry from the Raritan formation of New Jersey. *S. problematicus*, however, is more irregular in outline and infests *Sterculia*, which is not the host of the Tuscaloosa species.

A great variety of fungi have the habit of the present form and produce leaf spots in the higher plants. As the microscopic characters, particularly of the spores, are relied upon for specific differentiation, the correct determination of fossil forms of this sort is impossible, and the name chosen must be regarded as constituting a purely form genus. Though remains of this sort are of little botanic interest, except to a certain type of narrow specialists, they have a considerable biologic significance in the evidence which they afford of the existence during the mid-Cretaceous of fungi of this order.

Occurrence: Tuscaloosa formation, Shirleys Mill, Glen Allen, Fayette County; gully in the Tuscaloosa, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

Phylum BRYOPHYTA.

Class HEPATICAE.

Order JUNGERMANNIALES.

Genus JUNGERMANNITES Goeppert.

Jungermannites cretaceus Berry, n. sp.

Plate V, figures 2, 3.

Thallus creeping, foliose, dorso-ventral, with a stout flexuous axis that bears on its upper surface crowded overlapping ovate orbicular lobes of considerable consistency and about 2 millimeters or slightly less in length.

This unique form is unfortunately represented by only three specimens, two of which are figured. These have been submitted to Prof. A. W. Evans and Dr. M. A. Howe, authorities on the Hepaticae. Prof. Evans dissents from my opinion that the specimens represent a Cretaceous liverwort. Dr. Howe, not forgetting that the remains are problematic, sees a strong superficial resemblance to certain foliose and subfoliose liverworts, as for example, the genus *Chiloscyphus* of our Southern States or the tropical genus *Noteroclada*.

It must be admitted that the remains are not conclusive, but I know of no vegetative characters that can be shown by a fossil hepatic that are conclusive. They certainly impress the general student, who is less familar with the details of the living Hepaticae where complete material is available and who therefore does not expect impossible feats of preservation, as remarkably like existing foliose liverworts. Undoubted thalloid liverworts are well known in the Mesozoic, although represented by scant materials. Foliose forms are much rarer. Saporta [1] has described what he thinks is such a form from the Lower Cretaceous of Portugal as *Jungermannites vetustior*. There are several Tertiary species, including well-preserved and conclusive material from the Baltic amber.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Phylum PTERIDOPHYTA.

Order EQUISETALES.

Genus EQUISETUM Linné

Equisetum? sp. Berry.

A small fragment of what appears to be the stem of an *Equisetum* occurs in the collections from the big gully on the Snow place in Tuscaloosa County, Ala. It is 3.5 centimeters long and about 3 millimeters in diameter, with 10 to 12 prominent ribs. Nodes about 6 millimeters apart.

The material is entirely insufficient for specific characterization but is of interest as indicating the probable presence of this type of plant in the Tuscaloosa flora. The New Jersey Raritan species *Carpolithus pruniformis* New

[1] Saporta, Gaston de, Flore fossile du Portugal, p. 123, pl. 23, fig. 14, 1894.

berry[1] also probably represents fossilized *Equisetum* tubers.

Occurrence: Tuscaloosa formation, big gully on the Snow place, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Order LYCOPODIALES.

Genus LYCOPODIUM Linné.

Lycopodium cretaceum Berry?

Lycopodium cretaceum Berry, Am. Jour. Sci., 4th ser., vol. 30, p. 275, figs. 1–6, 1910.

These remains consist of fruiting spikes, loosely imbricated, of modified foliage leaves or bracts. The largest spike seen, which is nearly complete, is 5 centimeters in length and 5 millimeters in diameter, and is probably somewhat flattened, the bulk of the specimens indicating somewhat smaller dimensions. Axis stout. Bracts several-ranked, peduncled, with a cordate or retuse base and an abruptly narrowed, acute, recurved apex, with an entire margin, each bract subtending a large spheroidal sporangium which may possibly be reniform, although as preserved in the form of impressions in the clay it appears to be globular. There is considerable variation in size, the shorter and smaller spikes being less crowded and somewhat lax in appearance.

I have described this species from rather abundant and relatively well preserved material found in the Middendorf arkose member of the Black Creek formation of South Carolina, a somewhat later Cretaceous horizon than the occurrence here discussed, which is based upon poor material that was collected at Shirleys Mill from the lower part of the Tuscaloosa formation and is queried because of its unsatisfactory character.

Occurrence: Tuscaloosa formation, Shirleys Mill, Glen Allen, Fayette County, Ala.

Collections: U. S. National Museum.

Genus LYCOPODITES Brongniart.

Lycopodites tuscaloosensis Berry, n. sp.

Plate V, figures 4–7.

Slender, elongated fruiting axes, bearing relatively distant, spirally arranged, short and stout, acuminate and often recurved bracts, each subtending an axillary sporangium of considerable size.

The axes vary in diameter from 0.5 millimeter to 2 millimeters, and some are preserved for a length of 8 centimeters. The distance between successive bracts ranges from 3 to 6 millimeters, averaging nearer the smaller than the larger figure. The bracts are short and stout, curved or recurved, slightly flattened and sharply pointed. The supposed sporangia are badly preserved and are commonly wanting. They are ovoid in outline, broadest proximad, and are about 2 millimeters in diameter. They appear to be of considerable consistency and some specimens show longitudinal angles suggesting a comparison with the recent genus *Psilotum*.

These curious fossils are exceedingly abundant in the clays of the basal part of the Tuscaloosa formation at the Shirleys Mill locality, occurring sparingly at Glen Allen. Only two possible relationships can be suggested—one that they represent some angiospermic fruit axes and the other that they are lycopodiaceous. The evidence from the specimens, which are fairly well preserved, does not lend any support to the former view. I believe that the latter view is conclusive, although naturally their preservation as impressions in clay leaves much to be desired. I was at first disposed to refer them to *Psilotites*, but there is no positive evidence that the sporangia were bilocular or trilocular, unless their angled exterior may indicate that they were compound, and this feature may be due to compression of a sporangium of considerable consistency, such as these were. There is certainly a flexing of the axis and a slight swelling at the base of the sporangium that reminds one of *Psilotum*, but the subtending bract is simple and not forked as in *Psilotum*, although it is of the relative proportions and shape of a single fork of a *Psilotum* bract. Some of the axes without traces of sporangia are comparable to the main axes of *Psilotum* with reduced leaves, and there are no other indications of foliar parts in the fossils. The arrangement and spacing of the parts are distinctly more open than in any recent lycopodiums known to me, the supposed foliage is much more reduced, and the sporangia are relatively larger.

It is possible that the fossil represents an early Upper Cretaceous type intermediate in habit between *Lycopodium* and *Psilotum*. I know of no described fossils with which close comparisons can be made. The only similar form is that based on remains from the Ceno-

[1] Newberry, J. S., The flora of the Amboy clays: U. S. Geol. Survey Mon. 26, p. 133, pl. 46, fig. 42, 1896.

manian of Bohemia, which were identified by Velenosky[1] as fruit twigs of a *Myrica*, an identification which is very doubtful.

Occurrence: Tuscaloosa formation, Shirleys Mill (common) and Glen Allen (rare), Fayette County, Ala.

Collection: U. S. National Museum.

Order FILICALES.

Family POLYPODIACEAE.

Genus CLADOPHLEBIS Brongniart.

Cladophlebis alabamensis Berry, n. sp.

Plate V, figure 8.

This species is based upon a single ultimate pinnule of a fern of the *Cladophlebis* type, which therefore fails to shed any light on the character of the frond as a whole, or on the shape of the normal pinnae and pinnules of the proximal part of the frond. It may be characterized as follows: Frond certainly bipinnate and probably tripinnate. Normal pinnae probably made up of numerous lanceolate falcate pinnules, each attached by its entire base. Pinnae pass distad into pinnatifid pinnules like the specimen preserved. These ultimate pinnules are linear-lanceolate in outline, about 3 centimeters in length and 4 millimeters in greatest width. The texture is coriaceous and the midrib stout. The margin is cut to form subopposite to alternate aquiline pointed lobes separated nearly to the midrib proximad but becoming gradually obsolete distad. The secondaries are fine and show for each lobe the typical venation of a normal *Cladophlebia* pinnule—that is, a midrib which sends off on either side at acute angles simple or dichotomously, once-forked veinlets which run directly to the margin.

This species is clearly distinct from previously described forms, although it suggests various Lower Cretaceous species, as, for example, *Cladophlebis albertsii*, *C. browniana*, *C. ungeri*, and *C. parva*, all of which have similar ultimate pinnules. It is closest perhaps to *C. browniana* and *C. parva*, both of which range from the bottom to the top of the Lower Cretaceous in the Maryland-Virginia area. There is a certain resemblance to various Cretaceous species that have been referred to the genus *Gleichenia*, but this resemblance is believed to be purely superficial.

[1] Velenovsky, Josef, Die Flora der böhmischen Kreideformation, pt. 2, p.11, pl. 5, figs. 9-12, 1883.

Cladophlebis is essentially a form genus which is restricted at the present time to include only certain fern remains of Mesozoic age, although this type of frond is practically identical with those of some Paleozoic genera, as, for example, *Pecopteris*, and it can also be closely matched by a variety of Tertiary and living ferns.

Cladophlebis was proposed by Brongniart[2] in 1849 for those species which formed his section *Pecopteris neuropteroides*,[3] which he regarded as transitional between *Pecopteris* and *Neuropteris*. Certain of their characters were mentioned, but no formal diagnosis was attempted. The genus has been characterized by Saporta,[4] Schimper,[5] Seward,[6] and the present writer.[7]

Much difference of opinion has prevailed regarding the unity and the systematic position of the genus, Saporta[8] having long ago pointed out that Brongniart's Paleozoic species had nothing in common with those of the Mesozoic, and that the Liassic and Oolitic forms, those which the former author was discussing, give evidence of common characters. At the present time evidence is still lacking from such fructified remains as have been discovered of close relationship between all of the various species of *Cladophlebis*. Thus Heer discovered, in the Siberian Jurassic, fragments of the type of *C. whitbyensis* with soral characters which he compared with those of *Diplazium*, a subgenus of *Asplenium*,[9] and Schenk has figured fertile pinnules of the same type in the allied *Asplenites roesserti*.[10] Certain sepcimens of the Jurassic species *C. lobifolia* show that the sporangia in this species were apparently borne in semicircular pocket-like depressions on the edges of the fertile segments,[11] whereas the fructifications of *C. denticulata* are in the form of narrow, oblong sori parallel with the secondary veins and are compared by Seward[12] with the modern forms *Asplenium lugubre* and *Phegopteris decussata*. In his latest work on this

[2] Brongniart, Adolphe, Tableau des genres de végétaux, p. 25, 1849.

[3] Brongniart, Adolphe, Histoire des végétaux fossiles, p. 320, 1828.

[4] Saporta, Gaston de, Paléontologie française, ser. 2, Végétaux, Plantes urassiques, vol. 1, pp. 298, 299, 1873.

[5] Schimper, W. P., Traité de paléontologie végétale, vol. 3, p. 503, 1874.

[6] Seward, A. C., Wealden flora, pt. 1, p. 88, 1894.

[7] Berry, E. W., Maryland Geol. Survey, Lower Cretaceous, p. 239, 1911.

[8] Saporta, Gaston de, op. cit., vol. 4, p. 357, 1888.

[9] Heer, Oswald, Flora fossilis arctica, vol. 4, p. 38, pl. 21, figs. 3, 4, 1877.

[10] Schenk, August, Die fossile Flora der Grenzschichten des Keupers und Lias Frankens, p. 51, pl. 7, figs. 7, 7a, 1867.

[11] Seward, A. C., The Jurassic flora, pt. 1, fig. 23, 1900.

[12] Idem, p. 141.

subject he states that "there are fairly good grounds for the assertion that some at least of the fronds described under this name are those of Osmundaceae."[1] Zeiller[2] in 1910 described a species from the Wealden of Peru which he considers identical with or very close to *C. browniana*, in which the sporangia are biseriate, oval, and annulate as in the Schizaeaceae. These species are said to be very like those of the Jurassic genus *Klukia* of Raciborski. In 1890 Fontaine described 14 so-called species of *Aspidium* Swartz [*Dryopteris* Adanson], mostly fertile fronds from the Lower Cretaceous flora of the Potomac group. These leaves showed mostly large elliptical or reniform sori in rows on each side of the midvein, and located generally on the distal branch of a furcate vein, usually wanting in the apical part of the pinnule. These species were compared by this author with modern species of *Aspidium*, *Cystoperis*, *Polystichum*, and *Didymochlaena*. By careful comparison I have correlated the fertile specimens described as *Dryopteris* with the sterile *Cladophlebis* fronds of the same species in five of the types that are represented in the Potomac flora by sterile and fertile fronds.[3]

Though the foregoing facts are not in unison in regard to the systematic position of *Cladophlebis* they all point to the inclusion of the American species in the family Polypodiaceae, or what answered to this family in Lower Cretaceous time. It is quite possible that ferns of more than one subfamily of the Polypodiaceae, or, indeed, of other families, are included among the various described species of *Cladophlebis*. It need but be remembered how many unrelated modern ferns have fronds of the *Cladophlebis* type, as, for example, certain species of *Alsophila*, *Asplenium*, *Cyathea*, *Dryopteris*, *Gleichenia*, *Onoclea*, *Osmunda*, *Polypodium*, and *Pteris*, to cast doubt upon the botanic affinity of *Cladophlebis* species unless these are attested by a considerable body of evidence.

A larger number of species of *Cladophlebis* have been described, of which two species, according to Arber, occur in the "Permo-Carboniferous" of India. The genus appears in force in the Keuper and Rhaetic, with more than a dozen recorded species. Over a score are recorded during the Jurassic, certain types, such as *C. denticulata*, apparently becoming world-wide in their distribution. For the Lower Cretaceous Saporta has founded a large number of species based upon Portuguese material, and Fontaine has instituted a still larger number of American species. From the Potomac group of Maryland and Virginia the latter author recorded 23 different species, besides several varieties of *Cladophlebis*, all of which I have recently revised to form eight legitimate species.[4]

Occurrence: Tuscaloosa formation, big gully on the Snow place, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

Genus DRYOPTERITES Berry.

Dryopterites stephensoni Berry.

Dryopterites stephensoni Berry, U. S. Geol. Survey Prof. Paper 84, p. 103, pl. 17, figs. 1, 2, 1914.

Fronds bipinnate or possibly tripinnate. Pinnules thick in texture, ovate or lanceolate in outline, ascending, merging toward the apex of the pinnae. A single vein enters each pinnule, branching from the rachis at an extremely acute angle and immediately breaking up into three branches, the upper usually remaining simple and running to the upper margin, the lower usually forking once and running to the lower lateral margin, and the middle dividing four or five times to form the main vascular system of the pinnule, the distal branches tend to remain simple and the proximal usually fork once. The Alabama specimens are infested with a leaf-spot fungus which simulate sori.

This species was recently described by me from the Upper Cretaceous of Georgia. It is quite distinct from any forms known from the Upper Cretaceous but suggests a comparison with various previously described forms, as, for example, the fern remains described by Debey and Ettingshausen from Aachen (Senonian) on the Prussian border as *Pteridolemma gymnorachis*.[5] Other forms which show a superficial resemblance to the one under consideration are those described by Kerner from Lesina, Dalmatia (Cenomanian), as various species of *Pachypteris*.[6]

Still other fern remains described as *Sphenopteris grevilloides* Heer,[7] *Grevillea tenera* Vele-

[1] Seward, A. C., Fossil plants, vol. 2, p. 345, 1910.
[2] Zeiller, C. R., Compt. Rend., vol. 150, p. 1488, 1910.
[3] Berry, E. W., op. cit., p. 239.
[4] Berry, E. W., op. cit., p. 239.
[5] Debey, M. H., and Ettingshausen, C. von, K. Akad. Wiss. Wien Denkschr., vol. 17, p. 234, pl. 7, figs. 21, 22, 1859.
[6] Herner, F., K.-k. geol. Reichsanstalt Jahrb., vol. 45, pp. 39 et seq., 1895.
[7] Heer, Oswald, Flora fossilis arctica, vol. 3, pt. 2, p. 34, pl. 11, figs. 10, 11, 1874.

novsky,[1] and *Thyrsopteris grevilloides* Hollick,[2] and which range from the Kome beds of Greenland to the Upper Cretaceous of Marthas Vineyard (Magothy formation), are suggestive of the present fern in general aspect but are seen to differ both in outline and venation when careful comparisons are made. The modern genus *Dryopteris* Adanson (*Aspidium* Swartz) is composite and has between 400 and 500 species of wide geographic distribution in the existing flora. Fossil species, which were set apart from the modern genus as the genus *Dryopterites* by the writer in 1911, have been described from the Lower Cretaceous upward, the Upper Cretaceous records including *Dryopteris oerstedi* (Heer) Knowlton, from the Atane and Patoot beds of Greenland, and *Dryopteris kennerleyi* (Newberry) Knowlton, from Vancouver Island, neither of which appears to be closely related to the present plant. The form identified as *Dryopteris oerstedi* from the Patapsco formation of Virginia is *Cladophlebis browniana*.

Occurrence: Tuscaloosa formation, big gully on the Snow place, Tuscaloosa County, Ala. (collected by W. M. Fontaine). Ripley formation (Cusseta sand member), cut on the Central of Georgia Railway, 1½ miles northeast of Byron, Houston County, Ga. (collected by L. W. Stephenson).

Collections: U. S. National Museum.

Genus ASPLENIUM Linné.

Asplenium dicksonianum Heer.

Asplenium dicksonianum Heer, Flora fossilis arctica, vol. 3, pt. 2, p. 31, pl. 1, figs. 1–5, 1874; idem, vol. 6, pt. 2, pp. 3, 33, pl. 2, fig. 2; pl. 32, figs. 1–8, 1882.

Dawson, Roy. Soc. Canada Trans., vol. 1, sec. 4, p. 11, 1883; idem, vol. 3, sec. 4, p. 5, pl. 3, fig. 1, 1885; Canada Geol. Survey Ann. Rept., new ser., vol. 1, p. 76, 1886; idem, vol. 10, sec. 4, p. 91, 1892.

Lesquereux, The flora of the Dakota group, p. 24, pl. 1, fig. 1, 1892.

Newberry, The flora of the Amboy clays, p. 39, pl. 1, figs. 6, 7; pl. 2, figs. 1–8; pl. 3, fig. 3, 1896.

Ward, U. S. Geol. Survey Nineteenth Ann. Rept., pt. 2, p. 704, pl. 170, fig. 1, 1899; Jour. Geology, vol. 2, pp. 259, 261, 1894.

Fontaine in Ward, U. S. Geol. Survey Nineteenth Ann. Rept., pt. 2, p. 664, pl. 162, figs. 6–8, 1899 (not Fontaine, 1888).

Kurtz, Contribuciones á la palaeophytología argentina, III: Rev. Museo La Plata, vol. 10, p. 49 (1899), 1902.

Berry, Torrey Bot. Club Bull., vol. 38, p. 409, 1911; New Jersey Geol. Survey Bull. 3, p. 68, pl. 5, figs. 3, 4, 1911.

[1] Velenovsky, Josef, Die Flora der böhmischen Kreideformation, Theil 4, p. 11, pl. 7, figs. 9, 14, 16, 1885.

[2] Hollick, Arthur, U. S. Geol. Survey Mon. 50, p. 31, pl. 1, figs. 10–13, 1907

This species was described by Heer in 1874 from the Kome beds (Lower Cretaceous) of Greenland as follows:

> A. foliis triplicato-pinnatis, stipite firmo, rigido; pinnis primariis secundariisque ovato-lanceolatis, pinnulis anguste lanceolatis, inferioribus acute serratis, superioribus integerrimis, acutis.

It was subsequently identified by Heer from the much later Atane beds (Upper Cretaceous) of Greenland; Dawson reported it from a number of localities in the Kootenai formation (Lower Cretaceous) of British Columbia, and Fontaine and Ward described it from the Lower Cretaceous of the Black Hills. It is also reported by both Lesquereux and Ward from the Dakota sandstone and by Kurtz from Argentina. It seems very doubtful if these specimens can all be the same plant, and the geologic range alone suggests that the earlier and the later forms may be distinct. The Lower Cretaceous forms certainly suggest a relationship with those widespread types of sterile fronds variously identified as *Thyrsopteris* or *Onychiopsis*, and they may be compared with *Onychiopsis goepperti* (Schenk) Berry. Those of the Upper Cretaceous suggest *Anemia* rather than *Asplenium* and are much like an undescribed *Anemia* from the lower Eocene (Wilcox group) of the Mississippi embayment area, as well as the widespread Eocene species *Anemia haydenii* (Lesquereux) and *Anemia subcretacea* (Saporta) Gardner and Ettingshausen. However, in the absence of representative material from the different horizons, it seems unwise to attempt any segregation at the present time, and the synonymy is cited in full for the use of some future student who may have access to enough material to enable him to make an accurate revision and segregation of this so-called species. Attention should also be called to its resemblance to the form occurring in the Upper Cretaceous of Greenland, the Raritan formation of New Jersey, and the Tuscaloosa formation of Alabama, which goes by the name of *Dicksonia groenlandica* Heer, although the ground for considering it a *Dicksonia* is entirely inconclusive.

In addition to the localities enumerated above the present species is abundant in the Raritan formation of New Jersey and Maryland and material that is absolutely identical with the New Jersey Raritan material which I have seen, and with that from the Dakota

sandstone, occurs in the lower part of the Tuscaloosa.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Family CYATHEACEAE.

Genus DICKSONIA Presl.

[Tentamen pteridographiae, etc., p. 135, 1836.]

Dicksonia groenlandica Heer.

Dicksonia groenlandica Heer, Flora fossilis arctica, vol. 6, Abt. 2, p. 23, pl. 35, figs. 8, 9, 1882; idem, vol. 7, p. 2, pl. 48, figs. 1–3, 1883.

Berry, New Jersey Geol. Survey Bull. 3, p. 66, pl. 4, fig. 1, 1911.

Dicksonia borealis Heer, Flora fossilis arctica, vol. 6, Abt. 2, p. 23, pl. 44, fig. 2, 1882 (not *D. borealis* Heer, 1878, a very different Jurassic species).

Sequoia heterophylla Velenovsky, Ward, in Smith, E. A., On the geology of the Coastal Plain of Alabama, p. 348, 1894 (not Velenovsky).

Anemia stricta Newberry, The flora of the Amboy clays, p. 38, pl. 3, figs. 1, 2, 1896.

Heer's description, published in 1882, is as follows:

D. foliis bipinnatis, pinnulis erectis, oblongo-lanceolatis, basi attenuatis, integerrimis, nervis subtilissimis, nervillis angulo acuto egredientibus, erectis.

Both of Heer's types, which are here united with Newberry's species, are small fragments of ultimate pinnae, which their author confesses are very similar, a fact well brought out by a comparison of the figured specimens. The material from the middle part of the Raritan formation at Woodbridge, N. J., is more ample, and, as may be seen lower down on the frond, the pinnules become toothed and finely pinnatifid, a feature not seen in the Greenland material. There is slight reason, however, for doubting their identity. Newberry himself pointed out that the *Dicksonia borealis* of Heer was probably identical with his species from New Jersey. Although common at Woodbridge, N. J., this species has not been found elsewhere in the Coastal Plain except in the Tuscaloosa formation of Alabama. It is present in both the Atane and Patoot beds of Greenland.

In Alabama it does not appear to be common, and the specimens are rather fragmentary. In this State it is distinguishable with difficulty from *Sequoia heterophylla*, which is also present in the Tuscaloosa formation and with which Ward confused the present species. The two species are easily and sharply distinguished by the great difference in the characters of their venation.

Occurrence: Tuscaloosa formation, upper ravine and big gully on the Snow place, Tuscaloosa County; Shirleys Mill, Fayette County, Ala.

Collections: U. S. National Museum.

Family GLEICHENIACEAE.

Genus GLEICHENIA Smith.

Gleichenia delicatula Heer.

Gleichenia delicatula Heer, Flora fossilis arctica, vol. 3, Abt. 2, p. 54, pl. 9, figs. 11e, f; pl. 10, figs. 16, 17, 1874; idem, vol. 6, Abt. 2, p. 9, 1882.

Velenovsky, Die Farne der böhmischen Kreideformation, p. 7, pl. 3, figs. 12–14, 1888.

(?) Hollick, Torreya, vol. 2, p. 147, pl. 3, fig. 4, 1902.

Gleichenia micromera Heer. Newberry, The flora of the Amboy clays, p. 36, pl. 3, fig. 6, 1896.

Berry, New Jersey Geol. Survey Bull. 3, p. 66, 1911.

Heer's description, published in 1874, is as follows:

Gl. fronde gracillima, dichotoma, bipinnata, rachi tenuissima, pinnis approximatis, patentibus, linearibus, pinnulis minutissimis, rotundatis.

This species is a very delicate and handsome type, with tiny rounded coriaceous pinnules close set and united to the rachis by their entire base, and with elongated linear pinnae not over 1 millimeter to 1.5 millimeters in width. It is separated with difficulty from the contemporaneous small pinnuled gleichenias, especially if the material comprises only the distal portions of the pinnae of these other forms. It was described from the Kome beds (Lower Cretaceous) of Greenland by Heer in the third volume of his Arctic Flora, where it is immediately followed by the description of *Gleichenia micromera*, which may represent the same plant, the sole stated difference being the ovate shape of the pinnules of *G. micromera*, which are not united to the rachis by their entire base. The occurrence of *Gleichenia micromera* in the Raritan is based upon the misidentification by Newberry of fragmentary specimens that are identical with those from the Tuscaloosa formation of Alabama. Both specimens have their pinnules united by their whole base and therefore belong to *Gleichenia delicatula* as defined by Heer. Similar remains are present in the Upper Cretaceous of the Cumberland coal field in Wyoming, according to Knowlton. They have also been reported in considerable abundance from the Cenomanian of Bohemia by Velenovsky.

The genus *Gleichenia* (including *Dicranopteris*) is a most interesting one. In the living

flora it has about 25 species, widely distributed throughout the tropics of both hemispheres, subtropical eastern Asia, and the humid regions of the southern zone. The fossil species are equally numerous and widespread. Aside from those forms from the Paleozoic and older Mesozoic which have been referred to the Gleicheniaceae, which reference is not conclusive, the genus enjoyed a wide adaptive radiation during the lower and middle Cretaceous. In the Lower Cretaceous (Kome beds) of Greenland Heer has described 15 species of Gleichenia, some of which reach the interior of North America, but none apparently occur in the Atlantic Coastal Plain. By the middle Cretaceous several of these Greenland forms had become widespread, and identical species occur in such widely separated localities as Europe and Kansas, or Europe, Greenland, Wyoming, and New Jersey. Four of the Greenland species find their way south along the Atlantic Coastal Plain and four reach Europe, where several additional species have also been described. With the gradual change of Tertiary climates the Gleicheniaceae moved southward, the only American fossil species of that age being the doubtful *Gleichenia obscura* Knowlton from the Tertiary Esmeralda formation (Oligocene?) of Nevada. This southern movement probably continued until Pleistocene time, sending the Gleicheniaceae into the West Indies, along the Andes into South America, along the eastern Asiatic coast, and across southern Europe into Africa.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Family MARATTIACEAE (?).

Genus MARATTIA Swartz (?).

Marattia cretacea Velenovsky (?).

Marattia cretacea Velenovsky, Die Farne der böhmischen Kreideformation, p. 9, pl. 1, fig. 13, 1888.

Velenovsky's description, published in 1888, is as follows:

Frond large and long, with a finely toothed margin, slender midrib and numerous slender once or more dichotomously forked lateral veins.

This species was described by Velenovsky in 1888 from a single specimen found in the Perucer clays near Melnik in Bohemia (Cenomanian). A small fragment indistinguishable from this specimen occurs in the clays of the Tuscaloosa formation at Glen Allen, Ala. It suggests very much the Lower Cretaceous remains usually referred to the form genus *Taeniopteris*, as, for example, *Taeniopteris nervosa* (Fontaine) Berry [1] from the Patuxent formation of the Atlantic Coastal Plain. The evidence for its reference to the genus *Marattia* is entirely inadequate and inconclusive.

Occurrence: Tuscaloosa formation, Glen Allen, Fayette County, Ala.

Collection: U. S. National Museum.

Phylum SPERMATOPHYTA.

Class GYMNOSPERMAE.

Order CYCADALES (?).

Genus PODOZAMITES Friedrich Braun.

Podozamites marginatus Heer.

Plate VI, figure 1.

Podozamites marginatus Heer, Flora fossilis arctica, vol. 6, Abt. 2, p. 45, pl. 16, fig. 10, 1882 (not Berry, 1903).
Newberry, The flora of the Amboy clays, p. 44, pl. 13, figs. 5, 6, 1896.
Berry, Torrey Bot. Club Bull., vol. 38, p. 410, 1911; New Jersey Geol. Survey Bull. 3, p. 74, 1911.

Pinnules rather large, ranging from 15 to 20 centimeters in length, variable in width, which ranges from 1.5 to 3 centimeters, the Tuscaloosa specimens being of minimum rather than maximum dimensions. Apex and base pointed, the angle dependent on the width of the pinnules. Base somewhat thickened and more or less abruptly narrowed in wide forms. Veins parallel, very fine and numerous, 30 or more in number. Texture thin but probably coriaceous.

This species was described by Heer from the Atane beds of western Greenland and was illustrated by a single rather poor figure. It was tentatively identified by Newberry from the middle part of the Raritan formation of Woodbridge, N. J. The Alabama form is certainly identical with the New Jersey material, and the same species is present in the Raritan in Maryland. Whether these are identical with the type is not certain, although such identity is probable. I have recorded this same species from the Magothy formation of New Jersey,[2] but this material proves to be referable to the subsequently discovered genus

[1] Berry, E. W., Maryland Geol. Survey, Lower Cretaceous, p. 293, pl. 77, fig. 1, 1911.
[2] Berry, E. W., New York Bot. Garden Bull., vol. 3, p. 99, pl. 46, figs. 1, 3, 1903.

Doryanthites of the Black Creek formation in North Carolina and homotaxial deposits in Georgia and Alabama.

Podozamites marginatus is exceedingly abundant at some outcrops near the base of the Tuscaloosa formation. It is represented to the exclusion of almost all other plant types near the top of the fossiliferous portion of the section in the big gully on the Snow place. The remains, like most of those represented at this outcrop, are very badly macerated and must have been thoroughly decayed before fossilization, being much split between the veins. Similar distorted fragments were mistaken by Fontaine for Lower Cretaceous forms of *Laricopsis*. The present species shows considerable similarity to the Lower Cretaceous species *Zamites tenuinervis* Fontaine, which is so common in the Patapsco formation of the Potomac River valley.

Occurrence: Tuscaloosa formation, Soap Hill, Bibb County; Snow place, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

Genus CYCADINOCARPUS Schimper.

[Traité de paléontologie végétale, vol. 2, p. 208, 1870.]

Cycadinocarpus circularis Newberry.

Cycadinocarpus circularis Newberry, The flora of the Amboy clays, p. 46, pl. 46, figs. 1–4, 1896.
Smith, E. A., On the geology of the Coastal Plain of Alabama, p. 348, 1894.
Berry, New Jersey Geol. Survey Bull. 3, p. 79, 1911.

Discoid fruits almost circular in outline from 6 to 12 millimeters in diameter, sometimes slightly emarginate on one side at the point which Prof. Newberry believed to be the point of attachment but which is probably the distal micropylar extremity. As usually preserved, the impression shows two concentric circles 1 to 2 millimeters apart, the inner representing the outline of the inner seed coat and the outer layer the slightly fleshy external coat.

These fruits always occur detached and are present in considerable abundance in the middle part of the Raritan formation of New Jersey. Similar remains are recorded from the Tuscaloosa formation of Alabama, and they are also present in the Black Creek formation of North Carolina. As their name indicates, they are assumed to represent the fruit of some contemporaneous species of cycad.

Occurrence: Tuscaloosa formation, Glen Allen, Fayette County, Ala.

Collection: U. S. National Museum.

Order CONIFERALES.

Genus CEPHALOTAXOSPERMUM Berry.

Cephalotaxospermum carolinianum Berry.

Cephalotaxospermum carolinianum Berry, Torrey Bot. Club Bull., vol. 37, p. 187, 1910.

Drupaceous fruits solitary (?), sessile, or with an extremely short and stout peduncle, ovid, somewhat pointed apically and inclined to become slightly cordate below, consisting of an outer fleshy layer and an inner bony layer, as in the Cycadales and Ginkgoales; the surface mammillated much as in the *Podocarpus elongata* but less markedly so. Bony endocarp ovate-acuminate, immersed in the apical part of the exocarp. Evidently the drupaceous fruits of some Cretaceous member of the Taxaceae, which finds its closest homology in the recent flora in the fruits of *Cephalotaxus* and certain species of *Podocarpus*. These drupes have the following dimensions, as preserved in a much flattened condition: Length 6 to 13 millimeters, averaging about 10 millimeters; breadth 5 to 10 millimeters, averaging about 8 millimeters; thickness about 3 millimeters; fruit in life probably almost circular in cross section. Peduncle short and stout, or wanting. Stone ovate-acuminate, lying in the apical part of the fleshy exocarp, with the beaked micropylar end reaching almost or quite to the apex. As preserved in a much flattened condition in the clays, these fruits tend to split into two parts, disclosing the bony endocarp or merely a cast of its cavity. The fleshy part of the fruit is carbonized and fails to show any histologic details. There is some evidence or at least a suggestion in some specimens of the remains of a micropylar canal. Away from the pointed apex, the exocarp is 1 to 2 millimeters in thickness, reaching a thickness of 3 millimeters at the chalazal end.

These fruits are very abundant at certain localities in the Black Creek formation in North Carolina, and they have been collected in the extension of this formation near Florence, S. C. In Alabama they have only been collected in the basal part of the Eutaw formation in Hale County.

Fruits referable to the Taxaceae are extremely rare in the fossil state, as are also remains of foliage which can be referred with certainty to this family. Both *Tumion* and *Cephalotaxopsis* from the Lower Cretaceous of Maryland and Virginia are founded upon foliage which seems referable with considerable certainty to this family, and these same strata in those States abound in the foliage referred to the genus *Nageiopsis*, which seems to be closely related to *Podocarpus*, so that there is considerable reason for expecting to find Upper Cretaceous representatives of the family in this same general region. Heer[1] described a leafy twig from the Patoot beds (Senonian) of Greenland, with a large solitary fruit which he called *Cephalotaxites insignis*, an identification which Solms-Laubach[2] seems to consider probable. Bertrand[3] has described carbonized seeds from the Aachenien of Tournay, Belgium, under the name of *Vesquia tournaissii*, which he considers, because of the arrangement of the vascular bundles, as intermediate between *Tumion* and *Cephalotaxus*. It certainly seems to be significant that remains of this sort occur at nearly homotaxial horizons in America, Europe, and Greenland.

None of the foregoing, however, are comparable with the present forms, although certain indefinite remains described by Lesquereux as *Inolepis* sp.,[4] are remotely suggestive of them. It is not believed, however, that they are congeneric.

The modern genus *Cephalotaxus* Siebold and Zuccarine, with four species, is confined to the China-Japan region, although it seems evident that it was much more widespread in former geologic times, and to it should probably be referred some of the leafy twigs included in the genus *Taxites* of Brongniart. Fruits of three species of *Cephalotaxus*, apparently identified correctly, are described by Kinkelin[5] from the upper Pliocene deposits of the Main Valley in Germany. The features which seem to indicate a closer relation with *Cephalotaxus* than with *Podocarpus* are the absence of the thickened peduncle of *Podocarpus* and the presence of foliage in the same beds with these seeds described by the writer as *Tumion carolinianum*[6] and which is of the same type as that of *Cephalotaxus*.

Occurrence: Eutaw formation (basal beds), 2 miles south of Havana, Hale County, Ala.

Collections: U. S. National Museum.

Genus PROTOPHYLLOCLADUS Berry.

[Torrey Bot. Club Bull., vol. 30, p. 440, 1903.]

Protophyllocladus subintegrifolius (Lesquereux) Berry.

Phyllocladus subintegrifolius Lesquereux, Am. Jour. Sci., 2d ser., vol. 46, p. 92, 1868; The Cretaceous flora, p. 54, pl. 1, fig. 12, 1874; The flora of the Dakota group, p. 34, pl. 2, figs. 1–3, 1892.

Protophyllocladus subintegrifolius (Lesquereux) Berry, Torrey Bot. Club Bull., vol. 30, p. 440, 1903; idem, vol. 31, p. 69, pl. 1, fig. 5, 1904; Johns Hopkins Univ. Circ., new ser., No. 7, pp. 89-91, fig. 6, 1907; New Jersey Geol. Survey Bull. 3, p. 98, pl. 9, 1911.

Hollick, The Cretaceous flora of southern New York and New England, p. 36, pl. 5, figs. 1–6, 1906.

Thinnfeldia lesquereuxiana Heer, Flora fossilis arctica, vol. 6 Abt. 2, p. 37, pl. 44, figs. 9, 10; pl. 46, figs. 11, 12a, b, 1882.

Hollick, New York Acad. Sci. Trans., vol. 2, p. 99, pl. 3, fig. 6, 1892.

Newberry, The flora of the Amboy clays, p. 59, pl. 11, figs. 1-17, 1896.

Thinnfeldia subintegrifolia (Lesquereux) Knowlton, U. S. Geol. Survey Bull. 152, p. 228, 1898.

Hollick, New York Acad. Sci. Ann., vol. 2, pp. 58, 419, pl. 3, figs. 4, 5, pl. 36, fig. 6, 1898; New York Bot. Garden Bull., vol. 2, p. 403, pl. 41, figs. 13, 14, 1892.

Leaves oblong to linear in outline and coriaceous in texture, from 3 to 17 centimeters in length by 0.6 centimeter to 3 centimeters in width. Apex usually obtuse, rarely pointed. Base decidedly and narrowly cuneate to the short petiole. Margins entire below, above obtusely dentate or undulate, with a few teeth which are acute. Midrib stout below, becoming attenuated above and commonly disappearing some distance below the apex. Laterals numerous, close, immersed; they branch at an angle of about 20°, running nearly straight and approximately parallel to the margin, in places forking. Stomata scattered on both surfaces, with typical guard cells.

[1] Heer, Oswald, Flora fossilis arctica, vol. 7, p. 10, pl. 53, fig. 12, 1883.

[2] Solms-Laubach, H., Fossil botany, p. 61, 1891.

[3] Bertrand, C. E., Soc. bot. France Bull., vol. 30, p. 293, 1883.

[4] Lesquereux, Leo, in Hayden, F. V., U. S. Geol. and Geol. Survey Terr. Ann. Rept. for 1874, p. 337, pl. 4, fig. 8, 1876; The Cretaceous and Tertiary floras, p. 33, pl. 1, fig. 8, 1883.

[5] Engelhardt, Hermann, and Kinkelin, T., Senckenberg. naturf. Gesell Abh., vol. 293, p. 194, pl. 23, figs. 9–13, 1908.

[6] Berry, E. W., Am. Jour. Sci., 4th ser., vol. 25, pp. 382–386, figs. 1–3, 1908.

This widespread species ranges in considerable abundance from Greenland (Atane beds) to New Jersey (Raritan and Magothy formations) and west to Kansas and Nebraska (Dakota sandstone). It was originally referred to *Phyllocladus* by Lesquereux, and his type is almost identical with certain phylloclads of modern members of this genus. Subsequently discovered remains from Kansas are considerably larger than the type, as are also a number of the Greenland specimens. Some of the Raritan forms have a somewhat different aspect, being long and narrow; some of the margins are entire, but many of them are more or less sharply toothed.

Much controversy has centered around these forms and especially around the older Mesozoic forms referred to the genus *Thinnfeldia* Ettingshausen, to which these later forms were once referred. That genus has been referred successively to the conifers, the ferns, and the cycads. There has never been much doubt that the later forms were gymnospermous. I can positively affirm this conclusion, and also that they are true phylloclads and not leaves in the strict morphologic sense.

Whether or not they are closely related to the modern genus *Phyllocladus* is still in doubt, although there are some excellent arguments for such a relationship. Though fossil remains of undoubted relationship to *Phyllocladus* are extremely rare, Gothan[1] has described wood of a similar type from the Jurassic of the east coast of Greenland under the name of *Phyllocladoxylon*. The present species has not heretofore been found in the Coastal Plain south of the New Jersey area, being apparently replaced in the Magothy formation of Maryland by an allied species, *Protophyllocladus lobatus* Berry,[2] which is a very abundant form in the Middendorf arkose member of the Black Creek formation of South Carolina. The Alabama remains consist of scarce fragments of the proximal parts of phylloclads and may possibly represent *Protophyllocladus lobatus*, although they are more like *Protophyllocladus subintegrifolius*. Characteristic remains of the latter have recently been sent to me from Sakhalin Island by M. Kryshtofovich, a Russian paleobotanist.

[1] Gothan, Walter, K. svenska Vet.-Akad. Handl., vol. 42, No. 10, 1907.
[2] Berry, E. W., Torrey Bot. Club Bull., vol. 38, p. 403, 1911.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Genus CUNNINGHAMITES Presl.

Cunninghamites elegans (Corda) Endlicher.

Cunninghamia elegans Corda in Reuss, Versteinerungen der böhmischen Kreideformation, pt. 2, p. 93, pl. 49, figs. 29–31, 1846.

Cunninghamites elegans (Corda) Endlicher, Synopsis Coniferarum, p. 305, 1847.

Berry, U. S. Geol. Survey Prof. Paper 84, p. 106, 1914.

I have recently discussed the occurrence of this form in the Eastern Gulf Cretaceous in the paper cited.

Occurrence: Ripley formation (Cusseta sand member), near Byron, Houston County, Ga.

Collection: U. S. National Museum.

Genus DAMMARA Lamarck.

[Encyclopédie méthodique, vol. 2, p. 259, 1786.]

Dammara borealis Heer.

Dammara borealis Heer, Flora fossilis arctica, vol. 6, Abt. 2, p. 54, pl. 37, fig. 5, 1882.

Velenovsky, Květena českého cenomanu, vol. 7, pl. 1, figs. 28, 29, 1889.

Hollick, New York Acad. Sci. Trans., vol. 12, p. 31, pl. 1, fig. 17, 1892; New York Bot. Garden Bull., vol. 2, p. 402, pl. 41, fig. 6, 1902; The Cretaceous flora of southern New York and New England, p. 37, pl. 2, figs. 2–11 (part), 12–26 (part), 27a, 1907.

Newberry, The flora of the Amboy clays, p. 46, pl. 10, fig. 8, 1896.

Berry, New Jersey Geol. Survey Bull. 3, p. 80, 1911.

——— (not named) Hitchcock, Final report on the geology of Massachusetts, vol. 2, p. 430, pl. 19, figs. 4, 5, 1841.

Heer's description, published in 1882, is as follows:

D. strobilorum squamis coriaceis, radiatum sulcatis, 22 mm. latis, apice obtuse rotundatis, apiculatis, basi attenuatis.

Scalelike organisms from 1 centimeter to 2 centimeters or possibly more in length, rounded distally and showing in some specimens a slightly emphasized apiculate point. Greatly expanded laterally in the upper part to a breadth reaching 2.5 centimeters, abruptly contracted at or about the middle to a cuneate or straight-margined flat peduncle about 5 millimeters in width, with numerous resin canals, approximately parallel with the lateral margins and dying out proximad, filled with an amber-like substance.

Remains of this species were described and figured by Hitchcock in his account of the organic remains found at Gay Head, Marthas Vineyard, as long ago as 1841. He did not name them but remarks: "It seems to me very obvious that these remains must be the seed vessels of some coniferous plants." In 1882 Heer found similar forms in the material from the west coast of Greenland and named and described them, as well as two other very similar forms, and definitely recognized their relation to *Dammara*. Subsequently, they have been recorded from the European Cenomanian by Velenovsky, Krasser, and Beyer, from the Raritan formation of New Jersey by Newberry, and from Long Island and Staten Island by Hollick. They are abundant in the middle part of the Raritan at Woodbridge, N. J., and occur in the upper part of the Raritan (at the same horizon as the beds at South Amboy, N. J.) immediately across the Arthur Kill on Staten Island.

The writer has found these scales in the Matawan formation of Maryland and in the Black Creek formation of North Carolina. They have not yet been detected in the Cretaceous deposits of South Carolina or Georgia and are not common in the Tuscaloosa formation, the only known locality being the one cited from western Alabama where this species is very sparingly represented.

Similar remains have been considered by Heer, White, Krasser, and others as representing the fruits of *Eucalyptus*, but it seems obvious that their relations are definitely with the araucarian conifers.

Occurrence: Tuscaloosa formation, upper ravine and big gully on the Snow place, Tuscaloosa County; Shirleys Mill, Fayette County, Ala.

Collections: U. S. National Museum.

Genus BRACHYPHYLLUM Brongniart.

[Prodrome d'une histoire des végétaux fossiles, p. 109, 1828.]

Brachyphyllum macrocarpum formosum Berry.

Plate V, figure 9.

Brachyphyllum macrocarpum Berry, Torrey Bot. Club Bull., vol. 37, p. 183 (not Newberry, 1896), 1910.

?*Brachyphyllum macrocarpum* Berry, idem, vol. 38, p. 420, 1911.

Brachyphyllum macrocarpum formosum Berry, idem. vol. 39, p. 392, pl. 30, 1912.

Slender elongated twigs, pinnately branched, covered with medium-sized, crowded, appressed leaves, spirally arranged. Leaves bluntly pointed, relatively smooth, thick.

In the consideration of the various specimens that have been referred to *Brachyphyllum macrocarpum* a very considerable variation within certain fixed limits is at once obvious. This variation is usually one of size, the more slender specimens being at the same time more elongated and smoother. This feature has been frequently noted by the writer and is commented upon by Knowlton,[1] who in discussing the younger forms from Wyoming suggests that the species on the verge of extinction became smaller in its proportions. In studying the material from the South Atlantic and Gulf States I noticed a constant difference in size. This difference may reflect a slight difference in climatic conditions, and all the forms may be interpreted as the variations of a single species; in fact, Newberry's figure from the Raritan formation in New Jersey[2] is approximately the same size as the forms from the Montana group of the West and is associated with the normal stout, club-shaped type. That the variety has no particular stratigraphic significance is indicated by its abundance in beds as old as the lower part of the Tuscaloosa and its presence in the Woodbine sand of Lamar County, Tex.

In general, however, the present variety occurs at later and more southern horizons than the type. This difference might be ascribed to the fact that only the slender terminal twigs are preserved, but such an explanation is regarded as improbable, for the same reasoning should hold good for the areas where only thicker twigs have been found.

The remains are usually much macerated and broken, and the immediate cause for the recognition of a new variety was the discovery of a relatively large specimen from the Magothy formation of Maryland, which showed such striking unlikeness to the type that separation was demanded and specific differentiation was

[1] Knowlton, F. H., U. S. Geol. Survey Bull. 163, p. 29, pl. 4, figs. 5, 6, 1900.

[2] Newberry, J. S., U. S. Geol. Survey Mon. 26, pl. 7, fig. 7, 1896.

even considered. In view, however, of the occurrence of both forms in association in Maryland and the well-known variation of not only the type but of coniferous foliage in general, it seemed wiser to consider the present form as a variety of the type, which as time progressed supplanted it to a large extent, if not altogether.

The new specimen from Maryland shows the terminal part of two approximately parallel and curved twigs, about 12 centimeters in length, united proximad. These twigs in their thickest portion are only 6 millimeters in diameter. At intervals of 3 to 5 millimeters subopposite lateral branches are given off in a pinnate manner. These branches are relatively much elongated, curved, and slender, averaging about 4 centimeters in length by 2 millimeters in diameter, bluntly pointed, and not tapering to any appreciable extent. They have been occasionally observed to fork pseudodichotomously, and some of them give off toward their distal ends tiny lateral branchlets less than a centimeter in length and about a millimeter in diameter.

The general proportions are thus decidedly different from the supposed parent type. The leaves are slightly smaller and smoother and somewhat more elongated in their relative proportions, at the same time lacking the apical papilla and the convergent striae. The form is much more graceful than the type in appearance and in its general aspect suggests the Lower Cretaceous genus *Arthrotaxopsis* of Fontaine.

Though tiny species of *Brachyphyllum* like *Brachyphyllum microcladum* Saporta, of the Neo-Jurassic, have been described, the new variety is even more slender than *Brachyphyllum gracile* Brongniart, of the Jurassic. The most closely allied form known appears to be one from the Albian of Buarcos in Portugal described by Saporta [1] as *Brachyphyllum obesiforme elongatum*. There is also considerable resemblance to *Brachyphyllum crassicaule* Fontaine, of the Patapsco formation in Maryland and Virginia.

Remains of this new variety are not at all uncommon in the Tuscaloosa formation, where they range from a horizon near its base in Fayette County up into the basal portion of the Eutaw formation in Hale County and also just east of Chattahoochee River in Georgia. It also occurs in the Magothy formation of Maryland and in the Woodbine sand of Texas.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County; Whites Bluff, Greene County, Ala. Eutaw formation (basal beds), 2 miles south of Havana, Hale County, Ala.; McBrides Ford, Chattahoochee County, Ga.

Collections: U. S. National Museum.

[1] Saporta, Gaston de, Flore fossile du Portugal, p. 176, pl. 31, fig. 14, 1894.

Genus PROTODAMMARA Hollick and Jeffrey.

[Am. Naturalist, vol. 40, p. 199, 1906.]

Protodammara speciosa Hollick and Jeffrey.

Protodammara speciosa Hollick and Jeffrey, Am. Naturalist, vol. 40, p. 199, pl. 1, figs. 5–13; pl. 2, figs. 1–5, 1906; New York Bot. Garden Mem., vol. 3, p. 46, pl. 4, figs. 1–11; pl. 10, figs. 1–3; pl. 14, figs. 1, 4, 5; pl. 15, figs. 1–6; pl. 16, fig. 1, 1909.

Dammara microlepis Hollick (non Heer), New York Acad. Sci. Ann., vol. 11, p. 57, pl. 3, figs. 9a, b, 1898.

Dammara minor Hollick. The Cretaceous flora of southern New York and New England, p. 40, pl. 2, figs. 35–37, 1906.

The description by Hollick and Jeffrey, published in 1906, is as follows:

> Organisms consisting of kite-shaped cone scales, from 4 to 6 millimeters long by 4 to 6 millimeters broad above, abruptly narrowed from about the middle to the base, rounded, incurved, and apiculate above; resin ducts five or more, extending down the lower surface of the limb; seed scars three in number, crescentically arranged above the middle and approximately in the broadest part of the scale, with the central one higher up than the laterals.

These interesting cone scales, of which structural material has been described by Hollick and Jeffrey from the Raritan formation at Kreischerville, Staten Island, and which is recorded by Hollick from the Magothy formation of Block Island, occurs at Shirleys Mill in the Tuscaloosa formation. The dimensions of the specimens from the Tuscaloosa are 4 by 5 millimeters. They are preserved in a plastic clay and show a lunate distal boss, the short apical point being entirely obscured, as it is in most of the similarly preserved specimens figured by Hollick.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Genus GEINITZIA Endlicher.

Geinitzia formosa Heer.

Geinitzia formosa Heer, Zur Kreideflora von Quedlinburg, p. 6, pl. 1, fig. 9; pl. 2, 1871.
Newberry, The flora of the Amboy clays, p. 51, pl. 9, fig. 9, 1896.
Hollick, New York Acad. Sci. Trans., vol. 16, p. 129, pl. 12, figs. 1, 2, 1897.
Knowlton, U. S. Geol. Survey Bull. 163, p. 28, pl. 5, figs. 1, 2, 1900.
Berry, New York Bot. Garden Bull., vol. 3, p. 57, 1903; Torrey Bot. Club Bull., vol. 31, p. 68, figs. 2, 3, 1904; New Jersey Geol. Survey Bull. 3, p. 97, 1911.
Geinitzia sp., Newberry, Lyceum Nat. Hist. New York City Proc., 2d ser., p. 10, 1873.
Sequoia reichenbachi (Geinitz) Heer. Lange, Deutsche geol. Gesell. Zeitschr., vol. 42, p. 660, 1890 (in part).
Stanton and Knowlton, Geol. Soc. America Bull., vol. 8, p. 137, 1897.
Sequoia gracillima (Lesquereux) Newberry, The flora of the Amboy clays, pl. 9, figs. 1–3, 1896 (not foliage described on p. 50).
Berry, New York Bot. Garden Bull., vol. 3, p. 57, pl. 48, figs. 21, 22, 1903; Torrey Bot. Club Bull., vol. 31, p. 69, pl. 2, 1904; Am. Geologist, vol. 34, pl. 15, 1904; Torrey Bot. Club Bull., vol. 32, p. 44, 1905; idem, vol. 33, p. 165, 1906; New Jersey Geol. Survey Ann. Rept. State Geologist for 1905, p. 139, 1906.

Heer's description, published in 1871, is as follows:

Strobili ovato-cylindrici, squamis rachi validae spiraliter insertis, apice peltatis, disco concavo, margine crenato, toroso; semina sub quavis squama quatuor (?), squamarum stipite crasso inserta, striata.

G. formosa, ramulis elongatis, virgatis, foliis omnino tectis, foliis subfalcatis, angustis, apice valde attenuatis, uninerviis, ramis adultis pulvinis rhombeis obtectis.

The American occurrences of cones of this species have heretofore been referred to *Sequoia gracillima* Newberry, a composite made up of *Geinitzia* cones and *Widdringtonites* foliage. These cones are exceedingly abundant in the Magothy formation at Cliffwood Bluff, N. J., where those that are more or less pyritized are washed out of the clays by storms and high tides. When preserved as flattened lignitic inclusions they are somewhat different in appearance, and it is believed that lignitic material of this species is the basis for the Raritan forms which were identified as *Microzamia gibba* Corda by Newberry.[1] A doubtful fragment and another somewhat more definite cone are contained in the Tuscaloosa collections made by me at Shirleys Mill, Ala.

[1] Newberry, J. S., The flora of the Amboy clays: U. S. Geol. Survey Mon. 26, p. 45, pl. 12, figs. 6, 7, 1896.

The foliage, which resembles somewhat that of *Sequoia reichenbachi* (Geinitz) Heer, as well as that of *Cunninghamites squamosus* Heer, shows rather thick twigs with slender curved needle leaves interspersed with small scale-like leaves. It has been found at a number of localities in this country and is represented in the Tuscaloosa formation by a single doubtful specimen.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County; Cottondale, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

Genus ARAUCARIA Jussieu.

Araucaria bladenensis Berry.

Plates IX, X.

Araucaria bladenensis Berry, Torrey Bot. Club Bull., vol. 35, p. 255, pls. 12–14, figs. 1–3, 1908.
(?) Berry, idem, vol. 38, p. 405, 1911.

Foliage dense, phyllotaxy spiral, leaves decurrent, coriaceous, ovate-lanceolate, about 1.6 by 8 centimeters, the base rounded, apex thickened, cuspidate; veins immersed, averaging 16 in number, straight, parallel, stomata small, in rows on ventral surface.

Leaves ranging from 1 centimeter to 2.8 centimeters in length by 0.5 centimeter to 1.2 centimeters in width, averaging 1.6 centimeters by 0.8 centimeter, obovate in outline, with a broad rounded base narrowing abruptly and decurrent; the blade broadest about one-third of the distance from the base, above which point it narrows sharply to a thickened cuspidate tip; phyllotaxy spiral; leaf substance represented by a thick sheet of lignite about 0.5 millimeter thick, in which the veins are immersed. These veins average 14 to 16 in number, although in a few specimens there are as many as 20; they are stout, incurved at the base (forking not observed), but become parallel and run directly upward until they abut against the leaf margin—that is, they are not convergent toward the tip of the leaf. In spite of their striking megascopic appearance their microscopic structure is not preserved.

One or two rather inferior specimens, which are in a more argillaceous matrix, show the arrangement and outlines of the stomata, which are broadly ovate in shape with very thin guard cells (at least when viewed on the surface). They are arranged in somewhat

irregular rows on the ventral surface of the leaf, the number of rows between the two veins being usually four. Aside from the foregoing facts, the preservation is such that no other details can be made out.

This species is most remarkably similar to the living *Araucaria bidwilli* of the Australian region. This resemblance in form, habit, and stomatal characters, reinforced by the occurrence of characteristic araucarian cone scales in the same beds at certain localities, renders the identification reasonably conclusive.

The most nearly related form seems to be *Araucarites ovatus* described by Hollick[1] from the "Cliffwood clay" (Magothy formation) of New Jersey, which differ merely by their larger size, absence of basal characters, and much less pointed tips; in fact, if the two were found in closer association or if in the abundant material any specimens had approached *Araucarites ovatus* in size I would be disposed to consider them as the variants of a single species. It seems better, however, to institute a new species, as the leaves in the material from the southern Coastal Plain are sufficiently and uniformly different enough to be readily recognized, and there is the further possibility that the New Jersey species may be more or less closely related to the modern genus *Dammara* rather than *Araucaria*.

A European form, which must surely be considered as a nearly related congener of *Araucaria bladenensis*, is Saporta's *Araucaria toucasi* described from the Turonian of Beausset near Toulon, France.[2] This species is strikingly similar to the American species in every respect and is likewise closely allied, in appearance at least, to the living *Araucaria bidwilli* of Australia.

Kerner[3] records *Pachyphyllum* (*Pagiophyllum*) *rigidum* Saporta and *Pachyphyllum* (*Pagiophyllum*) *araucarium* Saporta from the Cenomanian of Lesina, an island in the Adriatic off the coast of Dalmatia, both being originally Jurassic species from the French Coralline of Verdun. Both are very similar to the American species and are about the same age. The probable identity of Cenomanian and Coralline species seems extremely doubtful, and both of Kerner's species should undoubtedly be considered as new species of *Araucaria*, and nearly related to if not identical with such Cretaceous forms as *Araucaria bladenensis* or *Araucaria toucasi*. This species is exceedingly common in and characteristic of the Black Creek formation in North Carolina. In South Carolina it is found in the extension of these beds. It is present in the lower part of the Eutaw formation and in later Cretaceous deposits in western Georgia and along Chattahoochee River. Careful search has failed to discover this species in the fossiliferous plant beds of western Alabama of Tuscaloosa age, but it is present in great abundance at the very base of the Eutaw deposits in Hale County. Recent collections have shown it to be present in the Magothy formation in Maryland.

Occurrence: Eutaw formation (basal beds), 2 miles south of Havana, Hale County, Ala.; Chimney Bluff, Chattahoochee County, Ga. Ripley formation (Cusseta sand member), Buena Vista, Marion County, Ga.

Collections: U. S. National Museum.

Araucaria jeffreyi Berry.

Araucaria jeffreyi Berry, Torrey Bot. Club Bull., vol. 35, p. 258, pl. 16, 1908; U. S. Geol. Survey Prof. Paper 84, p. 105, 1914.

These cone scales were completely described in the papers cited and need not be discussed here.

Occurrence: Eutaw formation, Chimney Bluff, Chattahoochee County, Ga. Ripley formation (Cusseta sand member), near Byron, Houston County, Ga.

Collections: U. S. National Museum.

Genus ANDROVETTIA Hollick and Jeffrey.

Androvettia carolinensis Berry.

Plate VII, figures 1–10.

Androvettia carolinensis Berry, Torrey Bot. Club Bull., vol. 37, p. 183, pl. 19, figs. 1–6, 1910.

Remains of leafy twigs, consisting of much flattened, phylloclad-like, opposite twigs, the leaves on the flat surfaces being reduced to mere points and not visible without magnification, the marginal leaves strictly opposite, with a regular alternation of a blunt dentate lobe, which probably represent reduced lateral twigs and a serrate point, the two fused proxi-

[1] Hollick, Arthur, New York Acad. Sci. Trans., vol. 16, p. 128, pl. 12, figs. 3a, 4, 1897.

[2] Saporta, G. de, Le monde des plantes avant l'apparition de l'homme, p. 198, fig. 27, 1879.

[3] Kerner, F. von, K.-k. geol. Reichsanstalt Jahrb., Band 45, p. 49, pl. 4, figs. 1, 3, 1895.

mad. Venation, consisting of immersed vascular bundles, not seen except in a strong transmitted light. The midvein is strong and straight, the visible lateral veins, which are the midveins of the coalesced leaves and lateral twigs, are pinnately arranged and single in the pointed leaves. In the round lobes they are usually dichotomously forked, but in this form the marginal lobes probably represent coalesced leaves of reduced lateral twigs. Their angle of divergence is greater than in *Androvettia statenensis* Hollick and Jeffrey and the whole arrangement is more distinctly cyclic in character. The texture is very coriaceous; the epidermal cells are, however, large in size, though with thick walls. The stomata are fairly numerous, apparently on both surfaces, and consist of the familiar sausage-shaped guard cells surrounded by four accessory cells.

The general appearance of this species is even more fernlike than is the type of the genus, one reason being its smaller size and the absence in the collected material of the supposed male aments found in connection with some specimens of the Staten Island species. The present species was described by the writer from the exposures of the Black Creek formation on Tar River in North Carolina and is considerably younger than the Staten Island form.

This remarkable genus was erected by Hollick and Jeffrey[1] for the reception of a single species discovered recently in the upper part of the Raritan formation near Kreischerville, Staten Island, and these authors content themselves with a very good account of this species and refrain from framing a generic diagnosis.

These remains are all entirely fernlike in superficial appearance, uniformly coriaceous in texture, and from the details of their external characters and internal structure are indubitable gymnosperms of the order Coniferales. Their positive reference to the Araucarineae by Hollick and Jeffrey will, however, undoubtedly be questioned by many students. The North Carolina remains are not common and are confined to a single locality on Tar River. The lateral leaves along the edges of phylloclad-like twigs are markedly opposite, but the scale leaves on its flat surfaces are much more reduced than in *Androvettia statenensis* and can not be made out at all except in microscopic preparations of the epidermis, when they are seen to be reduced to mere points of termination of certain leaf traces. The lateral twigs are strictly opposite, as is the course of the vascular bundles, which consist of a regular alternation of opposite simple bundles and dichotomously forked bundles. The remains of a third species described by the writer as *Androvettia elegans* and collected from the basal part of the Eutaw formation in western Georgia, vary from *Androvettia statenensis* in the other direction and scarcely merit the term phylloclad-like; the leaves both marginal and surficial are opposite and well developed, very regular, with a vascular arrangement like that of the present form. They are distichous and opposite on a naked stem, which is thus more fernlike in appearance than either of the other two species. As the anatomy of these forms has not yet been studied the reader is referred to the memoir cited above, where the histology of the Staten Island form is discussed.

Regarding the systematic position of this genus, as already remarked, their relationship with the Araucarian group of conifers is questionable. They seem clearly distinct from *Phyllocladus*, and they are equally distinct from the various species of *Protophyllocladus* which have been recorded from the Raritan and the later Cretaceous formations of North America. They seem equally distinct from *Thinnfeldia* but may eventually prove to be related to *Moriconia*.

The Mississippi occurrence of this species is based upon fragmentary but characteristic specimens which are even smaller and more broken than is the type material from North Carolina. When the extremely coriaceous nature of this foliage and its almost complete maceration are considered in connection with its known range of about 600 miles in an air line and almost twice that distance along the Upper Cretaceous coast line, there seems to be a plausibility in attributing its scarcity and absence in the intervening region to its having lived in areas remote from those in which sediments were being deposited. The broken condition of the remains would thus be due to the length of time they had been in the water in their stream journey from their inland and possibly also upland habitat.

Occurrence: Tuscaloosa formation, cut on Southern Railway, $1\frac{5}{8}$ miles east of Iuka,

[1] New York Bot. Garden Mem., vol. 3, p. 22, 1909.

Tishomingo County, Miss. (collected by L. W. Stephenson).

Collection: U. S. National Museum.

Androvettia elegans Berry.

Androvettia elegans Berry, U. S. Geol. Survey Prof. Paper 84, p. 103, pl. 18, figs. 1–10, 1914.

This form is allied to *Androvettia carolinensis* and was recently described by the writer in the publication cited.

Occurrence: Eutaw formation (basal beds), McBrides Ford, Chattahoochee County, Ga.

Collection: U. S. National Museum.

Genus ABIETITES Hisinger.

Abietites foliosus (Fontaine) Berry.

Leptostrobus foliosus Fontaine, The Potomac or younger Mesozoic flora, p. 230, pl. 101, fig. 4; pl. 103, fig. 5; pl. 104, fig. 1, 1889; Status of the Mesozoic floras of the United States, p. 482, 1905.

Abietites foliosus (Fontaine) Berry, U. S. Nat. Mus. Proc., vol. 40, p. 314, 1911; Maryland Geol. Survey, Lower Cretaceous, p. 408, 1911.

Laricopsis longifolia Fontaine, The Potomac or younger Mesozoic flora, p. 233, pl. 102, figs. 7, 8; pl. 103, figs. 2, 3; pl. 165, fig. 4; pl. 168, figs. 5, 6, 1889; U. S. Nat. Mus. Proc., vol. 16, p. 268, pl. 36, fig. 9, 1893 (?); Status of the Mesozoic floras of the United States, p. 312, pl. 73, figs. 11, 14, 1905.

Leaves long and slender, 0.5 to 1 millimeter in width, full length not seen, at least several centimeters, much crowded; seen to be in bundles, where the preservation is fairly good, on stout, dichotomously forked twigs.

This species is clearly distinct from the other species of *Abietites*. It is not fully characterized because of the poorness of preservation, as evinced by the fact that the leaves are detached in a number of the specimens collected. The forms which were the basis for *Laricopsis longifolia* Fontaine have been united with the species, as they are indistinguishable and probably identical in character.

This species occurs in both the Patuxent and Patapsco formations of the Potomac group of Virginia, and it has also been recorded from the Kootenai formation of Montana. The fragment from the Trinity group of Texas, which Fontaine identified with such certainty, is, in the writer's judgment, absolutely untrustworthy. Characteristic remains are common at a single locality in the Tuscaloosa formation. Their significance in correlation is somewhat minimized, however, by the occurrence in the Magothy formation of remains very similar to these which I have described as *Pinus delicatulus*.[1] They may be compared with the foreign material described by Heer as *Pinus quenstedti*.

Occurrence: Tuscaloosa formation, big gully and upper ravine on the Snow place, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Genus SEQUOIA Endlicher.

[Synopsis coniferarum, p. 197, 1847.]

Sequoia reichenbachi (Geinitz) Heer.[2]

Plate VI, figure 2.

Araucarites reichenbachi Geinitz, Charakteristik der Schichten und Petrefakten des sächsisch-böhmischen Kreidegebirges, pt. 3, p. 98, pl. 24, fig. 4, 1842.

Sequoia reichenbachi (Geinitz) Heer, Flora fossilis arctica, vol. 1, p. 83, pl. 43, figs. 1d, 2b, 5a, 1868.

Fontaine, The Potomac or younger Mesozoic flora, p. 243, pl. 118, figs. 1, 4; pl. 119, figs. 1–5; pl. 120, figs. 7, 8; pl. 122, fig. 2; pl. 167, fig. 5, 1889.

Nathorst, in Felix and Lenk, Beiträge zur Geologie und Paleontologie der Republik Mexico, p. 52, figs. 4, 5, 1893.

Fontaine, in Ward, U. S. Geol. Survey Nineteenth Ann. Rept., pt. 2, p. 674, pl. 165, figs. 1, 2; pl. 166, fig. 1, 1899; Status of the Mesozoic floras of the United States, pp. 177, 263, 281, 544, pl. 55, figs. 7, 8; pl. 69, figs. 4, 5, 1905.

Lesquereux, The Cretaceous flora, p. 51, pl. 1, figs. 10–10b, 1874; The flora of the Dakota group, p. 35, pl. 2, fig. 4, 1892.

Engelhardt, Naturwiss. Gesell. Isis in Dresden Abh. 7, Jahrg. 1891, p. 91, 1892.

Hollick, New York Acad. Sci. Trans., vol. 12, p. 30, pl. 1, fig. 18, 1892; The Cretaceous flora of southern New York and New England, p. 42, pl. 2, fig. 40; pl. 3, figs. 4, 5, 1907.

Newberry, The flora of the Amboy clays, p. 49, pl. 9, fig. 19, 1896.

Berry, New York Bot. Garden Bull., vol. 3, p. 59, pl. 48, figs. 15–18, 20, 1903; Torrey Bot. Club. Bull., vol. 31, p. 69, pl. 4, fig. 8, 1904; idem, vol. 32, p. 44, pl. 1, fig. 3, 1905; idem, vol. 33, p. 165, 1906; New Jersey Geol. Survey Bull. 3, p. 93, 1911; Maryland Geol. Survey, Lower Cretaceous, p. 444, pl. 77, fig. 7, 1911.

Knowlton, Smithsonian Misc. Coll., vol. 4, pt. 1, p. 126, pl. 12, figs. 7, 8, 1907; U. S. Geol. Survey Mon. 32, p. 657, 1899; U. S. Geol. Survey Bull. 257, p. 131, pl. 14, figs. 3–5, 1905.

Araucaria reichenbachi (Geinitz) Heer. Debey, Entwurf geognostisch-geogenetischen Darstellung den Gegend von Aachen, Nachtrage, 1849.

Sequoia reichenbachi longifolia Fontaine, The Potomac or younger Mesozoic flora, p. 244, pl. 117, fig. 8, 1889.

[1] Berry, E. W., Torrey Bot. Club Bull., vol. 31, p. 68, pl. 1, fig. 12, 1904.

[2] Only representative citations, chiefly American, of this widespread and persistent species are given.

Sequoia densifolia Fontaine, The Potomac or younger Mesozoic flora, p. 246, pl. 121, fig. 4, 1889.

Sequoia? sp. Fontaine, The Potomac or younger Mesozoic flora, p. 248, pl. 116, fig. 7; pl. 132, figs. 2, 5, 6, 1889.

Sequoia sp. Fontaine, The Potomac or younger Mesozoic flora, p. 248, pl. 132, fig. 10, 1889.

Sequoia? inferna Ward. Fontaine, in Ward, Status of the Mesozoic floras of the United States, p. 507, 1905.

Sequoia couttsiae Heer. Hollick, New York Acad. Sci. Trans., vol. 12, p. 30, pl. 1, fig. 5, 1892.

This species has a recorded range on this continent from the supposed Neocomian of Mexico to the Livingston formation of Montana, being very abundant at numerous horizons, and it has likewise been identified from Greenland and Europe. The view has frequently been voiced that some at least of these identifications are erroneous, which is probable enough, although the Tertiary *Sequoia langsdorfii* has an almost equally wide range, both geologic and geographic. In a memoir recently published, Hollick and Jeffrey[1] present their studies of the anatomy of some twigs of the *Sequoia reichenbachi* type from the upper part of the Raritan formation of Staten Island. According to these authors their results indicate that these remains are referable to the genus *Geinitzia* and are araucarian in their affinity, a view which has been tentatively suggested by numerous students since the days of Geinitz, who referred them to the genus *Araucarites*. In order to make out a good case Hollick and Jeffrey are under the necessity of finding araucarian characters in certain associated cone scales of the *Sequoia* type, as these supposed araucarian twigs frequently are found with *Sequoia*-like cones attached to them. This they do, referring these cone scales to new genera which they term *Eugeinitzia* and *Pseudogeinitzia*, although the evidence for an araucarian affinity is extremely slender.

As might be expected from their great range, fossils of the *Sequoia reichenbachi* type are of slight stratigraphic value; nevertheless the remains are very abundant from New Jersey to Alabama at the Magothy, Black Creek (including Middendorf), Tuscaloosa, and Eutaw horizon, apparently identical in character and commonly cone bearing, the cones being small, a prolate spheroid in shape, and consisting of relatively few, peltate, umbilicate, *Sequoia*-like scales. *Sequoia* twigs are very resistant to maceration, and commonly are about the last vegetable remains to disintegrate in marine waters.

This species is rare in the Raritan formation but common at later Upper Cretaceous outcrops in New Jersey, Delaware, Maryland, North Carolina, South Carolina, Georgia, and Alabama. In Alabama it has been found from the lower third of the Tuscaloosa formation upward through the Eutaw formation. It is not commonly represented in the earliest Tuscaloosa sediments, where it appears to be replaced by *Sequoia ambigua* Heer and species of *Widdringtonites*. How far its absence represents merely accidents of preservation can not be determined. Material that may represent this species but in a much macerated and not positively determinable condition occurs near the base of the Tuscaloosa formation near Cottondale, in Tuscaloosa County, Ala. Toward the top of the Tuscaloosa and in the basal part of the Eutaw formation it is very common.

Occurrence: Tuscaloosa formation, big gully on the Snow place and upper beds at Cottondale (?), Tuscaloosa County; Whites Bluff, Greene County, Ala. Cut on Southern Railway, 1⅝ miles east of Iuka, Tishomingo County, Miss. (common). Eutaw formation (basal part), 2 miles south of Havana, Hale County, Ala.; McBrides Ford, Chimney Bluff, Broken Arrow Bend, Chattahoochee County, Ga.

Collections: U. S. National Museum.

Sequoia heterophylla Velenovsky.

Sequoia heterophylla Velenovsky, Die Gymnospermen der böhmischen Kreideformation, p. 22, pl. 12, fig. 12; pl. 13, figs. 2–4, 6–9, 1885; K. böhm. Gesell. Wiss. Sitzungsber., 1888, p. 593, figs. 7, 8. (Not Smith, E. A., On the geology of the Coastal Plain of Alabama, p. 348, 1894.)

Engelhardt, Naturwiss. Gesell. Isis in Dresden Abh. 7, Jahrg. 1891, p. 104, 1892 (?).

Hollick, New York Acad. Sci. Trans., vol. 12, p. 3, pl. 1, fig. 18, 1892; The Cretaceous flora of southern New York and New England, p. 41, pl. 3, figs. 2, 3, 1906.

Ward, U. S. Geol. Survey Fifteenth Ann. Rept., pp. 378, 380, 382, 392, 1895.

Newberry, The flora of the Amboy clays, p. 49, pl. 6, figs. 1–13, 1896.

Knowlton, U. S. Geol. Survey Bull. 257, p. 132, pl. 16, fig. 5, 1905.

Berry, Torrey Bot. Club Bull., vol. 33, p. 165, 1906; idem, vol. 34, p. 189, 1907; New Jersey Geol. Survey Ann. Rept. for 1905, p. 139, 1906; New Jersey Geol. Survey Bull. 3, p. 95, pl. 6, 1911.

This characteristic species, described originally from the Cenomanian and Emscherian of

[1] Hollick, Arthur, and Jeffrey, E. C., New York Bot. Garden Mem., vol. 3, p. 38, pl. 5, 1909.

Bohemia, may be readily recognized by the form of the foliage—the flat, lanceolate, decurrent leaves above, and the short and appressed leaves below. Newberry says of this species that it is "one of the most common conifers of the Amboy clays," but he mentioned no localities. I have found it only in the upper part of the Raritan formation at South Amboy, N. J., where it is very common, and at a still higher horizon in the Raritan, at the Hylton Pits, and it has been collected by Hollick from a probably equivalent horizon at Kreischerville, Staten Island.

In the overlying Magothy formation it is a common species, and its recorded range extends from Marthas Vineyard to Maryland. It also occurs in the allied Black Creek formation of North Carolina. In the West it is said to occur in the Judith River formation of Montana.

In 1888 Velenovsky described additional twigs of this species and cones from the Cenomanian of Hloubětín, Bohemia, although he does not state that they were attached. The cones were of small size, 2.3 by 1.5 centimeters, elliptical in outline, and were made up of a relatively small number of slender, rhomboidal, umbilicate scales of the *Sequoia* type.

In the Alabama area *Sequoia heterophylla* was identified by Ward in collections from the Snow place, Tuscaloosa County, and recorded from there by Smith in 1894.[1] This determination was erroneous, however, as the material lacks the dimorphism of this species, and in its venation shows that it is identical with *Dicksonia groenlandica* Heer. Typical specimens of *Sequoia heterophylla* have been collected by the writer, however, from the Tuscaloosa formation.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County; Whites Bluff, Greene County, Ala.

Collections: U. S. National Museum.

Sequoia ambigua Heer.

Plate VI, figures 3, 4.

Sequoia ambigua Heer, Flora fossilis arctica, vol. 3, pt. 2, pp. 78, 91, pl. 21, figs. 1–11; pl. 25, fig. 5, 1874; vol. 6, pt. 2, pp. 17, 52, pl. 1, fig. 3, 1882.

Fontaine, The Potomac or younger Mesozoic flora, p. 245, pl. 118, fig. 2; pl. 120, figs. 1–6; pl. 127, fig. 5; pl. 132, fig. 3, 1889.

Nathorst, in Felix and Lenk, Beiträge zur Geologie und Paleontologie der Republik Mexico, p. 51, figs. 1–3, 1893.

Fontaine, in Ward, Status of the Mesozoic floras of the United States, pp. 272, 281, 538, pl. 69, fig. 6; pl. 110, fig. 13, 1905.

Berry, Maryland Geol. Survey, Lower Cretaceous, p. 449, pl. 78, figs. 1–7, 1911.

Sphenolepidium recurvifolium Fontaine, The Potomac or younger Mesozoic flora, p. 258, pl. 128, figs. 2–6; pl. 129, fig. 5; pl. 130, figs. 4–6, 10, 1889.

Fontaine, in Ward, Status of the Mesozoic floras of the United States, pp. 484, 528, 538, 546, 555, 1905.

Sequoia gracilis Fontaine, in Ward, U. S. Geol. Survey Nineteenth Ann. Rept., pt. 2, p. 675, pl. 166, fig. 2, 1899.

Arthrotaxopsis expansa Fontaine, in Ward, Status of the Mesozoic floras of the United States, pp. 533, 535, 538, 555, 573, pl. 109, figs. 12, 13 (not pp. 504, 520, 547, 571), 1905.

Remains of the foliage of this species are distinguishable from those of contemporaneous conifers, which occur in the beds with them, by the relatively short and very stout, acuminate, falcate, or recurved, decurrent leaves.

The cones are spherical and consist of relatively few, short scales with longitudinally striated peduncles and suddenly expanded, quadrangular, peltate, umbilicate tips. These cones are abundant in the Lower Cretaceous of Maryland, occurring usually as detached ferruginized mud casts, and are fully described by the writer elsewhere.[2]

As recorded in the literature cited above, *Sequoia ambigua* is widely distributed geographically, and it has an equally great geologic range. It was described originally from the Kome beds (Barremian) of Greenland by Heer, and this author soon afterward recorded it from the Upper Cretaceous Atane beds of that country. It has been recorded by Nathorst from the supposed Neocomian of Mexico and it is present in the Kootenai formation of Montana. It is a member of the Shasta flora of the Pacific coast (Horsetown formation) and is probably represented in the Fuson shale of eastern Wyoming by what Fontaine calls *Sequoia gracilis*. In the Upper Cretaceous, remains in every way identical with these Lower Cretaceous occurrences are present in the Magothy formation at Gay Head, Marthas Vineyard, and at a number of localities in Maryland, as well as in the Tuscaloosa formation of Alabama. After much comparison and

[1] Smith, E. A., On the geology of the Coastal Plain of Alabama, p. 348, Alabama Geol. Survey, 1894.

[2] Berry, E. W., Maryland Geol. Survey, Lower Cretaceous, p. 449, pl. 78, figs. 1–7, 1911.

study the writer is unable to formulate good characters for the separation of the later from the earlier Cretaceous forms of this species.

The Upper Cretaceous forms resemble greatly some of the homotaxial remains referred by Heer and others to *Sequoia subulata* Heer and to *Sequoia fastigiata* (Sternberg) Heer. They are, however, different from the types of both of these species, and it seems probable that the later identifications include diverse species under these names. The fragments figured in 1876 by Lesquereux from the Dakota sandstone as *S. fastigiata* are also quite similar to the Alabama specimens. The species has recently been fully discussed and illustrated by the writer.[1]

Occurrence: Tuscaloosa formation, upper ravine and foot of big gully on the Snow place, Tuscaloosa County, Ala. (common). Eutaw formation, 2 miles south of Havana, Hale County, Ala.

Collections: U. S. National Museum.

Sequoia fastigiaa (Sternberg) Heer.

Caulerpites fastigiatus Sternberg, Versuch einer geognostisch-botanischen Darstellung der Flora der Vorwelt, vol. 2, p. 23, 1833.

Sequoia fastigiata (Sternberg) Heer, Flora von Moletein in Mähren, p. 11, pl. 1, figs. 10–13, 1869; Flora fossilis arctica, vol. 3, pt. 2, pp. 102, 128, pl. 27, figs. 5, 6; pl. 38, figs. 12, 13, 1874; idem, vol. 6, pt. 2, p. 53, pl. 3, figs. 7–9; pl. 17, fig. 4; pl. 28, fig. 6, 1882; idem, vol. 7, p. 15, pl. 51, figs. 11, 12; pl. 53, figs. 3, 4, 1883.

Lesquereux, U. S. Geol. and Geog. Survey Terr. Bull., vol. 1, p. 391 (1875), 1876; U. S. Geol. and Geog. Survey Terr. Ann. Rept. for 1874, p. 335, pl. 3, figs. 2, 8, 1876; The Cretaceous and Tertiary floras, p. 31, 1883.

Velenovsky, Die Gymnospermen der böhmischen Kreideformation, p. 21, pl. 8, fig. 13; pl. 9, figs. 3, 4, 9, 10; pl. 11, figs. 1, 2; pl. 12, fig. 13, 1885.

Hollick, The Cretaceous flora of southern New York and New England, p. 43, pl. 3, fig. 15, 1906.

Thuites alienus Sternberg, idem, vol. 1, pl. 45, fig. 1, 1833.

Widdringtonites fastigiatus (Sternberg) Endlicher, Synopsis coniferarum, p. 272, 1847.

Goeppert, Monographie der fossilen Coniferen, p. 176, 1850.

Unger, Genera et species plantarum fossilium, p. 342, 1850.

Remains that are supposed to represent this species are recorded from the Cenomanian of Moravia and Bohemia, the Cretaceous of Greenland and Spitzbergen, the Dakota sandstone of Kansas, and the Magothy formation on Marthas Vineyard. The students who have described this form may possibly have confused it with *Sequoia gracilis* Heer and *Sequoia concinna* Heer, as well as with other supposed species of *Sequoia* and *Widdringtonites*. A revision of all of these similar if not in part identical forms would be desirable but should not be attempted without abundant and representative material from the different countries. Specimens identical with what has been called *Sequoia fastigiata* occur in the lower part of the Tuscaloosa formation, where they are associated with forms of similar appearance but of larger size, which are referred to *Sequoia ambigua* Heer, and with smaller forms shown by their cones to be *Widdringtonites subtilis* Heer. I doubt very much the specific integrity of *Sequoia fastigiata*, but until the whole question can be revised unnecessary changes are undesirable. Similar foliar remains from the Bingen formation in Arkansas have been referred to *Sequoia concinna* Heer because of the associated cones.[2]

Occurrence: Tuscaloosa formation, big gully on the Snow place, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Genus WIDDRINGTONITES Endlicher.

[Synopsis coniferarum, p. 271, 1847.]

Widdringtonites subtilis Heer.

Plate VIII, figures 1–12.

Widdringtonites subtilis Heer, Flora fossilis arctica, vol. 3, Abt. 2, p. 101, pl. 28, fig. 1b, 1874; idem, vol. 6, Abt. 2, pl. 7, figs, 14, 15; pl. 28, fig. 4b, 1882.

Newberry, The flora of the Amboy clays, p. 57, pl. 10, figs. 2–4, 1896.

Hollick, The Cretaceous flora of southern New York and New England, p. 45, pl. 4, figs, 2–5, 1906.

Berry, New Jersey Geol. Survey Bull. 3, p. 89, 1911; Torrey Bot. Club Bull., vol. 39, pp. 341–348, pls. 24, 25, 1912.

Widdringtonites reichii (Ettingshausen) Heer. Hollick, New York Acad. Sci. Ann., vol. 11, p. 58, pl. 3, fig. 8, 1898.

Berry, Johns Hopkins Univ. Circ., new ser., No. 7, p. 81, 1907.

This species was described from the Atane beds of Greenland by Heer in 1874. His mate-

[1] Berry, E. W., Maryland Geol. Survey, Lower Cretaceous, p. 449, pl. 78, figs. 1–7, 1911.

[2] Berry, E. W., Torrey Bot. Club Bull., vol. 43, p. 172, pl. 7, figs. 1–5, 1917.

rial was, however, extremely scanty. Subsequently it was found in considerable abundance in the Raritan formation of New Jersey, and still more recently Hollick has recorded it from Marthas Vineyard and Block Island (Magothy formation). I have found it in the Magothy formation of Maryland and the Middendorf arkose member of the Black Creek formation of South Carolina. Possibly also some of the coniferous material described by Velenovsky from the Bohemian Cretaceous under other names should be compared with the present form.

The material from the Tuscaloosa formation is abundant, especially so at the locality known as the Snow place, and enables us to make a considerable addition to the knowledge of this species, which may be described as follows: Twigs slender, relatively short, somewhat lax in habit. Foliage somewhat dimorphic, at least the leaves on the young shoots are quite different in appearance from those on the older twigs. Young leaves short, thick, and directed distad, ovate, and appearing bluntly rounded apically because of the inwardly directed pointed tip, 0.5 to 1 millimeter in length, having the appearance of a cyclic phyllotaxy but really arranged spirally. With age the leaves become elongated basally and somewhat spreading, at times falcate. The old leaves are two or three times as long as the young leaves, and as they are about the same thickness they are relatively much more slender and needle-like. The twig enlarged in Plate VIII shows the two kinds of leaves. The degree of spreading or appression differs in different specimens, owing probably in some measure to the conditions attending fossilization. A form with uniformly slender and spreading leaves is common at Shirleys Mill, a twig of which is shown in figure 5. In his discussion of this species Newberry mentions a vague cone about 1 centimeter in diameter as included in the Raritan material. I have not seen this specimen, but I have found a number of poorly preserved detached cones among the abundant remains of this species in the Upper Cretaceous beds of South Carolina. A number of specimens from the Tuscaloosa formation have these cones attached to the characteristic twigs of this species. These cones are terminal, roughly spheroidal in outline, and apparently consist of four thick, subequal scales with wide blunt tips and somewhat extended bases. They are 7 centimeters to 9 millimeters in length and 4 or 5 millimeters in diameter, and are closely comparable to the cones from the Upper Cretaceous of eastern Europe ascribed to *Widdringtonites reichii* by both Velenovsky and Krasser. These authors refer this form directly to the genus *Widdringtonia*, and it would seem that the cones attached to the Alabama specimens of *Widdringtonites subtilis* conclusively demonstrate the relationship between a number of these Mesozoic conifers and the existing species of *Callitris*, *Widdringtonia*, and *Frenela*, which Eichler lumps into the single genus *Callitris* Ventenat.

At the present time they constitute a small group confined to the Australian region on the one hand (*Frenela*) and to northern Africa (*Eucallitris*) and southern Africa and Madagascar (*Widdringtonia*) on the other. In former geologic periods they were much more abundant. *Frenelopsis* is recorded in America from Greenland to Texas, and *Widdringtonites* from Greenland to Alabama. Abroad both types occur abundantly in central and western Europe. Like so many other types of plants which were widespread in Mesozoic time, they became more and more restricted in their range during the Tertiary until to-day they are not found at all in the Western Hemisphere. As regards Cretaceous species of *Widdringtonites*, 4 occur in the Neocomian, 1 in the Barremian, 1 in the Albian, 3 in the Cenomanian, and 1 in the Senonian.

The present species has much shorter twigs than the Upper Cretaceous species, *Widdringtonites reichii* (Ettingshausen) Heer, or the late Lower Cretaceous species, *Widdringtonites ramosus* (Fontaine) Barry.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County; upper ravine and foot of big gully on the Snow place, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

Widdringtonites reichii (Ettingshausen) Heer.

Frenelites reichii Ettingshausen, Die Kreideflora von Niederschoena in Sachsen, p. 12, pl. 1, figs. 10a-c, 1867.

Hollick, New York Acad. Sci. Trans., vol. 12, p. 29, pl. 1, fig. 23, 1892.

Widdringtonites reichii (Ettingshausen) Heer, Flora fossilis arctica, vol. 6, pt. 2, p. 51, pl. 28, fig. 5, 1882; idem, vol. 7, p. 13, pl. 52, figs. 4, 5, 1883.

Smith, On the geology of the Coastal Plain of Alabama, p. 348, 1894.

Newberry, The flora of the Amboy clays, p. 57, pl. 8, figs. 1–5, 1896.

Berry, Torrey Bot. Club Bull., vol. 33, p. 169, 1906; New Jersey Geol. Survey Ann. Rept. for 1905, p. 138, 1906; New Jersey Geol. Survey Bull. 3, p. 87, pl. 8, figs. 1, 2, 1911.

Hollick, The Cretaceous flora of southern New York and New England, p. 44, pl. 4, figs. 6–8, 1906.

Widdringtonia reichii (Ettingshausen) Velenovsky, Die Gymnospermen der böhmischen Kreideformation, p. 27, pl. 8. figs. 4–6; pl. 10, figs. 1, 11, 12, 1885; K. böhm. Gesell. Wiss. Sitzungsber., 1886, p. 639 (6), pl. 1, figs. 14–16, 1887.

Engelhardt, Naturwiss. Gesell. Isis in Dresden Abh. 7, Jahrg. 1891, p. 92, 1892.

Marik, Prispevek, k. fl. českého cenomanu, p. 9, pl. 1, fig. 23; pl. 2, fig. 2, 1901.

Krasser, Beitr. Paläontologie Oesterr.-Ungarns u. des Orients, Band 10, p. 126 (14), pl. 14 (4), fig. 6; pl. 17 (7), figs. 4, 7, 8, 1896.

Glyptostrobus gracillimus Lesquereux, Am. Jour. Sci., 2d ser., vol. 46, p. 92, 1868; The Cretaceous flora, p. 52, pl. 1, figs. 8, 11–11f, 1874; The Cretaceous and Tertiary floras, p. 32, pl. 1, figs. 6–6b, 1883; The flora of the Dakota group, p. 38, 1892.

Sequoia gracillima (Lesquereux) Newberry, The flora of the Amboy clays, p. 50 (in part), (not pl. 9, figs. 1–3, 1896); The later extinct floras of North America, p. 19 (in part), pl. 14, fig. 6, 1898 (not pl. 26, fig. 9).

Smith, On the geology of the Coastal Plain of Alabama, p. 348, 1894.

Ettingshausen's description, published in 1867, is as follows:

F. ramis suberectis fastigiatis, ramulis filiformibus confertis, foliis adpressis e basi ovata subulatis, strobilis axillaribus duplo longioribus quam latis.

Medium-sized branches with more or less crowded, slender, elongated, fastigiate twigs, bearing reduced ovate-subulate leaves, spirally arranged. The cones are small oval bodies, 5 to 12 millimeters long by 3 to 7 millimeters in diameter, usually poorly preserved, said by Ettingshausen to be axillary in position but evidently many of them terminal, as evinced by some of the Raritan material as well as by some of the better-preserved cones from the Cenomanian of Bohemia and Moravia. The Bohemian and Moravian material clearly shows that the cones consisted of four scales. This feature would ally it with either the subgenus *Widdringtonia* of the genus *Callitris* Ventenat, to which Eichler, in his treatment of the living species in Engler and Prantl (1887) refers Endlicher's genus, or to the subgenus *Eucallitris* Brongniart, which also is characterized by four cone scales. *Eucallitris* has a single living species of northern Africa, and *Widdringtonia* has three or four species of southern Africa and Madagascar. The propriety of Eichler's classification may well be questioned, and in any event paleobotanists must necessarily prefer the older segregation of *Frenela* and *Widdringtonia* and their respective form genera.

There seems to be but little doubt that the present species should be referred to *Widdringtonia*, as Velenovsky and Krasser have done, but as the term *Widdringtonites* is equally indicative of its true affinity, little is to be gained by making the proposed change.

The species was described originally by Ettingshausen from the Cenomanian of Niederschoena in Saxony as a species of *Frenelites*. When Heer discovered it in the Greenland material, where it has been collected from both the Atane and the Patoot beds, he transferred it to the present genus. It has subsequently been reported from the Cenomanian of Bohemia and Moravia, from the Magothy formation of the Atlantic Coastal Plain at numerous localities, and from the islands of southern New England. It is also present in North Carolina and South Carolina. Heer made *Glyptostrobus gracillimus* Lesquereux, of the Dakota sandstone, a synonym of this species, and this form, under the name *Sequoia gracillima* Newberry, has been identified from a large number of localities, including the Dakota sandstone of the West.

Widdringtonites reichii is closely allied to if not identical with a common conifer of the Patapsco formation (Albian) of Maryland and Virginia, which the writer has described as *Widdringtonites ramosus*.[1] This species is based upon *Taxodium ramosum* and other so-called species described by Fontaine from the Potomac group.

Occurrence: Tuscaloosa formation, Shirleys Mill and Glen Allen, Fayette County; Whites Bluff, Greene County; big gully and upper

[1] Berry, Maryland Geol. Survey, Lower Cretaceous, p. 428, pl. 73, figs. 1–6, 1911.

ravine on the Snow place, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

Genus PINUS Linné.

[Species plantarum, p. 1000, 1753.]

Pinus raritanensis Berry.

Pinus raritanensis Berry, Torrey Bot. Club Bull., vol. 36, p. 247, 1909. New Jersey Geol. Survey Bull. 3, p. 92, 1911.

Pinus sp., Newberry, The flora of the Amboy clays, p. 47, pl. 9, figs. 5, 6; figs. 7, 8 (?), figs. 17, 18 (?), 1896.

This species was discovered in the upper part of the Raritan formation of South Amboy, N. J. The remains consist of slender leaves in fascicles of threes and poorly preserved winged seeds. Similar remains occur in the Magothy formation of New Jersey, in the Black Creek formation of North Carolina, and in the Middendorf arkose member of the Black Creek formation of South Carolina. They are too indefinite to have much stratigraphic value, and they are of slight botanic interest beyond showing the presence of a pinelike form in the Upper Cretaceous of the Atlantic coast. In this connection attention should be called to structural material of *Pinus*, described by Hollick and Jeffrey,[1] from the Raritan formation on Staten Island, N. Y., as *Pinus triphylla*, which may be identical with the present form.

Pinus-like leaves are recorded from the Kome beds of Greenland, the Kootenai formation of the West, the Trinity group of Texas, the Lakota sandstone of the Wyoming-South Dakota region, and the Patapsco formation of Maryland, and the Albian of Europe is remarkable for the large number of *Pinus*-like cones which it contains. Heer has also recorded five species from the Atane beds of western Greenland.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Genus TUMION Rafinesque.

Tumion carolinianum Berry (?).

Tumion carolinianum Berry, Am. Jour. Sci., 4th ser., vol. 25, p. 383, figs. 1–3, 1908; U. S. Geol. Survey Prof. Paper 84, p. 107, 1914.

This species has recently been described by me in the publications cited.

[1] Hollick, Arthur, and Jeffrey, E. C., New York Bot. Garden Mem., vol. 3, p. 14, pl. 3, figs. 6, 7 (?); pl. 22, fig. 1, 1909.

Occurrence: Eutaw formation, McBrides Ford, Chattahoochee County, Ga.

Collection: U. S. National Museum.

Genus CUPRESSINOXYLON Goeppert.

Cupressinoxylon sp.

Silicified wood is not uncommon in the Coffee sand of western Tennessee. Sections were cut of fragments broken from large logs preserved in these sands at Coffee Bluff. The material had evidently undergone considerable decay before silicification and the essential features for specific diagnosis are obscure, so that it has seemed best not to attempt a description until better preserved material becomes available.

Occurrence: Eutaw formation (Coffee sand member), Coffee Bluff, Hardin County, Tenn.

Collection: Johns Hopkins University.

Class ANGIOSPERMAE.

Subclass MONOCOTYLEDONAE.

Order LILIALES.

Genus DORYANTHITES Berry.

Doryanthites cretacea Berry.

Plate XIII, figure 1.

Doryanthites cretacea Berry, Torrey Bot. Club Bull., vol. 38, p. 406, 1911.

Leaves, as preserved, linear, presumably lanceolate above and sheathing below, 4.5 to 6 centimeters in width and preserved without any diminution in width for a length of 50 centimeters. Texture very coriaceous. Margins entire. Veins simple and parallel, immersed, considerably less than 1 millimeter apart. Leaves alike on both surfaces. In the hollows between the veins occur rows of small stomata with the guard cells all oriented in a direction parallel with the veins and equally numerous on both surfaces of the leaf. Leaf surface under the microscope appearing finely striated parallel with the veins.

These curious remains, which call to mind the leaves of the Paleozoic *Cordaites* or some modern giant bromeliad, are not uncommon in the Upper Cretaceous. They were first discovered by the writer in the Black Creek formation of North Carolina, and it is from this material that the stomatal characters are described. Recently this same form was discovered in considerable abundance at the Georgia locality near Buena Vista, Marion

County, and in the Magothy formation of Maryland.

With regard to similar remains previously described, it may be noted that Miquel [1] in 1853 described under the heading "Phyllitae monocotylei" two sorts of parallel-veined leaf fragments from the Upper Cretaceous of Aachen (Rhenish Prussia). The first [2] he calls *Yuccites?*, and the second, which suggests the fossils under discussion, is designated "*Palma* vel *Yuccites?*." From the Valanginian of Portugal, Heer [3] described what he calls *Bambusium latifolium*, which is also suggestive of the American material. Krasser [4] describes somewhat similarly appearing remains from the Cretaceous (Cenomanian?) of Moravia as *Typhaeloipum cretaceum*. These are somewhat smaller than the American forms and show transverse veinlets which are absent in the latter. Smaller but otherwise comparable Lower and Upper Cretaceous forms were named by Schenk *Eolirion*,[5] and similar older Mesozoic forms are commonly referred to the form genus *Yuccites*.[6] Perhaps the most similar fossils known are those referred to the genus *Krannera* [7] and fully described by Velenovsky, who does not, however, arrive at any satisfactory conclusion regarding their relationship, although he thinks they are cycadaceous.

It seems undesirable to refer the present material to *Yuccites*, for though it is similar in appearance to the more ancient remains so named, it is entirely improbable that it is congeneric with the Triassic type upon which this genus was founded, and such an identification would consequently be very misleading. Until the existing tropical Monocotyledonae are more abundantly represented in our larger herbaria, or more complete and decisive Cretaceous material is discovered, the botanic affinity of these anomalous forms must remain undetermined. The name chosen indicates superficial resemblance and does not imply actual relationship with the modern genus *Doryanthes* of the order Liliales.

Little reliance can be placed upon similarity of appearance in dealing with fragmentary remains of this sort, and the foregoing are mentioned merely as indicating the presence of undetermined monocotyledons of large size in the Cretaceous floras of the world.

Occurrence: Eutaw formation (basal part), 2 miles south of Havana, Hale County, Ala. Ripley formation (Cusseta sand member), Buena Vista, Marion County, Ga.

Collections: U. S. National Museum.

Order GRAMINALES.

Genus CYPERACITES Schimper.

Cyperacites sp. Hollick.

Cyperacites sp., Hollick, The Cretaceous flora of southern New York and New England, p. 48, pl. 6, figs. 7, 8, 1906.

Cyperites? Hollick, Torrey Bot. Club Bull., vol. 21, p. 63, pl. 180, fig. 3, 1894.

Grass or sedgelike remains indistinguishable from the above form, described by Hollick from the Magothy formation of Glen Cove, Long Island, are present in the Tuscaloosa flora. They are also practically indistinguishable from similar remains described by Heer from West Greenland and by other authors from different horizons. None of the specimens present real specific characters and they have little value or interest. The present remains greatly resemble those of *Podozamites marginatus* Heer, which is so abundant at near-by localities, but may be distinguished by their greater elongation and the possession of a well-marked midrib.

Occurrence: Tuscaloosa formation, roadside southwest of Northport, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Genus PHRAGMITES Trinius.

Phragmites prattii Berry.

Phragmites prattii Berry, idem, vol. 37, p. 191, 1910; U. S. Geol. Survey, Prof. Paper, p. 28, 1914; Bull. Torrey Bot. Club, vol. 43, p. 287, 1916.

Phragmites sp. Berry, Torrey Bot. Club Bull., vol. 34, p. 190, pl. 11, fig. 5, 1907.

I have described this form in the papers cited and the description need not be repeated here.

[1] Miquel, F. A. W., De fossiele planten van het Krijt in het Hertogdom Limburg, Comm. Geol. kaart. Nederland Verh., vol. 1, pp. 33-56, pl. 1-7, 1853.

[2] Idem, pl. 1, fig. 3.

[3] Heer, Oswald, Contributions à la flore fossile du Portugal, p. 22, pl. 19, figs. 1-3, 1881.

[4] Krasser, F. von, Beiträge zur Kenntniss der fossilen Kreideflora von Kunstadt, p. 15, pl. 2, fig. 4, 1896.

[5] Schenk, August, Palaeontographica, vol. 19, p. 20, 1869.

[6] Schimper, W. P., and Mougeot, A., Monographie des plantes fossiles du grès bigarré de la chaîne des Vosges, p. 42, 1844.

[7] Velenovsky, Josef, Die Gymnospermen der böhmsichen Kreideformation, p. 1, 1885.

Occurrence: Eutaw formation, Broken Arrow Bend, Chattahoochee County, Ga.; (Coffee sand member), Coffee Bluff, Hardin County, Tenn.

Collections: U. S. National Museum.

Order ARECALES.

Genus SABALITES Saporta.

Sabalites sp.

Plate XI, figure 1.

Fragments of leaves of a large fan palm are present in the basal Ripley formation of Benton and McNairy counties, Tenn. They indicate large flabellate leaves, with numerous rays 1.5 to 2 centimeters broad having an illy defined midrib and close-set parallel lateral veins. The texture is coriaceous.

The material is very fragmentary, one of the best specimens being that figured, which is altogether insufficient for specific diagnosis. It is in my judgment distinct from the so-called *Sabalites grayanus* Lesquereux of the Montana group of the West, *Sabalites magothiensis* Berry of the Magothy formation of the northern Atlantic coast, or *Sabalites carolinensis* Berry of the Middendorf arkose member of the Black Creek formation of South Carolina.

Occurrence: Ripley formation (McNairy sand member), half a mile from Camden, Benton County (collected by L. W. Stephenson); 2½ miles southwest of Selmer, McNairy County, Tenn. (collected by Bruce Wade).

Collections: U. S. National Museum.

Subclass DICOTYLEDONAE.

Order PIPERALES.

Family PIPERACEAE.

Genus PIPERITES Goeppert.

[Die Tertiärflora auf der Insel Java, p. 40, 1854.]

Piperites tuscaloosensis Berry, n. sp.

Plate XII, figure 3.

Leaves alternate on a flexuous twig, ovate-lanceolate in outline, inequilateral, about 6 to 7 centimeters in length by 3 centimeters in maximum width,[1] which is in the basal half of the leaf. Apex narrowed and acute. Base more or less inequilateral, at first broadly rounded and then slightly decurrent on the upper side, narrow and incurved on the lower side. Petiole mediumly stout, about 1.5 centimeters in length or slightly less. Midrib stout, usually curved. Secondaries stout, few in number, the basal pair subopposite, branching from the midrib near its base at an acute angle, longer and stouter than succeeding pairs, giving the leaves a decidedly triveined character. Margins entire, very slightly repand.

The present species is entirely unlike any previously known Upper Cretaceous plant, although the inequilateral leaves suggest at first sight the forms described from beds of similar age as different species of Phaseolites, as for example *Phaseolites formus* Lesquereux [2] from the Dakota sandstone and *Phaseolites elegans* [3] and *Phaseolites manhassettensis* Hollick [4] from the Raritan formation of Long Island and New Jersey. It is not impossible that Hollick's species may represent leaves of Cretaceous forms allied to the modern genus *Piper* instead of being the detached leaflets of Cretaceous species allied to the modern genus *Phaseolus* with trifoliate leaves. This last possibility certainly is not indicated for the Alabama material, which shows an unmistakable likeness to many of the numerous existing species of the genus *Piper*. The representatives of that genus are numerous in the warmer parts of both hemispheres, the various species combining a form like that of a fossil with a venation ranging from pinnate secondaries to subpalmate and palmate species.

Forms referable to the present family have been rarely recognized in fossil floras, except for the unmistakable forms described from the Tertiary of the East Indies by Heer and Goeppert.[5] Ettingshausen described a species [6] from the Tertiary of Australia and Lesquereux one [7] from the Denver formation at Golden, Colo., but I have not seen any of these forms.

Occurrence: Tuscaloosa formation, grounds of the State University, Tuscaloosa, Tuscaloosa County; Shirleys Mill, Fayette County, Ala.

Collections: U. S. National Museum.

[1] All measurements of leaves in this report are of the blades. The lengths given are exclusive of the petiole, which when preserved is given separately.

[2] Lesquereux, Leo, Flora of the Dakota group, p. 147, pl. 55, figs. 5, 6, 12, 1892.

[3] Hollick, Arthur, U. S. Geol. Survey Mon. 50, p. 85, pl. 32, fig. 4, 1907.

[4] Hollick, Arthur, New York Bot. Garden Bull., vol. 3, p. 414, pl. 78, figs. 1, 2, 1904.

[5] *Piperites bullatus* Göppert, *P. hasskarlianus* Göppert, and *P. miquelianus* Göppert, from Java, and *Piper antiquum* Heer, from Sumatra.

[6] *Piper feistmantelii* Ettingshausen, Beiträge zur Kenntniss der Tertiärflora Australiens, pt. 2, p. 16, pl. 9, fig. 4, 1886.

[7] *Piper heerii* Lesquereux, Harvard Coll. Mus. Comp. Zool. Bull., vol. 16, p. 44, 1888.

Order **JUGLANDALES.**

Family **JUGLANDACEAE.**

Genus **JUGLANS** Linné.

Juglans arctica Heer.

Juglans arctica Heer, Flora fossilis arctica, vol. 6, pt. 2, p. 71, pl. 40, fig. 2; pl. 41, fig. 40; pl. 42, figs. 1–3; pl. 43, fig. 3, 1882.

Lesquereux, The flora of the Dakota group, p. 68, pl. 19, fig. 3, pl. 39, fig. 5, 1892.

Newberry, The flora of the Amboy clays, p. 62, pl. 20, fig. 2, 1896. Hollick, Ann. Acad. Sci. New York, vol. 11, p. 58, pl. 3, fig. 7, 1898. Berry, New Jersey Geol. Survey Ann. Rept. for 1905, p. 139, pl. 21, fig. 1, 1906; Torrey Bot. Club Bull., vol. 33, p. 170, 1906; New Jersey Geol. Survey Bull. 3, p. 110, 1911.

Hollick, The Cretaceous flora of southern New York and New England, p. 54, pl. 9, figs. 6–8, 1906.

Ficus atavina Heer. Hollick, New York Acad. Sci. Trans., vol. 11, p. 103, pl. 4, fig. 5, 1892.

The leaves of this species differ considerably in size and outline, as might be expected in the present genus. Heer's type material is somewhat imperfect, and some of it can with difficulty be discriminated from some of the forms referred to the same author's *Juglans crassipes*, although that species is on the whole a much larger form with a narrower base and is less oblong in outline. *Juglans arctica* is oblong-ovate in outline with an obtusely pointed apex, and a rounded, generally inequilateral base. The petiole and midrib are stout. Secondaries numerous, well marked, parallel, camptodrome. The size ranges in complete specimens from 9 to 15 centimeters in length and from 3 to 6 centimeters in width.

A nut and catkins are associated with the leaves at the type locality in the Atane beds of Greenland, which confirms their reference to this genus. The species has a wide range, having been recorded from both the east and west in the United States.

In the Atlantic Coastal Plain it ranges from the middle part of the Raritan formation of New Jersey upward through the Magothy formation of that State and synchronous deposits southward into the basal beds of the Eutaw formation of western Georgia. It is sparingly represented from beds near the base of the Tuscaloosa formation in western Alabama and from this most southerly known occurrence it ranges northward to western Greenland, or over about 38° of latitude, occurring in Georgia, South Carolina, North Carolina, Maryland, New Jersey, New York, and Massachusetts.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County, Shirleys Mill, Fayette County, Ala. Eutaw formation (basal part), McBrides Ford, Chattahoochee County, Ga.

Collections: U. S. National Museum.

Order **MYRICALES.**

Family **MYRICACEAE.**

Genus **MYRICA** De Candolle.

Myrica emarginata Heer.

Plate XIII, figure 4.

Myrica emarginata Heer, Flora fossilis arctica, vol. 6, Abt 2, p. 66, pl. 41, fig. 2, 1882.

Lesquereux, The flora of the Dakota group, p. 67, pl. 12, fig. 1, 1892.

Newberry, The flora of the Amboy clays, p. 62, pl. 41, figs. 10, 11, 1896.

Berry, New Jersey Geol. Survey Bull. 3, p. 104, pl. 10, fig. 5, 1911.

Heer's description, published in 1882, is as follows:

M. foliis oblongis, integerrimis, apice emarginatis, basi attenuatis, nervis secundariis subtilissimis.

The Raritan leaves referred to this species by Newberry are not quite typical of this species being somewhat more elongate and lacking the strictly obovate outline shown in the Atane leaves and those from the Dakota sandstone. The remains from the Tuscaloosa formation which are referred to this species are intermediate in character between the Raritan leaves and the type from Greenland, being relatively wider and more robust than the type. They may be characterized as follows: Leaves obovate in outline, widest at the rounded, truncate, and more or less emarginate apex, with entire margins narrowing to the cuneate base. Midrib mediumly stout, flexed in the Alabama material. Secondaries, five thin pairs, subopposite, diverging from the midrib at angles of about 45°, camptodrome. The reference of this species to the genus *Myrica* is entirely problematic. The present species is astonishingly close to a form from Niederschoena, Saxony, described by Engelhardt[1] as *Mimusops ballotaevides*.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County, and Shirleys Mill, Fayette County, Ala.

Collections: U. S. National Museum.

[1] Engelhardt, Hermann, Naturwiss. Gesell. Isis in Dresden Abh. 7, Jahrg. 1891, p. 98, pl. 2, fig. 13, 1892.

Myrica longa (Heer) Heer.

Proteoides longus Heer, Flora fossilis arctica, vol. 3, Abt. 2, p. 110, pl. 29, fig. 8b; pl. 31, figs. 4, 5, 1874.
Dawson, Roy. Soc. Canada Trans., vol. 1, sec. 4, p. 22, pl. 2, fig. 8, 1883.
Myrica longa (Heer) Heer, Flora fossilis arctica, vol. 6, Abt. 2, p. 65, pl. 18, fig. 9b; pl. 29, figs. 15–17; pl. 33, fig. 10; pl. 41, fig. 4d, 1882; idem, vol. 7, p. 21, 1883.
Lesquereux, The flora of the Dakota group, p. 67, pl. 3, figs. 1–6, 1892.
Bartsch, Iowa Univ. Lab. Nat. Hist. Bull., vol. 3, p. 180, 1896.
Knowlton, U.S. Geol. Survey Twenty-first Ann. Rept., pt. 7, p. 314, pl. 39, fig. 7, 1901.
Berry, Torrey Bot. Club Bull., vol. 33, p. 170, 1906.

Leaves of variable size, linear to lanceolate in outline, with a stout midrib, numerous thin, ascending camptodrome secondaries, entire margins, obtusely pointed apex, narrowly decurrent base, and long, stout petiole.

This species was described by Heer as a *Proteoides* and subsequently referred to the genus *Myrica*. It occurs in both the Atane and Patoot beds of Greenland, in the Dakota sandstone of the West, in the Magothy formation of Maryland, and in the Woodbine sand of Texas. It is very common at the Tuscaloosa locality.

Occurrence: Tuscaloosa formation, big gully and upper ravine on the Snow place, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Myrica dakotensis minima Berry, n. var.

Plate XIII, figure 5.

Leaves of very small size, linear or oblong lanceolate in outline, gradually narrowed and decurrent to a short thick curved petiole. Length about 1.5 centimeters. Maximum width, in the middle part of the leaf, about 3.5 millimeters. Margins entire at base, above this closely crenulate. Midrib relatively stout, flat. Secondaries numerous, thin, subparallel, diverging from the midrib at angles of about 45°, curving slightly upward, eventually camptodrome.

This characteristic little leaf is identical with the Dakota sandstone species *Myrica dakotensis* Lesquereux,[1] except that it is only about one-fourth or one-fifth the size of the western form. Its relationship to *Myrica* is questionable.

[1] Lesquereux, Leo, The Cretaceous and Tertiary floras, p. 35, pl. 4, fig. 9, 1883.

Occurrence: Tuscaloosa formation, Glen Allen, Fayette County, Ala.

Collection: U. S. National Museum.

Myrica ripleyensis Berry.

Plate XI, figure 2.

Myrica ripleyensis Berry, Torrey Bot. Club Bull., vol. 43, p. 288, 1916.

Leaves of medium size, linear-lanceolate in outline with a gradually narrowed and acuminate tip and a cuneate base. Length about 13 centimeters. Maximum width, in the middle part of the leaf, about 1.75 centimeters. Margins conspicuously serrate toothed, the teeth somewhat irregular in size and disposition; distad they are reduced and close-set. They increase in size proximad until in the median and basal part of the leaf they are large and triangular, the intervening sharp sinuses reaching nearly to the midrib and closely simulating our recent *Comptonia* in character. Texture coriaceous. Petiole not preserved, presumably short and stout. Midrib stout, flexuous. Secondaries numerous, diverging from the midrib at wide angles, about 70°, every third or fourth one straighter than the rest and running to a marginal tooth, the intervening ones somewhat more curved and camptodrome.

This species is exceedingly well marked and is entirely distinct from previously described forms. It resembles closely some of the leaves of our existing *Comptonia peregrina* (Linné) Coulter. It is also much like some of the European Tertiary forms about which so much controversy raged in times past as to whether they were myricaceous or proteaceous.[2] For example, some of the forms of *Comptonia vindobonensis* (Ettingshausen) Berry are similar to the present species. A somewhat similar form is described by Velenovsky from the Bohemian Cretaceous as *Dryandra cretacea* [3] and another by Unger from the Cretaceous of Transylvania as *Comptonites antiquus*.[4] These

[2] See Berry, E. W., Living and fossil species of *Comptonia*: Am. Naturalist, vol. 40, pp. 485–520, pls. 1–4, 1906.
[3] Velenovsky, Josef, Die Flora der Bohmischen Kreideformation, pt. 2, p. 1, pl. 1, figs. 1–5, 1883.
[4] Unger, Franz, Ueber einige fossile Pflanzenreste aus Siebenbürgen und Ungarn: K. Akad. Wiss. Wien Sitzungsber., Band 51, pt. 1, p. 2, pl. 1, fig. 1, 1865.

are both generically distinct from the present species, as shown by their characteristic habit.

Occurrence: Ripley formation (McNairy sand member), Camden-Paris road, 13 miles northwest of Camden, Benton County, Tenn. (collected by L. W. Stephenson); 2½ miles southwest of Selmer, McNairy County, Tenn. (collected by Bruce Wade).

Collections: U. S. National Museum.

Order FAGALES.

Family FAGACEAE.

Genus DRYOPHYLLUM Debey.

Dryophyllum gracile Debey.

Plate XXXII, figure 2.

Dryophyllum gracile Debey, Feuilles querciformes d'Aix-la-Chapelle, p. 10, figs. 10, 11, 1881.
Berry, Torrey Bot. Club Bull., vol. 43, p. 290, pl. 16, fig. 6, 1916.

Leaves oblong-lanceolate in outline, with a cuneate base and a gradually narrowed tip. Length about 12 centimeters. Maximum width, about midway between the apex and the base, ranging from 1.75 to 2.5 centimeters. Petiole missing. Texture subcoriaceous. Margin with regularly spaced, fairly prominent, nearly straight serrate teeth. Midrib stout, prominent on the lower surface of the leaf. Secondaries thin, regularly spaced, about 15 craspedodrome pairs branching from the midrib at angles of 45° or more, curving regularly upward, subparallel, terminating in the marginal teeth. Tertiaries thin, partly percurrent and partly alternating, joined midway between adjacent secondaries by a zigzag vein.

This well-marked species is represented by five specimens from the Ripley formation of Tennessee. None of these are complete, each showing about two-thirds of a leaf, enough to demonstrate their identity with the European type, which came from the Emscherian of Aix-la-Chapelle, Rhenish Prussia. Additional European occurrences are Tannenberg, Bohemia, and Kieslingswalde, Silesia, all at about the same horizon and probably in the Santonian substage of the Emscherian.

Occurrence: Ripley formation (McNairy sand member), big cut on the Southern Railway near Cypress and 2½ miles southwest of Selmer, McNairy County, Tenn.

Collection: Johns Hopkins University.

Order SALICALES.

Family SALICACEAE.

Genus SALIX Linné.

Salix flexuosa Newberry.

Plate XIII, figure 3.

Salix flexuosa Newberry, Lyceum Nat. Hist. New York City Ann., vol. 9, p. 21, 1868; Illustrations of Cretaceous and Tertiary plants, pl. 1, fig. 4, 1878.
Berry, New Jersey Geol. Survey Ann. Rept. for 1905, p. 145, 1906; Torrey Bot. Club Bull., vol. 33, p. 171, 1906; New Jersey Geol. Survey Bull. 3, p. 115, 1911.
Salix proteaefolia linearifolia Lesquereux, The flora of the Dakota group, p. 49, pl. 44, figs. 1–3, 1892.
Hollick, The Cretaceous flora of southern New York and New England, p. 52, pl. 8, fig. 12, 1906.
Salix proteaefolia flexuosa (Newberry) Lesquereux, The flora of the Dakota group, p. 50, pl. 44, figs. 4, 5, 1892.
Hollick, Torrey Bot. Club Bull., vol. 21, p. 50, pl. 174, fig. 5, 1894; New York Acad. Sci. Ann., vol. 11, p. 59, pl. 4, fig. 5a, 1898; The Cretaceous flora of southern New York and New England, p. 51, pl. 8, figs. 5, 6a; pl. 37, fig. 8b, 1906.
Berry, New York Bot. Garden Bull., vol. 3, p. 67, pl. 48, fig. 12; pl. 51, fig. 2, 1903.

Leaves narrow, linear-lanceolate in outline, equally pointed at both ends, short petioled, ranging from 5 to 10 centimeters in length, and from 8 to 13 millimeters in maximum width. Margins entire. Midrib stout below, tapering above, somewhat flexuous in many specimens. Secondaries more or less remote, about 10 alternate pairs, branching from the midrib at angles ranging from 35° to 45°, camptodrome, of fine caliber, many of them obsolete.

This species was described by Newberry from the Dakota sandstone in 1868. Lesquereux subsequently made it one of the varieties of his *Salix proteaefolia*, although it is obviously entitled to independent specific rank. It is of rare occurrence in the Raritan formation of New Jersey, where it is first found in the uppermost beds at South Amboy, N. J., and it is preeminently a species which characterizes the Magothy formation from New Jersey to Maryland and homotaxial horizons to the south. It is recorded from the Magothy formation from Marthas Vineyard to Potomac River.

It occurs in the Black Creek formation of North and South Carolina, and in the Middendorf arkose member of the Black Creek in the latter State. In Georgia, though not especially abundant, characteristic leaves of this species are found in the lower part of the Eutaw formation in the western part of the State. In Alabama it is very common at a relatively large number of localities from the base to the top of the Tuscaloosa formation.

Occurrence: Tuscaloosa formation, Shirleys Mill, Glen Allen, Fayette County; big gully and upper ravine on the Snow place; Robertson's upper landing, and Sanders Ferry Bluff, gully at Tuscaloosa, Tuscaloosa County; Whites Bluff, Greene County; near Maplesville, Chilton County, Ala. Eutaw formation, McBrides Ford, Chimney Bluff, Broken Arrow Bend, Chattahoochee County, Ga.

Collections: U. S. National Museum.

Salix lesquereuxii Berry.

Salix lesquereuxii Berry, Torrey Bot. Club Bull., vol. 36, p. 252, 1909; idem, vol. 37, pp. 21, 194, 1910; New Jersey Geol. Survey Bull. 3, p. 114, 1911.

Salix proteaefolia Lesquereux, Am. Jour. Sci., 2d ser., vol. 46, p. 94, 1868 (not Forbes); The Cretaceous flora, p. 60, pl. 5, figs. 1–4, 1874; The Cretaceous and Tertiary floras, p. 42, pl. 1, figs. 14–16, pl. 16, fig. 3, 1883; The flora of the Dakota group, p. 49, 1892.

Newberry, The flora of the Amboy clays, p. 66, pl. 18, figs. 3, 4, 1896.

Kurtz, Rev. Mus. La Plata, vol. 10, p. 51, 1902.

Berry, New Jersey Geol. Survey Ann. Rept. for 1905, p. 139, 1906; Torrey Bot. Club Bull., vol. 33, p. 171, pl. 7, fig. 2, 1906; Johns Hopkins Univ. Circ., new ser., No. 7, p. 81, 1907.

Salix proteaefolia longifolia Lesquereux, The flora of the Dakota group, p. 50, pl. 44, fig. 9, 1892.

Bartsch, Univ. Iowa Lab. Nat. Hist. Bull., vol. 3, p. 179, 1896.

Proteoides daphnogenoides Heer. Newberry, The flora of the Amboy clays, p. 72 (part), pl. 32, fig. 11, 1896.

Dewalquea groenlandica Heer. Newberry, The flora of the Amboy clays, p. 129 (part), pl. 41, fig. 12, 1896.

Leaves ovate-lanceolate in outline, somewhat more acuminate above than below, variable in size, ranging from 6 to 12 centimeters in length, and from 1.1 to 2.2 centimeters in greatest width, which is usually slightly below the middle. Petiole stout, much longer than in *Salix flexuosa*, having a maximum length of 1.2 centimeters. Midrib stout below, tapering above. Secondaries numerous, in some specimens as many as 20 pairs; they branch from the midrib at angles of about 45° and are parallel and camptodrome.

This species is exceedingly variable, as might be expected in a *Salix*, and Lesquereux established several varieties, of which at least one, *linearifolia*, is referable to *Salix flexuosa* Newberry. Some of Lesquereux's forms are distinguishable with difficulty from *Salix flexuosa*, and this is especially shown in the leaves which he figures in Plate I of his "Cretaceous and Tertiary floras." They are, however, larger and somewhat more robust, of a thicker texture, and broadest near the base, from which they taper upward to an exceedingly acuminate tip. In general *Salix lesquereuxii* is a relatively much broader, more ovate form with more numerous and better seen secondaries and a longer petiole.

This species is an exceedingly abundant Cretaceous type in both the East and the West, ranging chronologically in the Coastal Plain from the base of the Raritan formation to the top of the Tuscaloosa formation, and possibly through the Eutaw formation as well. It is abundant in the Magothy and Black Creek formations, including the Middendorf arkose member of the Black Creek. In the west it is common in the Dakota sandstone. It is one of the forms recorded by Kurtz from the Upper Cretaceous of Argentina, indicating, if the identification is correct, a very considerable migration during the early Upper Cretaceous. In Alabama it ranges from the bottom to the top of the Tuscaloosa formation.

Occurrence: Tuscaloosa formation, Shirleys Mill and Glen Allen, Fayette County; big gully on the Snow place, left bank of Black Warrior River at Tuscaloosa; Sanders Ferry Bluff, Cottondale, and gully in Tuscaloosa, Tuscaloosa County, Ala. Eutaw formation, Chimney Bluff, Chattahoochee County, Ga.

Collections: U. S. National Museum.

Salix eutawensis Berry.

Salix eutawensis Berry, Torrey Bot. Club Bull., vol. 37, p. 193, pl. 22, figs. 1–11, 1910; U. S. Geol. Survey Prof. Paper 84, p. 109, pl. 19, fig. 3, 1914; Torrey Bot. Club Bull., vol. 43, p. 289, 1916.

This characteristic species was recently described in the papers cited and the discussion need not be repeated here.

Occurrence: Eutaw formation (basal part), Broken Arrow Bend, Chattahoochee County, Ga.; (Coffee sand member), cut on the Nashville, Chattanooga & St. Louis Railway, just east of Parsons, Decatur County, Tenn.

Collections: U. S. National Museum.

Salix meekii Newberry.

Salix meekii Newberry, Lyceum Nat. Hist. New York City Ann., vol. 9, p. 19, 1868; The later extinct floras of North America, p. 58, pl. 2, fig. 3, 1898.
Lesquereux, The Cretaceous and Tertiary floras, p. 42, 1883.
Hollick, New York Bot. Garden Bull., vol. 2, p. 404, pl. 41, fig. 1, 1902; New York Acad. Sci. Trans., vol. 16, p. 130, pl. 13, figs. 3, 4, 1897; The Cretaceous flora of southern New York and New England, p. 51, pl. 8, figs. 1c, 8, 9, 1906.
Berry, New York Bot. Garden Bull., vol. 3, p. 68, 1903.
Salix cuneata Newberry, Lesquereux, Illustrations of Cretaceous and Tertiary plants, pl. 1, figs. 2, 3, 1878.
Salix proteaefolia lanceolata Lesquereux, The flora of the Dakota group, p. 50, pl. 64, figs. 6–8, 1892.
Hollick, New York Acad. Sci. Ann., vol. 11, p. 59, pl. 4, fig. 4, 1898; The Cretaceous flora of southern New York and New England, p. 52, pl. 8, figs. 1a, 2–4, 1906.

The original description of this species, published by Newberry in 1868, is as follows:

Leaves petioled, thin and delicate, lanceolate, acute at both ends, nervation delicate, midrib slender, secondary nerves fine, springing from the medial nerve at an angle of 35°, gently arched and anastomosing near the margins; network of tertiary veins somewhat lax but composed of nervules of such tenuity as to be rarely visible.

This is one of the historic Dakota sandstone plants, a sketch of which was submitted to Heer by Meek in the early days of the study of that formation. It has since been recorded from a large number of localities in the Magothy formation of the Atlantic Coastal Plain and from strata of supposed Colorado age in western Iowa.[1] It is not common in the Tuscaloosa flora but is represented by typical thin lanceolate leaves. It is doubtfully distinct from the associated *Salix lesquereuxii* Berry.

[1] Stanton, T. W., The Colorado formation and its invertebrate fauna: U. S. Geol. Survey Bull. 106, p. 21, 1893.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Genus POPULUS Linné.

Populus hyperborea Heer.

Populus hyperborea Heer, Flora fossilis arctica, vol. 3, pt. 2, p. 106, pl. 27, fig. 8d; pl. 29, figs. 6–9; pl. 30, fig. 2b, 1874; idem, vol. 6, pt. 2, p. 64, pl. 17, figs. 6, 7; pl. 21, fig. 1a, 1882.
Lesquereux, The flora of the Dakota group, p. 43, pl. 3, figs. 9–11; pl. 8, fig. 1; pl. 47, fig. 5, 1892.
Bartsch, Iowa Univ. Lab. Sci. Bull., vol. 3, p. 179, 1896.

Leaves ovate to elliptical in outline with a broadly rounded apex and a broadly rounded to cuneate base. Length ranges from 4 to 7 centimeters. Maximum width, in middle part of the leaf, 5 to 6 centimeters. Margins entire. Texture coriaceous. Petiole stout, curved, about 2 centimeters long. Midrib stout. Secondaries stout, 5 or 6, opposite to alternate pairs, diverging from the midrib at acute angles and somewhat crowded toward the base of the midrib, camptodrome, the lower ones giving off outwardly directed camptodrome tertiaries. Balance of tertiaries thin, percurrent.

This species was described by Heer from very fragmentary material from the Atane beds of West Greenland. Lesquereux described much more complete material from the Dakota sandstone, in which this species is common both in Kansas and Iowa. The species is represented by considerable material from the Tuscaloosa formation that is obviously identical with that from Kansas with which comparisons can be made much more conclusively than with the figures of the Greenland specimens.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Genus POPULITES Lesquereux.

Populites tuscaloosensis Berry, n. sp.

Plate XIII, figure 2.

Leaves ovate-elliptical in outline with an obtusely rounded apex and a cuneate base.

Length about 7 centimeters. Maximum width about 5.25 centimeters in the basal half of the leaf. Texture subcoriaceous. Margin entire below, becoming undulate or slightly repand above by the development of a very shallow rounded sinus between the tips of some of the secondaries. Midrib stout, slightly flexuous. Secondaries stout, becoming thin distad, about five alternate, parallel, craspedodrome pairs; they branch from the midrib at regular intervals at angles of almost exactly 45° and pursue a straight course to the margins. Tertiaries mostly percurrent, those which run outward from the basal secondaries apparently running directly to the margin.

This species is entirely distinct from any of the previously described species of *Populites* which are so numerous and variable in the Dakota sandstone. It is closest to some of the forms of *Populites litigiosus* of Lesquereux, which both Heer and Newberry referred directly to the genus *Populus*. Knowlton has described a species which he names *Populus cretacea*[1] and which comes from the Montana group of Montana. In some of its forms [2] this species is similar to *Populites tuscaloosensis*. The other figured forms are not at all like the Tuscaloosa leaves. A comparison of the similar form of *Populus cretacea* with the Tuscaloosa species shows that the latter is pinnatifid and presents no indication of any differentiation in the lower secondaries. The secondaries are stouter; the teeth are much feebler, less numerous, less acute, and never present except at the apex of secondaries. The tertiaries are more regularly percurrent.

The two species are believed to be entirely distinct, and the Alabama form is clearly allied with the Dakota sandstone forms of *Populites* in all of its essential characters.

Occurrence: Tuscaloosa formation, Glen Allen, Fayette County; gully at Tuscaloosa, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

[1] Knowlton, F. H., U. S. Geol. Survey Bull. 257, p. 138, pl. 17, figs. 1–5, 1905.

[2] Idem, pl. 17, fig. 1.

Order URTICALES.

Family MORACEAE.

Genus FICUS Linné.

Ficus krausiana Heer.

Ficus krausiana Heer, Allg. schweiz. Gesell. gesammt. Naturwiss. Bern Neue Denkschr., Band 23, p. 15, pl. 5, figs. 3–6, 1869.

Lesquereux, The flora of the Dakota group, p. 81, pl. I, fig. 5, 1892.

Hollick, Geol. Soc. America Bull., vol. 7, p. 13, 1895; New York Acad. Sci. Ann., vol. 11, p. 59, pl. 3, fig. 1, 1898; The Cretaceous flora of southern New York and New England, p. 58, pl. 9, fig. 9, pl. 10, figs. 1–3, 1906.

Berry, Torrey Bot. Club Bull., vol. 33, p. 172, 1906; idem, vol. 43, p. 291, 1916.

Ficus beckwithii Lesquereux, The Cretaceous and Tertiary floras, p. 46, pl. 16, fig. 5; pl. 17, figs. 3, 4, 1883.

Ficus suspecta Velenovsky, Die flora der böhmischen Kreideformation, pt. 4, p. 10, pl. 5, figs. 6, 9, 1885.

Ficus atavina Heer (?). Hollick, New York Acad. Sci. Trans., vol. 11, p. 103, pl. 4, figs. 4, 6, 1892.

Leaves of large size, ovate-lanceolate in outline, broadest at or below the middle. Apex and base acutely pointed, the apex often extended and attenuated. Petiole and midrib stout. Secondaries regular, open, thin, ascending, camptodrome, branching from the midrib at angles of 45° or more. Length about 17 centimeters. Greatest width about 4 centimeters.

This well-known Upper Cretaceous species was described originally from the Cenomanian of Moravia, and it has been subsequently recorded from a large number of American localities. In the West it occurs in the Dakota sandstone; in the East it is common from Marthas Vineyard to Alabama and is present between these limits in Maryland, North Carolina, South Carolina, and Georgia. These occurrences are all in beds of Magothy age or younger. In both North Carolina and South Carolina fruits of *Ficus* are associated with this species, but whether they are to be referred to it or to some of the other rather numerous species of *Ficus* which occur at the same localities can not be determined. The present species is one of the commonest post-Raritan

fossils in the Coastal Plain, and it is especially abundant in the Middendorf arkose member of the Black Creek formation of South Carolina. In Alabama it is not uncommon in the Tuscaloosa formation, and it persists into the basal beds of the Eutaw formation in Hale County.

Occurrence: Tuscaloosa formation, Shirleys Mill and Glen Allen, Fayette County; Cottondale (?), Sanders Ferry Bluff, and upper ravine on the Snow place, Tuscaloosa County, Ala. Eutaw formation (basal part), 2 miles south of Havana, Hale County, Ala.; Chimney Bluff, Chattahoochee County, Ga.; Coffee sand member of Eutaw formation, Coffee Bluff, Hardin County, Tenn.

Collections: U. S. National Museum.

Ficus crassipes (Heer) Heer.

Proteoides crassipes Heer, Flora fossilis arctica, vol. 3, Abt. 2, p. 110, pl. 31, figs. 6–8a, 1874.

Ficus crassipes (Heer) Heer, Flora fossilis arctica, vol. 6, Abt. 2, p. 70, pl. 17, fig. 9a, pl. 24, figs. 1, 2.

Lesquereux, The flora of the Dakota group, p. 79, pl. 13, fig. 3, 1892.

Berry, Torrey Bot. Club Bull., vol. 33, p. 172, 1906; idem, vol. 43, p. 291, 1916.

Ficus daphnogenoides (Heer) Berry, Johns Hopkins Univ. Circ., new ser., No. 7, p. 81, 1907.

Leaves entire, narrowly lanceolate in outline, about equally tapering to the acuminate apex and base. Length 12 to 20 centimeters. Greatest width, which is in the middle part of the leaf, 1.8 to 2.5 centimeters. Texture coriaceous. Midrib stout, in many specimens extraordinarily so. Secondaries thin, open, ascending, camptodrome.

This species was described originally from the Atane beds of western Greenland; the first rather fragmentary specimens collected suggested a relationship with the genus *Proteoides*. Subsequently the original describer referred it to *Ficus*, where it undoubtedly belongs. Lesquereux has recorded it from the Dakota sandstone of the West, and it is common in the Magothy formation of the northern Atlantic Coastal Plain and in the Black Creek formation of North Carolina. It persists into the Eutaw formation of Georgia and is especially common in the Middendorf arkose member of the Black Creek formation of South Carolina. It is not very common in the Tuscaloosa formation and is a species which is especially characteristic of the post-Raritan and pre-Matawan horizons of eastern North America.

The leaf substance is partially preserved in the Sanders Bluff material and shows in microscopic preparations the spiral tracheids of the leaf veins and numerous lactiferous cells. Both lower and upper epidermal layers are well preserved. They are thin and highly cuticularized, the epidermis consisting of very small, nearly equilateral, quadrangular thick-walled cells. The stomata are few and scattered and are confined to the lower surface. They consist of two rather thin, sausage-shaped guard cells set on edge—that is, much higher than wide, the length equal to two epidermal cells.

Occurrence: Tuscaloosa formation, Sanders Ferry Bluff, and big gully and upper ravine on the Snow place, Tuscaloosa County, Ala. Eutaw formation, Chimney Bluff, Chattahoochee County, Ga. (Coffee sand member), Coffee Bluff, Hardin County, Tenn.

Collections: U. S. National Museum.

Ficus georgiana Berry.

Ficus georgiana Berry, U. S. Geol. Survey Prof. Paper 84, p. 111, pl. 20, fig. 1, 1914.

I have recently described this form from the Eastern Gulf region in the paper cited.

Occurrence: Ripley formation (Cusseta sand member), near Buena Vista, Marion County, Ga.

Collection: U. S. National Museum.

Ficus ovatifolia Berry.

Ficus ovatifolia Berry, Torrey Bot. Club Bull., vol. 36, p. 253, 1909; U. S. Geol. Survey Prof. Paper 84, p. 111, pl. 19, figs. 5–7, 1914.

Ficus ovata Newberry, The flora of the Amboy clays, p. 70, pl. 24, figs. 1–3, 1896 (not Don).

I have recently discussed this species for the Eastern Gulf area in the paper cited. It may be distinguished from the closely allied *Ficus woolsoni* by its greater elongation and narrower base.

Occurrence: Eutaw formation (basal beds), McBrides Ford, Chattahoochee County, Ga.; (Coffee sand member), Coffee Bluff, Hardin County, Tenn.

Collections: U. S. National Museum.

Ficus daphnogenoides (Heer) Berry.

Plate XIII, figures 6, 7.

Proteoides daphnogenoides Heer, Phyllites crétacées du Nebraska, p. 17, pl. 4, figs. 9, 10, 1866.
Lesquereux, The Cretaceous flora, p. 85, pl. 15, figs. 1, 2, 1874; The flora of the Dakota group, p. 90, 1892.
Hollick, New York Acad. Sci. Trans., vol. 11, p. 98, pl. 3, figs. 1, 2, 1892; idem, vol. 12, p. 36, pl. 2, figs. 4, 9, 13, 1893; Torrey Bot. Club Bull., vol. 21, p. 52, pl. 177, fig. 1, 1894; The Cretaceous flora of southern New York and New England, p. 59, pl. 12, figs. 1–5, 1906.
Smith, On the geology of the Coastal Plain of Alabama, p. 348, 1894 (determined by Ward).
Newberry, The flora of the Amboy clays, p. 72, pl. 17, figs. 8, 9; pl. 32, figs. 11, 13, 14; pl. 33, fig. 3; pl. 41, fig. 15, 1896.
Berry, New York Bot. Garden Bull., vol. 3, p. 74, pl. 51, figs. 6–9, 1903.
Ficus daphnogenoides (Heer) Berry, Torrey Bot. Club Bull., vol. 32, p. 327, pl. 21, 1905; idem, vol. 33, p. 173, pl. 7, fig. 5, 1906; idem, vol. 34, p. 194, pl. 11, figs. 10, 11, 1907.
Ficus proteoides Lesquereux, The flora of the Dakota group, p. 77, pl. 12, fig. 2, 1892.
Eucalyptus? attenuata Newberry, The flora of the Amboy clays: New Jersey Geol. Survey Bull. 3, p. 122, pl. 12, fig. 4, 1911; pl. 16, fig. 5 (not figs. 2, 3), 1896.

Heer's description, published in 1866, is as follows:

Les feuilles sont coriaces, à la base atténuées, entières; la nervure médiane est forte; elle porte deux nervures secondaires faibles, acrodromes, qui sont presque parallèles au limbe; mais elles ne sont pas opposées, comme chez les *Daphnogene* et *Cinnamomum*.

This species was described by Heer from the Dakota sandstone of Nebraska, and was based upon very incomplete material. His specimens have some long ascending secondaries, but Lesquereux's more complete specimens from the same formation and region show that these secondaries were not acrodrome but camptodrome. The species in this feature, and also in other respects, differs from *Protea* and its allies, which are more coriaceous and have the secondaries branching at acute angles and massed toward the generally apetiolate base. When compared with the genus *Ficus* it is found to closely resemble a number of different species from such widely separated localities as Central and South America and the Celebes. Especially among the Mexican and Central American forms are very similar leaves seen; for example, *Ficus fasciculata* Watson, *Ficus lancifolia* Hooker and Arnott, *Ficus ligustrina* Kunth and Bouché, and especially *Ficus sapida* Miquel, which has much the same outline and consistency, the same prominent midrib, and the same venation. When the fossil forms are placed in the genus *Ficus*, where they properly belong, they find their affinity in the group which includes, among others, such species as *Ficus elongata* Hosius, *Ficus berthoudi* Lesquereux, *Ficus suspecta* Velenovsky, and *Ficus krausiana* Heer.

This species has been found to be quite variable in size, ranging in length from 11 to 22 centimeters and in width from 1.9 to 3.7 centimeters. It is usually widest in the lower half of the leaf, although in some specimens the base is quite narrow and the widest part is toward the middle. In all unequivocal material the upper half of the leaf is narrow and is produced as a long, slender, commonly recurved tip, which is one of the characteristic features of the species. This tip is strictly comparable with the "dripping points" developed on various leaves in the modern Tropics where precipitation is heavy.

Ficus daphnogenoides is a widespread and common form, ranging from Marthas Vineyard to Alabama in eastern North America and from the Northwest Territory to Kansas and Nebraska in the Western Interior region.

Occurrence: Tuscaloosa formation, Shirleys Mill and Glen Allen, Fayette County; Cottondale, big gully and upper ravine on the Snow place, and gully at Tuscaloosa, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

Ficus inaequalis Lesquereux.

Plate XII, figure 1.

Ficus inaequalis Lesquereux, the flora of the Dakota group, p. 82, pl. 49, figs. 6–8; pl. 50, figs, 3, 6, 1892.
Smith, On the geology of the Coastal Plain of Alabama, p. 348, 1894.
Bartsch, Iowa Univ. Lab. Nat. Hist. Bull., vol. 3, p. 180, 1896.
Berry, Torrey Bot. Club Bull., vol. 34, p. 194, pl. 12, figs. 2, 3, 1907.

Leaves broadly ovate-acuminate in outline, many of them inequilateral. Size variable, ranging from 4 to 12 centimeters in length by 2 to 4.5 centimeters in maximum width, which is slightly below the middle, averaging about 8 centimeters in length by 3 to 3.5 centimeters in maximum width. From the middle the entire margins curve downward in a full curve to the

slightly decurrent base and upward to the more or less extended and commonly falcate-acuminate apex. Petiole short and stout, 2.5 centimeters long in the largest specimen seen. Midrib stout below, becoming much attenuated in the acumen. Secondaries numerous, mostly thin, somewhat irregularly spaced, branching from the midrib at angles of about 45°, and curving upward, regularly camptodrome. In some specimens one of the lower secondaries on either or both sides may be larger than the rest, giving the leaf the appearance of being triple veined. Tertiaries fine, of the usual *Ficus* type.

This handsome species was described originally from the Dakota sandstone of Kansas. It was subsequently recognized by Ward in collections from the Tuscaloosa formation, by Bartsch in the Dakota sandstone of Iowa, and by the writer in the Black Creek formation of North Carolina. The acuminate apex, though not developed to the conspicuous extent that it is in some of the other members of the Tuscaloosa flora, fully merits the appellation of "dripping point." Its presence in so many different forms in this flora is a clear indication of humidity and heavy rainfall.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County; Cottondale, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

Ficus shirleyensis Berry n. sp.

Plate XIII, figure 8.

Leaves ovate-acuminate in outline, about 10 centimeters in length by about 3.5 centimeters in maximum width, which is at a point about one-third of the distance from the base to the tip. Margins full and curved at the broadest part of the blade, becoming incurved and decurrent at the base and incurved upward to the narrow, extended, acuminate tip. Petiole stout, short. Midrib stout, curved. Secondaries numerous, thin, approximately parallel, camptodrome; they branch from the midrib at angles of about 45°, those in the broader part of the blade sweeping upward in a wide curve, approximately parallel with the lower lateral margin, and those in the acumen becoming short and nearly straight. Tertiaries fine, of the usual type found in *Ficus* leaves with the habit of the present species.

This form is exceedingly striking and graceful, and it is entirely distinct from any known Cretaceous species, although it may be readily matched by a number of modern tropical American species. It resembles to a certain extent the contemporaneous species *Ficus inaequalis* Lesquereux, and *Ficus daphnogenoides* (Heer) Berry, being intermediate in its characters. Thus it is relatively shorter and broader than *Ficus daphnogenoides* and relatively larger than *Ficus inaequalis* and is more elegantly proportioned than either of these, at the same time preserving the same general facies. The long acumen or "dripping point," which has been commented upon in connection with other members of the Tuscaloosa flora, is exceedingly well developed and may be duplicated in species now growing in the tropical rain forests of northern South America. The preservation of these features in the present species also affords a clear indication of the quiet waters in which the Tuscaloosa sediments were laid down at this point and further indicates that the form was a marginal species and was not brought down to the basin of sedimentation by rivers from some inland habitat.

Among previously described fossil plants the present species bears a close resemblance to the larger leaves of the form from the Cenomanian of Bohemia described by Velenovsky [1] as *Cassia melanophylla*.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Ficus woolsoni Hollick.

Plate XII, figure 2.

Ficus woolsoni Hollick, New York Acad. Sci. Trans., vol. 12, p. 33, pl. 2, figs. 1, 2c, 1892; New York Acad. Sci. Ann., vol. 11, p. 419, pl. 37, fig. 9, 1898; The Cretaceous flora of southern New York and New England, p. 59, pl. 11, figs. 5, 6, 1906.

Smith, On the geology of the Coastal Plain of Alabama, p. 348, 1894.

Newberry, The flora of the Amboy clays, p. 70, pl. 20, fig. 3; pl. 23, figs. 1–6, 1896.

Berry, New York Bot. Garden Bull., vol. 3, p. 74, pl. 47, fig. 7, 1903; Torrey Bot. Club Bull., vol. 33, p. 172, 1906; New Jersey Geol. Survey Ann. Rept. for 1905, p. 119, 1906; New Jersey Geol. Survey Bull. 3, p. 124, pl. 12, figs. 1, 2, 1911.

Leaves broadly ovate to cordate in outline, 5 to 10 centimeters in length, by 3.25 to 10

[1] Velenovsky, Josef, Die Flora der böhmischen Kreideformation, pt. 4, p. 5, pl. 8, figs. 1, 2, 8, 9, 11, 12, 1885. See especially fig. 1.

centimeters in breadth, with a usually acute apex and a cordate to a rounded, more or less decurrent base. Margin entire. Principal veins three, the midrib being the stoutest. The laterals branch at a variable angle from the top of the petiole, traverse considerably more than the basal half of the leaf, and join the camptodrome secondaries above; they give off on the outside numerous camptodrome branches, the lowest of which in some specimens branch from their extreme base, so that basal fragments of these leaves have the appearance of *Hedera primordialis* Saporta.

As I have previously pointed out, this species has many points of resemblance to *Ficus ovatifolia* Berry but is decidedly shorter and broader, with a more orbicular outline and a marked tendency toward a cordate base. It was evidently of a more coriaceous texture, as the finer venation is obsolete.

Ficus woolsoni is a much more abundant form in the Raritan formation of New Jersey than *Ficus ovatifolia*, and it has a considerably wider distribution, for it is recorded from Staten Island and from North Carolina and Georgia. It is also present in the Magothy formation in the New Jersey-Maryland region.

Occurrence: Tuscaloosa formation, Glen Allen and Shirleys Mill, Fayette County; gully at Tuscaloosa, Cottondale, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

Ficus alabamensis Berry, n. sp.

Plate XIV, figure 5.

Leaves of large size, cordate in outline, about 15 centimeters in length by 13 to 14 centimeters in greatest width, which is in the basal half of the leaf. Margin entire, with wide shallow indentations at irregular intervals. Apex pointed. Lateral margins rounded to the broad, truncate (not emarginate) base. Petiole short and stout, about 2.5 centimeters in length, swollen below and then constricted at the point of attachment. Midrib stout below, becoming greatly reduced and more or less curved distad. Secondaries stout, about seven subopposite pairs, branching from the midrib at angles of 45° or more, and curving upward, camptodrome; those in upper half of the leaf much reduced. Tertiaries camptodrome along the margin, transverse and curved between the secondaries. Texture somewhat coriaceous, but leaf substance not especially thick.

This handsome species is based upon splendid material from Shirleys Mill, Ala., near the base of the Tuscaloosa formation, and is entirely distinct from any known Cretaceous forms. Although its secondary venation is pinnate, it belongs with the palmate-veined species of *Ficus* represented in the Tuscaloosa by *Ficus woolsoni*, which is truly tri-veined and smaller than the present species. It bears the same relation to this type as the pinnately veined species of *Populus* bear to those which are clearly palmate in their venation.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collections: U. S. National Museum.

Ficus fontainii Berry, n. sp.

Plate XI, figure 3.

Leaves of medium to small size, broadly elliptical and more or less inequilateral in general outline, with a shallow rounded sinus on each side in the upper part, giving them a trilobate form, with full rounded lateral lobes and a narrow rounded apical lobe. Basal margins full and rounded, slightly decurrent. Length ranging from 7.5 to 11 centimeters. Maximum width, about halfway between the apex and the base, 5 to 8 centimeters. Margins entire. Texture coriaceous. Petiole stout, tapering proximad, about 1.25 centimeters in length. Midrib stout and curved, prominent on the lower surface of the leaf. Secondaries pinnate, irregularly spaced, becoming close together in the basal part of the leaf; they are stout, rather prominent on the lower surface of the leaf and rather irregular in their courses; six to eight mostly alternate pairs diverge from the midrib at acute angles and pursue a rather straight ascending course, forking in some specimens but as a rule regularly camptodrome except the second or third one from the base, which terminates at the apex of the lateral lobe. Tertiaries thin, mostly percurrent and subparallel.

This handsome and characteristic species is unfortunately represented by fragmentary material, the most complete leaf being the rather small one figured. This material was collected in 1888 by W. M. Fontaine, for whom it is

named. It suggests somewhat the American late Cretaceous and early Eocene forms that have been referred to *Ficus tiliaefolia* (Alexander Braun) Heer, as well as the two Dakota sandstone species *Benzoin masoni* (Lesquereux) Knowlton and *Benzoin venustum* (Lesquereux) Knowlton, both of which, however, are palmately triveined, with deep narrow sinuses, ovate lobes, and cuneate bases. It is, however, typically *Ficus*-like in the characters of its venation and perfectly distinct from previously described forms.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County; Shirleys Mill, Fayette County, Ala.

Collections: U. S. National Museum.

Order PLATANALES.[1]

Family PLATANACEAE.

Genus PLATANUS Linné.

[Species plantarum, p. 999, 1753.]

Platanus asperaeformis Berry, n. sp.

Plate XVI, figure 1.

Platanus newberryana Heer, Flora fossilis arctica, vol. 7, p. 28 (part), pl. 59, fig. 2, 1883 (not remainder of Heer's figures).

Leaves of medium size, orbicular in general outline, somewhat trilobate, with acute apex and cordate (?) base. Primaries three in number, of about equal prominence, the laterals branching from the midrib at angles of about 45°, slightly curved, terminating in the pointed tips of the lateral lobes, which are but slightly extended. Secondaries thin, numerous, craspedodrome. Tertiaries of the usual *Platanus* type. Margin prominently toothed. Teeth numerous, markedly aquiline-serrate, those at the termination of the secondaries enlarged.

This species is somewhat similar but more ample than the Dakota sandstone species, *Platanus newberryana* Heer,[2] and has a somewhat different margin. However, the leaf from western Greenland identified by Heer as *P. newberryana* and cited above seems to differ from it and to be identical with the present species, indicating the remarkable range from Alabama to Greenland. As the occurrence in Greenland is in a somewhat younger horizon, the species may have migrated northward, although it has always been assumed that the usual direction of migration of the Cretaceous floras was from the north southward.

The present species is not common and is associated with *Platanus shirleyensis* Berry, from which it shows well-marked differences. It is named in allusion to its great resemblance and possible ancestral relation to *Platanus aspera* Newberry,[3] an upper Eocene species of the Pacific Coast region. There is also a somewhat more distant resemblance to the Fort Union species *Platanus raynoldsii* Newberry.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collections: U. S. National Museum.

Platanus shirleyensis Berry, n. sp.

Plate XV, figures 1–5.

Leaves of small and medium size, ranging from 5 to 15 centimeters in length, by 3.5 to 12 centimeters in maximum width, at a point about halfway between the apex and the base. Trilobate, the median lobe ovate, the lateral lobes directed outward and upward, conical in form. Lateral sinuses, narrowly rounded, extending less than half the distance to the base, which is cuneate or slightly decurrent. Petiole stout, enlarged and partly sheathing proximad, as in the leaves of the modern species, variable in length, only 1 centimeter long in the smallest specimen figured but 4 centimeters long in other specimens which were collected. Lateral primaries, one on each side, stout, of the same caliber as the midrib, from which they branch either at or above its base, their relative position being determined by the amount of decurrence or truncation of the basal part of the leaf blade. Angle of divergence with the midrib about 30°. They terminate at the tips of the lateral lobes. Secondaries somewhat stout and fairly numerous, regularly spaced and approximately parallel in the larger leaves but more variable in this respect in small leaves; they diverge at angles of about 45°, pursue a more or less slightly curved course, and terminate in the marginal teeth, hence they are craspedodrome.

[1] I follow Griggs (Torrey Bot. Club Bull., vol. 36, pp. 389–395, 1909) in removing Platanus from the Rosales and making it the type of an order in the Apetalae next above the Urticales.

[2] Heer, Oswald, Phyllites crétacées du Nebraska, p. 16, pl. 1, fig. 4, 1866.

[3] Newberry, J. S., U. S. Nat. Mus. Proc., vol. 5, p. 509, 1882; U. S. Geol. Survey Mon. 35, p. 102, pl. 42, figs. 1–3; pl. 44, fig. 5; pl. 59, fig. 3, 1898.

Margins entire below, especially in the smaller leaves, above with broad-pointed serrate teeth directed upward, one to each secondary and with intermediate less prominent teeth. Tertiary venation typical of *Platanus*. Some of the leaves are infested with a spot fungus, *Sphaerites alabamensis* Berry.

This species is totally unlike any previously described *Platanus* and exhibits a rather wide range of variations. The small forms in particular, in their remote teeth, some of them crenate, and in the character of their base suggest some forms of *Sassafras* or of *Aralia wellingtoniana* Lesquereux. They are, however, connected by numerous intermediate forms with leaves that are typically those of *Platanus*, a relationship emphasized by the character of the petiole in both large and small forms.

The present species suggests somewhat *Platanus asperaeformis* Berry, which occurs with it in Fayette County, but the form is relatively narrower and longer, the teeth are much less aquiline, the lobes are more pronounced, and the base is different. Another species which resembles *Platanus shirleyensis* is *Platanus kümmelii*, which I have described from the Magothy formation of New Jersey.[1] Some of the leaves of *P. kümmelii*, which is abundantly represented by both leaves and fruit, are very close to the present species, although the typical form is that of a much larger, more prominently lobed and toothed, and more modern-looking leaf.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County; Cottondale, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

Platanus latior (Lesquereux) Knowlton.

Platanus aceroides? Goeppert var. *latior* Lesquereux, Am. Jour. Sci., 2d ser., vol. 46, p. 97, 1868.
Platanus latior (Lesquereux) Knowlton, U.S. Geol. Survey Bull. 152, p. 170, 1989; U. S. Geol. Survey Twenty-first Ann. Rept., pt. 7, p. 314, 1901.
Platanus primaeva Lesquereux, The Cretaceous flora, p. 69, pl. 7, fig. 2; pl. 26, fig. 2, 1874; The flora of the Dakota group, p. 72, pl. 8, figs. 7, 8b; pl. 10, fig. 1, 1892.

Leaves large, palmately trilobate broadly rhomboidal in outline. Length of specimen from Alabama about 17 centimeters. Maximum width about 15 centimeters. Margins somewhat irregularly dentate, entire at the broadly cuneate base. Lateral lobes short; intervening sinuses scarcely differentiated. Petiole long and stout. Primaries stout, three in number, diverging at or near the base in the material from Alabama, but commonly suprabasilar in the forms from the Dakota sandstone. Venation strictly platanoid. Texture coriaceous.

This fine large species is very abundant in the Dakota sandstone of Kansas, Nebraska, and Minnesota, and Lesquereux differentiated three varieties, namely, *integrifolia*, *subintegrifolia*, and *grandidentata*. The forms from Alabama are closer to the type than they are to any of the varieties.

The species appears to have been common near Cottondale, and it occurs in the Woodbine sand of Texas, according to Knowlton. It is readily distinguishable from the other two Tuscaloosa species of *Platanus* and in size and general appearance suggests *Platanus kümmelii* Berry [1] of the Magothy formation of New Jersey but is more entire and less prominently toothed.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Platanus ripleyensis Berry, n. sp.

Plate XXXII, figure 6.

Leaves small, trilobate, about 7 centimeters in length by 8 centimeters in maximum width from tip to tip of the lateral lobes. Base cuneate or slightly decurrent. Sinuses open, shallow, extending less than halfway to the base. Margins entire below, elsewhere with large serrate teeth directed distad. Petiole stout. Primaries three, suprabasilar. Secondaries mostly craspedodrome—a few intermediate ones camptodrome. Tertiaries thin, numerous, typically platanoid.

This species is a very modern-looking *Platanus*, and is readily distinguishable from the known Upper Cretaceous species. It is also clearly different from the imperfect material from the near-by locality on Cowikee Creek referred to *Platanus* sp. In its general facies it might readily be mistaken for a small leaf of *Platanus orientalis* or *Platanus occidentalis* or for the common Miocene species *Platanus*

[1] Berry, E. W., New Jersey Geol. Survey Ann. Rept. for 1905, p. 146, pl. 23, figs. 2, 3; pl. 24, 1906.

aceroides. It is, unfortunately, represented by a scanty amount of material which was collected by C. W. Cooke several years after the remainder of the present report was written.

Occurrence: Ripley formation, roadside 6¾ miles north of Eufala, Barbour County, Ala.

Collection: U. S. National Museum.

Platanus sp.

Plate XXXI, figures 7, 8.

Fragments of what appear to represent a new species of *Platanus* were collected from the lower part of the Ripley formation of eastern Alabama. They are insufficient for proper diagnosis but are included in the present report and figured because plant fossils are so extremely rare in these beds.

Occurrence: Ripley formation, near mouth of Cowikee Creek, Barbour County, Ala.

Collection: U. S. National Museum.

Order PROTEALES.

Family PROTEACEAE.

Genus PROTEOIDES Heer.

Proteoides conospermaefolia Berry, n. sp.

Plate XIV, figure 4.

Leaves narrowly oblanceolate in outline, with a rounded apex and a gradually narrowed, straight margined, extended base. About 8 centimeters in length by 1 centimeter in greatest width, which is in the distal half of the leaf. Midrib stout below, narrow above. Secondaries fine, numerous, diverging from the midrib at angles of over 45°, immersed in the coriaceous leaf substance and indistinct toward the margins along which they arch. Tertiaries fine, mostly obsolete, forming quadrangular or polygonal meshes.

This well-marked new species resembles a number of European Upper Cretaceous species, as, for example, *Euphorbiophyllum antiquum* Saporta and Marion [1] from the Turonian of Bagnols, France. It still more closely resembles certain leaves from the Cenomanian of the island of Lesina, off the Dalmatian coast, which Kerner [2] describes as *Proteoides* cf. *P. grevillaeformis* Heer, although in my judgment they are certainly not to be identified as that species.

[1] Saporta, G. de, and Marion, A. F., L'évolution du règne végétal, Phanérogames, vol. 2, p. 117, fig. 125c, 1885.

[2] Kerner, F. von, K.-k. geol. Reichsanstalt Jahrb., Band 45, p. 54, pl. 5, fig. 2, 1896.

The present species is clearly referable to the genus *Proteoides*, by which I mean that it represents an Upper Cretaceous species of the family Proteaceae, whose exact generic relationship is uncertain because of the parallelism in the foliar characters of so many of the genera of this family. The present leaves can be almost exactly duplicated in the existing genus *Conospermum* of the Australian region, and this resemblance has suggested the specific name which has been adopted.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collections: U. S. National Museum.

Genus PERSOONIA Swartz.

Persoonia lesquereuxii Knowlton.

Plate XIV, figure 2.

Persoonia lesquereuxii Knowlton, in Lesquereux, The flora of the Dakota group, p. 89, pl. 20, figs. 10–12, 1892.
Newberry, The flora of the Amboy clays, p. 71, pl. 42, fig. 16, 1896; New Jersey Geol. Survey Bull. 3, p. 126, pl. 20, fig. 6, 1911.
Berry, Torrey Bot. Club Bull., vol. 33, p. 173, 1906.
Andromeda latifolia Newberry, The flora of the Amboy clays, p. 120 (part), pl. 33, fig. 9, 1896 (not figs. 6–8, 10).

Leaves obovate in outline, with a broadly rounded apex, submarginate in one of the specimens from the Dakota sandstone, gradually narrowing to the decurrent base. They range from 1.7 to 5 centimeters in length by 1.2 to 2.5 centimeters in greatest width, which is toward the apex. Petiole stout. Texture subcoriaceous. Secondaries sparse, 3 or 4 pairs, thin, alternate, branching from the stout midrib at an angle of 45° or less, camptodrome.

This species, which was described originally from the Dakota sandstone of Kansas, is somewhat variable in appearance. Hollick referred a small, almost orbicular leaf from the Raritan formation of New Jersey to it, presumably on the basis of its resemblance to Knowlton's figure 12. For the same reason the writer is inclined to think that the form shown in Newberry's Plate XXXIII, figure 9, which he calls an *Andromeda*, is also referable to this species. Similar obovate leaves are also present in the overlying Magothy formation.

As far as I can discover, this species in New Jersey is not found below the upper part of the Raritan.

Occurrence: Tuscaloosa formation, Shirleys Mill, and Glen Allen, Fayette County, Ala.

Collections: U. S. National Museum.

Persoonia lesquereuxii minor Berry, n. var.

Plate XIV, figure 3.

Leaves spatulate in outline, somewhat inequilateral, with a rounded apex and decurrent base. Length above 3 centimeters. Maximum width 1.35 centimeters in the upper part of the leaf. Texture coriaceous. Petiole stout, about 7 millimeters in length. Midrib slender, immersed. Secondaries ascending camptodrome, mostly obsolete.

This variety greatly resembles the smaller leaves which are referred to the species, especially those from the Raritan formation of New Jersey, which have been identified by Newberry. The variety is more coriaceous, has more completely immersed venation, and is relatively narrower and more inequilateral in outline. It is considerably smaller than the species as it occurs in the Dakota sandstone of Kansas.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Order RANALES.

Family RANUNCULACEAE (?).

Genus DEWALQUEA Saporta and Marion.

[Acad. roy. sci., lettres et beaux arts Belgique Mém. couronnés et mém. des savants étrangers, vol. 37, p. 55, 1874.]

Dewalquea smithi Berry.

Plate XIV, figure 1; Plate XVI, figures 2, 3.

Dewalquea smithi Berry, Torreya, vol. 10, p. 36, fig. 1, 1910; Torrey Bot. Club Bull., vol. 43, p. 293, 1916.

Leaves palmately decompound, the petiole dividing into three principal branches, the angle of divergence ranging from 20° to 60°, and the two lateral branches forking at an acute angle 1 centimeter to 2 centimeters above their base. The middle leaflet is lanceolate in outline, being widest in its central part and tapering almost equally to the acute apex and base. Length 7.5 to 16 centimeters. Maximum width 1 centimeter to 4 centimeters. Margin entire or serrate, usually entire below and serrate in the apical three-fourths, in some specimens with large aquiline-serrate teeth. Midrib stout. Secondaries regular, subopposite, parallel; about 20 pairs, branching from the midrib at angles ranging from 45° to 70°, usually about 50°, curving upward and running to the marginal teeth, or camptodrome. The base of the leaflet extends downward to a point within 2 or 3 millimeters of the forks of the petiole.

Lateral leaflets, more or less inequilateral, usually somewhat smaller than the middle leaflet. The internal lateral leaflet is lanceolate, the outer lamina starting at or very near the point where the lateral branch of the petiole forks. The inner lamina, however, extends downward almost to the base of the lateral branch, making the base markedly inequilateral. In general outline and marginal and venation characters, it is identical with the middle leaflet. The outer lateral leaflet is also somewhat inequilateral but less so than the internal lateral leaflet, the internal lamina starting at or near the fork and its outer lamina extending more or less below the fork. The marginal and venation characters are like those of the other leaflets.

This handsome species, of which a restoration is shown in figure 11, is abundantly represented in the Middendorf arkose member of the Black Creek formation of South Carolina, mostly by terminal leaflets, a number of which have been figured. It is common in the Tuscaloosa formation at Whites Bluff on the right bank of Black Warrior River, 309 miles above Mobile, Ala. A small collection of fossil plants from this outcrop contained no less than 27 specimens of this form. Several of these specimens were complete and were sketched at the time they were collected, which proved fortunate, for the extremely arenaceous matrix did not withstand shipment very well. The material in the National Museum, although considerably broken, comprises several detached leaflets and three or four basal parts of the leaf, showing the mode of division of the petiole. The species is also represented by detached leaflets at Shirleys Mill in Fayette County.

The genus *Dewalquea* was founded by Saporta and Marion in 1874 upon remains from the Senonian of Westphalia, communicated by Debey and named by him in manuscript *Araliophyllum*, and on additional remains collected by those authors from the Paleocene of Gelinden, Belgium (Marnes heersiennes, étage Thanétien). Three species were enumerated,

Dewalquea haldemiana and *Dewalquea aquisgranensis* from the Westphalian Senonian, and *Dewalquea gelindenensis* from the basal Eocene. In the past 35 years several additional species have been referred to this genus. These include another species from the German Senonian (*Dewalquea insignis*), described by Hosius and Von der Marck;[1] two species from the Cenomanian of Bohemia (*Dewalquea coriacea* and *Dewalquea pentaphylla*), described by Velenovsky;[2] two American species from the Dakota sandstone (*Dewalquea dakotensis* and *Dewalquea primordialis*), described by Lesquereux,[3] both of which are fragmentary and of uncertain relationship; a species from the Raritan formation of New Jersey (*Dewalquea trifoliata*), described by Newberry;[4] and a species described by Heer[5] from Greenland (*Dewalquea groenlandica*) and subsequently recorded from Staten Island, New Jersey, North Carolina, and Alabama.

Hosius and Von der Marck[6] record the Eocene species from the Senonian of Westphalia; the remains, however, are not of this species but are fragments of *Dewalquea haldemiana*, which is common at that horizon. The European species *Dewalquea insignia* is recorded by Heer[7] from both the Atane and Patoot beds of Greenland, and by Hollick[8] from the Cretaceous of Staten Island, but both of these determinations are based upon fragments of single leaves and are in my judgment entirely untrustworthy. Attention should also be called to the possibility that *Celastrus arctica* Heer[9] represents the leaflets of a *Dewalquea*. This

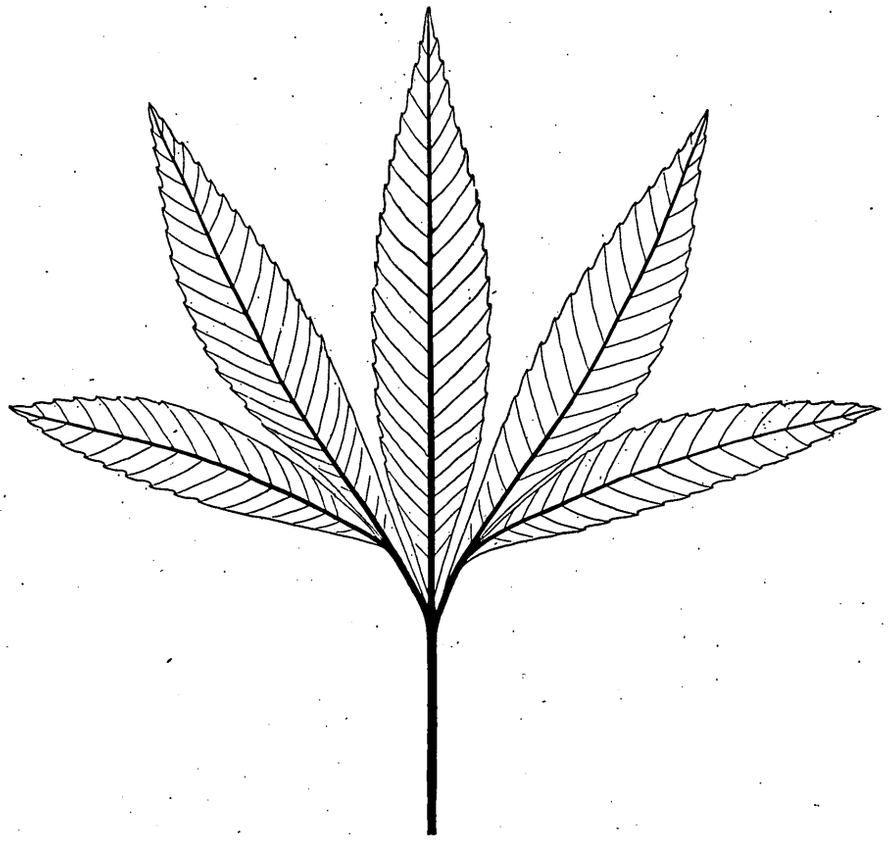


FIGURE 11.—Restoration of *Dewalquea smithi*.

[1] Hosius, A., and Von der Marck, W., Palaeontographica, vol. 26, p. 172, pl. 32, figs. 111–113; pl. 33, fig. 109; pl. 34, fig. 110; pl. 35, fig. 123, 1880.

[2] Velenovsky, Josef, Die Flora der böhmischen Kreideformation, vol. 3, p. 11, 14, pl. 1, figs. 1–9, pl. 2, fig. 2, pl. 8.

[3] Lesquereux, Leo, The flora of the Dakota group, p. 211, pl. 59, figs. 5, 6, 1892; Minnesota Geol. and Nat. Hist. Survey, vol. 3, p. 18, pl. A, fig. 10, 1892.

[4] Newberry, J. S., The flora of the Amboy clays; U. S. Geol. Survey Mon. 26, p. 129, pl. 22, figs. 4–7, 1896.

[5] Heer, Oswald, Flora fossilis arctica, vol. 6, pt. 2, p. 87, pl. 29, figs. 18, 19; pl. 42, figs. 5, 6; pl. 44, fig. 11, 1882.

[6] Hosius, A., and Von der Marck, W., op. cit., p. 50.

[7] Heer, Oswald, op. cit., vol. 6, p. 86, pl. 25, fig. 7; pl. 33, figs. 14–16, 1882; idem, vol. 7, p. 37, pl. 58, fig. 3; pl. 62, fig. 7, 1883.

[8] Hollick, Arthur, The Cretaceous flora of southern New York and New England: U. S. Geol. Survey Mon. 50, p. 106, pl. 8, fig. 24, 1907.

[9] Heer, Oswald, op. cit., vol. 7, p. 40, pl. 61, figs. 5d, 5e, 1883.

species was described from the Patoot beds of Greenland, where it is sparsely represented. It is abundant, however, in the upper part of the Raritan formation of New Jersey, but of some scores of specimens examined by the writer all were detached and failed to show their habit of growth.

The botanic relationship of *Dewalquea* has always remained obscure, and there is no better discussion of it than that given by Saporta and Marion,[1] who, after comparing these leaves with those of *Ampelopsis*, *Arisaema*, *Anthurium* (Araceae), Araliaceae, and other forms, arrive at the conclusion that they are prototypes of the tribe Helleboreae of the Ranunculaceae. The claims of the Araliaceae, pointed out by Schenk and others, should not be overlooked in this connection.

The present species is markedly distinct from the American species of *Dewalquea* previously described, all of which were apparently tripartite. Among the European species it is quite similar to the Senonian species *Dewalquea insignis* Hosius and Von der Marck, which is, however, entirely distinct. It is also similar to *Dewalquea coriacea* and *Dewalquea pentaphylla*, which are described by Velenovsky from the Cenomanian of Bohemia.

As mentioned above, this Alabama species shows entire and serrated forms, and it is remarkable that wherever this genus has been found to occur in any abundance, two species are usually described, one entire and one with toothed margins. Thus in Germany *Dewalquea haldemiana* is entire, whereas *Dewalquea insignis* is toothed, though probably both are the leaves of the same plant. In Bohemia *Dewalquea pentaphylla* is entire, whereas *Dewalquea coriacea* is toothed. Both the entire and serrate leaves of the Alabama plant are believed to be specifically identical, as the material shows a great many gradations in the size of the teeth and great variability regarding the proportion which the entire part bears to the toothed part on single leaflets.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County; Whites Bluff, Greene County, Ala. Eutaw formation (Coffee sand member), Coffee Bluff, Hardin County, Tenn.

Collections: U. S. National Museum.

[1] Saporta, G. de, and Marion, A. F., L'évolution du règne végétal, Phanérogames, vol. 2, pp. 55–61, 1885.

Family MAGNOLIACEAE.

Genus MAGNOLIA Linné.

[Species plantarum, p. 535, 1753.]

Magnolia speciosa Heer.

Plate XVIII, figures 3, 4.

Magnolia speciosa Heer, Allg. schweiz. Gesell. gesammt. Naturwiss. Bern Neue Denskchr., Band 23, p. 20, pl. 6, fig. 1; pl. 9, fig. 2; pl. 10, fig. 1, 1869.

Lesquereux, The Cretaceous and Tertiary floras, p. 72, 1874; The flora of the Dakota group, p. 202, pl. 60, figs. 3, 4, 1892.

Hollick, New York Acad. Sci. Trans., vol. 12, p. 234, pl. 7, fig. 4, 1893; Torrey Bot. Club Bull., vol. 21, p. 60, pl. 178, fig. 5, 1894; Geol. Soc. America Bull., vol. 7, p. 13, 1895; The Cretaceous flora of southern New York and New England. p. 64, pl. 19, figs. 1–4, 1906.

Knowlton, U. S. Geol. Survey Twenty-first Ann. Rept., pt. 7, p. 318, 1901.

Smith, On the geology of the Coastal Plain of Alabama, p. 348, 1894.

Berry, Torrey Bot. Club Bull., vol. 31, p. 76, pl. 3, fig. 10, 1904; idem, vol. 32, p. 46, pl. 2, figs. 4, 5, 1905; New Jersey Geol. Survey Bull. 3, p. 129, pl. 14, fig. 3, 1911.

Magnolia auriculata Newberry, The flora of the Amboy clays, p. 75 (part), pl. 41, fig. 13; pl. 58, fig. 10, 1896.

Heer's description, published in 1869, is as follows:

M. foliis maximis, coriaceis, ovato-ellipticis, apice longe attenuatis, valde acuminatis, basi in petiolum validum attenuatis, nervo primario crasso, nervis secundariis valde curvatis, camptodromis.

This species is somewhat variable in size. The American material, which is somewhat smaller than the type material from Moletein, Moravia, ranges in length from 8.5 to 19 centimeters and in maximum width from 4 to 7.5 centimeters. It is ovate-elliptical in outline, with the apex more or less produced and the base decurrent. The midrib and petiole are stout. The secondaries are well marked, camptodrome; they number seven to nine pairs and are subopposite, branching from the midrib at angles of about 45° and curving upward. The texture is coriaceous.

This species, which was described originally from the Cenomanian of Moravia, has been found to have a wide range in America. Typical leaves occur in the Dakota sandstone and also as far south as Texas. It is present on Marthas Vineyard and Long Island and in the Magothy formation of New Jersey. Though not heretofore reported from the Raritan formation, it would seem as if some of the leaves

which Prof. Newberry described as *Magnolia auriculata* should be referred to this species. They range down in size, but this is also true of some of the western leaves of this species. *Magnolia auriculata* was reported by Ward from the Tuscaloosa formation of Alabama, but all of the specimens so labeled which have come into the writer's hands for study are closer to *M. speciosa*, and not one shows any tendency toward an auriculate base, which is the main characteristic of *M. auriculata*. This may of course have been a variable feature, as it is to a certain extent in the existing *M. fraseri* Walter and *M. macrophyllia* Michaux, but if it is worth anything at all in the fossils it is worth emphasizing.

Magnolia speciosa is common in the lower part of the Tuscaloosa formation and is the most abundant form at the Cottondale locality. It has not been discovered in the upper part of the Tuscaloosa or in the Eutaw formation.

Occurrence: Tuscaloosa formation, Shirleys Mill and Glen Allen, Fayette County; Cottondale, and gully at Tuscaloosa, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

Magnolia capellinii Heer.

Plate XVIII, figure 1; Plate XXXII, figure 7.

Magnolia capellinii Heer, Phyllites crétacées du Nebraska, p. 21, pl. 3, figs. 5, 6, 1866; Flora fossilis arctica, vol. 3, Abt. 2, p. 115, pl. 33, figs. 1–4, 1874; idem, vol. 6, Abt. 2, p. 90, pl. 24, figs. 3–5, pl. 25, figs. 1–3, pl. 45, fig. 1, 1882.

Velenovsky, Die Flora der böhmischen Kreideformation, pt. 2, p. 20, pl. 7, figs. 8, 9, 1883.

Lesquereux, The flora of the Dakota group, p. 203, pl. 46, fig. 1, 1892.

Dawson, Roy. Soc. Canada Trans., 1st ser., vol. 11, sec. 4, p. 63, pl. 11, fig. 49; pl. 13, fig. 49a, 1894.

Hollick, New York Acad. Sci. Trans., vol. 12, p. 234, pl. 6, fig. 6, 1893; New York Bot. Garden Bull., vol. 3, p. 413, pl. 78, fig. 3, 1904; The Cretaceous flora of southern New York and New England, p. 63, pl. 17, figs. 3, 4, 1907.

Berry, Torrey Bot. Club Bull., vol. 31, p. 76, pl. 3, fig. 3, 1904; New Jersey Geol. Survey Ann. Rept. for 1905, p. 138, 1906; Torrey Bot. Club Bull., vol. 34, p. 195, pl. 12, figs. 4, 5, 1907.

Magnolia sp. Berry, Johns Hopkins Univ. Circ., new ser., No. 7, p. 81, 1907.

The leaves of this species vary considerably in size, averaging about 13 centimeters in length by 7 centimeters in maximum width. Outline broadly ovate, the base and apex usually about equally pointed, although a few specimens have a somewhat obtuse apex, whereas others have it extended, as it is in some of the material from North Carolina and in the fragments identified as this species from South Carolina. Texture coriaceous or subcoriaceous. Midrib and petiole stout. Secondaries usually seven or eight alternate or subopposite pairs at regular intervals, approximately parallel, camptodrome.

This widespread species in some of its forms approaches quite close to the less narrow and less apically extended form of *Magnolia speciosa* Heer. Ordinarily, however, *Magnolia speciosa* may be readily distinguished by its relatively narrower form, with the produced tip and decurrent base. *Magnolia capellinii* was described originally from the Dakota sandstone by Heer and has been collected from a large number of localities of homotaxial age, from eastern Europe, Greenland, and the Pacific coast of North America. In the Atlantic Coastal Plain it characterizes the Magothy formation of the northern slope and is present in the Black Creek formation of North Carolina, the Middendorf arkose member of the Black Creek formation of South Carolina, and the Tuscaloosa formation of Georgia and Alabama. In Alabama it is only known from the single locality cited, where it is not abundant and may be simply a variant of *Magnolia speciosa*, which is so very common at that locality. A slightly variant form occurs in the Ripley formation of western Tennessee.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County, Ala. Eutaw formation (basal beds), McBrides Ford, Chattahoochee County, Ga. Ripley formation (McNairy sand member), 2½ miles southwest of Selmer, McNairy County, Tenn.

Collections: U. S. National Museum.

Magnolia newberryi Berry.

Plate XX, figure 4.

Magnolia newberryi Berry, Torrey Bot. Club Bull., vol. 34, p. 195, pl. 13, fig. 6, 1907; New Jersey Geol. Survey Bull. 3, p. 133, pl. 13, 1911.

Magnolia longifolia Hollick, New York Acad. Sci. Trans., vol. 12, p. 36, pl. 3, fig. 9, 1892; New York Acad. Sci. Ann., vol. 11, p. 422, pl. 37, fig. 3, 1898; The Cretaceous flora of southern New York and New England, p. 66, pl. 20, figs. 2, 3 (not Sweet, 1826), 1906.

Smith, On the geology of the Coastal Plain of Alabama, p. 348, 1894.

Newberry, The flora of the Amboy clays, p. 76, pl. 55, figs. 3, 5; pl. 56, figs. 1–4.

Leaves mostly of large size, ovate to oblong in outline, about 20 centimeters in length by 9 to 10 centimeters in maximum width, broadest toward the base. Apex subacute or obtuse. Base varying from obtusely rounded, almost truncate, to somewhat cuneate. Petiole and midrib stout. Secondaries comparatively thin and open, about 12 pairs, camptodrome. Tertiaries forming 4, 5, or 6 sided areoles, prominent in some specimens.

This is the largest fossil *Magnolia* of the Coastal Plain, and some of its leaves are said by Newberry to reach a length of 30 centimeters or more. In a general way it resembles an immense leaf of *Magnolia woodbridgensis*, and it also approaches somewhat *Magnolia longipes*, but the petiole is only about one-third the length of that of the latter species. It is common in the middle part of the Raritan formation of New Jersey through the Black Creek formation in North Carolina and is present at various points along the Atlantic Coastal Plain. It is present in the lower part of the Tuscaloosa formation in western Alabama, but owing to its large size it has generally become more or less broken before fossilization.

Occurrence: Tuscaloosa formation, Glen Allen, Fayette County, Ala.

Collections: U. S. National Museum.

Magnolia obtusata Heer.

Plate XVII, figures 7, 8.

Magnolia obtusata Heer, Flora fossilis arctica, vol. 6, Abt. 2, p. 90, pl. 15, fig. 12, pl. 21, fig. 3, 1882.

Lesquereux, The flora of the Dakota group, p. 201, pl. 60, figs. 5, 6, 1892.

Berry, New York Bot. Garden Bull., vol. 3, p. 76, pl. 47, fig. 4, 1903; Torrey Bot. Club Bull., vol. 37, p. 23, 1910.

Magnolia capellinii Heer, Flora fossilis arctica, vol. 3, Abt. 2, pl. 33, fig. 4, 1874 (no other citations of this species).

Leaves of variable size, oblong ovate or obovate in outline, entire, with a broadly rounded apex and a narrowed cuneate base, ranging from 7 to 14 centimeters in length by 2.4 to 7 centimeters in greatest width, which is above the middle. Petiole and midrib stout. Secondaries few in number ascending, curved, camptodrome. Texture coriaceous.

This species was described from the Atane beds of Greenland by Heer and was based upon rather fragmentary material. Subsequently Lesquereux recorded some fine specimens from the Dakota sandstone of Kansas. It is present in the Magothy formation from New Jersey to Maryland, and in beds of homotaxial age in South Carolina. In western Alabama it appears to be confined to the lower part of the Tuscaloosa formation of Fayette County.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collections: U. S. National Museum.

Magnolia boulayana Lesquereux.

Plate XVIII, figure 2.

Magnolia boulayana Lesquereux, The flora of the Dakota group, p. 202, pl. 60, fig. 2, 1892.

Magnolia glaucoides Hollick, Torrey Bot. Club Bull., vol. 21, p. 60, pl. 175, figs. 1, 7, 1894.

Magnolia glaucoides Hollick. Smith, On the geology of the Coastal Plain of Alabama, p. 348, 1894.

Magnolia glaucoides Newberry, The flora of the Amboy clays, p. 74, pl. 57, figs. 1–4, 1896.

Magnolia boulayana Lesquereux. Knowlton, U. S. Geol. Survey Twenty-first Ann. Rept., pt. 7, p. 318, 1901.

Magnolia glaucoides Hollick, The Cretaceous flora of southern New York and New England, p. 67, pl. 19, fig. 6; pl. 20, fig. 6, 1906.

Magnolia boulayana Lesquereux. Berry, Torrey Bot. Club Bull., vol. 36, p. 254, 1909; idem, vol. 37, p. 23, 1910.

New Jersey Geol. Survey Bull. 3, p. 131, pl. 14, fig. 2, 1911.

Leaves narrowly elliptical in outline, unusually uniform in size and shape, 8.5 to 13 centimeters in length and 3.5 to 4.5 centimeters in maximum width. Apex usually bluntly rounded, in some specimens acute. Base matching the apex. Petiole rather stout, 3 to 4 centimeters in length. Midrib rather stout. Secondaries slender, commonly obsolete, about 11 pairs, equidistant, parallel, camptodrome, branching from the midrib at an angle of about 40°. Tertiaries, when seen, transverse. Texture coriaceous.

This species was described originally from the Dakota sandstone of Kansas by Lesquereux. Newberry described the Raritan remains, which are abundant at the Woodbridge locality, as a new species and it has been kept distinct by Hollick, who recognized, however, its practical identity with the Dakota sandstone plant. There can be no question but that they belong to the same species, and it seems probable that *Magnolia vaningeni* described by Hollick[1] should also be referred to the same species.

[1] Hollick, Arthur, Torrey Bot. Club Bull., vol. 21, p. 61, pl. 175, fig. 6, 1894.

In addition to the localities already mentioned this species is found on Marthas Vineyard and Long Island, in the Eutaw formation of western Georgia, and in the Woodbine sand of the western Gulf region (Texas). Characteristic specimens of this species are present in the lower beds of the Tuscaloosa formation of Fayette County, Ala.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala. Eutaw formation (basal beds), McBrides Ford, Chattahoochee County, Ga.

Collections: U. S. National Museum.

Magnolia longipes Hollick.

Magnolia longipes Hollick, Torrey Bot. Club Bull., vol. 21, p. 60, pl. 178, fig. 3, 1894.
Newberry, The flora of the Amboy clays, p. 76, pl. 54, figs. 1–3, 1896.
(?) Hollick, The Cretaceous flora of southern New York and New England, p. 64, pl. 21, figs. 5, 6, 1906.
Berry, Torrey Bot. Club Bull., vol. 37, p. 23, 1910; New Jersey Geol. Survey Bull. 3, p. 135, pl. 14, fig. 1, 1911.
Magnolia alternans Heer. Ward, in Smith, On the geology of the Coastal Plain of Alabama, p. 348, 1894 (not Heer).

Leaves oblong-ovate in outline, apparently about 18 centimeters in length by 6 to 7 centimeters in maximum width, which was below the middle. Apex obtusely rounded. Base usually cuneate. Midrib and petiole very stout, the latter unusually long, reaching 12 to 13 centimeters in some specimens. Secondaries camptodrome, relatively thin and remote, 10 to 12 pairs, branching from the midrib at angles of about 45° and curving upward in a short distance to join a branch from the secondary next above. The secondaries thus form a series of large arches which approximately parallel the margin and constitute one of the distinctive characters of this species, another being the long petiole and the oblong, almost straight-sided shape.

This leaf is a very striking *Magnolia* and is common in the middle part of the Raritan formation at Woodbridge, N. J. Fragmentary specimens which have been correlated with these remains are reported from Long Island. It is apparently quite different in appearance from any of the other Cretaceous species of *Magnolia*, although it suggests somewhat a gigantic form of *Magnolia woodbridgensis*. It is found in the Magothy formation of Maryland. The occurrence in Alabama is based upon the material from the Cottondale locality, which is more or less fragmentary and similar to that identified as *Magnolia alternans* Heer by Ward. In the absence of complete specimens, only the basal part as a rule being preserved, it is quite possible that the present specimens are not distinct from *Magnolia speciosa*, which is so abundant at this locality.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County; Shirleys Mill, Fayette County, Ala.

Collections: U. S. National Museum.

Magnolia lacoeana Lesquereux.

Plate XVII, figure 9

Magnolia lacoeana Lesquereux, The flora of the Dakota group, p. 201, pl. 60, fig. 1, 1892.
Newberry, The flora of the Amboy clays, p. 73, pl. 55, figs. 1, 2, 1896.
Hollick, The Cretaceous flora of southern New York and New England, p. 65, pl. 17, fig. 2, 1906.
Berry, Torrey Bot. Club Bull., vol. 37, p. 23, 1910; New Jersey Geol. Survey Bull. 3, p. 134, pl. 16, fig. 2, 1911.

Leaves broadly oval to almost orbicular in outline, obtuse or abruptly pointed above and rounded to a somewhat cuneate base below, 10 to 12 centimeters in length by 8.5 to 9.5 centimeters in maximum width. Midrib stout, somewhat flexuous. Secondaries numerous, camptodrome, rather stout, 10 to 12 pairs; they branch from the midrib at acute angles, immediately curving outward, forming festoons near the margin, which is somewhat undulate in one specimen that Newberry referred to this species.

This species differs from its contemporaries, especially in its nearly round outline; Lesquereux finds a resemblance to *Magnolia inglefieldi* Heer from Greenland, and it also suggests some of the Arctic forms which have been referred to *Magnolia capellinii* Heer.

Although this species is reported from such widely separated points as Marthas Vineyard and Kansas, it is nowhere abundant and is usually poorly preserved, suggesting that the leaves were readily macerated. It also occurs in unreported collections from the Magothy formation in Maryland. In Alabama it appears to be confined to the lower part of the Tuscaloosa formation of Fayette County.

Occurrence: Tuscaloosa formation, Shirleys Mill and Glen Allen, Fayette County, Ala.

Collections: U. S. National Museum.

Magnolia hollicki Berry.

Magnolia hollicki Berry, Torrey Bot. Club Bull., vol. 36, p. 253, 1909; New Jersey Geol. Survey Bull. 3, p. 136, pl. 15, fig. 3, 1911.

Magnolia auriculata Hollick, Torrey Bot. Club Bull., vol. 21, p. 61, pl. 179, figs. 6, 7, 1894; The Cretaceous flora of southern New York and New England, p. 67, pl. 19, fig. 5; pl. 20, figs. 5, 8, 1906 (not Lamarck, 1783).

Smith, On the geology of the Coastal Plain of Alabama, p. 348, 1894.

Newberry, The flora of the Amboy clays, p. 75, pl. 58, figs. 1–9, 11, 1896 (not fig. 10).

Berry, Torrey Bot. Club Bull., vol. 33, p. 174, 1906.

Dicotyledonous leaf impression, Hitchcock, Final report on the geology of Massachusetts, vol. 2, p. 430, pl. 19, fig. 1 (part), 1841.

Leaves orbicular-ovate in outline, 4 to 10 centimeters in length by 2 to 5.5 centimeters in width, petiolate. Apex acute, slightly extended in one or two specimens. Base usually pronouncedly auriculate. Petiole and midrib stout. Secondaries few, 6 or 7 pairs subopposite, camptodrome. Texture smooth and subcoriaceous.

This magnificent species is abundant and well preserved at Woodbridge, N. J., in the Raritan formation, on Marthas Vineyard, and in the Magothy formation of Maryland. Newberry was somewhat uncertain as to its relationship with *Magnolia* and compared it with *Aristolochia*, *Polygonum*, and *Toxylon*. Of these genera *Toxylon* is the only one which is at all suggestive, and none of its species has the auriculate base, whereas this character of base prevails in more than one modern species of *Magnolia*. The outline, consistency and venation, are all in accord in pointing to *Magnolia* as the proper generic reference. This form is one of those mentioned from Marthas Vineyard by Hitchcock.[1]

Ward identified this species from Cottondale, Shirleys Mill, and Glen Allen, in Alabama, but in restudying these collections I have referred these forms to *Magnolia speciosa* Heer and confined *M. hollicki* to forms with an auriculate base. I have seen only a single specimen of *M. hollicki*, which is, however, typical, being an almost exact counterpart of Newberry's figure 11 in size and outline, differing merely in the more pronounced basal auricles of the Tuscaloosa specimen.

[1] Hitchcock, Edward, Final report on the geology of Massachusetts, vol. 2, p. 430, 1841.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Genus LIRIODENDRON Linné.

Liriodendron meekii Heer.

Plate XX, figure 2.

Liriodendron meekii Heer, in Meek and Hayden, Acad. Nat. Sci. Philadelphia Proc., vol. 10, p. 265, 1858.

Heer, Phyllites crétacées du Nebraska, p. 21, pl. 4, figs. 3, 4, 1866.

Newberry, Illustrations of Cretaceous and Tertiary plants, pl. 6, figs. 5, 6, 1878.

Lesquereux, The flora of the Dakota group, p. 205, pl. 28, figs. 5, 6, 1892.

Engelhardt, Naturwiss. Gesell. Isis in Dresden Abh. 7, Jahrg. 1891, p. 100, 1892 (?).

Kurtz, Rev. Mus. La Plata, vol. 10, p. 53, 1902 (?).

Liriodendron meekii genuina Heer, Flora fossilis arctica, vol. 6, Abt. 2, p. 89, pl. 22, figs. 12, 13; pl. 23, fig. 6, 1882.

Liriodendron primaevum Newberry, Lyceum Nat. Hist. New York City Ann., vol. 9, p. 12 (part), 1868.

Newberry, Illustrations of Cretaceous and Tertiary plants, pl. 6, fig. 7, 1878 (misnumbered as fig. 6).

Lesquereux, The flora of the Dakota group, p. 203 (part), pl. 26, fig. 2, 1892.

Newberry, The later extinct floras of North America, p. 96, pl. 6, fig. 7, 1898.

Hollick, New York Acad. Sci. Trans., vol. 12, p. 8, pl. 3, fig. 4, 1892.

Hollick, The Cretaceous flora of southern New York and New England, p. 68, pl. 21, fig. 7, 1906.

Liriodendron meekii primaeva Heer, Flora fossilis arctica, vol. 6, Abt. 2, p. 88 (part), pl. 23, fig. 5, 1882.

Leaves of relatively small size, more or less panduriform in outline; described by Newberry as three-lobed with the median lobe emarginate. Length along the midrib 5 to 10 centimeters, usually about 5 centimeters, the specimen from Alabama being 4.7 centimeters. Greatest width, which is toward the base of the leaf, 2.4 to 7 centimeters, averaging about 4 centimeters, the specimen from Alabama being 4.3 centimeters. Lobes more or less well marked, the basal pair directed laterally and broadly rounded, the upper pair directed diagonally, usually less well marked, rounded at the outside and inclined toward angularity at the tip. Lateral sinuses more or less indented in the typical forms, such as the specimen figured from Alabama, extending nearly halfway to the midrib and broadly rounded. Apical sinus wide and open, usually cuneate in outline. Base somewhat descending close to the midrib, broadly and somewhat curved

cuneate. Midrib stout, straight, or somewhat curved. Secondaries thin, parallel, about six pairs, branching from the midrib at angles of over 45° and gently curving upward toward their extremities, probably camptodrome, their ultimate course not made out.

The middle Cretaceous leaves variously described as *Liriodendron meekii*, *L. primaevum*, *L. semialatum*, and *L. simplex* are in a state of almost hopeless confusion, owing largely to the difficulty of determining the specific lines of cleavage in a probably genetic and variable series of forms.

Liriodendron meekii, from the Dakota sandstone of Nebraska, was described by Heer in 1858, in an appendix to a paper by Meek and Hayden. It was described as trilobate and was not figured, but was compared with the European *Liriodendron procaccinii* Unger and with the living *Liriodendron tulipifera* Linné. In 1866 the same author returned to this subject and gives figures of the two well-known specimens, which have been reproduced by both Lesquereux and Newberry. It would seem that this form must be considered as the type of this species and the present writer so considers it. However, Heer, in describing the Atane flora of Greenland in 1882, returned to this subject and considered this form, as well as various simple emarginate *Liriodendropsis*-like forms, as different varieties of *Liriodendron meekii*. In this treatment he was subsequently followed by Lesquereux, but not by Newberry, who insisted upon the distinctness of the lobate form. We find one of Heer's varieties, *Liriodendron meekii genuina*, which may belong here, although the leaves are exceptionally large and poorly preserved. Another variety, *Liriodendron meekii primaeva*, includes the slightly lobate forms subsequently referred to *Liriodendron primaevum* Newberry. It is apparently the latter which Engelhardt reports from the Cenomanian of Saxony. It would seem that the small entire retuse leaves which have been variously referred to *Leguminosites*, *Bumelia*, *Bignonia*, *Liriodendron meekii*, and *L. primaevum*, as well as to *L. simplex* and to the genus *Liriodendropsis*, are more probably allied to the Leguminoseae than to *Liriodendron*, and they are so considered in the present study. On the other hand, *Liriodendron meekii* is restricted to include only such lobate forms as do not seem to be specifically distinct from the originally figured types, and with them are merged those forms usually referred to *Liriodendron primaevum* Newberry, which are simply variants of the type just mentioned with less prominently developed lobes.

As here delimited, the species is found in the Dakota sandstone; in morainic material on Staten Island, derived from the Raritan formation, or possibly from the Magothy formation; somewhat doubtfully in the Atane beds of Greenland; doubtfully in the lower part of the Black Creek formation of North Carolina;[1] positively in the lower part of the Tuscaloosa formation in Alabama; and doubtfully in the South American Cretaceous and in the Cenomanian of Saxony.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

Family MENISPERMACEAE.

Genus COCCULUS De Candolle.

Cocculus cinnamomeus Velenovsky (?).

Plate XVII, figure 1.

Cocculus cinnamomeus Velenovsky, Die Flora der Böhmischen Kreideformation, pt. 4, p. 65(4), pl. 8 (31), figs. 16–21, 1885.

Hollick, The Cretaceous flora of southern New York and New England, p. 62, pl. 12, figs. 10–12, 1906.

Leaves small, ovate in outline, with acute base and apex, triveined from a point at or near the base. Primaries acrodrome. Margins entire. Very close to the existing *Cocculus laurifolius* De Candolle.

The Alabama material, which is fragmentary, denotes a smaller leaf than the type, which is from the Cenomanian of Bohemia. It is, however, unquestionably identical with the leaves from Marthas Vineyard which Hollick identifies as this species. As the grounds for this long-range identification are more or less insecure the occurrence of this species in Alabama is queried. The modern species of *Cocculus* number about thirty and are massed in the oriental Tropics, although several are known from the Western Hemisphere.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

[1] Berry, E. W., Torrey Bot. Club Bull., vol. 34, p. 197, 1907.

Cocculus polycarpaefolius Berry, n. sp.

Plate XVII, figures 2, 3.

Leaves of relatively medium size, elliptic-acuminate in outline, with a short acuminate apex, full rounded sides, and broad, at length decurrent base. Length 4 to 6 centimeters. Maximum width 2 to 4 centimeters in the basal half of the leaf. Primaries three, thin, acrodrome from the base, of equal caliber. Angle of divergence between the laterals and the midrib acute, about 20° or less. The laterals give off two or three curved camptodrome secondaries on the outside, and in some specimens the lower, which diverges at an acute angle, bends upward and pursues an acrodrome course, parallel with the margin, precluding the development of distal lateral secondaries. Tertiaries thin, obliquely transverse.

The present species, which is an obviously new element in our eastern Cretaceous floras, is named in allusion to its resemblance to *Cocculus polycarpus* Roxburg from India. It is readily distinguishable from the associated Tuscaloosa species of *Cocculus*.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

Cocculus problematicus Berry, n. sp.

Plate XVII, figure 4.

Leaves oblong-linear in outline, 9 to 10 centimeters in length, by about 2 centimeters in maximum width. Apex obtusely pointed. Base broadly rounded, slightly decurrent at the short, stout, curved petiole. Margins entire. Venation acrodrome from the base. Midrib stout. Lateral primaries thin, two on each side branching from the extreme base, the outer forming a thin, more or less arching, marginal hem, the inner 1 millimeter to 2 millimeters inside the outer and somewhat more prominent, connected with the midrib by oblique transverse tertiaries.

This species is unique in character and of rather uncertain botanic affinity. It is more elongated and linear than *Cocculus cinnamomeus* Velenovsky, although it resembles somewhat some of the forms from Marthas Vineyard which Hollick refers to this species.[1] They differ in their greater elongation, less ovate outline, and broader base.

Occurrence: Tuscaloosa formation, Glen Allen, Fayette County, Ala.

Collections: U. S. National Museum.

Genus MENISPERMITES Lesquereux.

Menispermites integrifolius Berry, n. sp.

Plate XX, figure 1.

Leaves deltoid-ovate in outline, with a short, sharply pointed apex and a truncate or slightly cordate, peltate base. Length about 6.5 centimeters. Maximum width, in the basal part of the leaf, about 6.5 centimeters. Margins entire, full and rounded. Texture subcoriaceous. Petiole missing. Midrib stout, enlarged proximad. Lateral primaries subopposite, suprabasilar, only slightly differentiated from true secondaries, of which they constitute the second pair. They diverge from the midrib at angles of about 45° or slightly more, and are relatively straight for more than half the distance to the margin, then curve upward and are eventually camptodrome. Secondaries well marked, four or five opposite to alternate pairs, irregularly spaced, one pair below the primaries, all camptodrome. Primaries give off on their outer sides three to five curved camptodrome laterals. Tertiaries thin, percurrent, with a few laterals from midrib parallel with secondaries.

This species is not at all trilobate, as are some of the species from the Dakota sandstone from which it also differs in having camptodrome instead of craspedodrome lateral primaries. Among described forms it is like some of the leaves from the Raritan formation of New Jersey that Newberry referred to *Menispermites borealis* Heer, without greatly resembling the type material of that species. The most similar figured form is one given by Newberry,[2] which differs from the present species in its inequilateral form. Superficially *Menispermites integrifolius* suggests the associated *Cordia apiculata* (Hollick) Berry, differing especially in its peltate base. It may also be compared with different Upper Cretaceous leaves that have been commonly referred to *Populus*, some of which have been referred by various students to *Cocculus*. The fossil seems to resemble

[1] Hollick, Arthur, U. S. Geol. Survey Mon. 50, pl. 12, fig. 13, 1907.

[2] Newberry, J. S., The flora of the Amboy clays: U. S. Geol. Survey Mon. 26, pl. 50, fig. 2, 1895.

Cocculus more closely, but in view of the uncertainty of such a reference *Menispermites* will serve equally well as a generic designation for leaves of the family *Menispermaceae*.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Menispermites trilobatus Berry, n. sp.

Plate XVII, figures 5, 6.

Leaves of relatively small size, elliptical in general outline, trilobate, 3.5 to 5 centimeters in length by 4 to 6 centimeters in maximum width, which is from tip to tip of the lateral lobes. Petiole stout, about 1.5 centimeters in length. Margins entire, slightly repand in places. Apex broadly rounded, in some specimens retuse mucronate. Base very broadly rounded, more or less peltate. Apical lobe wide and rounded, lateral sinuses very open and shallow, extending inward not more than one-seventh of the distance to the base, broadly rounded. Lateral lobes directed at angles of 45° to 55° with the midrib, with rounded tips, which are somewhat narrower than that of the median lobe; the position of the tips of the lateral lobes is about half the distance between the apex and the base of the leaf, or somewhat less. From this point the margin curves downward in a full lunate curve that is not broken for the attachment of the petiole, which is within the margin a distance of several millimeters.

Midrib rather stout from the peltate base. Lateral primaries of about the same caliber diverge from the extreme base at angles of 45° to 55° and run to the tips of the lateral lobes in an almost straight course. The lateral primaries, as well as the midrib, give off several pairs of secondaries, at angles somewhat in excess of 45°, which are curved and ultimately camptodrome. Marginal tertiaries form small arches within the margin and more or less open pentagonal and inequilateral meshes within the secondaries.

This fine species is entirely distinct from any previously described forms and is clearly referable to the genus *Menispermites* and genetically related to the modern Menispermaceae. *Menispermites* is an abundant type and is especially well represented in the flora of the Dakota sandstone, the present species suggesting a close relationship with *Menispermites grandis* Lesquereux [1] and *M. obtusilobus* Lesquereux [2] of that formation. Curiously enough Kurtz [3] has recorded *M. obtusilobus* from the Upper Cretaceous of Argentina in southern South America, but as he has failed to publish figures of any of his forms their identification can not be considered to be above suspicion. The Tuscaloosa species resembles a small leaf of *Aspidiophyllum trilobatum* Lesquereux [4] of the Dakota sandstone, differing somewhat in the character of the base.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Menispermites variabilis Berry.

Menispermites variabilis Berry, U. S. Geol. Survey Prof. Paper 84, p. 113, pl. 21, figs. 1–4, 1914.

This species was recently described by me from the eastern Gulf area in the publication cited and the discussion need not be repeated here.

Occurrence: Eutaw formation (basal beds), McBrides Ford, Chattahoochee County, Ga.

Collection: U. S. National Museum.

Order PAPAVERALES.

Family CAPPARIDACEAE.

Genus CAPPARITES Berry, n. gen.

Relatively large, orbicular or elliptical, more or less retuse, pinnately veined, petiolate, entire margined, leaves of the general character of those of the modern genus *Capparis* of Linné.

Capparites cynophylloides Berry, n. sp.

Plate XXII, figure 1.

Leaves of relatively large size and variable form, ranging in outline from elliptical to deeply retusely obovate. Length ranging from 6 to 8 centimeters. Maximum width 4.75 to 7 centimeters in the middle part of the leaf. Margins entire, more or less repand, full, reflected in apical part of leaf to form a retuse sinus with a maximum depth of 1.5 centimeters. Petiole stout, about 2.5 centimeters in length.

[1] Lesquereux, Leo, The Cretaceous and Tertiary floras, p. 80, pl. 15, figs. 1, 2, 1883.

[2] Lesquereux, Leo, The Cretaceous flora, p. 94, pl. 25, figs. 1, 2; pl. 26, fig. 3, 1874.

[3] Kurtz, Federico, Rev. Mus. La Plata, vol. 10, p. 53, 1902.

[4] Lesquereux, Leo, The Cretaceous and Tertiary floras, p. 87, pl. 12, fig. 1; pl. 13, figs. 1–5; pl. 14, fig. 1, 1883.

Midrib stout, usually curved. Secondaries relatively thin, five to seven opposite to alternate pairs, branching from midrib at angles of 45° or more, somewhat irregular in both their spacing and course, ultimately camptodrome. Texture coriaceous.

This species varies from the equilateral almost obcordate leaf figured to the inequilateral elliptical form also figured. Among modern species it is so close to *Capparis cynophallophora* Linné, a West Indian species, that the genus has been named *Capparites*. The modern genus *Capparis* Linné includes over a hundred species of trees the majority of which inhabit Central America and northern South America, although it is also present in the Tropics of the Old World.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala. (Collected by E. W. Berry.)

Collection: U. S. National Museum.

Capparites orbiculatus Berry, n. sp.

Plate XXII, figures 2, 3.

Leaves somewhat smaller than in the preceding species, nearly orbicular in general outline, about 5 to 6 centimeters in longitudinal and lateral diameter. Margin entire, slightly repand. Texture subcoriaceous. Petiole missing but apparently present, as shown by the character of the broken base in the figured specimen. Midrib thinner than in *Capparites cynophylloides* Berry, decidedly flexuous. Secondaries thin, four or five subopposite to alternate pairs, branching from the midrib at angles of 45° or more, curving upward, camptodrome. Tertiaries consisting of camptodrome veins in marginal region and percurrent veins internally. In the lower marginal region there are three or four camptodrome tertiaries from the outside of the basal secondaries, and one or two nearly horizontal camptodrome pseudosecondaries from the midrib on either side, below the lowest true secondaries.

The present species, which is not common, is similar to some of the forms assumed by the existing *Capparis cynophallophora* Linné as well as to other tropical American species of *Capparis*, and it may be only a variety of *C. cynophylloides*, especially as it occurs at the same outcrop.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala. (Collected by E. W. Berry.)

Collection: U. S. National Museum.

Order ROSALES.

Family MIMOSACEAE.

Genus INGA Willdenow.

Inga cretacea Lesquereux.

Plate XXII, figures 4, 5.

Inga cretacea Lesquereux, The flora of the Dakota group, p. 153, pl. 55, fig. 11, 1892.
Bartsch, Iowa Univ. Lab. Nat. Hist. Bull., vol. 3, p. 181, 1896.
Knowlton, U. S. Geol. Survey Twenty-first Ann. Rept., pt. 7, p. 318, 1901.

Leaves narrowly oblong-lanceolate in outline, usually inequilateral, about 9 centimeters in length by about 2 centimeters in maximum width, which is below the middle. They taper downward from this point to the cuneate and slightly decurrent base and upward to the acuminate tip, which in a measure suggests a small leaf of *Ficus daphnogenoides*, as may be seen by comparing the present species with figures of some of the specimens of that species from Alabama. Petiole short and thick, about 1 centimeter in length. Midrib stout below and curved, becoming thin distad. Secondaries numerous, about 14 opposite or subopposite pairs, branching from the midrib at acute angles of about 30°, camptodrome.

This species was described by Lesquereux from the Dakota sandstone of Kansas. It has been recorded by Bartsch from this same formation in Iowa, and by Knowlton from the Woodbine sand of Texas. The present is the first recorded occurrence of this species east of Mississippi River. It may be compared with many described species of *Leguminosites* and also to a lesser extent with numerous European Tertiary species referred to *Cassia*. Lesquereux called attention to its resemblance to the European Tertiary *Inga icari* Unger,[1] and to the living *Inga semialata* Martius of tropical Brazil.

The writer has collected leaves of the *Inga* type not greatly different from the present species from both the lower Eocene (Wilcox

[1] Unger, Franz, Die fossile Flora von Kumi auf der Insel Euboea, p. 87, pl. 16, fig. 10, 1867.

group) and the middle Eocene (Claiborne group) of the Mississippi embayment region.

The modern species of *Inga* are numerous, more than 150 being known. These species inhabit the American tropics, extending southward into the subtropical region of South America but not reaching northward as far as the United States.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Family CAESALPINIACEAE.

Genus HYMENAEA Linné.

[Species plantarum, p. 1192, 1753.]

Hymenaea fayettensis Berry, n. sp.

Plate XXIII, figure 2.

Leaves with a short, stout petiole; compound; consisting of two ovate-lanceolate, entire margined leaflets. Leaflets sessile with a markedly inequilateral, cuneate or slightly decurrent base but not noticeably inequilateral above the base; 6.5 to 8 centimeters in length, by 2 to 3 centimeters in maximum width, which is in the lower half of the leaflets; tips extended, acuminate. Midribs stout below, becoming thin above. Secondaries thin, camptodrome, numerous, seven or eight subopposite to alternate pairs in each leaflet; they branch from the midrib at angles ranging from 30° to 50° and curve upward, the lower being quite ascending and the angle of divergence becoming progressively greater toward the apex of the leaflets. Tertiaries numerous, very fine, transverse. Texture less coriaceous than in most of the recent species.

This form is a well-defined species of this interesting genus of the Caesalpiniaceae and is quite distinct from any of those previously described. Although the genus *Hymenaea* is confined to tropical America in the existing flora, it seems to have been cosmopolitan in the late Mesozoic, several well-characterized species having been described from the Upper Cretaceous of this country and Europe. The present species is most like *Hymenaea primigenia* Saporta, a species described by Saporta [1] and Velenovsky [2] from the Cenomanian of Bohemia and recorded by Hollick [3] from the Magothy formation on Marthas Vineyard. In this form the leaflets are petiolate, and the margins are commonly crenate-dentate. The other known American Cretaceous species is *Hymenaea dakotana* described by Lesquereux [4] from the Dakota sandstone of Kansas, and recorded by Newberry [5] from the Raritan formation (probably upper Raritan) of New Jersey, by Hollick [6] from Long Island and Marthas Vineyard, and by me [7] from the Magothy formation of New Jersey.

This widespread species is not unlike the present species in some specimens, but in general the leaflets are much smaller and more inequilateral, with shorter tips and with petiolules of considerable length. The two species are perfectly distinct.

The curious bifoliolate leaf habit which characterizes *Hymenaea* is not confined to that genus but is shared by other genera of the Caesalpiniaceae and Mimosaceae, as, for example, by certain species of *Bauhinia*, *Leucaena*, *Cassia*, *Acacia*, *Cynometra*, and *Inga*. Usually, however, the general habit, shape, venation characters, and other features enable the student to distinguish between them.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collections: U. S. National Museum.

Genus BAUHINIA Linné.

[Species plantarum, p. 374, 1753.]

Bauhinia cretacea Newberry.

Bauhinia cretacea Newberry, Torrey Bot. Club Bull., vol. 13, p. 77, pl. 56, 1886; The flora of the Amboy clays, p. 91, pl. 43, figs. 1–4; pl. 44, figs. 1–3, 1896.
Berry, New Jersey Geol. Survey Bull. 3, p. 162, pl. 19, fig. 3, 1911.

Newberry's description of this species, published in 1896, is as follows:

Leaves large, from 10 to 18 centimeters in diameter, general outline circular, deeply two-lobed, sinus reaching below the middle, margin entire, base rounded, lobes oblong or broadly spatulate; nervation strong, radiate or bilateral, midrib slender, from 1 to 4 centimeters in length, running to bottom of medial sinus, there forking equally, each slender branch running parallel with the margin of

[1] Saporta, G. de, Le monde des plantes avant l'apparition de l'homme, p. 199, fig. 2, 1879.

[2] Velenovsky, Josef, Die Flora der böhmischen Kreideformation, pt. 3, p. 9, pl. 5, fig. 4; pl. 6, figs. 1–4, 1884.

[3] Hollick, Arthur, U. S. Geol. Survey Mon. 50, p. 84, pl. 32, figs. 8, 9, 1907.

[4] Lesquereux, Leo, U. S. Geol. Survey Mon. 17, p. 145, pl. 55, figs. 2, 3; pl. 56, figs. 1, 2; pl. 62, fig. 2, 1892.

[5] Newberry, J. S., U. S. Geol. Survey Mon. 26, p. 90, pl. 41, fig. 14, 1896.

[6] Hollick, Arthur, op. cit., p. 83, pl. 32, figs. 5–7.

[7] Berry, E. W., New Jersey Geol. Survey Ann. Rept. for 1905, p. 138, pl. 22, figs. 1, 2, 1906.

the sinus; lateral nerves strong, usually two, rarely one on each side, springing from a common base, the interior lateral nerve strongest, forking several times and giving off fine branches, which inosculate to form a graceful festoon near the upper margin; the exterior lateral nerves throwing off numerous branches which anastomose in loops near the margin, producing a camptodrome nervation. In those which have but a single lateral nerve the lobes are narrower, and each is covered with the ramification of the branches, which spring chiefly from the outer side of the single main nerve.

The form and nervation of these leaves are so precisely those of some of the Bauhinias of the present flora that there can be no reasonable doubt that we here have the remains of a well-marked species of this genus, which grew near the mouth of the Hudson River in the middle of the Cretaceous age, and was the associate of the magnolias, tulip trees, aralias, etc., which composed the angiosperm forest of eastern North America. In size some of these leaves exceed those of any living bauhinia, and the outline and nervation indicate that the genus was as perfectly defined and highly specialized in the Cretaceous age as now.

The living bauhinias inhabit the tropical and subtropical regions of the Old and New Worlds, India, Mauritius, Surinam, Cuba, Mexico, etc. The genus is closely related to *Cercis*, and most of the species have a similar habit. In a few the leaves are orbicular or slightly emarginate, but they are generally bilobed, the sinus reaching the middle of the leaf, sometimes extending to the base, as is the case with the only species inhabiting the United States, *B. lunaroides* Gray, of Texas and Mexico.

In most of the East India species the nervation is more crowded than in the fossil leaves before us, each nerve having three and sometimes four lateral nerves, the medial nerve, however, being quite the same. In several oriental species, and all those of the New World, the nervation is simpler and especially like that of the fossil.

A fossil species of *Bauhinia* from the Tortonian deposits of Oeningen, Baden, was described by Heer in 1859.[1] Soon afterward Unger described two additional species,[2] both based on pods, from Croatia. Five years later the same author described another species from the Aquitanian of Kumi, Greece.[3] In 1885 Velenovsky described another species from the Cenomanian of Bohemia,[4] without, however, recognizing its true relationship. The next year Newberry described this and another larger species from the middle part of the Raritan formation of New Jersey. In 1908 I described a small but striking new species[5] from the Magothy formation of Maryland and the following new and ornate species from the lower part of the Eutaw formation in Alabama. A late Tertiary species has been described by Cockerell[6] from the Miocene lake deposits at Florissant, Colo.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County; Cottondale, Tuscaloosa County, Ala. Eutaw formation (basal part), Havana, Hale County, Ala.

Collections: U. S. National Museum. (The type of this species from New Jersey is in the New York Botanical Garden.)

Bauhinia marylandica Berry.

Bauhinia marylandica Berry, Torreya, vol. 8, p. 218, figs. 1–3, 1908.

Leaves small, about 3 centimeters in greatest length by 2.5 centimeters in greatest breadth, elliptical in general outline, bilobate; the apical sinus narrow and pointed, reaching one-half to two-thirds of the distance to the base; lobes narrow, ascending, somewhat falcate in outline, obtusely pointed; midrib straight, giving off one, two, or three sharply ascending pairs of opposite, camptodrome secondaries, and these give off a series of broadly rounded, inequilateral tertiary arches, which are directly upward and outward; the upper pair of secondaries is the most prominent; from the juncture of the midrib and sinus a pair of much reduced secondaries is given off, and these join the secondary next below in one or two broad arches.

The present species was described in 1908 from the Magothy formation at Grove Point, Md., where it is abundant. It is only sparingly represented in the lower part of the Tuscaloosa formation.

The form and venation of these leaves are exactly like those of several existing forms and are so well marked that there can be no doubt of the existence of a species of *Bauhinia* growing along the middle and south Atlantic coast during the deposition of the Upper Cretaceous, whose descendants along with those of its congeners migrated finally to their present tropical habitat, perhaps gradually with the oscillation of climatic conditions, and perhaps

[1] Heer, Oswald, Flora tertiaria Helvetiae, vol. 3, p. 109, pl. 134, fig. 21, 1859.

[2] Unger, Franz, Sylloge plantarum fossilium, vol. 2, p. 31, pl. 11, figs. 2, 3, 1862.

[3] Unger, Franz, Die fossile Flora von Kumi auf der Insel Euboea, p. 61, pl. 15, fig. 36, 1867.

[4] Velenovsky, Josef, Die Flora der böhmischen Kreideformation, pt. 4, p. 12, pl. 6, fig. 4, 1885.

[5] Berry, E. W., A new Cretaceous *Bauhinia*: Torreya, vol. 8, p. 218, fig. 3, 1908.

[6] Cockerell, T. D. A., Two new fossil plants from Florissant, Colo.: Torreya, vol. 9, p. 184, 1909.

not until the Pleistocene glaciation to the north forced them to make a comparatively sudden retreat southward.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County; Shirleys Mill, Glen Allen, Fayette County, Ala.

Collections: U. S. National Museum.

Bauhinia alabamensis Berry.

Plate XXIII, figure 8.

Bauhinia alabamensis Berry, Am. Jour. Sci., 4th ser., vol. 29, pp. 256–258, text fig. 1, 1910.

Bilobate leaves of medium and large size, 8 to 15 centimeters in greatest length by 11 to 18 centimeters in greatest width. Median sinus rather broad and rounded, reaching two-thirds of the distance toward the base or even more. Lobes somewhat reniform in outline, sublobate, rounded above and with three broadly rounded sublobes on the outer side, the entire margin curving upward and inward from the lower and largest lobe to the truncate or deeply cordate base, which appears to be slightly peltate in some specimens. Midrib comparatively slender, 1.7 to 3 centimeters in length, running to the base of the median sinus and sending off two branches in its upper part, one on each side, which curve upward parallel with the inner margin to join inwardly directed branches from the lateral primaries. Main lateral primaries stout, sending two or three upwardly directed branches inward and three or four longer, less oblique branches outward, the latter forking and forming broad arches in the lateral lobes. One or two additional primaries on each side take their origin from the common point of divergence of the palmate or bilateral system of venation of this species and are confined to the lower lateral lobe on each side along the margin of which their branches arch.

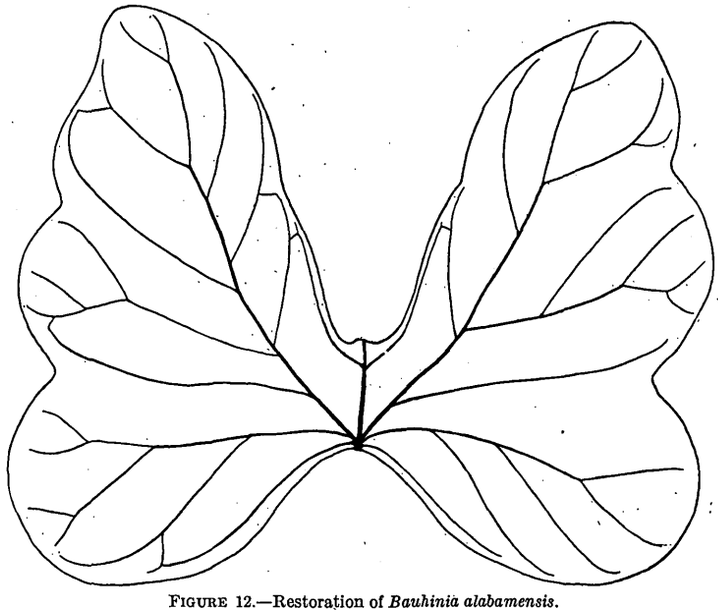


FIGURE 12.—Restoration of *Bauhinia alabamensis*.

This ornate and butterfly-like species of *Bauhinia* is not uncommon in the sandy clays near Havana, in Hale County, Ala., but owing to the unsatisfactory character of the matrix, which is too sandy for good collecting, and also to the fact that the plant remains had evidently been in the water a long time before entombment, only fragmentary specimens were obtained. These represent, however, all parts of the leaf and are complete enough to serve as an entirely accurate basis for the complete leaf shown in the figure 12.

This species is markedly distinct from any of the fossil species hitherto known. In size and general appearance it suggests *Bauhinia cretacea* Newberry, and it may well be a descendant of that species, which, as time passed, widened out and became sublobate. It differs from any existing species known to me in its great width and sublobate character, although several recent smaller-leaved species approach it in the sublobate character, and if representative collections of the foliage of the recent forms showing the limits of specific variation were available for comparison, a tendency would probably be found toward the formation of sublobes. Two recent species were noted as showing this marginal character. These are *Bauhinia hookeri* F. v. Müller of Australia and *Bauhinia tomentosa* Linné of the West Indies.

The display of species of this modern tropical genus in the Upper Cretaceous of the Atlantic Coastal Plain is certainly remarkable, for it embraces very small and very large forms and shows a variety almost as great as that furnished by the existing species.

Occurrence: Eutaw formation (basal beds), 2 miles south of Havana, Hale County, Ala.

Collections: U. S. National Museum.

Bauhinia ripleyensis Berry.

Plate XXIII, figure 7.

Bauhinia ripleyensis Berry, Torrey Bot. Club Bull., vol. 43, p. 294, pl. 16, fig. 1, 1916.

Leaves of medium size, more or less bilobate but much less deeply divided than in the preceding species, obovate in general outline. Length along the midrib, 4.5 centimeters; from apex of lobes to base, 6.7 centimeters. Width across upper part of the leaf, 5.5 centimeters. Apical sinus open, extending about one-fourth of the distance toward the base of the leaf, its margins at the tip of the midrib forming an angle of about 90°, curving slightly upward and then conspicuously outward to the pointed tips of the lobes, which are directed laterally. Outer margins of the leaf full and rounded, becoming straight toward the broadly cuneate base. Midrib of medium size. Lateral primaries branching from the base at angles with the midrib of about 25°, of medium size, curving upward and then outward, and running to the tips of the lobes. They give off four or five camptodrome secondaries on the outside and two or three on the inside. The midrib, in its upper half, also gives off one or two secondaries on each side. Leaf substance somewhat coriaceous.

This species, which is sparingly represented in the argillaceous greensand marls along Cowikee Creek and is associated with shallow water or estuarine mollusks of the Ripley formation, is markedly distinct from any described species of *Bauhinia*. It is much smaller and less deeply divided than *Bauhinia gigantea* Newberry or *Bauhinia alabamensis* Berry and is much less ornate in character. It is, on the other hand, much larger than *Bauhinia marylandica* Berry of the Magothy formation in the Maryland area. It differs from all these American Cretaceous species in its pointed, outwardly directed lobes but is not unlike a number of existing species of this genus.

Occurrence: Ripley formation (Cusseta sand member), right bank of Cowikee Creek, one-eighth of a mile above its mouth, Barbour County, Ala.; (McNairy sand member), 2½ miles southwest of Selmer, McNairy County, Tenn.

Collections: U. S. National Museum.

Genus PALEOCASSIA Ettingshausen.

Paleocassia laurinea Lesquereux.

Plate XXIII, figure 1.

Palaeocassia laurinea Lesquereux, The flora of the Dakota group, p. 147, pl. 64, fig. 12, 1892.

Leaflets ovate-lanceolate in outline, subinequilateral, with a pointed apex and a cuneate base. Length ranging from 3 to 6 centimeters. Maximum width, at or below the middle, about 2 centimeters. Margins entire, somewhat irregular, emarginate halfway up on one side in the figured specimen. Petiolule short, curved, gradually enlarged proximad, about 5 millimeters in length. Midrib of medium size, curved. Secondaries thin, camptodrome.

This species, which was described from the Dakota sandstone of Kansas, is present in the lower part of the Tuscaloosa formation.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Genus CASSIA Linné.

Cassia vaughani Berry, n. sp.

Plate XXII, figure 8.

Leaflets of relatively large size, elliptical in general outline, with a somewhat extended, obtusely pointed apex, and a broadly rounded base, about 8 centimeters in length by about 4 centimeters in maximum width, which is about midway between the apex and the base. Margins entire, full and rounded. Petiole absent in the material collected. Midrib stout. Secondaries numerous, thin, and more or less obsolete, about ten pairs, camptodrome; they branch from the midrib at angles of 45° or slightly more. Tertiary venation obsolete.

This species, which is named in honor of T. Wayland Vaughan, is clearly new. It resembles the leaves of a number of unrelated tropical genera in the existing flora but stands closest to the genus *Cassia*, greatly resembling a number of existing species and being also identical in its characters with the fossil leaves which European paleobotanists refer to this genus.

The genus *Cassia* in the modern flora has more than 400 species of herbs, shrubs, and trees, which are widely distributed in the warmer parts of both hemispheres, and there is a distinct massing of species in the American tropical and subtropical regions.

Occurrence: Tuscaloosa formation, Glen Allen, Fayette County, Ala.

Collections: U. S. National Museum.

Family PAPILIONACEAE.

Genus PHASEOLITES Unger.

Phaseolites formus Lesquereux.

Plate XXII, figure 7.

Phaseolites formus Lesquereux, The flora of the Dakota group, p. 147, pl. 55, figs. 5, 6, 1892.
(?) Kerner, K.-k. geol. Reichsanstalt Jahrb., Band 45, Heft 1, p. 54, pl. 5, fig. 4, 1895.
Berry, Torrey Bot. Club Bull., vol. 37, p. 198, 1910.

Leaves ovate, inequilateral and somewhat variable in outline, more or less falcate, with an acute apex and base, 5 to 8 centimeters in length by 2.5 to 5 centimeters in maximum width, which is near the middle. Petiole stout, curved, about 1 centimeter in length. Midrib stout below, thin above, curved. Secondaries of medium size, about 8 pairs, branching from the midrib at angles of 45° to 50°, curving upward, camptodrome. Finer venation indistinct. Texture subcoriaceous.

This species was described by Prof. Lesquereux from the Dakota sandstone of Kansas. It was subsequently recorded by von Kerner from the island of Lesina, off the coast of Dalmatia (Cenomanian). The citation is questioned, for the identity of these widely removed occurrences is doubtful, although the actual specimens are very similar in appearance.

I have recorded this species from the lower part of the Black Creek formation in North Carolina, and it is represented by closely allied forms in the northern Atlantic Coastal Plain. In the Alabama area it is known only from the lower part of the Tuscaloosa formation.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County; Cottondale, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

Genus COLUTEA Linné.

[Species plantarum, p. 723, 1753.]

Colutea obovata Berry.

Plate XXIII, figure 3.

Colutea obovata Berry, Torrey Bot. Club Bull., vol. 33, p. 175, figs. 5, 6, 1906.

Leaves small, obovate in general outline, inequilateral, with rounded margins and apical auricles separated by a deep and rounded sinus. The Tuscaloosa leaf is somewhat smaller than the type and measures 1.3 centimeters along the midrib, 1.6 centimeters from apices to base, and 1.2 centimeters in greatest width, which is in the distal half of the leaf. Base cuneate. Midrib slightly curved. Secondaries 4 or 5 subopposite pairs which are thin, ascending, and camptodrome. Tertiaries fine, not seen in the material from Alabama.

This small species was described by the writer from material collected in the Magothy formation of Maryland and appears to be entirely distinct from the known Cretaceous species, of which there are several. It resembles more or less some of the leaves which have been identified as *Colutea primordialis* Heer from Greenland, the Atlantic Coastal Plain, and the western interior region.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collections: U. S. National Museum.

Genus LIRIODENDROPSIS Newberry.

[U. S. Geol. Survey Mon. 26, p. 82, 1896.]

Liriodendropsis simplex (Newberry) Newberry.

Plate XXII, figure 6.

Liriodendron simplex Newberry, Torrey Bot. Club Bull., vol. 14, p. 6, pl. 62, figs. 2, 3, 1887 (part).
White, Am. Jour. Sci., 3d ser., vol. 39, p. 98, pl. 2, figs. 6, 7, 1890.
Uhler, Maryland Acad. Sci. Trans., vol. 1, p. 207, 189?.
Hollick, New York Acad. Sci. Trans., vol. 11, p. 99, pl. 2, figs. 2, 4, 5, 7, 9, 1892; idem, vol. 12, p. 235, pl. 5, figs. 1, 2, 4, pl. 7, fig. 2, 1893; New York State Mus. Fifty-fifth Ann. Rept., p. 50, 1903.
Pollard, New York Acad. Sci. Trans., vol. 13, p. 180, 1894.
Liriodendropsis simplex (Newberry) Newberry, The flora of the Amboy clays, p. 83, pl. 19, figs. 2, 3; pl. 53, figs. 1–4, 7, 1896.
Smith, On the geology of the Coastal Plain of Alabama, p. 348, 1894.
Hollick, The Cretaceous flora of southern New York and New England, p. 72, pl. 23, figs. 1–7; pl. 24, figs. 1–9; pl. 25, figs. 1, 4, 5, 7, 10–12; pl. 26, figs. 1b, c, d, 1906.
Berry, New Jersey Geol. Survey Bull. 3, p. 158, pl. 19, fig. 2, 1911.

Leaves or leaflets ovate to ovate-lanceolate in outline, with entire margins, emarginate apex, and cuneate base, ranging from 3 to 10 centimeters in length and from 2.2 to 5 centimeters in width. Midrib stout. Secondaries numerous, camptodrome, their intervals filled by more or less parallel, reticulating, fine ter-

tiaries. The angles of divergence are variable, even in the same leaf, and the peculiarities of preservation obscure the finer venation in some specimens, giving them a strikingly different appearance from others in which the preservation is more complete.

These leaves are exceedingly variable in size and outline. The apex in many specimens is angular at the corners of the leaf blade and at the sinus; in other specimens it is rounded. The sinus may be shallow or moderately deep. The leaflets are much wider than those of *L. angustifolia*, described below, and the width is usually greatest in the upper part, although this feature is far from constant.

This species is very common at a number of localities in the Raritan formation of New Jersey and also on Marthas Vineyard, Long Island, and Staten Island. It is also common in the lower part of the Tuscaloosa formation of western Alabama. None of the American specimens, abundant as they are, show definitely a trifoliate character, but this is indicated by the relative position of the leaflets in some of the specimens figured by Hollick.

These leaves were segregated from *Liriodendron* by Newberry on the basis of their simple nature, emarginate apex, crowded and fine venation, and relatively small size, although their describer says that they are evidently related to *Liriodendron*. Since 1896 much new material has been collected, especially from Long Island. Holm [1] in 1890 suggested that these leaves were not related to *Liriodendron* but were comparable to those of a number of leguminous genera. Somewhat similar leaves were described from Bohemia as *Myrsinophyllum varians* by Velenovsky,[2] and more closely allied forms as *Bignonia pulcherrima* by Bayer,[3] the latter sufficiently well preserved to show their trifoliate nature.

Ward [4] refers a species, described by Saporta as a species of *Chondrophyton* from the Cenomanian of Portugal, to *Liriodendropsis*, to which it is obviously not related, as the writer pointed out some years ago.[5] Recently Hollick [6] has given a résumé of the genus together with descriptions of new species and a large number of illustrations. The probabilities are all in favor of their reference to the Leguminosae, to which family they are referred in the present contribution.

Occurrence: Tuscaloosa formation, Shirleys Mill and Glen Allen, Fayette County, Ala.

Collections: U. S. National Museum.

Liriodendropsis angustifolia Newberry.

Liriodendropsis angustifolia Newberry, The flora of the Amboy clays, p. 84, pl. 53, fig. 8, 1896.
Smith, On the geology of the coastal plain of Alabama, p. 348, 1894.
Hollick, The Cretaceous flora of southern New York and New England, p. 71, pl. 26, figs. 1a, 2–5, 1906.
Berry, New Jersey Geol. Survey Bull. 3, p. 160, 1911.
Liriodendron simplex Newberry, Torrey Bot. Club Bull., vol. 14, p. 6, pl. 62, fig. 4, 1887 (part).

Leaves or leaflets lanceolate to linear-lanceolate in outline, relatively long and narrow, with an emarginate, generally angular apex and a cuneate base. Size variable, from 6 to 9 centimeters in length by 1.9 to 3 centimeters in greatest breadth, which is never in the upper part of the leaf, the margins as a rule being straight and almost parallel from the angular apical corners, bowing outward slightly in the lower half of the leaf, and curving downward to the rather long petiole. Midrib stout. Secondaries numerous, camptodrome. Tertiaries as in the preceding species.

It may be doubted if this species is anything more than a variant of the preceding species, but as the remains are so abundant it may represent a closely allied, although specifically distinct type. Hollick has described two additional species in the abundant material of this general type contained in the insular Cretaceous flora, namely, *Liriodendropsis constricta* and *L. spectabilis*. He makes *L. spectabilis* one extreme of a series of which *L. angustifolia* Newberry is the other. The relations are obviously as pointed out, but it seems questionable, in view of the individual variation even of these segregates, whether it would not have been better to have considered all these forms as variations of a single species.

The present form is abundant in the middle part of the Raritan formation at Woodbridge, N. J., and also on Marthas Vineyard and at

[1] Holm, Theodore, U. S. Nat. Mus. Proc., vol. 13, pp. 15–35, 1890; Bot. Gazette, vol. 20, pp. 312–316, 1895.
[2] Velenovsky, Josef, Květena českého cenomanu, p. 25, pl. 4, figs. 8, 9; pl. 5, fig. 12; pl. 6, figs. 10, 11, 1889.
[3] Bayer, Edwin, Studien im Gebiete der böhmischen Kreideformation; Perucer Schichten, p. 156, f. 126a, b, 1901.
[4] Ward, L. F., U. S. Geol. Survey Sixteenth Ann. Rept., pt. 1, p. 540, pl. 107, figs. 6–8, 1896.
[5] Berry, E. W., Torrey Bot. Club Bull., vol. 31, p. 77, 1904.
[6] Hollick, Arthur, The Cretaceous flora of southern New York and New England: U. S. Geol. Survey Mon. 50, pp. 69–73, 1907.

Glen Cove, Long Island. It was recognized by Ward from the Tuscaloosa formation of Alabama and recorded by Smith, as cited in the synonymy, a number of years ago.

Occurrence: Tuscaloosa formation, Shirleys Mill and Glen Allen, Fayette County, Ala.

Collections: U. S. National Museum.

Liriodendropsis constricta (Ward) Hollick.

Liriodendropsis simplex constricta Ward, U. S. Geol. Survey Sixteenth Ann. Rept., pt. 1, p. 540, pl. 107, fig. 8, 1896.

Liriodendropsis constricta (Ward) Hollick, The Cretaceous flora of southern New York and New England, p. 71, pl. 22, fig. 7; pl. 26, figs. 6–15; pl. 40, fig. 15, 1906.

Liriodendropsis simplex (Newberry) Newberry. Hollick, New York Acad. Sci. Trans., vol. 12, p. 235, pl. 7, fig. 3, 1893.

Leaves ovate in general outline, with a rounded, ultimately cuneate base; constricted abruptly on each side, the apical portion narrowed and straight sided with an emarginate apex. Length ranges from 4 to 9 centimeters. Maximum width, in the basal part, ranges from 2 to 4 centimeters. Secondary and tertiary venation indistinguishable from that of *Liriodendropsis simplex* or *L. angustifolia*, of one or the other of which it is probably a variant and not a distinct species.

Forms which answer to the foregoing diagnosis are recorded from Marthas Vineyard, Mass., and Glen Cove, Long Island, where they are associated with large numbers of leaflets of *Liriodendropsis simplex* and *L. angustifolia*. A single leaflet is likewise associated with these two species in Alabama, which fact lends emphasis to its doubtful specific rank.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

LEGUMINOSAE (position uncertain).

Genus LEGUMINOSITES Bowerbank.

Leguminosites ingaefolia Berry, n. sp.

Plate XXIII, figure 5.

Leaflets of small size, elliptical-lanceolate and slightly inequilateral in general outline, with a rounded apex and base, the apex mucronate and the base correspondingly decurrent. Length about 2.75 centimeters. Maximum width, in the lower half of the leaflet, 6 millimeters to 1.2 centimeters. Margins entire. Texture subcoriaceous. Petiolule stout, curved, about 5 millimeters in length. Midrib stout, flexuous. Secondaries four to six, irregularly spaced, camptodrome pairs, those in the proximal half of the lamina fewer and more ascending than those in the distal half, particularly the lowest secondary. Tertiaries mostly immersed.

This small-leafed species, which is obviously new, is clearly allied to the Leguminosae and is much like some of the Tertiary and existing species of *Inga*, of which a large-leafed species, *Inga cretacea* Lesquereux, occurs in the Tuscaloosa formation, and several species not unlike the present one occur in the Eocene of the Mississippi embayment area.

Occurrence: Tuscaloosa formation, Glen Allen and Shirleys Mill, Fayette County, Ala.

Collections: U. S. National Museum.

Leguminosites omphalobioides Lesquereux.

Leguminosites omphalobioides Lesquereux, The flora of the Dakota group, pl. 38, fig. 4, 1892.

Newberry, The flora of the Amboy clays, p. 97, pl. 42, fig. 39, 1896.

Berry, Torrey Bot. Club Bull., vol. 37, p. 24, 1910; New Jersey Geol. Survey Bull. 3, p. 155, 1911.

Leaflets elliptical in outline, 3.2 to 4 centimeters in length by 1.5 to 1.7 centimeters in greatest width, which is about halfway between the apex and the base, Texture subcoriaceous. Apex rather broadly rounded. Base slightly narrowed and decurrent to the point of attachment. Lesquereux speaks of a short petiole, but this is lacking in his type figure and in all the specimens examined by the writer. The midrib is not especially wide but is quite prominent. The secondaries are thin and alternate; they number about six pairs and branch from the midrib at angles of 50° or somewhat less, curving upward close to the margins, camptodrome.

This species was described originally from the Dakota sandstone of Kansas. The Tuscaloosa leaf is very close to the type, differing merely in that the outline is more nearly elliptical than it is in the western form.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Leguminosites shirleyensis Berry, n. sp.

Plate XXIII, figure 4.

Diospyros rotundifolia Lesquereux, The flora of the Dakota group, pl. 17, fig. 11 (not figs. 8–10), 1892.

Leaflets of small size, orbicular or elliptical in general outline, with a rounded or slightly retuse apex. Base rounded, slightly inequilateral, abruptly decurrent to form linear wings along the lateral margins of the petiolule. Length about 1.75 centimeters. Maximum width, in the middle part of the leaflet, about 1.1 centimeters. Margins entire, slightly irregular. Petiolule stout, alate, about 3 millimeters long. Midrib stout proximad, becoming attenuated in a short distance distad. Secondaries thin, irregularly spaced, about six camptodrome pairs.

This small leaflet appears to be related to the Leguminosae, although it is similar to the leaves of a number of unrelated genera, as for example, *Celastrophyllum*, *Bumelia*, *Vaccinium*, and various Rhamnaceae. It is believed to represent an Upper Cretaceous species of the Leguminosae or possibly of the Rhamnaceae. The small leaf from the Dakota sandstone which Lesquereux referred to *Diospyros rotundifolia* is obviously identical with this species from Alabama and is quite unlike the usual forms of *Diospyros rotundifolia*.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Leguminosites tuscaloosensis Berry, n. sp.

Plate XXIII, figure 6.

Leaflets of medium size, sessile, ovate-lanceolate and markedly inequilateral in general outline, with a cuneately pointed apex and a decurrent base. Length about 3 to 5 centimeters. Maximum width, about midway between the apex and the base, 1.5 to 2.5 centimeters, one side commonly about twice the width of the other. Petiolule wanting. Midrib thin and curved, stout at base. Secondaries thin, numerous, subparallel, diverging from the midrib at acute angles and camptodrome, more or less immersed in the leaf substance. Tertiaries obsolete. Margins entire. Texture subcoriaceous.

These more or less falcate leaflets are unlike previously described forms and appear to be referable to the Leguminosae, resembling a variety of recent forms in each of the families into which the old family has been segregated in recent years.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Order GERANIALES.

Family RUTACEAE.

Genus CITROPHYLLUM Berry.

Citrophyllum aligerum (Lesquereux) Berry.

Ficus aligera Lesquereux, The flora of the Dakota group, p. 84, pl. 10, figs. 3–6, 1892.

Berry, Torrey Bot. Club Bull., vol. 33, p. 172, 1906; New Jersey Geol. Survey Ann. Rept. for 1905, p. 139, 1906.

Citrophyllum aligerum (Lesquereux) Berry, Torrey Bot. Club Bull., vol. 36, p. 258, pl. 18a, figs. 1–8, 1909; New Jersey Geol. Survey Bull. 3, p. 169, pl. 21, figs. 1–8, 1911.

Leaves small, elliptical to ovate or ovate-lanceolate in outline, coriaceous, ranging from 2.5 to 6 centimeters in length by 1.8 to 3.2 centimeters in width. Margins entire, in some specimens slightly undulate. Apex rounded or obtusely acuminate. Base rounded, subtruncate or cuneate. Petiole stout, 0.7 centimeter to 2 centimeters in length, conspicuously alate. The petiolar wings may be oblong-lanceolate or obovate; together they are from 2.5 to 5 millimeters in width, averaging about 3.5 millimeters. Midrib stout. Secondaries fine, more or less obscured by the coriaceous leaf-substance, about 9 alternate pairs, branching from the midrib at angles of 45° to 50°, parallel, camptodrome.

These curious leaves were described by Lesquereux from the Dakota sandstone as a species of *Ficus* and compared with *Ficus bumelioides* Ettingshausen and *Ficus mudgei* Lesquereux, neither of which has alate petioles, and the first has an emarginate apex. Subsequently the same leaves were found in the Magothy formation of New Jersey and only recently a single small leaf was found in the upper beds of the Raritan formation of South Amboy, N. J. They have also been recognized in the Black Creek formation of North Carolina and in the Middendorf arkose member of the Black Creek formation of South Carolina. They exhibit considerable variability in outline, but all have exactly the same aspect and conspicuous alate petioles.

They appear to be related to the leaves of the modern genus *Citrus*, which have exactly the same texture and venation, the same variability in outline and marginal undulations, the same stout midrib and conspicuously alate petioles. In examining a suite of specimens of leaves of *Citrus* and comparing them with the fossils, the conclusion seems irresistible that they are related, and the writer has consequently referred the fossils to a new genus with a name that emphasizes this relationship to the modern genus

Possible arguments against the present view may be based on the theory that the modern alate petioles are derived from ancestors with compound leaves; in fact, some modern species still have trifoliate leaves, and if this were true of the fossils as well it would require considerable rapidity of evolution in this genus previous to the middle Cretaceous. The modern leaves absciss from the top of the petiole and would be unlikely to occur as fossils with the petiole attached, neither can any indication of such an abscission line be made out in the fossils. This argument is difficult to combat. However, modern leaves are sometimes shed in their entirety, and we are justified in predicating the occasional fall of leaves before maturity, when the abscission layer of cells has not yet become weakened. The agency might be violent winds, the passage of large animals like some of the Cretaceous dinosaurs, or weakened conditions due to insect or fungous diseases.

The Tuscaloosa forms are of the elliptical type occurring in the Raritan formation of New Jersey and in the Dakota sandstone of the West. Some of the western leaves are more elongated, as are those collected from the Magothy and Black Creek formations and the Middendorf member. It is possible that two species are represented, but if so, differential specific characters are not obvious. The genus is represented by well-marked species in the undescribed collections from the lower Eocene (Wilcox group) and middle Eocene (Claiborne group) of the Mississippi embayment area.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County; Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Family EUPHORBIACEAE.

Genus CROTONOPHYLLUM Velenovsky.

Crotonophyllum panduraeformis Berry.

Crotonophyllum panduraeformis Berry, U. S. Geol. Survey Prof. Paper 84, p. 48, pl. 7, figs. 5-10, 1914.

Leaves of variable size and irregular panduriform outline, about 8 to 10 centimeters in length by 3 to 4 centimeters in greatest width, which is in the basal half of the leaf. General outline ovate, separated by a sharp lateral sinus on each side into a broad basal portion with full rounded margins, and an upper narrower portion which is more or less rounded or elongated. In some specimens the sinus is wanting on one side, and it may be wanting on both sides and the leaf be ovate-lanceolate in outline if the habit of the Bohemian species is any criterion. Tip bluntly pointed, dependent on the width of the apical segment. Base slightly decurrent to the stout petiole, which is of considerable length. Texture coriaceous. Midrib stout. Secondaries numerous, rather stout, branching from the midrib at angles of about 45°, parallel, camptodrome below and in some specimens also in the apical portion of the leaf; in these specimens they pursue an upwardly curved course. In other specimens they are straight in the apical half of the leaf, and their ends are connected by a nearly straight marginal vein, which is the continuation of some lower secondary; in fact the regularly camptodrome lower secondaries are parallel with the margin before they finally inosculate.

These curious leaves are not uncommon in the Middendorf arkose member of the Black Creek formation of the South Carolina Cretaceous, although they are generally incomplete. They are wholly unlike any American Cretaceous leaves, although they suggest the leaf described from the Upper Cretaceous of Vancouver Island by Dawson as *Liriodendron succedens*.[1] That leaf is hardly a Liriodendron, but Dawson's figures are all inaccurate, and as the writer has not seen the original material, no conclusion on this point is legitimate. The genus *Crotonophyllum* was proposed by Velenovsky for leaves from the Cenomanian of

[1] Dawson, J. W., Roy. Soc. Canada Trans., vol. 11, sec. 4, p. 62, pl. 8, fig. 6, 1893.

Vyserovic, Bohemia, which are very similar to the present species. A single species, *Crotonophyllum cretaceum*,[1] was described and compared with the existing species of Croton, but as the discussion is in Bohemian it can not be followed without a translation. The illustrations are, however, ample and depict a leaf which is surely congeneric with the American species. The genus is also represented by undescribed forms from the lower Eocene (Wilcox group) of the Mississippi embayment area.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Genus MANIHOTITES Berry.

Manihotites georgiana Berry.

Manihotites georgiana Berry, Torrey Bot. Club Bull., vol. 37, p. 507, figs. 1, 2, 1910; U. S. Geol. Survey Prof. Paper 84, p. 114, pls. 22, 23, 24, figs. 4, 5; text figs. 2, 3, 1914; Torrey Bot. Club Bull., vol. 43, p. 295, 1916.

This remarkable form was recently described by me in the papers cited above, and the discussion need not be repeated here.

Occurrence: Eutaw formation (basal beds), McBrides Ford, Chattahoochee County, Ga.; (Coffee sand member), Coffee Bluff, Hardin County, Tenn. Ripley formation (Cusseta sand member), near Buena Vista, Marion County, Ga.; (McNairy sand member), 2½ miles southwest of Selmer, McNairy County, Tenn.

Collections: U. S. National Museum.

Order SAPINDALES.

Family ILICACEAE.

Genus ILEX Linné.

Ilex masoni Lesquereux.

Ilex masoni Lesquereux, The flora of the Dakota group, p. 179, pl. 7, fig. 6; pl. 63, fig. 6, 1892.

The original description of this species by Lesquereux, which was published in 1892, is as follows:

Leaf subcoriaceous, linear-oblong, slightly enlarged in the lower part, cuneiform to the base, apparently obtuse (point broken) repand-dentate on the borders; primary nerve comparatively thick; secondaries open, arched in passing toward the borders, camptodrome, anastomosing in broad, angular curves at a distance from the borders to which they are joined by branches at right angles to the curves.

The first leaf is about 12 centimeters long, 4.5 centimeters broad below the middle, where it is slightly enlarged, is marked by a few obtuse teeth, the upper part being entire or slightly undulate. The lower pair of secondaries are thin, at a more acute angle of divergence, 50°, inequidistant, parallel, somewhat strong, distinctly camptodrome, the upper pair appearing more curved in ascending toward the apex. The bows formed by angular anastomosis of the secondaries at a short distance from the borders are linked to them by short nervilles at right angles. The surface is smooth, nearly polished, indistinctly marked by transverse nervilles. The other fragment indicates a leaf scarcely broader but much longer, broken at both ends, and cut in deeper, large teeth.

These leaves resemble those of *Ilex borealis* Heer[2] but are larger, also *Ilex longifolia* Heer,[3] the borders of which are also minutely dentate, etc.

Whatever may be thought of the botanic affinity of this relatively large-leafed species as determined by Lesquereux, it is certainly not uncommon in the lower part of the Tuscaloosa formation, although the material is for the most part rather fragmentary.

Occurrence: Tuscaloosa formation, Glen Allen, Fayette County; Cottondale, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

Family CELASTRACEAE.

Genus CELASTROPHYLLUM Goeppert.

Celastrophyllum decurrens Lesquereux.

Celastrophyllum decurrens Lesquereux, The flora of the Dakota group, p. 172, pl. 36, fig. 1, 1892.
Berry, New Jersey Geol. Survey Bull. 3, p. 176, pl. 22, fig. 8, 1911.
Celastrophyllum angustifolium Newberry, The flora of the Amboy clays, p. 100, pl. 14, figs. 8–17, 1896.

Leaves of variable size, lanceolate in general outline. Length ranging from 5 to 15 centimeters. Maximum width, in the middle part of the leaf, ranging from 1.5 to 4 centimeters. Apex usually acuminate, rarely subacute. Base narrowed and decurrent. Margins entire near the base, above this they are serrulate or finely crenate-dentate. Petiole stout, curved. Midrib stout, usually curved or flexuous. Secondaries thin, numerous, usually about 2 millimeters apart, subparallel, diverging from the midrib at angles of 40° to 45°, finally branching and forming an intricate network along the margin, the ultimate branches running directly to the margin. Texture subcoriaceous.

[1] Velenovsky, Josef, Květena českého cenomanu, p. 20, pl. 5, figs. 4–11, 1889.

[2] Heer, Oswald, Flora fossilis arctica, vol. 7, p. 39, pl. 64, figs. 3, 4, 1883.

[3] Idem, vol. 1, p. 124, pl. 48, figs. 3, 4, 1868.

This species was based on a single specimen from the Dakota sandstone of Kansas. It is common from the base to the top of the Raritan formation in New Jersey. Only one specimen has been found in the Tuscaloosa formation. It is very similar to *Myrica fragiliformis* (Zenker) Engelhardt,[1] a species described from the Cenomanian of Saxony[2] and recorded under the name *Myrica zenkeri* Heer from the Atane beds of Greenland[3] and the Magothy formation at Glen Cove, Long Island.[4] The form from Long Island is an extremely questionable identification.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Celastrophyllum shirleyensis Berry, n. sp.

Plate XXIV, figures 3, 8.

Leaves of medium to small size, elongate-elliptical in general outline, with a somewhat narrowed, rounded tip, and a broadly rounded base. Length about 5.25 centimeters. Maximum width, in the lower part of the leaf, about 1.7 centimeters. Margins irregularly dentate, the teeth directed laterally. Texture subcoriaceous. Petiole not preserved, evidently stout. Midrib stout, curved, prominent. Secondaries stout, about 11 opposite to alternate pairs, variably spaced, diverging from the midrib at wide angles of 55° to 70°; the basal pairs craspedodrome; the distal pairs regularly camptodrome; the median pairs forking and anastomosing and sending branches to the margins.

The present species is similar to *Celastrophyllum brittonianum* Hollick but differs in being widest below instead of above the middle, in having the marginal teeth larger and crenate instead of denticulate, and in the less numerous and earlier forked secondaries. It also resembles somewhat the Patapsco species *Celastrophyllum acutidens* Fontaine, which is, however, a coarser leaf with very large irregular teeth and more ovate form. It is also much like *Celastrophyllum albaedomus* Ward,[5] a Patapsco species with which I at one time confused it.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Celastrophyllum undulatum Newberry.

Celastrophyllum undulatum Newberry, The flora of the Amboy clays, p. 102, pl. 38, figs. 1-3, 1896.
Smith, On the geology of the Coastal Plain of Alabama, p. 348, 1894 (nomen nudum).
Berry, New Jersey Geol. Survey Bull. 3, p. 175, 1911.

Leaves of large size, 10 to 15 centimeters in length by 4 to 8 centimeters in breadth, ovate-oblong or ovate in outline, with an obtuse or bluntly pointed apex and somewhat narrowed base. Margin strongly undulate or broadly and coarsely crenate, somewhat variable in the character of its teeth. Midrib stout. Secondaries numerous, a dozen or more subopposite pairs, which branch from the midrib at a wide angle and fork near the margins to form festoons, which coincide approximately with the marginal teeth.

This very large species resembles the larger leaves that are referred to *Celastrophyllum crenatum* Heer but is much larger and more elongate in outline. Its size has apparently rendered perfect specimens rare, and as a rule the remains that are obtained are fragmentary. Velenovsky hints at its identity with the leaves named by him *Myrica zenkeri* from the Bohemian Cretaceous, although this resemblance is obviously slight, the present species more nearly resembling the Bohemian leaves which this author identifies as a species of *Ternstroemia*, as well as various lower Eocene species of *Ternstroemites* of the Mississippi embayment area.

It was described originally from the Raritan formation of New Jersey and is represented by considerable fragmentary material in the lower beds of the Tuscaloosa formation. Large leaves of this species occur in the Black Creek formation of North Carolina.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

[1] Engelhardt, Hermann, Naturwiss. Gesell. Isis in Dresden Abh. 7, Jahrg. 1891, p. 93, 1892.
[2] Ettingshausen, C. von, Die Kreideflora von Niederschoena in Sachsen, p. 23, pl. 3, figs. 1, 3, 10, 11, 1867.
[3] Heer, Oswald, Flora fossilis arctica, vol. 3, Abt. 2, p. 108, pl. 31, fig. 2, 1874.
[4] Hollick, Arthur, U. S. Geol. Survey Mon. 50, p. 54, pl. 7, fig. 23, 1907.
[5] Ward, L. F., Status of the Mesozoic flora of the United States: U. S. Geol. Survey Mon. 48, p. 489 (footnote), pl. 108, fig. 3, 1906.

Celastrophyllum newberryanum Hollick.

Celastrophyllum newberryanum Hollick, in Newberry, The flora of the Amboy clays, p. 101, pl. 49, figs. 1–27, 1896; New York Acad. Sci. Trans., vol. 16, p. 133, pl. 14, fig. 1, 1897.

Knowlton, in White and Schuchert, Geol. Soc. America Bull., vol. 9, p. 353, 1898.

Berry, New York Bot. Garden Bull., vol. 3, p. 86, 1903; Torrey Bot. Club Bull., vol. 31, p. 78, 1904; New Jersey Geol. Survey Bull. 3, p. 174, pl. 22, figs. 5–7, 1911.

Leaves of medium size, 2.5 to 6 centimeters in length by 1 to 2.5 centimeters in maximum width, ranging in outline from narrowly to broadly ovate or obovate. Apex somewhat rounded, although it may be acute or apiculate in the narrower form. Base somewhat cuneate and slightly decurrent. Margins entire in the basal third of the leaf, in some specimens so throughout, elsewhere with mostly small, closely set, appressed denticles. Midrib rather stout. Secondaries five or six pairs, branching from the midrib at angles of about 45°, curved, camptodrome.

In size, outline, and venation this species, which is exceedingly abundant, is very close to modern members of the family Celastraceae and may be compared with our existing *Celastrus scandens* Linné, which it closely resembles.

It is probably present in the Atane beds of Greenland in some of the leaves which Heer includes under his *Celastrophyllum crenatum*, and it has been reported by Hollick from the Magothy formation at Cliffwood Bluff, N. J., where it is apparently rare. It would seem as if such an abundant element in the late Raritan, which reappears in the Tuscaloosa formation of Alabama, would be present in allied floras at intermediate points, but as yet its presence has not been detected.

Forms from the Bohemian Cretaceous that are practically identical with the smaller and more pointed leaves of this species are referred by Velenovsky to the genus *Phillyrea* of the Oleaceae, and compared with the living *Phillyrea latifolia* Linné of southern Europe.[1]

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collections: U. S. National Museum.

[1] Velenovsky, Josef, Die Flora der böhmischen Kreideformation, pt. 1, p. 7, pl. 4, figs. 2–5, 1885.

Celastrophyllum grandifolium Newberry.

Plate XXIV, figure 5.

Celastrophyllum grandifolium Newberry, The flora of the Amboy clays, p. 104, pl. 19, fig. 8; pl. 21, figs. 1–4, 1896.

Hollick, The Cretaceous flora of southern New York and New England, p. 88, pl. 33, fig. 8, 1906.

Berry, New Jersey Geol. Survey Bull. 3, p. 179, pl. 23, fig. 1, 1911.

Leaves large, 10 to 25 centimeters in length by 3.5 to 7 centimeters in maximum width, ovate-lanceolate in outline. Apex rounded or subacute. Base varying from rounded to cuneate. Margins entire below, above somewhat irregularly undulate or closely serrate, or with coarse rounded teeth. Petiole long (maximum length 4.5 centimeters), very stout. Midrib stout. Secondaries numerous and slender for such large leaves, 12 to 15 pairs, branching from the midrib at angles of 45° or slightly more, somewhat flexuous and irregular in their course, camptodrome. Tertiaries generally transverse, forming a coarsely quadrangular areolation.

This species is quite variable not only in size but especially in marginal characters, which show every gradation from nearly entire forms to closely serrate forms. This variation is more or less characteristic of all the species of this genus. This species, however, is very distinct, its nearest ally apparently being *Celastrophyllum lanceolatum*, which is described by Ettingshausen from the Cretaceous of Saxony,[2] and which Heer apparently recognized in his material from Greenland.[3]

This species is very common in the Raritan formation of New Jersey but is sparingly represented in the Tuscaloosa collections. None of the very large forms have been discovered at Shirleys Mill, and at first sight the two appear to be entirely distinct. However, the Raritan form shows a series of gradations, and the smaller leaves are identical with the figured specimen from the Tuscaloosa. Fragments of large leaves of this species are found at the Cottondale locality.

[2] Ettingshausen, C. von, Die Kreideflora von Niederschoena in Sachsen, p. 260, pl. 3, fig. 9, 1867.

[3] Heer, Oswald, Flora fossilis arctica, vol. 7, p. 40, pl. 54, fig. 9a; pl. 55, figs. 7, 8, 1883.

This and other Cretaceous species commonly referred to *Celastrophyllum* greatly resemble the leaves of various modern tropical species of the family Ternstroemiaceae (Theaceae) and it is quite possible that they may represent ancestral types of this family. This relationship is further indicated by the presence of types belonging to this family in the Wilcox and Claiborne groups of the Eocene of the embayment area, which I have described as species of *Ternstroemites*.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County; Cottondale, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

Celastrophyllum carolinensis Berry.

Plate XXIV, figures 6, 7.

Celastrophyllum carolinensis Berry, U. S. Geol. Survey Prof. Paper 84, p. 51, pl. 13, figs. 1–5, 1914.

Leaves lanceolate in outline, with a pointed apex and a cuneate base, maximum dimensions about 14 centimeters in length by 2.9 centimeters in width, which is about midway between the apex and the base, tapering equally in both directions. Midrib stout, rather flexuous. Secondaries numerous, thin, branching from the midrib at acute angles of 45° or less, curving upward, usually camptodrome, some of them craspedodrome in the upper part of the leaf; sending tertiary branches into the marginal teeth. Margins entire for a short distance at the base, above which they are crenate or biconvex, the teeth large, interspersed with smaller subordinate teeth of the same character. Leaf substance thin.

This striking form is rather common at a single locality in the Middendorf arkose member of the Black Creek formation of South Carolina, but the leaves are always much broken, although fragments of all parts of the leaf are present. The Alabama material is also badly macerated.

This species has been compared with a very large amount of material of existing species in the National Herbarium and in that of the New York Botanical Garden. It shows analogies with a variety of existing genera, as, for example, *Cunonia, Clerodendron, Symplocos, Ternstromia,* and *Panax,* but is believed to find its nearest relatives among the Celastraceae, although the possibility of this species as well as *Celastrophyllum grandifolium* Newberry being referable to the family Ternstroemiaceae should not be overlooked. It is not close to any described fossil species, although there is a general resemblance to a number of the American Cretaceous species of *Celastrophyllum.* There is also a general resemblance to *Grevilleophyllum constans* [1] and *Aralia coriacea,* [2] both Cenomanian species described by Velenovsky from Bohemia. Leaves of this sort have also been referred to *Dryandroides* (cf. *D. quercinea* Velenovsky), *Myrica* (cf. *M. serrata* Velenovsky), *Quercus,* and *Fraxinus.*

Occurrence: Tuscaloosa formation, upper ravine and big gully on the Snow place, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

Celastrophyllum crenatum Heer.

Celastrophyllum crenatum Heer, Flora fossilis arctica, vol. 7, p. 41, pl. 62, fig. 2, 1885.
Smith, On the geology of the Coastal Plain of Alabama, p. 348, 1894.
Newberry, The flora of the Amboy clays, p. 99, pl. 68, figs. 1–19, 1896.
Berry, Torrey Bot. Club Bull., vol. 34, p. 197, pl. 13, fig. 5, 1907; New Jersey Geol. Survey Bull. 3, p. 178, pl. 22, fig. 9; pl. 23, fig. 2, 1911.

Leaves very variable in size, 2 to 8 centimeters in length by 1 to 5 centimeters in width, ovate or elliptical in outline, broadly rounded above, narrowed and generally inequilateral below. Margins entire below, coarsely toothed above, with somewhat variable, rounded, crenate, or crenate-dentate teeth. A few specimens are entire throughout and some have a markedly inequilateral base. Midrib rather stout. Secondaries numerous, nine or ten pairs, subopposite, branching from the midrib at angles somewhat in excess of 45°, slightly curved upward and parallel, branching near the margin to form festoons from which branches enter the marginal teeth.

This species was described originally by Heer from the Patoot beds of Greenland, but unfortunately only a single small leaf was figured. The Raritan leaves that have been identified as *Celastrophyllum crenatum* are abundant and grade into much larger forms, which are also present in the Black Creek formation of North Carolina and the Tuscaloosa formation of Alabama.

[1] Velenovsky, Josef, Die Flora der böhmischen Kreideformation, pt. 2, p. 3, pl. 1, figs. 6–10, 1883.
[2] Idem, pt. 3, p. 11, pl. 1, figs. 1–9; pl. 2, fig. 2, 1884.

The species is rare in South Carolina, fragmentary specimens being sparsely represented in the Middendorf arkose member of the Black Creek formation. The genus is characteristic of the late Lower and the Upper Cretaceous of eastern North America.

Occurrence: Tuscaloosa formation, Cottondale and big gully on the Snow place, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

Celastrophyllum crenatum ellipticum Berry, n. var.

Plate XXIV, figures 1, 2.

Leaves of small to medium size, elliptical to orbicular in outline, ranging from 2.2 to 5 centimeters in length by 1.5 to 4.5 centimeters in maximum width, which is midway between the apex and the base. Apex broadly and evenly rounded. Base equally rounded, narrowly and inconspicuously decurrent. Margins entire for a short distance at the base, passing gradually into large crenate and biconvex teeth which are typically those of *Celastrophyllum crenatum* Heer. Petiole stout, curved, 1 to 1.5 centimeters in length. Midrib of medium size. Secondaries thin, few in number, about five pairs, branching from the midrib at angles of 45° or more, camptodrome.

The present well-marked variety differs from the type in its orbicular or elliptical instead of obovate outline, in its fewer secondaries, longer petiole, and in the nearer approach to the base of the marginal teeth. The younger leaves are elliptical, but the older ones, which are slightly smaller than the average for the type, are nearly orbicular.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collections: U. S. National Museum.

Celastrophyllum alabamensis Berry, n. sp.

Plate XXIV, figures 10–12.

Leaves of small to medium size, elliptical in general outline, showing a tendency in the larger specimens toward a somewhat trilobate form. Length ranges from 1.75 to 10 centimeters. Maximum width, which is in the basal half of the leaf, ranges from 1 to 9 centimeters. Margin somewhat irregularly crenate, with large and small teeth, some of which are dentate, though the larger ones are broad scallops, exactly similar to the marginal characters so well shown in *Celastrophyllum crenatum* Heer. Petiole of medium length, 4 millimeters in the smallest specimen figured, 2 centimeters in larger specimens, rather stout and curved. Midrib relatively stout. Secondaries stout, about six pairs, branching from the midrib at angles of about 45°, craspedodrome, sending off curved craspedodrome tertiaries to the subordinate teeth, especially laterally from the lowest pair.

This species is exceedingly variable in size and appearance, ranging from small elliptical leaves similar to those of *Celastrophyllum crenatum ellipticum* Berry to large forms, somewhat triangular in outline, almost trilobate, with toothed lobules at the apex of each secondary, suggestive of *Betula nigra* Linné or *Crataegus coccinea* Linné. It is, as a whole, entirely distinct from the rather numerous forms of *Celastrophyllum* that are present in the Tuscaloosa formation of Alabama or in homotaxial deposits in the Upper Cretaceous of the Atlantic Coastal Plain, where this genus is so well represented.

This species is only known from the single locality cited, where it is exceedingly abundant in all sizes and is the only recognizable form in the collection.

Occurrence: Tuscaloosa formation, 4 miles east of Centerville on Centerville-Randolph road, Bibb County, Ala.

Collections: U. S. National Museum.

Celastrophyllum brittonianum Hollick.

Plate XXIV, figure 4.

Celastrophyllum brittonianum Hollick, in Newberry, The flora of the Amboy clays, p. 105, pl. 42, figs. 37, 38, 46, 47, 1896.

Ward, U. S. Geol. Survey Fifteenth Ann. Rept., pp. 349, 358, 377, 378, 379, 1895; Status of the Mesozoic floras of the United States, p. 492, pl. 107, fig. 7, 1905.

Berry, New Jersey Geol. Survey Bull. 3, p. 180, 1911; Maryland Geol. Survey, Lower Cretaceous, p. 479, pl. 90, fig. 3, 1911.

Leaves small, 4 to 5 centimeters in length by 1.2 to 2.1 centimeters in maximum width, ovate-lanceolate or in some specimens somewhat spatulate in outline. Apex subacute. Base somewhat decurrent and straight sided (cuneate). Margins entire below, denticulate above. Midrib rather stout. Secondaries numerous, somewhat irregular, branching from the midrib at angles of about 45°, of fine caliber but prominent, camptodrome.

This species, which was described originally from the Raritan formation of New Jersey, is clearly distinct from *Celastrophyllum spatulatum* Newberry, although it stands nearer to that form than to any other that is known. It seems to be a somewhat older type, for it has been recognized in the considerably older deposits of the Patapsco formation (Albian) in Virginia. It would be interesting to know from what horizon or horizons in the Raritan formation it had been collected, but Newberry failed to indicate the locality in connection with any of his several specimens, and it has not been collected in that region since his day.

Though not common in the Tuscaloosa formation of western Alabama unquestionable remains of this species occur in the lower beds, and it is one of the very few species which survived from the Lower Cretaceous. It resembles somewhat *Celastrophyllum albaedomus* Ward, which is associated with it, but differs in the more spatulate outline, the finer denticulate teeth, and the more numerous, less ascending, and less branched secondaries.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collections: U. S. National Museum.

Celastrophyllum gymindaefolium Berry, n. sp.

Plate XXIV, figure 9.

Leaves more or less inequilateral, obovate in outline, with a broadly rounded, in some specimens slightly retuse, apex, and a narrowed decurrent base. Length 3 to 3.5 centimeters, maximum width, at or above the middle, 2 centimeters, or slightly more. Petiole short and stout, curved, 3 to 4 millimeters in length. Midrib stout below, becoming thin distad. Secondaries very thin, diverging at an acute angle, forking and arching to form oblanceolate meshes, the points of the meshes directed inward from the margin. Margins entire. Texture coriaceous.

This handsome species is clearly distinct from previously described species of *Celastrophyllum*, and it is as clearly related to the modern *Gyminda grisebachii* Sargent, which is a small tree that ranges from the Florida Keys through the West Indies to Trinidad and is found also in southern Mexico and Central America. This resemblance is most marked; the leaves of the modern species in their short petiole, more or less inequilateral blade, decurrent base, and broadly rounded apex, as well as in their texture and venation, are identical with their Upper Cretaceous ancestor.

In accordance with custom the fossil form is referred to *Celastrophyllum*, a form genus for leaves of this family, and the specific name chosen denotes the remarkable resemblance to its existing representative, the genus *Gyminda*.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala. (Collected by E. W. Berry.)

Collection: U. S. National Museum.

Celastrophyllum praecrassipes Berry, n. sp.

Plate XXIV, figure 13.

Leaves of small size, orbicular in general outline, with an equally rounded apex and base. Diameter about 1.5 centimeters. Margins entire. Texture subcoriaceous. Petiole missing, presumably short and stout. Midrib stout below, slender distad, flexuous. Secondaries thin, three or four, irregularly spaced, camptodrome pairs.

The present species is named from its resemblance to the smaller leaves of the Dakota sandstone species, *Celastrophyllum crassipes* Lesquereux,[1] and is clearly referable to the Celastraceae or Rhamnaceae. It is not unlike *Celastrophyllum latifolium* Fontaine[2] of the Patapsco formation and is also similar to the more nearly contemporaneous *Celastrophyllum minus* Hollick[3] of the Raritan formation.

Occurrence: Tuscaloosa formation. Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Family SAPINDACEAE.

Genus SAPINDUS Linné.

Sapindus variabilis Berry, n. sp.

Plate XXVII, figures 1–3.

Leaflets differing greatly in size and outline, ranging from small lanceolate forms like the smallest specimen figured, which is 5 centimeters in length by 1.2 centimeters in maximum width, to forms like the largest specimen figured, which is oblong-elliptical in outline and 10 centimeters in length by 3 centimeters in maximum width. All are inequilateral, the ma-

[1] Lesquereux, Leo, The flora of the Dakota group, p. 174, pl. 57, figs. 6, 7, 1892.

[2] See Berry, E. W., Maryland Geol. Survey, Lower Cretaceous, p. 477, pl. 90, figs. 6–9, 1911.

[3] Hollick, Arthur, in Newberry, J. S., The flora of the Amboy clays: U. S. Geol. Survey Mon. 26, p. 105, pl. 42, figs. 51, 52, 1895.

jority markedly so, and many are falcate. The apex varies from an acute point but slightly elongated to forms in which the lamina is abruptly contracted to a long, slender acumen. The base is conspicuously decurrent and inequilateral. Margins entire. Texture coriaceous. Petiolule broad and flat, reaching a maximum length of 1.3 centimeters. Midrib stout below, becoming thin distad, more or less curved. Secondaries numerous, thin, subparallel, diverging from the midrib at angles of about 45°, rather straight, ultimately camptodrome, largely immersed in the leaf substance. Tertiaries obsolete.

This characteristic species is abundantly represented in the collections from Shirleys Mill, occurring rather sparingly at Glen Allen. Its range of size and variation are well shown in the accompanying illustrations. It resembles more or less several previously described fossil species, as, for example, *Sapindus diversifolius* Lesquereux [1] of the Dakota sandstone, which has a more prominent venation and which is represented in the Magothy formation of New Jersey and Long Island by the specimens erroneously identified by Hollick [2] as *Sapindus apiculatus* Velenovsky,[3] a species which comes from the European Cenomanian and which is also much like the present species. Both the species mentioned are most like the smaller leaflets of *Sapindus variabilis*. A form that resembles the larger leaflets is *Sapindus caudatus* Lesquereux,[4] which occurs in the basal Eocene of Colorado. Among recent species there are several tropical American forms that have leaflets very close to this fossil form.

Occurrence: Tuscaloosa formation, Shirleys Mill and Glen Allen, Fayette County, Ala.

Collection: U. S. National Museum.

Sapindus morrisoni Heer (Lesquereux MS.).

Sapindus morrisoni Heer, Flora fossilis arctica, vol. 6, pt. 2, p. 96, pl. 40, fig. 1; pl. 41, fig. 3; pl. 43, figs. 1a, b; pl. 44, figs. 7, 8, 1882; idem, vol. 7, p. 39, pl. 65, fig. 5, 1883.

Lesquereux, The Cretaceous and Tertiary floras, p. 83, pl. 16, figs. 1, 2, 1883; The flora of the Dakota group, p. 158, pl. 35, figs. 1, 2, 1892.

Hollick, New York Acad. Sci. Ann., vol. 11, p. 422, pl. 36, fig. 4, 1898; The Cretaceous flora of southern New York and New England, p. 90, pl. 33, figs. 16–20, 1906.

Knowlton, U. S. Geol. Survey Twenty-first Ann. Rept., pt. 7, p. 317, 1901.

Berry, N. Y. Bot. Garden Bull., vol. 3, p. 83, pl. 47, figs. 2, 3, 1903; Torrey Bot. Club Bull., vol. 31, p. 78, 1904; New Jersey Geol. Survey Ann. Rept. for 1905, pp. 138, 139, 1906.

Leaflets of variable, generally large size, lanceolate and more or less inequilateral in outline, with a broadly cuneate or rounded base and a pointed tip. Petiolulate. Texture subcoriaceous. Margins entire. Midrib stout, curved. Secondaries numerous, camptodrome.

The present species was described originally by Heer from West Greenland, to whom it must be credited, although it was based on Lesquereux's manuscript which appeared in print the following year. It is common in the Dakota sandstone of the West and in the Magothy formation of the northern Atlantic Coastal Plain and occurs in the Woodbine sand of the western Gulf area (Texas).

Occurrence: Tuscaloosa formation, roadside southwest of Northport, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Order RHAMNALES.

Family RHAMNACEAE.

Genus ZIZYPHUS Linné.

Zizyphus lamarensis Berry.

Zizyphus lamarensis Berry, Torrey Bot. Club Bull., vol. 39, p. 398, pl. 31, fig. 1, 1912.

Leaves elliptical in outline, 4.5 to 5 centimeters in length by 3 centimeters in maximum width about midway between the apex and the base, slightly nearer the base. Apex full and rounded, or abruptly and broadly pointed, slightly less full than the base. Margin with regular but shallow crenate teeth, becoming less prominent toward the base. Midrib slender but prominent, straight. Lateral primaries, one on each side, diverging from the midrib at its extreme base at an acute angle (about 10°), thin, slightly curved inward above the middle, joining a secondary in the apical part of the leaf. Two or three alternate thin pairs of secondaries from the midrib in the apical region, camptodrome. Five or six secondaries

[1] Lesquereux, Leo, The flora of the Dakota group: U. S. Geol. Survey Mon. 17, p. 158, pl. 64, fig. 18, 1892.

[2] Hollick, Arthur, The Cretaceous flora of southern New York and New England; U. S. Geol. Survey Mon. 50, p. 91, pl. 33, fig. 21, 1907.

[3] Velenovsky, Josef, Die flora der böhmischen Kreideformation, pt. 3, p. 6, pl. 7, figs. 1–8, 1884.

[4] Lesquereux, Leo, The Tertiary flora, p. 264, pl. 48, fig. 6, 1878.

from the lateral primaries on the outside, curved, camptodrome. The lowest is longest and branches at the most acute angle (about 10°) and from the extreme base. Each successively higher secondary subtends a slightly larger angle and follows a somewhat shorter course. Internal tertiaries more or less percurrent, marginal ones similar to the secondaries from the primaries in their arrangement and course, thin and camptodrome.

This handsome species of an undoubted *Zizyphus* was described recently from the Woodbine sand of Texas, where it is represented by very scanty material. It is entirely distinct from any previously described Cretaceous species and is much closer to some of the Tertiary and still existing forms.

Zizyphus has not yet been discovered in the European Cretaceous, but it is represented in the Western Hemisphere by four or five well-marked types. The one nearest to the present species is *Z. groenlandicus* Heer,[1] which occurs in the Magothy formation on Marthas Vineyard and in the Patoot beds of western Greenland. It is about the same size but relatively wider than the Texas form and has a somewhat different venation and much coarser teeth. The species from the Magothy of New Jersey, *Z. cliffwoodensis* Berry,[2] is a larger, lanceolate entire-margined form. The two species, *Z. elegans* [3] and *Z. oblongus*,[4] described by Hollick from the Cretaceous of Long Island are much smaller, entire-margined forms, and Hollick's *Z. lewisiana* [5] from the same locality and age is a small lanceolate leaf of doubtful affinity.

The existing species of *Zizyphus* number about 40 and are largely indigenous in the Indo-Malayan region, although the genus is represented in subtropical or tropical America, Africa, and Australia. One modern species, *Zizyphus vulgaris* Lamarck, an oriental form, has foliage almost identical with *Z. lamarensis*, the outline, margin, and venation being the same.

Occurrence: Tuscaloosa formation, Glen Allen, Fayette County, Ala.

Collection: U. S. National Museum.

[1] Heer, Oswald, Flora fossilis arctica, vol. 7, p. 42, pl. 62, fig. 20, 1883.
[2] Berry, E. W., Johns Hopkins Univ. Circ., new ser., No. 7, p. 88, fig. 5, 1907.
[3] Hollick, Arthur, Torrey Bot. Club Bull., vol. 21, p. 58, pl. 176, fig. 9, 1894.
[4] Hollick, Arthur, The Cretaceous flora of southern New York and New England: U. S. Geol. Survey Mon. 50, p. 92, pl. 34, figs. 9, 10, 1907.
[5] Hollick, Arthur, Torrey Bot. Club Bull., vol. 21, pl. 180, fig. 13. 1894.

Zizyphus laurifolius Berry.

Zizyphus laurifolius Berry, U. S. Geol. Survey Prof. Paper 84, p. 116, pl. 21, fig. 7, 1914.

This species was recently described by me from the eastern Gulf area, in the work cited, and the discussion need not be repeated here.

Occurrence: Eutaw formation (basal beds), McBrides Ford, Chattahoochee County, Ga.

Collection: U. S. National Museum.

Genus PALIURUS Linné.

Paliurus upatoiensis Berry.

Paliurus upatoiensis Berry, U. S. Geol. Survey Prof. Paper 84, p. 116, pl. 21, figs. 5, 6, 1914.

This species was recently described by me from the eastern Gulf area, in the work cited, and the discussion need not be repeated here.

Occurrence: Eutaw formation (basal beds), McBrides Ford, Chattahoochee County, Ga.

Collection: U. S. National Museum.

Genus EORHAMNIDIUM Berry, n. gen.

Leaves of small size, elliptical to ovate in outline, with entire margins, coriaceous texture, short petioles, and pinnate veins; the secondaries subparallel, ascending, and camptodrome. This genus is erected for a type of leaf that is particularly common in the Mississippi embayment area. It is closely allied to the modern genus *Rhamnidium* Reiss and its recent segregate *Krugiodendron* Urban and is believed to stand in an ancestral relationship to these modern forms. *Rhamnidium* has four species in the Brazilian area and a fifth, *Rhamnidium ferreum* (Vahl) Sargent (*Condalia ferrea* Grisebach), in the Florida Keys, the Bahamas, and the West Indies, which Urban makes the type and only species of *Krugiodendron*. The latter is one of the commonest small trees and is a strictly coastal form.

Eorhamnidium cretaceum Berry, n. sp.

Plate XXVIII, figure 10.

Leaves above the average size for the genus, 3.5 to 4 centimeters in length by 2.8 centimeters in maximum width, which is at a point below the middle. General outline ovate, the base broadly rounded or truncate and the apex bluntly pointed or slightly emarginate. Petiole short and stout. Midrib stout. Sec-

ondaries rather stout, about five subopposite to alternate pairs, diverging from the midrib at angles that range from 28° to 47°, slightly curved until they approach the marginal region, where they curve upward, subparallel with the margin and in a camptodrome manner. The margins are entire, and the texture is coriaceous.

The present species is clearly rhamnaceous, although labeled *Populus* by Ward. Among previously described forms it greatly resembles the single small leaf from the Dakota sandstone that Lesquereux [1] erroneously identified as *Populus stygia* Heer. I am not sure, however, whether or not that form is identical with the present species. *Eorhamnidium cretaceum* is much like some of the leaves of the modern *Krugiodendron ferreum*, a form whose foliage exhibits much minor diversity, and it is also very close to Tertiary forms from the Mississippi embayment area, which are as yet undescribed.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County; Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Eorhamnidium platyphylloides (Lesquereux) Berry, n. comb.

Cornus platyphylloides Lesquereux, The flora of the Dakota group, p. 126, pl. 64, fig. 15, 1892.

The original description of this species, by Lesquereux, which was published in 1892, is as follows:

Leaves small, thickish, subcoriaceous or membranous, oval, narrowly obtuse and narrowed to the base, entire; median nerve thick; secondaries seven pairs, very oblique, slightly curved in traversing the lamina, parallel, subopposite and subequidistant.

This species was described from the Dakota sandstone of Kansas and referred to the genus *Cornus* because of its great resemblance to *Cornus platyphylla* described by Saporta [2] from the Paleocene of France—a rather remote resemblance, it seems to me.

It is represented in the Tuscaloosa formation by material indistinguishable from the type material, except that it is relatively slightly less elongate. Its reference to *Cornus* was entirely questionable, for it almost certainly represents some genus of the Rhamnaceae.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Genus RHAMNUS Linné.

Rhamnus tenax Lesquereux.

Plate XXV, figures 1, 2.

Rhamnus tenax Lesquereux, Am. Jour. Sci., 2d ser., vol. 46, p. 101, 1868; The Cretaceous flora, p. 109, pl. 21, fig. 4, 1874; The flora of the Dakota group, p. 170, pl. 38, fig. 6, 1892.
Engelhardt, Naturwiss. Gesell. Isis in Dresden Abh. 7, Jahrg. 1891, p. 101, 1892.
Bartsch, Iowa Univ. Lab. Nat. Hist. Bull., vol. 3, p. 181, 1896.

Leaves ovate-lanceolate in outline, acuminate, slightly equilateral. Length about 8 centimeters; maximum width about 2 centimeters in the lower half of the leaf. The dimensions of these leaves are remarkably uniform in all the specimens from the Dakota sandstone of the West, as well as those from the Tuscaloosa formation in Alabama. Margins entire, curving inward somewhat abruptly to the petiole, which is stout, more or less curved, and about 1 centimeter or slightly more in length. Midrib stout, curved, becoming thin in the acuminate tip. Secondaries numerous, thin, approximately parallel, 12 to 14 subopposite to alternate pairs, branching from the midrib at angles of about 45° to 50°, curving slightly upward, camptodrome.

This species, which was described many years ago by Lesquereux from the Dakota sandstone of southern Kansas and subsequently recorded by Bartsch from the same horizon in Iowa, is represented in the lower beds of the Tuscaloosa formation of western Alabama by leaves which are identical in all of their characters with the type material and which seem to be closely allied to the Tertiary and modern forms of *Rhamnus*. It has been reported by Engelhardt from the Cenomanian of Niederschoena, Saxony.

[1] Lesquereux, Leo, U. S. Geol. Survey Mon. 17, p. 44, pl. 3, fig. 12, 1892.
[2] Saporta, G. de, Prodrome d'une flore fossile des travertins anciens de Sézanne, p. 103, pl. 11, figs. 8, 9, 1868.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Family VITACEAE.

Genus CISSITES Heer.

[Phyllites crétacéos du Nebraska, p. 19, 1866.]

Cissites formosus Heer.

Cissites formosus Heer, Flora fossilis arctica, vol. 6, pt. 2, p. 85, pl. 21, figs. 5–8, 1882.
Lesquereux, The flora of the Dakota group, p. 161, pl. 21, fig. 5, 1892.
?Hollick, Torrey Bot. Club Bull., vol. 21, p. 57, pl. 174, fig. 6, 1894; The Cretaceous flora of southern New York and New England, p. 94, pl. 37, fig. 7, 1906.
Newberry, The flora of the Amboy clays, p. 107, pl. 47, figs. 1–8, 1896.
Berry, New Jersey Geol. Survey Bull. 3, p. 185, 1911.

Heer's description, published in 1882, is as follows:

C. foliis palmatis, profunde trilobatis, lobo medio basi contracto, trilobato, lobis obtusis.

The foregoing description was based upon very fragmentary material from the Atane beds of Greenland, from which, nevertheless, Heer reconstructed the supposed outline of the perfect leaf. To judge by the specimens referred to this species by Lesquereux and Newberry it was an exceedingly variable form. In plan it is trilobate, but the subsidiary lobes developed upon both the median and the lateral lobes in some specimens obscure this trilobate character and suggest *Cissites parvifolius* Berry of the Albian of America and Europe, *Cissites dentatolobatus* Lesquereux of the Dakota sandstone, or *Cissus vitifolia* Velenovsky of the Cenomanian of Bohemia.

The primaries are stout and three in number; they may diverge from the top of the stout petiole or be suprabasilar; in many specimens the branches of the laterals approach so near the base that the leaves have the appearance of being palmately 5-veined.

This species is common but fragmentary in the Raritan formation; it ranges in size from 7 to 10 centimeters in length and from 6 to 12 centimeters between the tips of the main lateral lobes. The sinuses are all rounded, and the main ones may be deep or shallow. The fragment from Long Island referred to this species by Hollick is, as that writer remarks, exceedingly unsatisfactory and doubtful. It occurs also in the Dakota sandstone of Kansas and a closely related variety has been found in the Magothy formation of Maryland.

The genus *Cissites* was erected by Heer in 1866 for the species *Cissites insignis* from the Dakota sandstone of Nebraska, which presented points of affinity with the genus *Cissus* of Linné. It is a largely developed type in the upper half of the Cretaceous period but is replaced after the Eocene by forms which are definitely referable to modern allied genera such as *Cissus* and *Vitis*.

Occurrence: Tuscaloosa formation, Glen Allen, Fayette County, Ala.

Collection: U. S. National Museum.

Cissites crispus Velenovsky.

Cissites crispus Velenovsky, Die flora der böhmischen Kreideformation, pt. 4, p. 12, pl. 4, fig. 6, 1885 (not Newberry, 1896, or Berry, 1911).
Berry, Torrey Bot. Club Bull., vol. 43, p. 296, 1916.

Cissites crispus was identified from the Raritan formation of New Jersey by Newberry and from the Magothy formation of that State by Berry, but neither of these occurrences represents the European form, so that recently I have made them the basis of a new species, *Cissites newberryi*.[1]

A perfectly well characterized, small-leafed form which appears to be identical with the Bohemian type of *Cissites crispus* is, however, present in the Ripley formation of western Tennessee. It differs from *Cissites newberryi* in its relatively shorter and wider form, its crenate instead of serrate or dentate teeth, its less ascending secondaries and its cordate base.

The type and only other known occurrence of *Cissites crispus* is the Chlomeker beds (Emscherian) of Bohemia.

Occurrence: Ripley formation (McNairy sand member), 2½ miles southwest of Selmer, McNairy County, Tenn.

Collection: Johns Hopkins University.

[1] Berry, E. W., Maryland Geol. Survey, Upper Cretaceous, p. 856, 1916.

Order MALVALES.

Family TILIACEAE.

Genus GREWIOPSIS Saporta.

Grewiopsis formosa Berry, n. sp.

Plate XXV, figures 4, 5.

Leaves relatively large for this genus, more or less trilobate, about 10 centimeters in length by 9 or 10 centimeters in maximum width. Apex bluntly pointed. Base cordate. Lobes more or less developed, ovate conical. Sinuses usually open and shallow. Margin with large dentate teeth or sublobes at ends of secondaries and these finely and evenly denticulate. Petiole stout. Primaries stout, three in number, diverging at or near the base. Laterals form acute angles of about 25° with the midrib. Secondaries numerous, craspedodrome. Tertiaries, with the exception of those which run from the secondaries to the marginal teeth, transverse.

This fine species is usually found in a rather fragmentary condition. It is entirely distinct from previously described species and constitutes one of the earliest records of this genus.

The genus *Grewiopsis* was instituted by Saporta in 1866 for leaves referable to the order Malvales but not positively referable to existing genera. He compared these leaves, which were abundant in the Paleocene of Sézanne, France, with the existing genera, *Sida, Abutilon, Pterospermum, Dombeya, Grewia, Sparmannia, Luhea,* and *Tilia* of this order. They have also been compared with the extinct genus *Credneria* Zenker. About a score of species are known, largely from the early Eocene of Europe and America. Two species are known from the Dakota sandstone, *Grewiopsis aequidentata* and *Grewiopsis flabellata,* both described by Lesquereux. Lesquereux described a third species, *Grewiopsis mudgei,* but this was an unintentional redescription of the type of *Grewiopsis aequidentata. Grewiopsis flabellata* has been recorded from the Magothy formation in the Coastal Plain of Maryland.[1] A third species, *Grewiopsis cleburni,* has been recorded by Lesquereux from the Cretaceous of the Montana group.

Both this and the following Tuscaloosa species are entirely distinct from the foregoing and are more closely allied to certain modern genera of the family Tiliaceae. These are *Grewia* Linné, which has about 90 species, mostly tropical, in the old world; *Hockenya* Willdenow, which has about 15 species in the American Tropics, extending from the Antilles and Central America to Brazil; and *Triumfetta* Linné, with about 60 species in the Tropics of both hemispheres, extending northward in America to the Antilles.

In the deposits of the Mississippi embayment there is a small *Populus*-like species of *Grewiopsis* in the lower Eocene (Wilcox group) and a large and ornate species in the middle Eocene (Claiborne group).

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Grewiopsis tuscaloosensis Berry, n. sp.

Plate XXV, figure 3.

Leaves of small size, elliptical in general outline, about 4 centimeters in length by 3 to 3.5 centimeters in maximum width, which is about halfway between the apex and the base. Apex rounded or bluntly pointed. Base shallowly cordate. Margin dentate throughout; in upper half of the leaf sublobate dentations at ends of the secondaries, which are denticulate to match the teeth lower down. Petiole long, about 2.5 centimeters in length, rather stout. Midrib rather stout. Five or six subopposite pairs of secondaries, branching from the midrib at angles of about 45° or more, craspedodrome. On the outside these give off tertiary branches, which run to the marginal teeth and in turn some of them give off subordinate outside branches to the margin. Balance of the tertiaries transverse, as is the rule in this genus.

This species is much smaller than *Grewiopsis formosa* and altogether lacks the triveined, trilobate character of that species, although the possibility that it may represent an immature or slightly aberrant leaf of that species should not be lost sight of, for it occurs in the same deposits and less abundantly. It is strictly congeneric with the previously described species of *Grewiopsis* and serves to relate the Tuscaloosa formation with the Dakota sandstone as well as to clearly foreshadow the development of this type of vegetation in the early Eocene.

[1] Berry, E. W., Torrey Bot. Club Bull., vol. 33, p. 177, 1906.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collections: U. S. National Museum.

Family STERCULIACEAE.

Genus PTEROSPERMITES Heer.

Pterospermites carolinensis Berry.

Plate XXV, figures 6-8.

Pterospermites carolinensis Berry, Torrey Bot. Club Bull., vol. 34, p. 198, pl. 14, fig. 2, 1907; idem, vol. 43, p. 297, 1916.

Leaves broadly ovate or elliptical in outline. Apex missing but probably broadly pointed. Base broad, ranging from forms in which it is broadly cuneate and slightly decurrent to forms in which it is more or less cordate; in all specimens the lateral margins of the lamina continue downward as wings of the petiole for considerable distances. Length 10 to 15 centimeters (?). Greatest width, 5 to 8 centimeters in the basal half of the leaf. Margins entire, except that they may be somewhat undulate distad. Texture somewhat coriaceous. Petiole very stout, curved, about 2.5 centimeters in length. Midrib straight, rather stout, becoming enlarged to join the petiole. Secondaries subopposite to alternate, rather remote, relatively slender, the lower ones on each side commonly branching from the extreme base of the midrib, giving off at the point of branching a prominent tertiary which makes an angle of about 90° with the midrib and giving off also several tertiaries which arch along the lateral margins; similar marginal camptodrome veins are given off by the basal tertiary just described. The remainder of the secondaries, numbering four or five pairs, diverging from the midrib at angles of about 50°, curving upward, camptodrome. Nervilles thin, largely simple, straight or somewhat curved.

This species was described by the writer in 1907 from the Black Creek formation at Court House Bluff, N. C., where it is not uncommon, although mostly in a poor state of preservation. It appears to be common in the lower part of the Tuscaloosa formation, in western Alabama, where it is also not particularly well preserved, the apical half of the leaf being usually missing. It is present also in the Eutaw formation in Tennessee.

There are three additional species of *Pterospermites* recorded from the American Cretaceous—*P. modestus* Lesquereux of the Dakota sandstone in the West and the upper part of the Raritan formation in the East, *P. obovatus* (Newberry) Berry, of the Raritan formation of New Jersey, and *P. cordifolius* Heer, of the Atane beds of Greenland. During the Eocene there were species in Alaska and Europe, and the genus continued throughout the Tertiary in considerable abundance.

Occurrence: Tuscaloosa formation, Shirleys Mill and Glen Allen, Fayette County; Cottondale, Tuscaloosa County, Ala. Eutaw formation (Coffee sand member), Coffee Bluff, Hardin County, Tenn.

Collections: U. S. National Museum.

Genus STERCULIA Linné.

Sterculia snowii tennesseensis Berry.

Plate XXXII, figure 1.

Sterculia snowii tennesseensis Berry, Torrey Bot. Club Bull., vol. 43, p. 296, pl. 16, fig. 5, 1916.

Leaf bilobate, with a bluntly pointed base and gradually narrowed acuminate recurved apical lobes. Length about 11 centimeters. Width of the entire basal part of the leaf 2.5 to 2.75 centimeters. Width of lobes 1.1 to 1.6 centimeters. Margins entire. Texture subcoriaceous. Sinus extending halfway to the base or less, open, narrowly rounded. Midrib stout, flexuous. Lateral primary stout, diverging from the midrib at an acute angle about 3 centimeters above its base. Secondaries thin, largely immersed, diverging from the primaries at wide angles and at regular intervals, arching in a camptodrome manner near the margins.

This striking form is unfortunately represented by only two specimens, both of which are bilobate, although it, like so many fossil and existing species of *Sterculia*, may well have varied from entire to trilobate. Among previously described fossil forms it may be compared with the species from the Magothy formation in New Jersey and Maryland, *Sterculia minima* Berry, which is a smaller and more variable form, or with the species from the Dakota sandstone, *Sterculia mucronata* Lesquereux and *Sterculia snowii* Lesquereux. The latter, though often much larger and with five lobes, is extremely variable. Two named varieties of it have already been recognized, and the general character

and venation of this Tennessee form leads me to conclude that it represents another variety of this protean species.

Occurrence: Ripley formation (McNairy sand member), 2½ miles southwest of Selmer, McNairy County, Tenn.

Collection: Johns Hopkins University.

Order THYMELEALES.

Family LAURACEAE.

Genus CINNAMOMUM Blume.

Cinnamomum newberryi Berry.

Plate XXI, figures 6–9.

Cinnamomum newberryi Berry, Torrey Bot. Club Bull., vol. 38, p. 423, 1911; New Jersey Geol. Survey Bull. 3, p. 150, pl. 16, fig. 3, 1911.

Cinnamomum sezannense Heer, Flora fossilis arctica, vol. 6, Abt. 2, p. 77, pl. 19, fig. 8; pl. 33, figs. 11, 12, 1882 (not Watelet).

Heer, idem, vol. 7, p. 30, pl. 41, fig. 1a, 1883.

Lesquereux, The flora of the Dakota group, p. 107, pl. 12, fig. 7, 1892 (not fig. 6).

Dawson, Roy. Soc. Canada Trans., 1st ser., vol. 2, sec. 4, p. 64, pl. 13, fig. 58, 1894.

Hollick, Torrey Bot. Club Bull., vol. 21, p. 53, pl. 180, figs. 5, 7, 1894.

Penhallow, Roy. Soc. Canada Trans., 2d ser., vol. 8, sec. 4, p. 46, 1902.

Hollick, New York State Mus. Fifty-fifth Ann. Rept., for 1901, p. r50, 1903.

Cinnamomum intermedium Newberry. Smith, On the geology of the Coastal Plain of Alabama, p. 348, 1894 (nomen nudum) (not Ettingshausen).

Newberry, The flora of the Amboy clays, p. 89, pl. 29, figs. 1–8, 1896.

Berry, New Jersey Geol. Survey Ann. Rept. for 1905, p. 139, pl. 20, figs. 2–6, 1906; Torrey Bot. Club Bull., vol. 33, p. 179, pl. 7, figs. 3, 4; idem, vol. 37, p. 27, 1910.

Hollick, The Cretaceous flora of southern New York and New England, p. 74, pl. 29, fig. 7; pl. 30, figs. 1, 2, 1906.

Leaves subcoriaceous, lanceolate to ovate-lanceolate in outline, differing greatly in size and consequently in appearance. Apex short-pointed or more or less narrowly extended; base broad; narrowed to the petiole. Primaries three, usually suprabasilar.

This species is primarily distinguished from *Cinnamomum heerii* Lesquereux by its relatively narrower form and acute base. The present species, as here revised according to the foregoing citations, has a remarkable range in the earlier half of the Upper Cretaceous, being recorded from the Raritan formation of New Jersey, which is the oldest horizon from which it is known. Above the Raritan horizon it occurs in the Atane and Patoot beds of Greenland, in the Magothy formation from Long Island to Maryland, in the Black Creek formation of North Carolina, in the Middendorf arkose member of the Black Creek formation of South Carolina, in the Tuscaloosa formation of Georgia and Alabama, and in the Dakota sandstone of Kansas. It appears to be present in the Upper Cretaceous of the Pacific coast on Vancouver Island and is probably represented in the Texas remains of *Cinnamomum* recorded by Knowlton[1] from the Woodbine sand in Cooke County. Although not known from Europe the forms from the Cenomanian of Bohemia which Velenovsky describes as *Aralia daphnophyllum*[2] are very similar to the American species.

Occurrence: Tuscaloosa formation, Shirleys Mill, Glen Allen, Fayette County; Cottondale, Tuscaloosa County, Ala. Eutaw formation (basal beds), McBrides Ford, Chattahoochee County, Ga.

Collections: U. S. National Museum.

Cinnamomum heerii Lesquereux (?).

Cinnamomum heerii Lesquereux, Am. Jour. Sci., 2d ser., vol. 27, p. 361, 1859.

Berry, U. S. Geol. Survey Prof. Paper 84, p. 118, pl. 21, fig. 8, 1914; Torrey Bot. Club Bull., vol. 43, p. 298, 1916.

This species in the eastern Gulf area was recently discussed by me in the paper cited.

Occurrence: Eutaw formation (basal beds), McBrides Ford, Chattahoochee County, Ga.; (Coffee sand member), Coffee Bluff, Hardin County, Tenn.

Collections: U. S. National Museum.

Cinnamomum sp.

Cinnamomum sp. Berry, Torrey Bot. Club Bull., vol. 43, p. 299, 1916.

A characteristic *Cinnamomum*, apparently distinct from *Cinnamomum newberryi* and *Cinnamomum heerii*, the two most common and wide-ranging Upper Cretaceous species, is present in the Ripley formation. The material is too imperfect for satisfactory characterization.

[1] Knowlton, F. H., in Hill, R. T., U. S. Geol. Survey Twenty-first Ann. Rept., pt. 7, p. 317, 1901.

[2] Velenovsky, Josef, Die Flora der böhmischen Kreideformation, Theil 1, p. 23, pl. 5, figs. 5–8, 10; pl. 6, figs. 1–5, 1882.

Occurrence: Ripley formation (McNairy sand member), 2½ miles southwest of Selmer, McNairy County, Tenn.

Collection: Johns Hopkins University.

Genus PERSEA Gaertner.

Persea valida Hollick.

Plate XXI, figure 2.

Persea valida Hollick, The Cretaceous flora of southern New York and New England, p. 76, pl. 29, figs. 8, 9, 1906.

Leaves ovate-lanceolate in outline, with slightly waved margins, 9 to 11 centimeters in length by about 3 centimeters in maximum width, which is about halfway between the apex and the base. Apex somewhat abruptly acuminate. Base about equally sharp, cuneate. Petiole short and stout. Midrib stout, curved, and somewhat flexuous distad. Secondaries numerous, thin, 9 to 12 pairs, somewhat irregularly spaced and branching from the midrib at mostly acute angles, curving upward, camptodrome.

This well-marked species was recently described by Hollick from the Upper Cretaceous of Long Island. The Tuscaloosa leaves are identical in character with the type material, the specimen figured from Cottondale, Ala., being an almost exact counterpart of the smaller of Hollick's figures.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Genus OREODAPHNE Nees and Martius.

Oreodaphne shirleyensis Berry, n. sp.

Plate XIX, figures 1, 2.

Leaves of medium size, broadly ovate in outline, with an acuminate apex and a broadly rounded base, about 10 centimeters in length by 4.5 centimeters in maximum width, which is in the middle part of the leaf. From this point the margins are full and curved to the base. Distad they curve outward then inward, narrowing more or less gradually to the narrowly pointed apex. Midrib stout, curved. Secondaries about six pairs. The second pair from the base branch from the midrib at a somewhat more acute angle than those above or below. They are also somewhat stouter, straighter, and more ascending, although much thinner than the midrib. They are alternate and have the appearance of lateral primaries, giving the leaf somewhat the appearance of a triveined leaf, but they are really only slightly enlarged secondaries. All the secondaries are camptodrome.

This species is new to science and is clearly distinct from *Oreodaphne alabamensis* in size, outline, and general appearance. The base is quite different, and the development of a normal pair of secondaries below the alternate pseudoprimaries instead of the numerous parallel secondaries from the outer side of the true primaries, which are so conspicuous a feature in *Oreodaphne alabamensis*, affords a ready means of discrimination between the two species.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Oreodaphne alabamensis Berry.

Plate XIX, figures 3–5.

Oreodaphne alabamensis Berry, Torrey Bot. Club Bull., vol. 39, p. 400, pl. 32, 1912.

Leaves of large size, ovate in general outline, ranging from 13 to 20 centimeters in length, and from 4.75 to 7 centimeters in maximum width, which is at a point about midway between the apex and the base. From the point of greatest width the margins extend, both distad and proximad, in a very full curve, narrowing rather abruptly to the acuminate tip and also to the more or less decurrent base. Midrib stout, curved. Lateral primaries opposite, one on each side, branching from the midrib at an acute angle a considerable distance above its base, rather straight in their course, thinner than the midrib. Above the primaries there is an interval and then about six pairs of thin, curved, approximately parallel, camptodrome secondaries branch from the midrib at acute angles. The lateral primaries give off on the outside numerous regularly spaced and approximately parallel, curved camptodrome secondaries, this feature serving to distinguish this species from other fossil species of this genus, and from *Cinnamomum*, *Cocculus*, or other genera with somewhat similar leaves with which it might be compared. Texture coriaceous.

This fine, large species shows considerable variation in size and some in outline, the varia-

tion in outline being dependent on whether the leaf is widest nearer to or farther from the base. If the leaf is widest farther from the base the distal part is more fully rounded and abruptly contracted to the acuminate tip, whereas the base is more gradually narrowed and finally cuneate rather than decurrent. If the greatest width is nearer the base the apical portion is more gradually narrowed and the base is full and rounded abruptly, decurring to the petiole. It is also present in the Woodbine sand at Arthurs Bluff, Lamar County, Tex.

This species is markedly different from previously described fossil forms but may be matched by several modern tropical American species of *Oreodaphne*. The genus *Oreodaphne* of Nees, which is exclusively American in the existing flora, is made a subgenus of *Ocotea* Aublet by Pax.[1] Ocotea, which in paleobotanic usage may be considered as composite, has about 200 modern species, which occur chiefly in the American Tropics and range from southern Florida to Brazil and Peru but have some representation (subgenus *Mespilodaphne* Nees) in the Canary Islands, South Africa, Madagascar, and the Mascarene Islands.

Our single existing species in the United States, whose habit and environment may be taken as typical for the whole genus, is found in Florida southward from Capes Canaveral and Romano along the shores and islands, with the exception of some of the western keys, making its best growth in the rich, moist, hammock lands near the coast.

The genus is abundantly represented by several characteristic species in the Eocene floras of the Gulf region.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

Genus SASSAFRAS Nees.

[Handbuch der medizinisch-pharmaceutischen Botanik, vol. 2, p. 418, 1831.]

Sassafras acutilobum Lesquereux.

Sassafras acutilobum Lesquereux, The Cretaceous flora, p. 79, pl. 14, figs. 1, 2, 1874; The Cretaceous and Tertiary floras, p. 56, pl. 5, figs. 1, 5, 1883; The flora of the Dakota group, p. 100, 1892.

Hollick, New York Acad. Sci. Trans., vol. 12, p. 236, pl. 7, fig. 1, 1893; The Cretaceous flora of southern New York and New England, p. 77, pl. 30, figs. 8, 9, 1906.

Newberry, The flora of the Amboy clays, p. 87, pl. 25, figs. 1–10; pl. 26, figs. 2–6, 1896.

Kurtz, Rev. Mus. La Plata, vol. 10, p. 53, 1902.

Berry, Bot. Gazette, vol. 34, p. 438, 1902; New York Bot. Garden Bull., vol. 3, p. 81, pl. 45, figs. 1, 2, 1903; Torrey, Bot. Club Bull., vol. 31, pl. 1, fig. 6, 1904; New Jersey Geol. Survey Ann. Rept. for 1905, p. 139, pl. 22, figs. 4, 5, 1906; New Jersey Geol. Survey Bull. 3, p. 140, pl. 18, fig. 2, 1911.

Trilobate leaves, variable in size and outline. Length ranges from 2.5 centimeters in the young leaves to 14 centimeters in mature forms and averages 10 to 12 centimeters. Width from the tips of the lateral lobes likewise ranges from 1 to 15 centimeters averaging about 10 centimeters. Lobes mostly conical and acute, the middle one being usually slightly the broadest and longest. Lateral lobes directed more or less laterally. Base decurrent. The sinuses between the lobes as a rule are open and rounded, the margins forming an angle of approximately 90°. There is considerable variation, however, in this respect, some of the leaves having comparatively narrow sinuses with the lobes directed upward, as in *Sassafras progenitor* Hollick, whereas others, at the opposite extreme of the series, have extremely shallow sinuses, so shallow that the leaf has the appearance of a triangularly pointed, entire leaf. The lateral primaries may branch from the midrib at or near the base, as they do in a majority of the Raritan forms, or their point of divergence may be a considerable distance above the base, as in modern *Sassafras* leaves. Their angle of divergence from the midrib ranges from about 30° to 40°. The secondaries are usually numerous, regular, camptodrome, and connected by transverse tertiaries, although in the Raritan leaves this uniformity is often lacking. Petiole, long and stout. The marginal vein along the sinus, a marked feature in modern leaves of this genus, is generally absent in this species, although present in a few specimens.

This species is apparently widely distributed and almost as variable as the modern *Sassafras*. It was described originally from the Dakota sandstone as a variety of *Sassafras mudgei* and occurs also on Marthas Vineyard and Long Island and in the Raritan and Magothy formations of New Jersey and Delaware. It has been recorded from Cerro Guido, Argentina, and Velenovsky identified somewhat doubtful remains from the Cenomanian of Bohemia as this species. Probable *Sassafras* fruit has been

[1] Engler, A., and Prantl, K., Die natürlichen Pflanzenfamilie.

found in the same strata with *S. acutilobum*,[1] tending to show that it is a true *Sassafras*, notwithstanding its dissimilarities; however, the leaves and fruit were not found associated. Lesquereux's smallest figure of *S. acutilobum* is considerably smaller, with the lobes directed upward, and is probably a young leaf of his larger form. His other figure approaches some of the leaves which Newberry refers to this species but has narrower and more produced lobes.

There is considerable doubt as to whether these Coastal Plain leaves are generically related to *Sassafras*. Whether the Dakota sandstone forms are those of *Sassafras* it is not easy to decide. No modern *Sassafras* leaves have the primaries and the lateral lobes so nearly horizontal; the secondaries are not so uniformly regular, nor do they curve upward to join the next above at a point. In the modern leaf an outwardly and downwardly directed branch from the lateral lobe is emphasized. None of the modern forms have such an open sinus, which amounts in the fossil to nearly 90°, and the lobes in the modern leaf have their margins inflated and not straight. In these ancient leaves the sinus as a rule does not have a marginal vein, the secondary in this region usually forking and striding it, or curving to join its neighbor. The secondary system seems to be uniform throughout the leaf, but in the modern leaf there is always evidence of changes in the region around the sinus; the secondaries or their representatives from both the primaries and midrib are changed in size and direction, and as a rule belong to the tertiary system. None of the Dakota leaves of this species show the characteristic basal venation of the modern leaf. Though Cretaceous species should not necessarily be expected to conform to the modern type, still the character of the secondary system in the fossils is so different from what would obtain in a leaf descended from a simple ancestor, such as *Sassafras* is thought to have done, that I am inclined to associate these leaves with those trilobed forms which have been referred to *Aralia* or *Sterculia*, laying aside, for the present, any consideration as to whether they are true species of *Aralia* and *Sterculia*.

[1] Lesquereux, Leo, The flora of the Dakota group: U. S. Geol. Survey Mon. 17, p. 230, 1892.

However, in view of the present uncertainty, and because of the havoc to the stratigraphic value of these leaves which would be wrought by any change of name, they are retained in the genus *Sassafras* pending more positive evidence of their affinity.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Genus MALAPOENNA Nees.

Malapoenna cottondalensis Berry, n. sp.

Plate XXI, figure 4.

Leaves lanceolate in general outline, 11 to 12 centimeters in length by about 2.5 centimeters in maximum width in the basal half of the leaf. Apex gradually narrowed, acuminate. Base curved cuneate, pointed. Midrib stout, becoming thin distad. Secondaries about eight to ten pairs; the lowest pair are opposite and suprabasilar, diverging from the midrib at angles of about 25°, ascending for a distance of about 4 centimeters to a point where they join an outwardly directed branch from the secondaries next above, thus giving the basal part of the leaf a triveined appearance; after an interval the remaining secondaries are more or less equally spaced, approximately parallel and alternate, branching from the midrib at angles of about 40° to 45°, regularly curved upward and camptodrome.

This species, which is obviously new, is much larger than *Malapoenna falcifolia*. It is about the same size as *Malapoenna cretacea* but narrower and more elongated and attenuated above. The secondaries are thinner and only one pair extended to simulate primaries.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Malapoenna cretacea (Lesquereux) Knowlton.

Plate XXI, figure 3.

Litsea cretacea Lesquereux, The flora of the Dakota group, p. 96, pl. 15, fig. 2, 1892.

Malapoenna cretacea (Lesquereux) Knowlton, U. S. Geol. Survey Bull. 152, p. 142, 1898.

Leaves oblong-lanceolate in outline with a cuneate or slightly decurrent base, widest in the lower half of the leaf and tapering upward into an acuminate apex. Length 10 to 14 centimeters. Maximum width about 3 centi-

meters. Margins entire but slightly waved. Texture coriaceous. Petiole short and stout. Midrib stout. Secondaries thin, five or six pairs, irregularly spaced; proximad they branch from the midrib at acute angles and sweep upward in long, ascending curves, which give these leaves the semblance of being triveined; distad they branch at a wider angle and are shorter and more curved; all are finally camptodrome.

This handsome species, which was originally described from the Dakota sandstone of Kansas, to which it has hitherto been confined, is unmistakably present in the lower part of the Tuscaloosa formation of western Alabama.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Malapoenna falcifolia (Lesquereux) Knowlton.

Plate XXI, figure 5.

Litsea falcifolia Lesquereux, The flora of the Dakota group, p. 97, pl. 11, fig. 5, 1892.

Malapoenna falcifolia (Lesquereux) Knowlton, U. S. Geol. Survey Bull. 152, p. 142, 1898.

Berry, Torrey Bot. Club Bull., vol. 33, p. 180, 1906. New Jersey Geol. Survey Ann. Rept. for 1905, p. 139, 1906.

Leaves of relatively small size, lanceolate in outline, falcate. Length about 5 to 6 centimeters. Maximum width, which is about halfway between the apex and the base, if anything slightly nearer the base, about 1.7 centimeters. From this point the blade narrows to the lanceolate base and gradually tapers to the extended acuminate tip. Petiole not preserved. Midrib much curved, thin distad. Secondaries three or four pairs; the lower suprabasilar and subopposite pair should possibly be termed lateral primaries, as was done by the original describer of the species. These lower secondaries are thin and branch from the midrib at angles of 45° or less, sweeping upward in a long curve, at length camptodrome. Upper secondaries somewhat irregularly spaced, camptodrome. Tertiaries very fine and more or less obsolete. Texture coriaceous but not thick.

This attractive species is easily distinguished from other lauraceous forms, particularly from species of *Cinnamomum*, with which Lesquereux originally compared it, by its slight inequilaterality and marked falcate form, as well as by the lack of definiteness in the triple venation, the suprabasilar position of the so-called primaries, and the character of the tertiary venation. It was described originally from the Dakota sandstone of Kansas and subsequently was discovered by the writer in the Magothy formation of New Jersey. Some of the specimens from the lower part of the Tuscaloosa formation, though the materials are not extensive, are complete and are entirely characteristic.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Malapoenna horrellensis Berry.

Malapoenna horrellensis Berry, Torrey Bot. Club Bull., vol. 37, p. 198, pl. 24, figs. 1–9, 1910. Idem, vol. 43, p. 299, 1916.

I described this species in 1910 as follows:

Leaves ovate-lanceolate, about 8 centimeters long by 2.5 centimeters in greatest width; broadest at the evenly rounded or slightly acute base, narrowing gradually upward, the apex narrow and extended but obtusely pointed. Leaf substance thin but persistent, evidently coriaceous in life, since these leaves occur abundantly at a locality where all the vegetable remains except the resistant *Araucaria*, *Cunninghamites*, and *Pistia* were evidently thoroughly macerated before entombment. Secondaries 4 to 6 pairs, subopposite, curved upward, camptodrome, branching from the midrib at an acute angle, the lowest pair branching from the top of the petiole and extending upward halfway to the apex or farther, giving the leaf a triple-veined appearance. Perhaps they should be termed lateral primaries, although they are much finer than the medium stout midrib. The next pair of secondaries branch at a less acute angle a considerable distance above the base, one-third to one-half the distance to the apex. Tertiary venation typically lauraceous.

This species is markedly distinct from the species of lauraceous leaves hitherto described in its rounded base, the only genus of this family with such a character being *Cinnamomum*, the present species being possibly liable to be confused with *Cinnamomum heeri* Lesquereux when only the basal part of the leaf is found. The general proportions and characters of the whole leaf are, however, perfectly distinct.

It was described from several localities in the upper part of the Black Creek formation of North Carolina and is represented in the collections from the basal part of the Eutaw formation of Alabama from Hale County. It is

also present in the basal beds of the Eutaw in western Georgia.

Occurrence: Eutaw formation, Havana, Hale County, Ala.; Broken Arrow Bend, Chattahoochee County, Ga. Ripley formation (McNairy sand member), Big Cut near Cypress and 2½ miles southwest of Selmer, McNairy County, Tenn.

Collection: U. S. National Museum.

Genus LAURUS Linné.

Laurus plutonia Heer.

Laurus plutonia Heer, Flora fossiles arctica, vol. 6, abt. 2, p. 75, pl. 19, figs. 1d, 2–4; pl. 20, figs. 3a, 4–5; pl. 28, figs. 10, 11; pl. 42, fig. 4b, 1882; idem, vol. 7, p. 30, pl. 48, fig. 2; pl. 62, fig. 1a, 1883.

Lesquereux, The flora of the Dakota group, p. 91, pl. 13, figs. 5, 6; pl. 22, fig. 5, 1892; Minnesota Geol. and Nat. Hist. Survey, vol. 3, pt. 1, p. 14, pl. A, fig. 6; pl. B, fig. 5, 1895.

Newberry, The flora of the Amboy clays, p. 85, pl. 16, figs. 10, 11, 1896.

Velenovsky, Die flora der böhmischen Kreideformation, Theil 3, p. 1, pl. 4, figs. 2–4, 1884.

Hollick, New York Acad. Sci. Ann., vol. 40, p. 60, pl. 4, figs. 6, 7, 1898; The Cretaceous flora of southern New York and New England, p. 80, pl. 27, figs. 9, 11; pl. 28, figs. 1, 2, 1906.

Berry, New York Bot. Garden Bull., vol. 3, p. 79, pl. 1, figs. 9–11, 1903; Torrey Bot. Club Bull., vol. 31, p. 77, pl. 3, fig. 1, 1904; idem, vol. 33, p. 173, 1906; New Jersey Geol. Survey Ann. Rept. for 1905, pp. 138, 139, 1906; New Jersey Geol. Survey Bull. 3, p. 144, 1911.

Leaves lanceolate in outline, usually tapering almost equally in both directions but sometimes less acute at the base. Length, 7 to 11 centimeters. Maximum width, 1.5 to 2.5 centimeters. Midrib rather stout. Petiole short and stout, 6 to 15 millimeters in length. Secondaries slender, eight or more alternate pairs, camptodrome.

This species was described by Heer from the Atane beds of Greenland, and a large number of somewhat variable and fragmentary specimens were figured. Newberry records specimens from the Raritan formation of New Jersey without giving any specific localities. Those figured show leaves which are relatively wider than the usual leaves of this species, but these are comparable with some of the Greenland specimens.[1] Entire typical leaves occur in the top layer of the Raritan at the Hylton Pits near Camden, N. J.

Subsequent to its description by Heer, this species was recorded from a very large number of Cretaceous plant beds, so that its present range, both geographic and geologic, is rather wide. Many of these records are not entirely above question, and this appears to be especially true of the forms from the Cenomanian of Bohemia which Velenovsky so identifies.

Laurus plutonia is evidently a rare plant in the Raritan formation but becomes abundant in immediately succeeding floras, being common in that of the Dakota sandstone of the West and in the Magothy formation of the East at a number of localities in New Jersey and Maryland. It is a common form in the insular Cretaceous floras and also occurs in the southern Atlantic Coastal Plain. Supposed fruits are figured by Heer.[2] In South Carolina this species is represented by typical leaves which are not at all uncommon in the Middendorf arkose member of the Black Creek formation. It has not been detected in the North Carolina Cretaceous, although it ranges from the base to the top of the Tuscaloosa formation and into the base of the Eutaw formation in Alabama.

The generic name *Laurus* is used as a form genus for fossil Lauraceae, and its use does not imply an intimate relationship with the existing species of *Laurus*. The present form is probably not a true *Laurus* but is referable to *Oreodaphne*, *Mespilodaphne*, or *Nectandra*.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County; Cottondale, Tuscaloosa County, Ala. Eutaw formation (basal beds), 2 miles south of Havana, Hale County, Ala.

Collections: U. S. National Museum.

Genus LAUROPHYLLUM Goeppert.

Laurophyllum nervillosum Hollick.

Plate XXI, figure 1.

Laurophyllum nervillosum Hollick, The Cretaceous flora of southern New York and New England, p. 82, pl. 27, figs. 6, 7, 1906.

Berry, Torrey Bot. Club Bull., vol. 36, p. 255, 1909. New Jersey Geol. Survey Bull. 3, p. 146, 1911.

Proteoides daphnogenoides Heer. Hollick, New York Acad. Sci. Ann., vol. 2, p. 420, pl. 36, figs. 1, 3, 1898.

Leaves of comparatively large size, oblong-lanceolate in outline, somewhat inequilateral

[1] Heer, Oswald, Flora fossilis arctica, vol. 6, Abt. 2, pl. 20, fig. 5; pl. 28, fig. 11, 1882.

[2] Idem, pl. 42, fig. 4b.

in some of the Tuscaloosa material, about 15 centimeters in length by about 2.5 centimeters in greatest width, which is about midway between the apex and the base. Apex acuminate. Base pointed, narrowly cuneate. Midrib stout. Secondaries thin, close, parallel, branching from the midrib at angles not exceeding and usually somewhat less than 45°, ascending, nearly straight or somewhat flexuous, connected by transverse nervilles, branching and inosculating near the margin, where they merge in the tertiary venation.

This species was described originally from the transported morainic material at Tottenville, Staten Island, and probably represents transported Raritan materials, as it occurs in the Raritan formation at Milltown, N. J. It is, however, present in the succeeding Magothy formation and is not uncommon in the typical Black Creek formation of the Carolinas and in the Middendorf arkose member of the Black Creek formation in South Carolina. It is somewhat like *Laurophyllum lanceolatum* Newberry but has a markedly different venation and a less lanceolate outline. It is also very close to *Laurophyllum elegans* Hollick, which is, however, a more slender lanceolate leaf, with narrowly produced apex and base and a somewhat coarser venation, with less close and more curved camptodrome secondaries.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Laurophyllum angustifolium Newberry.

Laurophyllum angustifolium Newberry, The flora of the Amboy clays, p. 86, pl. 17, figs. 10, 11, 1896.
Berry, New York Bot. Garden Bull., vol. 3, p. 80, pl. 47, figs. 1, 5, 8; pl. 49, figs. 1–5, 1903; Torrey Bot. Club Bull., vol. 33, p. 178, 1906; New Jersey Geol. Survey Bull. 3, p. 148, 1911.

Leaves elongate-lanceolate, very symmetric in outline, 10 to 15 centimeters in length, by 1.5 to 2 centimeters in width, widest above the middle, tapering with almost straight sides to the elongate-acute base. Apex narrowed, subacute. Petiole short and stout. Midrib also stout. Secondaries fine, commonly obsolete, 12 to 15 pairs, branching from the midrib at an angle of about 45° and curving upward camptodrome. Texture subcoriaceous.

This species, which was described from the middle part of the Raritan formation of New Jersey, where it is common, has also been found in the overlying Magothy formation in both New Jersey and Maryland. In the absence of complete and well-marked specimens many of those available can with difficulty be differentiated from contemporaneous species of other genera with similar lanceolate leaves.

Occurrence: Tuscaloosa formation, upper ravine on the Snow place, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Laurophyllum elegans Hollick.

Laurophyllum elegans Hollick, The Cretaceous flora of southern New York and New England, p. 81, pl. 27, figs. 1–5, 1907.
Berry, U. S. Geol. Survey Prof. Paper 84, p. 53, pl. 12, fig. 6, 1914; Torrey Bot. Club Bull., vol. 43, p. 297, 1916.

Leaves elongate-lanceolate, somewhat flexuous, about 12 or 13 centimeters in length by about 2 centimeters in maximum width, which is about midway between the apex and the base; from this point they narrow gradually apicad into an attenuated acuminate and usually curved tip and basally into a long, narrowly cuneate base. Petiole and midrib stout. Secondaries numerous, usually less close and somewhat coarser than in *Laurophyllum nervillosum* Hollick, branching from the midrib at acute angles below but becoming more open above the basal region of the leaf; they are usually more curved than those of *Laurophyllum nervillosum* and more distinctly camptodrome. Tertiaries transverse throughout.

This species is certainly present in the upper beds of the Raritan formation at South Amboy, N. J., and is common in the Magothy formation of Maryland. It is sparingly represented in the Black Creek formation of North Carolina and in the Middendorf arkose member of the Black Creek formation of South Carolina.

Occurrence: Eutaw formation (Coffee sand member), Coffee Bluff, Hardin County, Tenn.

Collection: Johns Hopkins University.

Order MYRTALES.

Family MYRTACEAE.

Genus EUGENIA Linné.

Eugenia tuscaloosensis Berry, n. sp.

Plate XXVIII, figure 6.

Leaves of small size, lanceolate in outline, falcate, slightly inequilateral. Length ranging from 5 to 8 centimeters. Maximum width, which is in the lower half of the leaf, 1 to 1.3 centimeters; from this point the leaf tapers gradually upward into a long, attenuated tip, forming a "dripping point." Base narrowly cuneate. Margins entire. Petiole very stout and curved, about 7 millimeters in length. Midrib stout below, thinning distad, curved. Secondaries numerous, thin, ascending; they branch from the midrib at an acute angle, which is invariably less than 45°, and are straight at first, afterward curving upward, camptodrome. Texture coriaceous.

Eugenia, which is a genus that contains more than 500 existing species, is commonly represented in all tropical countries. Five species, of which four are small trees, reach as far northward as southern Florida and the Bahamas. They are all coastal types, growing on the keys, where they commonly form the "scrub" on coral rock, or in rich hammocks where the water table is near the surface, or on river or estuary banks near the coast.

The number of fossil species which have been described is inconsiderable. The present species is the first to be recognized in the Coastal Plain. A very different form, *Eugenia primaeva*, has been described from the Dakota sandstone by Lesquereux.[1] With the exception of these two the remainder of the species, numbering less than a dozen, are Tertiary in age and confined to Europe, although the genus is known to be present in the Eocene deposits of the Mississippi embayment.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County; Cottondale, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

[1] Lesquereux, Leo, U. S. Geol. Survey Mon. 17, p. 137, pl. 53, figs. 5–9, 1892.

Eugenia? anceps Berry.

Plate XXXII, figures 3–5.

Eugenia? anceps Berry, Torrey Bot. Club Bull., vol. 43, p. 301, pl. 16, figs. 2–4, 1916.

Coriaceous leaves of variable size and form, lanceolate or oblong-lanceolate in outline. Apex and base equally acuminate or the apex somewhat more attenuated. Margins entire. Length 7.75 to 10 centimeters. Maximum width, midway between the apex and the base, 11 to 18 millimeters. Petiole enlarged, short and stout, 3 to 4 millimeters in length. Midrib stout. Secondaries thin, immersed in the leaf substance.

This species is referred to *Eugenia* with considerable hesitation. The material is abundant but poorly preserved, and these leaves resemble a variety of forms referred to such genera as *Salix* and *Laurophyllum*.

Eugenia has furnished a species in the Tuscaloosa formation of Alabama, another in the Dakota sandstone of the western United States, and is not uncommon in the Eocene of the Mississippi embayment region.

Occurrence: Ripley formation (McNairy sand member), 2½ miles southwest of Selmer, McNairy County, Tenn.

Collection: Johns Hopkins University.

Genus MYRCIA De Candolle.

Myrcia havanensis Berry.

Plate XI, figure 4; Plate XXVIII, figure 7.

Myrcia havanensis Berry, Torrey Bot. Club Bull., vol. 43, p. 300, 1916.

Eucalyptus attenuata Ward (not Newberry), U. S. Geol. Survey Fifteenth Ann. Rept., p. 371, 1895.

Leaves linear-lanceolate in outline, falcate, about 9 centimeters in length by 1 centimeter in maximum width, which is in the lower half of the leaf. Margins entire. Apex gradually narrowed, acuminate. Base narrowly pointed, decurrent. Petiole very stout, tapering upward, 1.75 centimeters in length. Midrib stout, curved. Secondaries numerous, thin, somewhat irregularly spaced, 2 to 6 millimeters apart, branching from the midrib at angles of about 40°, running with but slight curvature to the well-marked and nearly straight longitudinal vein which forms a mar-

ginal hem less than 0.5 millimeter from the margin. Texture coriaceous.

The present species is very close to some of the numerous forms which from time to time have been referred to *Eucalyptus geinitzi* (Heer) Heer. It is, however, distinct from that species, especially when compared with Heer's type or with the more typical American material. In general it is a smaller leaf, has a larger and longer petiole and an outline less inclined toward ovate, and is relatively much more produced apically. It is typically *Myrcia*-like in all of its characters and is readily distinguishable from the forms from the Tuscaloosa formation which have been referred to *Eucalyptus geinitzi* in this work. It is confined to the basal beds of the Eutaw formation in Hale County, Ala., and the Ripley formation in western Tennessee, and takes its name from the town of Havana, near which the leaf-bearing laminated clays of this formation outcrop. A single specimen collected by R. T. Hill in 1891 at the big cut on the Southern Railway east of Pocahontas, Tenn., and identified by Ward as *Eucalyptus attenuata* Newberry, proves to belong to this species.

Occurrence: Eutaw formation (basal beds), 2 miles south of Havana, Hale County, Ala. Ripley formation (McNairy sand member), Camden-Paris road, 13 miles northwest of Camden, Benton County; big cut 1½ miles west of Cypress, 2½ miles southwest of Selmer, McNairy County, Tenn.

Collections: U. S. National Museum.

Genus EUCALYPTUS L'Héritier.

Eucalyptus latifolia Hollick.

Eucalyptus latifolia Hollick, The Cretaceous flora of southern New York and New England, p. 97, pl. 36, figs. 1–5, 1906.

Berry, Torrey Bot. Club Bull., vol. 37, p. 26, 1910.

Leaves elongate-ovate in outline, tapering to a somewhat abruptly attenuated and more or less curved or flexuous tip. Base cuneate. Length about 15 centimeters. Maximum width, about halfway between the apex and the base, about 5 centimeters. Midrib stout, flexuous. Secondaries thin, numerous, diverging from the midrib at angles of 45° to 50°, nearly straight or flexuous, their tips joined by a marginal vein. Margins entire. Texture subcoriaceous.

These large leaves occur in the Magothy formation of Marthas Vineyard, Long Island, and Maryland. They are not uncommon at a single locality in the lower part of the Tuscaloosa formation. Their relation to *Eucalyptus* is extremely doubtful, but a change of generic reference is not considered advisable at the present time. According to long-established usage, therefore, this species and *Eucalyptus geinitzi* and *E. angusta* are referred to the genus *Eucalyptus*, although it seems more probable that they represent the genus *Myrcia* of this same family, or its ancestral stock.

Occurrence: Tuscaloosa formation, upper ravine on the Snow place, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Eucalyptus geinitzi (Heer) Heer.

Plate XXVIII, figure 8.

Myrtophyllum geinitzi Heer, Flora von Moletein in Mähren, p. 22, pl. 11, figs. 3, 4, 1872; Flora fossilis arctica, vol. 3, Abt. 2, p. 116, pl. 32, figs. 14–17, 1874.

Eucalyptus geinitzi (Heer) Heer, Flora fossilis arctica, vol. 6, Abt. 2, p. 93, pl. 19, fig. 1c; pl. 4, figs. 1, 13, 1885.

Engelhardt, Naturwiss. Gesell. Isis in Dresden Abh. 7, Jahrg. 1891, p. 102, 1892.

Lesquereux, The flora of the Dakota group, p. 138, pl. 37, fig. 20, 1892.

Newberry, The flora of the Amboy clays, p. 110, pl. 32, figs. 2, 12 (not figs. 15, 16), 1896.

Hollick, New York Acad. Sci. Ann., vol. 11, p. 60, pl. 4, figs. 1–3, 1898; The Cretaceous flora of southern New York and New England, p. 96, pl. 35, figs. 1–8, 10–12, 1906.

Berry, New York Bot. Garden Bull., vol. 3, p. 87, pl. 53, fig. 3, 1903; Torrey Bot. Club Bull., vol. 31, p. 78, pl. 4, fig. 5, 1904; idem, vol. 33, p. 180, 1906; idem, vol. 34, p. 201, pl. 15, fig. 4, 1907; Johns Hopkins Univ. Circ. new ser., No. 7, p. 81, 1907; New Jersey Geol. Survey Bull. 3, p. 189, pl. 28, fig. 7, 1911.

Myrtophyllum warderi Lesquereux, The flora of the Dakota group, p. 136, pl. 53, fig. 10, 1892.

Hollick, The Cretaceous flora of southern New York and New England, p. 97, pl. 35, fig. 13, 1906.

Eucalyptus? angustifolia Newberry, The flora of the Amboy clays (not Desvaux, 1822), p. 111, pl. 32, figs. 1, 6, 7, 1896.

Hollick, New York Bot. Garden Bull., vol. 3, p. 408, pl. 70, figs. 8, 9, 1904; The Cretaceous flora of southern New York and New England, p. 95, pl. 35, figs. 9, 14, 15, 1906.

Berry, New Jersey Geol. Survey Bull. 3, pl. 28, fig. 5, 1911.

Leaves lanceolate in outline, broadest near the middle and tapering almost equally in both directions to the acute apex and base. There is considerable variation in size, the South Carolina leaves averaging about 15 centimeters in length by 2.2 centimeters in greatest width. The petiole is very stout, as is the prominent midrib, which leaves a sharp groove in impressions showing the lower surface. Secondaries numerous, thin, branching from the midrib at angles of about 45° and running with but a slight curvature to the marginal vein, which is either almost straight when the secondaries are close set or more or less bowed when the secondaries are some little distance apart, as they are in many specimens.

This species has a wide range. It was described originally from the Cenomanian of Moravia and has since been recorded from a number of other European Cenomanian localities, from the Atane beds of Greenland, the Dakota sandstone of the West, and from Marthas Vineyard to Alabama along the Atlantic coast. It ranges upward into the Black Creek formation of North Carolina and is not rare in the Middendorf arkose member of the Black Creek formation of South Carolina. In Alabama the species is not common, but this may simply be due to accidents of preservation.

Occurrence: Tuscaloosa formation, upper ravine and big gully on the Snow place, Tuscaloosa County; roadside southwest of Northport, Tuscaloosa County; near Maplesville, Chilton County, Ala.

Collection: U. S. National Museum.

Eucalyptus angusta Velenovsky.

Eucalyptus angusta Velenovsky, Die Flora der böhmischen Kreideformation, pt. 4, p. 3, pl. 3, figs. 2–12, 1885.
Berry, U. S. Geol. Survey Prof. Paper 84, p. 119, pl. 20, figs. 2–4, 1914.

This species was recently discussed by me for the eastern Gulf area in the paper cited.

It may well be doubted whether this and the preceding species are correctly referred to the genus *Eucalyptus*. Were it not for the havoc which would be wrought with the synonymy and the obscuring of their bearing on geographic distribution, I would refer these forms to the myrtaceous genus *Myrcia*, which is so abundant in the existing flora of tropical America and whose foliage is not distinguishable from the adult leaves of *Eucalyptus*. *Myrcia* is represented in the Eocene floras of the Mississippi embayment by several species, some of which are undoubtedly descended from these Upper Cretaceous species of so-called *Eucalyptus*.

Occurrence: Eutaw formation (basal beds), McBrides Ford, Chattahoochee County, Ga. Ripley formation (Cusseta sand member), near Buena Vista, Marion County, Ga.

Collection: U. S. National Museum.

Family COMBRETACEAE.

Genus CONOCARPITES Berry, n. gen.

Leaves of small or medium size, lanceolate to ovate-lanceolate, and more or less falcate in outline, of a coriaceous texture, and comparable in venation and all other features with those of the existing monotypic genus *Conocarpus* Linné of the strand flora of tropical Africa and America.

Conocarpites formosus Berry, n. sp.

Plate XXVIII, figure 9.

Leaves of medium size, about 7 centimeters in length by 2.5 centimeters in maximum width, which is halfway between the apex and the base. Outline ovate-lanceolate, slightly falcate, but the leaf is practically equilateral. Apex and base about equally acuminate. Petiole short and stout. Midrib stout, curved. Secondaries thin and for the most part immersed, five or six pairs, branching from the midrib at angles of more than 45°, curving upward, at length camptodrome. Tertiaries immersed. Texture coriaceous, the surface of the fossil form with the identical, somewhat granular appearance of the leaves in herbarium material of *Conocarpus erectus*.

This species, in its venation, texture, and outline, is very close to the larger leaves of the single recent species of *Conocarpus*.

The single recent species is widespread along low muddy or sandy tropical shores in Central and South America, and on the west coast of Africa (Guinea and Senegambia). It is said to occur in the Galapagos Islands on the Pacific coast of South America, and it extends northward from the West Indies to the Florida Keys and to Bermuda, where it is found on the

sand dunes. Its distribution is effected almost entirely through the agency of ocean currents. Not only is it a member of the ecologically specialized mangrove associations, but it is equally at home on sandy strand and dunes.

The genus *Conocarpus* has been detected by the writer in the undescribed Eocene flora of the Wilcox group of the Mississippi embayment area, and a typical species has been described from the Jackson group of the Eocene deposits of Georgia.[1] Though it is unknown in European Tertiary deposits it is represented in that area by very similar leaves which are referred to the allied genus *Eugenia*.

Occurrence: Tuscaloosa formation, Glen Allen, Fayette County, Ala. (collector, E. W. Berry).

Collection: U. S. National Museum.

Order UMBELLALES.

Family ARALIACEAE.

Genus ARALIA Linné.

Aralia cottondalensis Berry, n. sp.

Plate XXVI, figures 1–3.

Aralia wellingtoniana Ward, in Smith, On the geology of the Coastal Plain of Alabama, p. 348, 1894 (not Lesquereux).

Leaves of medium size, trilobate, ranging from 7 to 13 centimeters in length, by 6.5 to 11 centimeters in maximum width, from tip to tip of the lateral lobes. Tips acute. Base broadly cuneate or rounded. Lobes conical, pointed, directed upward; the median the larger. Sinuses narrow, rounded, reaching about halfway to the base. Margins entire below, above somewhat irregularly crenate, approaching serrate in some specimens. Primaries three in number, from a point at or very near the extreme base, the laterals diverging from the midrib at angles of about 25°, running to the tips of the lobes. Secondaries numerous, thin, approximately parallel, craspedodrome.

This species, which was confused by Ward with *Aralia wellingtoniana* Lesquereux, is common at the Cottondale locality, although most of the specimens are more or less fragmentary. It may be distinguished from this well-known species by the shorter, more conical lobes, the rounded instead of the conspicuously decurrent base, and the different character of the marginal teeth. It resembles somewhat *Aralia looziana* Saporta and Marion, a European lower Eocene species recorded by Ward in the Fort Union formation of the West.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Aralia eutawensis Berry.

Aralia eutawensis Berry, U. S. Geol. Survey Prof. Paper 84, p. 119, pl. 20, fig. 7, 1914.

This species was recently described by me from the eastern Gulf area in the paper cited, and the discussion need not be repeated here.

Occurrence: Eutaw formation (basal beds), McBrides Ford, Chattahoochee County, Ga.

Collection: U. S. National Museum.

Genus PANAX Linné.

Panax cretacea Heer.

Plate XXVI, figures 4, 5.

Panax cretacea Heer, Flora fossilis arctica, vol. 3, Abt. 2, p. 114, pl. 32, figs. 9, 9b, 9c, 9d, 10, 1874.
Hollick, The Cretaceous flora of southern New York and New England, p. 100, pl. 38, fig. 7, 1906.

Heer's original description, published in 1874, is as follows:

P. fructibus bicarpellaribus, acheniis complanatis, rotundatis, subtilissime regulosis.

This little fruit was described by Heer from rather well preserved material collected in the Atane beds of western Greenland. A single specimen of a form that appears to be identical with the Greenland material was recently described by Hollick, from the Magothy formation of Gay Head, Marthas Vineyard. The species is also represented by a single specimen in the lower part of the Tuscaloosa formation. It is broadly obcordate in outline and is 5 millimeters in total height by 6.5 millimeters in width.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

[1] Berry, E. W., U. S. Geol. Survey Prof. Paper 84, p. 147, pl. 29, figs. 4–7, 1914.

Family CORNACEAE.

Genus NYSSA Linné.

Nyssa snowiana Lesquereux.

Plate XXVI, figure 6.

Nyssa snowiana Lesquereux, The flora of the Dakota group, p. 126, pl. 52, fig. 11, 1892.

Leaves of relatively small size for this genus, broadly ovate in outline, abruptly contracted to a short acuminate tip, cuneate and finally slightly decurrent to the short, stout petiole. Length 5.5 centimeters. Greatest width, which is about halfway between the apex and the base, 3.3 centimeters. Petiole 6 millimeters long. Margins entire. Midrib rather stout, curved. Secondaries six to nine subopposite pairs branching from the midrib at angles of about 45° and sweeping upward in broad, gentle curves, camptodrome, as are their tertiary branches in the marginal part of the leaf.

This material from Alabama is clearly identical with that described by Lesquereux from the Dakota sandstone of Kansas, the type of which is in the collection of the University of Kansas (No. 935). These leaves in all of their characters are clearly referable to the Cornaceae and are associated with striated fruits which have been named *Nyssidium*. One other Cretaceous species has been described by Newberry from the Dakota sandstone. Throughout the Tertiary *Nyssa* is represented by a variety of species widely distributed and extending to Alaska on the one hand and Spitzbergen on the other. These occurrences are based for the most part upon characteristic fruits. There are a number of European species, some of which persist as late as the Pliocene, although the genus is not represented in the existing flora of Europe. In North America the genus has always been well represented, the Tertiary lignites of Vermont in particular containing an extraordinary variety of fruits of this genus. In existing floras *Nyssa* is confined to the eastern United States, with five species, and southern Asia with two species. A number of these species occur in small areas, and all are mesophytic types, the majority being confined to low swamps, and to estuary, river, and pond margins, mostly near the coast, the center of distribution of the American species being Georgia.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Genus CORNOPHYLLUM Newberry.

[U. S. Geol. Survey Mon. 26, p. 119, 1896.]

Cornophyllum vetustum Newberry.

Cornophyllum vetustum Newberry, The flora of the Amboy clays, p. 119, pl. 19, fig. 10, 1896.
Berry, New Jersey Geol. Survey Bull. 3, p. 196, 1911.

Leaves elliptical in outline, 7 to 8 centimeters in length by about 4 centimeters in maximum width, with an acute apex and base, the latter slightly decurrent and inequilateral. Margin entire, very slightly and inconspicuously undulate. Midrib slender and straight. Secondaries slender, about seven pairs, opposite or alternate, branching from the midrib at angles of about 45° and strongly curved upward, approximately parallel and camptodrome; they increase in length from the apex to the base, the lower ones sweeping upward in strong arches parallel with the margin and all drawn inward toward the apex.

With the exception of the delicate and somewhat flexuous character of the venation, these leaves are strictly comparable with those of *Cornus*, good species of which, very similar to this species, occur in the Dakota sandstone of the West, in Greenland, and in the Magothy formation of Maryland. Doubtless the Raritan species will eventually be referred to that genus, but meanwhile the present generic appellation is a sufficient index to its relationship.

This species is rather rare, both in New Jersey and Alabama and, as indicated above, serves to ally them with somewhat younger formations.

Occurrence: Tuscaloosa formation, Glen Allen, Fayette County, Ala.

Collections: U. S. National Museum (type from New Jersey in New York Botanical Garden).

Cornophyllum obtusatum Berry, n. sp.

Plate XXVI, figures 7, 8.

Leaves of medium, or large size, elliptical or obovate in general outline, with a broadly rounded apex and a cuneate or slightly decurrent base. Length ranges from 5.5 to 10 centimeters. Maximum width ranges from 3.3 to 5 centimeters, halfway between the apex and the base. Margin entire, slightly repand in places. Petiole short and stout. Midrib stout and flexuous. Secondaries thin, five or six pairs branching from the midrib at angles of

45° or less, usually less, and sweeping upward in long, more or less flexuous curves, approximately parallel with the lateral margins, eventually camptodrome, distinctly of the type usually associated with *Cornus*, *Rhamnus*, or *Berchemia*.

This new species is clearly allied with *Cornus*, the principal difference being that of outline and irregularity of venation. It differs from the only other known species of *Cornophyllum*, that from the Raritan formation of New Jersey, in its obtuse apex. Outside the lower part of the Tuscaloosa formation it is sparingly represented in the Black Creek formation of North Carolina.

Occurrence: Tuscaloosa formation, Cottondale, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Order ERICALES?

Family ERICACEAE?

Genus ANDROMEDA Linné.

Andromeda novaecaesareae Hollick.

Plate XXX, figures 1, 2.

Andromeda novaecaesareae Hollick, in Newberry, The flora of the Amboy clays, p. 121, pl. 42, figs. 9–12, 28–31, 1896.

Smith, On the geology of the Coastal Plain of Alabama, p. 348, 1894.

Berry, Torrey Bot. Club Bull., vol. 33, p. 181, 1906, idem, vol. 34, p. 204, 1907; idem, vol. 43, p. 301; 1916; New Jersey Geol. Survey Bull. 3, p. 204, pl. 25; fig. 6, 1911.

Leaves small, thick, and entire, with stout petioles and midribs and obscure secondary venation which is immersed in the thick lamina. Length 2.5 to 5 centimeters. Width varying from 0.9 centimeter to 1.3 centimeters. Venation, where visible, showing numerous parallel, camptodrome, relatively long and thin secondaries which branch from the midrib at acute angles. Though the majority of these leaves are equally acuminate at both ends there is considerable variation in this respect, and a well-marked tendency is shown in many specimens which are relatively broader, especially in the upper half, toward an obtusely rounded apex, the termination of the midrib showing as a small mucronate point. The base in these forms gradually narrows to the stout petiole. The variations in outline of this species are well shown in the figures reproduced in Newberry's monograph. The specimens collected from the South Atlantic Coastal Plain seem to have an obtusely rounded apex more commonly than those from New Jersey.

In the Raritan formation this species is only known with certainty from the uppermost beds at South Amboy, N. J. It becomes more abundant in the overlying Magothy formation, occurring from New Jersey to Maryland in beds of this age. Farther south it is found as one of the typical fossils of the Black Creek formation in North Carolina, being a prominent but never abundant element in the dark lignitic laminated clays of the upper beds associated with *Araucaria*, *Cunninghamites*, *Pistia*, and other forms and a marine fauna.

It occurs in the Middendorf arkose member of the Black Creek formation of South Carolina and is also present in Georgia. It has not been observed to be common in the Tuscaloosa formation, being only known from beds near the base. However, the abundance of this species at somewhat higher horizons in Georgia and Tennessee would indicate that its rarity in the Tuscaloosa deposits may be more apparent than real.

It may well be questioned whether this and the following species of *Andromeda* should be referred to the Ericales. Certainly the present form has numerous points of contact with the leaves of *Eugenia*, which has been positively recognized in the lower Eocene floras of this general region and doubtfully from both the Tuscaloosa and Ripley formations.

Occurrence: Tuscaloosa formation, Shirleys Mill and Glen Allen (Ward's determination), Fayette County; big gully on the Snow place, Tuscaloosa County, Ala. Ripley formation (Cusseta sand member), near Buena Vista, Marion County, Ga. Eutaw formation (Coffee sand member), Coffee Bluff, Hardin County, Tenn.

Collections: U. S. National Museum.

Andromeda grandifolia Berry.

Plate XXVII, figure 7.

Andromeda grandifolia Berry, Torrey, Bot. Club Bull., vol. 34, p. 204, pl. 15, fig. 3, 1907; New Jersey Geol. Survey Bull. 3, p. 205, pl. 26, figs. 1, 2, 1911.

Andromeda latifolia Newberry, The flora of the Amboy clays, p. 120, pl. 33, figs. 6–8, 10 (not fig. 9); pl. 34, figs. 6–11, pl. 34, fig. 10, 1896 (not Wright).

Smith, On the geology of the Coastal Plain of Alabama, p. 348, 1894.

Hollick, New York Bot. Garden Bull., vol. 3, p. 416, pl. 79, fig. 3, 1904; The Cretaceous flora of southern New York and New England, p. 100, pl. 39, fig. 1, 1906.

Leaves thick and coriaceous, varying considerably in size and shape. From 4 to 20 centimeters in length, by 1.5 to 7 centimeters in width. Ovate-lanceolate in outline with an entire, usually somewhat undulate or unsymmetric margin. Apex obtusely pointed or in some specimens rounded. Base somewhat wedge-shaped. Midrib and petiole very stout. Secondaries relatively few, 6 to 8 pairs, stout and flexuous, branching from the midrib at acute angles and sweeping upward in long curves, eventually inosculating to complete the strictly camptodrome venation.

This species occurs from the lower part of the Raritan formation of New Jersey to the top of the eastern leaf-bearing Cretaceous. It is a common fossil in the Magothy formation, the Black Creek formation of North Carolina, and the Tuscaloosa formation of Alabama. It is larger, relatively broader, and less regular than *Andromeda parlatorii* Heer.

Occurrence: Tuscaloosa formation, Shirleys Mill and Glen Allen, upper ravine on the Snow place, Fayette County; university grounds, Tuscaloosa, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Andromeda parlatorii Heer.

Andromeda parlatorii Heer, Phyllites crétacées du Nebraska, p. 18, pl. 1, fig. 5, 1866; Flora fossilis arctica, vol. 3, Abt. 2, p. 112, pl. 32, figs. 1, 2, 1874; idem, vol. 6, p. 79, pl. 21, figs. 1b, 11; pl. 42, fig. 4c, 1882.

Lesquereux, The Cretaceous flora, p. 88, pl. 23, figs. 6, 7; pl. 28, fig. 15, 1874; The flora of the Dakota group, p. 115, pl. 19, fig. 1; pl. 42, fig. 6, 1892.

Newberry, The flora of the Amboy clays, p. 120, pl. 31, figs. 1–7; pl. 33, figs. 1, 2, 4, 5, 1896.

Smith, On the geology of the Coastal Plain of Alabama, p. 348, 1894.

Hollick, New York Acad. Sci. Ann., vol. 11, p. 420, pl. 37, figs. 1–4, 1898; The Cretaceous flora of southern New York and New England, p. 101, pl. 39, figs. 2–5, 1906.

Berry, New York Bot. Garden Bull., vol. 3, p. 97, pl. 1, figs. 1–4, 1903; Torrey Bot. Club Bull., vol. 31, p. 79, pl. 1, figs. 1, 2, 1904; idem, vol. 33, p. 181, 1906; idem, vol. 34, p. 203, pl. 15, fig. 2, 1907; Johns Hopkins Univ. Circ., new ser., No. 7, p. 81, 1907; New Jersey Geol. Survey Bull. 3, p. 206, pl. 27, figs. 1–4, 1911.

Prunus? parlatorii (Heer) Lesquereux, Am. Jour. Sci., 4th ser., vol. 36, p. 102, 1868.

Leucothoe parlatorii (Heer) Schimper, Paléontologie végétale, vol. 3, p. 11, 1874.

Leaves ovate-lanceolate in outline, with a long and gradually narrowed apex, and a broad, somewhat rounded but finally cuneate or slightly decurrent base. Petiole and midrib stout. Length about 10 to 12 centimeters. Maximum width about 3 centimeters in the lower half of the leaf. Secondaries numerous, rather thin, subparallel, branching from the midrib at acute angles, long and ascending, at length camptodrome. Tertiaries mostly straight, transverse. There is considerable variation in the size of these leaves and in the angles which the secondaries form with the midrib, and consequently in their length and degree of curvature. Some of the specimens approach closely in appearance to the small leaves of *Andromeda grandifolia* Berry, which are more slender and apically attenuated than the normal-sized leaves of that species.

This species was first described by Prof. Heer in one of the earliest published accounts of the Dakota sandstone flora, and it has since been found to have a wide geographic range. It is one of the commonest fossils in the Dakota sandstone, having been recorded from Minnesota, Kansas, and Nebraska. In eastern North America it is recorded from the Atane beds of Greenland, the Magothy formation on Marthas Vineyard, the Raritan formation of New Jersey, the Magothy formation of New Jersey, Delaware, and Maryland, the Black Creek formation of North Carolina, and the Middendorf arkose member of the Black Creek formation of South Carolina. In Alabama it is common in the Tuscaloosa formation and extends into the lower beds of the Eutaw formation in Hale County.

The genus *Andromeda* of Linné has been much segregated by the subsequent taxon-

omists, and this is reflected in Schimper's proposal to refer this species to the genus *Leucothoe*. However, the more comprehensive name has obvious advantages for the paleobotanists in dealing with material where it is impossible to discriminate between the ericaceous genera with any degree of accuracy.

Occurrence: Tuscaloosa formation, Glen Allen and Shirleys Mill, Fayette County; university grounds, upper ravine and big gully on the Snow place, Cottondale, and gully at Tuscaloosa County, Ala. Eutaw formation (basal beds), 2 miles south of Havana, Hale County, Ala.

Collection: U. S. National Museum.

Andromeda wardiana Lesquereux.

Plate XXVII, figure 6.

Andromeda wardiana Lesquereux, The flora of the Dakota group, p. 119, pl. 64, fig. 17, 1892.
Berry, U. S. Geol. Survey Prof. Paper 84, p. 120, pl. 24, fig. 3, 1914.

Leaf narrowly elliptical in outline, with an entire margin. Apex and base about equally narrowed, the former bluntly rounded. Size somewhat variable. Length 4.7 to 6.5 centimeters. Maximum width 2 to 2.5 centimeters about halfway between the apex and the base. Midrib thin but prominent. Secondaries thin, five or six subparallel pairs diverging from the midrib at angles of about 40°, ascending, eventually camptodrome.

The type of this species came from the Dakota sandstone of Ellsworth County, Kans., and constituted the only known occurrence until a few years ago, when I collected it at the base of the Eutaw formation in western Georgia. The present occurrences are from the basal part of the Tuscaloosa formation near Shirleys Mill, Ala., and from a horizon in northeastern Mississippi which is nearly equivalent to the one in Georgia.

Occurrence: Tuscaloosa formation, cut on Southern Railway 1⅝ miles east of Iuka, Tishomingo County, Miss. (collected by L. W. Stephenson); Shirleys Mill, Fayette County, Ala. (collected by E. W. Berry). Eutaw formation (basal beds), McBrides Ford, Chattahoochee County, Ga.; (Coffee sand member), Coffee Bluff, Hardin County, Tenn.

Collection: U. S. National Museum.

Andromeda cretacea Lesquereux (?).

Andromeda cretacea Lesquereux, The flora of the Dakota group, p. 117, pl. 17, figs, 17, 18; pl. 24, fig. 5, 1892.
Berry, U. S. Geol. Survey Prof. Paper 84, p. 120, pl. 24, fig. 2, 1914.

The probable occurrence of this species in the eastern Gulf area was recently discussed by me in the paper cited above and need not be repeated here.

Occurrence: Eutaw formation (basal beds), McBrides Ford, Chattahoochee County, Ga.

Collection: U. S. National Museum.

Genus DERMATOPHYLLITES Goeppert.

Dermatophyllites acutus Heer.

Plate XXVII, figure 8.

Dermatophyllites acutus Heer, Flora fossilis arctica, vol. 6, pt. 2, p. 80, pl. 42, fig. 7, 1882.

Heer's description of this species, published in 1882, is as follows:

D. foliis minutis, coriaceis, anguste lanceolatis, apice acute acuminatis, basim versus attenuatis, integerrimis, nervo medio valido, nervis secundariis nullis.

Heer referred this tiny leaf, along with another species from the same horizon, to the genus *Dermatophyllites*, established by Goeppert for several Tertiary species of Ericaceae. Heer's species certainly occurs in the Tuscaloosa formation, showing that it had a very extensive latitudinal range. The indicated botanic affinity is entirely problematic, so that the name stands as given by the original describer.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Genus KALMIA Linné (?).

Kalmia brittoniana Hollick.

Kalmia brittoniana Hollick, New York Acad. Sci. Trans., vol. 12, p. 34, pl. 2, figs. 6–8, 1892; The Cretaceous flora of southern New York and New England, p. 100, pl. 39, figs. 8, 9, 1906.
Berry, Torrey Bot. Club Bull., vol. 34, p. 204, 1907.

Leaves of small size, petiolate, oblong-elliptical in general outline, with a rounded apex and a cuneate base. Length about 2.75 centimeters. Maximum width 6 or 7 millimeters in the middle part. Midrib prominent. Secondaries obsolete. Texture coriaceous.

This small-leafed species was described by Hollick from the Raritan formation on Staten

Island and subsequently recorded by me from the Black Creek formation of North Carolina. I do not believe that there is any foundation for its reference to the genus *Kalmia* or even to the Ericaceae. It probably represents some Upper Cretaceous species of Proteaceae or Myrtaceae.

Remains identical with the type are present in the Tuscaloosa formation.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Order PRIMULALES.

Family MYRSINACEAE.

Genus MYRSINE Linné.

Myrsine gaudini (Lesquereux) Berry.

Myrsinites? gaudini Lesquereux, The flora of the Dakota group, p. 115, pl. 52, fig. 4, 1892.

Myrsine gaudini (Lesquereux) Berry, Torrey Bot. Club Bull., vol. 36, p. 262, 1909; New Jersey Geol. Survey Bull. 3, p. 210, pl. 24, figs. 3, 4, 1911.

Myrsine elongata Newberry, MSS. Hollick, Torrey Bot. Club Bull., vol. 21, p. 54, pl. 177, fig. 2, 1894; New York Acad. Sci. Ann., vol. 11, p. 420, pl. 38, figs. 3, 4b, c, 1898; The Cretaceous flora of southern New York and New England, p. 102, pl. 8, fig. 1b; pl. 39, figs. 13, 14, 1906.

Newberry, The flora of the Amboy clays, p. 122, pl. 22, figs. 1–3, 1896.

Leaves oblanceolate or elongate-obovate in outline, 5.5 to 7 centimeters in length by 1.9 to 2.5 centimeters in greatest width. Margins entire. Apex obtusely rounded. Base somewhat elongated, narrowly cuneate. Petiole present, stout. Midrib stout below, diminishing in caliber in a short distance. Secondaries numerous, 8 to 10 pairs, alternate, branching from the midrib at angles of 40° to 45°, camptodrome. When tertiary venation is distinctly preserved, the venation is more typical of the genus than when only the secondaries are partly visible. This species is well distributed in the Raritan formation of New Jersey and has been recorded also from Long Island and Staten Island. The identification of *Myrsinites? gaudini* Lesquereux, with the eastern forms with which it is obviously identical, extends the range eastward from Kansas to Long Island. It may be readily distinguished from the other species of *Myrsine* by its relatively narrow, elongated form. It is present in the Black Creek formation of North Carolina and in the Middendorf arkose member of that formation in South Carolina. It is not abundant in the Alabama Cretaceous and is only present in the basal beds of the Tuscaloosa formation in western Alabama.

Occurrence: Tuscaloosa formation, roadside southwest of Northport, Cottondale, Tuscaloosa County; Glen Allen, Fayette County, Ala.

Collection: U. S. National Museum.

Myrsine borealis Heer.

Myrsine borealis Heer, Flora fossilis arctica, vol. 3, Abt. 2, p. 113, pl. 32, fig. 23, 1874; idem, vol. 6, Abt. 2, p. 81, pl. 24, figs. 7b, 8; pl. 27, fig. 1b; pl. 44, fig. 5a; pl. 46, figs. 19, 20, 1882.

White, Am. Jour. Sci., 3d ser., vol. 39, p. 98, pl. 2, fig. 5, 1890.

Smith, On the geology of the Coastal Plain of Alabama, p. 348, 1894.

Newberry, The flora of the Amboy clays, p. 122, pl. 24, figs. 4–6, 1896.

Hollick, Geol. Soc. America Bull., vol. 7, p. 13, 1895; The Cretaceous flora of southern New York and New England, p. 102, pl. 39, figs. 10, 11, 1906.

Berry, New Jersey Geol. Survey Bull. 3, p. 208, pl. 24, fig. 2, 1911.

Diospyros rotundifolia Lesquereux. Hollick, Torrey Bot. Club Bull., vol. 21, p. 53, pl. 179, fig. 2, 1894.

Heer's original description of this species, published in 1874, is as follows:

M. foliis ovatis (?), integerrimis, nervis secundariis numerosis, approximatis, ramosis, camptodromis.

Leaves ovate-elliptical in outline, obtusely rounded above and slightly cuneate below, 2.5 to 5 centimeters in length by 1.2 to 3 centimeters in maximum width, with a stout petiole about 1 centimeter in length. Margins entire. Texture coriaceous, more or less obscuring the venation. Midrib stout. Secondaries rather stout, five to eight alternate pairs, parallel, branching from the midrib at acute angles, camptodrome. Tertiaries fine, forming an inosculating series of elongated meshes, more or less parallel with the secondaries. In specimens in which the tertiary venation is visible the appearance is very different from that shown in Newberry's figures, where only the secondaries are seen. Newberry's specimens may be compared with the similarly preserved leaves from Greenland, figured by Heer.[1]

This species was described originally from the Atane beds of Greenland by Heer and was

[1] Heer, Oswald, Flora fossilis arctica, vol. 6, pl. 24, fig. 8; pl. 44, fig. 5a, 1882

subsequently collected in considerable abundance from the Raritan formation in New Jersey. It has also been recorded from Marthas Vineyard and Long Island, and from the Black Creek formation in North Carolina. In Alabama, so far as known, it is confined to the lower part of the Tuscaloosa formation of Fayette County, where it is not especially common.

Occurrence: Tuscaloosa formation, Shirleys Mill, Glen Allen, Fayette County; big gully on the Snow place, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Order EBENALES.

Family EBENACEAE.

Genus DIOSPYROS Linné.

Diospyros primaeva Heer.

Plate XXX, figure 3.

Diospyros primaeva Heer, Phyllites crétacées du Nebraska, p. 19, pl. 1, figs. 6, 7, 1866; Flora fossilis arctica, vol. 6, Abt. 2, p. 80, pl. 18, fig. 11, 1882; idem, vol. 7, p. 31, pl. 51, figs. 5a, b, c, 1883.
Englehardt, Naturwiss. Gesell. Isis in Dresden Abh. 7, Jahrg. 1891, p. 98, 1892.
Lesquereux, The flora of the Dakota group, p. 109, pl. 20, figs. 1–3, 1892.
Smith, On the geology of the Coastal Plain of Alabama, p. 348, 1894.
Newberry, The flora of the Amboy clays, p. 124, pl. 30, figs. 1–5, 1896.
Knowlton U. S. Geol. Survey Twenty-first Ann. Rept., pt. 7, p. 317, pl. 39, fig. 3, 1901.
Berry, Torrey Bot. Club Bull., vol 32, p. 46, pl. 2, 1905; idem, vol. 34, p. 204, 1907; idem, vol. 38, p. 417, 1911; New Jersey Geol. Survey Bull. 3, p. 211, pl. 29, fig. 1, 1911.
Hollick, The Cretaceous flora of southern New York and New England, p. 103, pl. 42, figs. 2, 11, 1906.

Leaves oblong-ovate in outline, variable according to age, ranging from 3 to 15 centimeters in length, by 1.3 to 5 centimeters in greatest width, which is in the middle part of the leaf. Apex acute or obtuse. Base cuneate. Margins entire. Petiole rather long and very stout. Midrib also stout. Secondaries branching from the midrib, generally at acute angles, subopposite or alternate, parallel camptodrome. Tertiaries forming polygonal areoles whose relative prominence is one of the features of this species.

This species, which is quite suggestive of the modern *Diospyros virginiana* Linné, was described by Heer from the Dakota sandstone of Nebraska nearly half a century ago. It has proved to be a form of very wide range, having been identified at both the Atane and Patoot horizons in Greenland and from the Cenomanian of Niederschoena in Saxony; from various localities within the Dakota sandstone, including its southern extension, the Woodbine sand of Texas; and with the exception of the fragments from Marthas Vineyard and Long Island, which are of questionable identity, it is common in the Raritan and Magothy formations, or homotaxial equivalents, from New Jersey to Alabama.

Its most marked character is the prominence of its tertiary areolation. It is common at various localities in the lower part of the Tuscaloosa formation of western Alabama and continues upward into those beds in Hale County which have been placed in the basal portion of the Eutaw formation and into the Coffee sand member in Tennessee.

Occurrence: Tuscaloosa formation, Shirleys Mill and Glen Allen, Fayette County; Cottondale; gully at Tuscaloosa, Tuscaloosa County, Ala. Eutaw formation (basal beds), 2 miles south of Havana, Hale County, Ala.; (Coffee sand member), Coffee Bluff, Hardin County, Tenn.

Collection: U. S. National Museum.

Diospyros amboyensis Berry.

Plate XXVII, figure 5.

Phyllites ellipticus Newberry, The flora of the Amboy clays, p. 130, pl. 24, fig. 9, 1896.
Diospyros amboyensis Berry, Torrey Bot. Club Bull., vol. 36, p. 262, 1909; New Jersey Geol. Survey Bull. 3, p. 212, pl. 29, fig. 5, 1911.

Leaves elliptical in outline, large, 8 to 9 centimeters long by 4.6 to 5 centimeters wide; margin more or less undulate; apex slightly narrowed, rounded, almost retuse; base broadly rounded, thus differing from the wedge-shaped base of *Diospyros primaeva* Heer; midrib strong, although not so strong as in *D. primaeva;* secondaries thin, numerous, 8 to 10 pairs, regular, leaving the midrib at an angle of about 45°, camptodrome; tertiary venation of large polygonal meshes, finer in caliber than in *D. primaeva.*

The type was a single specimen from the Raritan formation at Woodbridge, N. J. Similar remains are sparingly represented in

the collections from the basal beds of the Tuscaloosa formation. One of the leaves which Heer identifies from Atane schists of Greenland as *Populus hyperborea*,[1] though the apex is partly destroyed and the tertiaries are not shown, is very similar to the species under discussion. This similarity does not extend, however, to the other leaves identified as this species.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Diospyros rotundifolia Lesquereux.

Plate XXVII, figure 4; Plate XXX, figures 4, 5.

Diospyros rotundifolia Lesquereux, The Cretaceous flora, p. 89, pl. 30, fig. 1, 1874; The flora of the Dakota group, p. 112, pl. 17, figs. 8–11, 1892.

Berry, New Jersey Geol. Survey Ann. Rept. for 1905, p. 139, 1906; Torrey Bot. Club Bull., vol. 33, p. 181, 1906.

Leaves entire, variable in size, 4 to 10 centimeters in length, by 2 to 7 centimeters in maximum width, which is in the middle part. Outline broadly oval or elliptical. Apex broadly rounded. Base similarly rounded or somewhat narrowed and pointed. Petiole and midrib stout. Secondaries 6 or 7 pairs, branching from the midrib at angles of 50° to 60°, arched, camptodrome. Texture subcoriaceous. Venation less prominent than in *Diospyros primaeva* Heer.

This species is a characteristic element in the post-Raritan flora of the Atlantic Coastal Plain, although at times it is liable to be confused with *Myrsine borealis* Heer, or with some of the smaller, more orbicular, entire leaves of *Populus*. The venation is markedly different, however.

Diospyros rotundifolia was described originally from the Dakota sandstone of Kansas, and it is common in the Magothy formation in New Jersey, Delaware, and Maryland. In South Carolina it has only been found at a single locality in the Middendorf arkose member of the Black Creek formation. It is not rare in the lower part of the Tuscaloosa formation of western Alabama.

Occurrence: Tuscaloosa formation, Shirleys Mill, Glen Allen, Fayette County, Ala.

Collections: U. S. National Museum.

[1] Heer, Oswald, Flora fossilis arctica, vol. 3, Abt. 2, pl. 29, figs. 6, 18, 1874.

Family SAPOTACEAE.

Genus SAPOTACITES Ettingshausen.

Sapotacites ettingshauseni Berry, n. sp.

Plate XXIX, figure 7.

Leaves inversely triangular in general outline with a broad, slightly emarginate apex, rounded at the outer angles, and a cuneate base, about 4 centimeters in length by 4 to 5 centimeters in maximum width, which is at or above the middle. The margins are entire, straight below and full above, the apical margin slightly undulate and somewhat emarginate at apex of the midrib. Texture somewhat coriaceous. Petiole short or wanting. Midrib stout. Secondaries thin, three or four opposite or subopposite pairs. They branch from the midrib at angles of about 45° and pursue a slightly curved course almost to the margin, where they curve upward to join a lateral branch of the secondary next above. Tertiaries fine, arched along the margins; internally they are mostly transverse, forming somewhat irregular rectangular areoles.

This species is named in honor of the late Baron von Ettingshausen, who founded this genus in 1853 for those fossil leaves which are referable to the family Sapotaceae but which it is impossible to assign definitely to any of the existing genera. Perhaps a score of such species have been described. These range in age from the mid-Cretaceous of Europe and America through the Tertiary. The present species somewhat resembles certain genera of the Leguminosae, for example *Colutea* and *Amicia*. It is also much like the East Indian species *Mimusops obovata*.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Sapotacites shirleyensis Berry, n. sp.

Plate XXVIII, figure 11; Plate XXIX, figures 4–6.

Leaves rather small in size, elliptical in general outline, with a deeply emarginate apex and slightly decurrent base. Length 3.3 centimeters along the midrib, 4 centimeters from a line connecting the tips of lateral wings to the base, about 3 centimeters or slightly less in maximum width, which is about midway between the apex and the base. Margin entire, full and rounded, the apical lateral angles

directed upward and rounded. Apical sinus extending one-fifth to one-sixth of the distance to the base, its margins nearly straight, forming an angle of about 65°. Petiole short or wanting. Midrib stout. Secondaries thin, two or three alternate pairs, branching from the midrib at angles of about 45° and curving upward parallel with the lateral margin, eventually camptodrome. Tertiaries thin, arched along the margins and forming rectangular meshes internally. These are more regular and smaller than in *Sapotacites ettingshauseni*.

The present species, though different in general appearance, is close to *Sapotacites ettingshauseni*, differing in the elliptical instead of triangular outline, the full margins, rounded base, deep apical sinus, and alternate curved secondaries, features which would be largely duplicated if the tips in that species were directed upward instead of outward and brought toward each other in the line of the midrib. The present species resembles somewhat various described fossil species which have been referred to the genus *Colutea*, more especially *Colutea protogaea* Heer of the Greenland Cretaceous. However, the two species are believed to be perfectly distinct. I consider it undoubtedly ancestral to a common form of the lower Eocene of the Mississippi embayment area, which I have described in manuscript as a species of *Bumelia*.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Sapotacites formosus Berry, n. sp.

Plate XXX, figure 6.

Leaves of medium size, broadly elliptical in general outline, with a broadly rounded or slightly retuse apex, and a broad more or less decurrent base. Length about 4.75 centimeters. Maximum width, in the middle part of the leaf, about 3.25 centimeters. Margins entire, evenly rounded. Leaf substance thick and coriaceous. Petiole short and stout. Midrib very stout, especially proximad, somewhat flexuous. Secondaries stout, five or six alternate, irregularly spaced pairs; they diverge from the midrib at wide angles, between 60° and 65°, and are camptodrome in the marginal region. This species, which is clearly allied to various modern species of Sapotaceae, especially of the genera *Bumelia* and *Mimusops*, is much like the forms from the Dakota sandstone, *Sapotacites haydenii* Heer [1] and *Phyllites obcordatus* Heer.[2] The latter is described by Lesquereux as *Bumelia marcouana*;[3] it is most like the present species but is broader toward the apex and more narrowed toward the base, with thinner venation and texture and more retuse apex. *Sapotacites formosus* is very similar to the Raritan species, *Populus orbicularis* (Newberry) Berry,[4] and is also much like several lower Eocene species collected in the embayment area, which will be described by the writer as species of *Bumelia* and *Mimusops* in a subsequent publication. Some of these are unquestionably descended from the *Sapotacites formosus*.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Order GENTIANALES.

Family ASCLEPIADACEAE.

Genus ACERATES Nilsson.

Acerates amboyensis Berry.

Acerates amboyensis Berry, Torrey Bot. Club Bull., vol. 36, p. 263, 1909; New Jersey Geol. Survey Bull. 3, p. 214, 1911.

Acerates sp. Hollick, in Newberry, The flora of the Amboy clays, p. 124, pl. 32, fig. 17; pl. 41, figs. 4, 5, 1896.

Leaves narrow and elongated, somewhat falcate, lanceolate or linear-lanceolate, 5 to 7.5 centimeters in length by 5 to 8 millimeters in maximum width, gradually narrowed above and cuneate below. Margins entire, somewhat undulate. Petiole apparently wanting. Texture thick. Secondaries numerous, rather angular, branching from the midrib at acute angles, camptodrome.

This well-marked species was described by Newberry from the upper part of the Raritan formation of New Jersey, and I have detected it in the Black Creek formation of North Carolina, and several species of *Acerates* have been described by Prof. Heer from the Cretaceous deposits of western Greenland.

Though not common, unmistakable remains of this species, clearly allied to the modern

[1] Newberry, J. S., The later extinct floras of North America: U. S. Geol. Survey Mon. 35, p. 126, pl. 5, fig. 1, 1898.

[2] Idem, p. 136, pl. 5, fig. 2.

[3] Lesquereux, Leo, The Cretaceous flora, p. 90, pl. 28, fig. 2, 1874.

[4] Berry, E. W., New Jersey Geol. Survey Bull. 3, p. 112, pl. 11, figs. 5, 6, 1911.

representatives of this genus, are present in western Alabama.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County; Sanders Ferry Bluff, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

Order POLEMONIALES.

Family BORRAGINACEAE.

Genus CORDIA Linné.

Cordia apiculata (Hollick) Berry, n. comb.

Plate XXX, figures 7, 8.

Populus apiculata Hollick, New York Acad. Sci. Trans., vol. 12, p. 4, pl. 3, fig. 2, 1892; The Cretaceous flora of southern New York and New England, p. 49, pl. 7, figs. 28, 29, 1906 (?).

Smith, On the geology of the Coastal Plain of Alabama, p. 348, 1894.

Newberry, The flora of the Amboy clays, p. 65, pl. 15, figs. 3, 4, 1896.

Berry, Torrey Bot. Club Bull., vol. 33, p. 172, 1906; New Jersey Geol. Survey Bull. 3, p. 111, pl. 11, fig. 4, 1911.

Leaves variable in size and shape, ovate to orbicular in general outline, 5 to 10 centimeters in length by 3 to 7 centimeters in maximum width, which is at or below the middle. Apex usually somewhat abruptly produced into an acuminate tip. Base cuneate and slightly decurrent to rounded or almost truncate. Margins entire, in some specimens slightly repand. Petiole of medium length, stout. Midrib rather stout, commonly flexuous. Secondaries, 5 or 6 pairs, subopposite below, alternate above, slender, branching from the midrib at angles of 45° to 50° and arching upward, camptodrome. Tertiaries camptodrome in the marginal region, percurrent internally.

Newberry, the original describer of this species in manuscript, compared it with *Populus hyperborea* Heer and *P. berggreni* Heer but seemed doubtful of its real relation to *Populus*. This doubt seems to be well founded, for though these leaves are not unlike those usually referred to the genus *Populus*, this assumed relationship has by no means been proved for a number of the Upper Cretaceous forms so identified. Though it is not impossible that species of *Populus* may have flourished in the Gulf region during Tuscaloosa time, the association of a number of forms whose descendants are tropical led to an extended search among existing tropical American forms with the result that the present species is referred to the genus *Cordia*, which has more than 200 existing species of the Tropics, and warmer extratropical regions of both hemispheres, the majority being American and several reaching the Florida Keys, the Bahamas, and the valley of the Rio Grande. The fossil species in all its characters suggests most strongly the existing *Cordia sebestena* Linné which ranges from the Bahamas and Florida Keys to New Guinea in sandy soil not far from the coast. It also suggests *Cordia tremula* Grisebach of the West Indies, and there is a general generic likeness to other existing species of this genus. Leaves of the *Cordia* are variable and tend to have more or less toothed margins, as in some individuals of *Cordia sebestena*, but they are in general entire or slightly repand and like the fossil somewhat variable. *Cordia* is certainly represented in the lower Eocene flora of the Gulf region by forms that may be descendants of this Upper Cretaceous species. The present form has also been recorded from Staten Island and Long Island, from the Magothy formation of Delaware, and it is not rare in the lower beds of the Tuscaloosa formation.

Occurrence: Tuscaloosa formation, Glen Allen and Shirleys Mill, Fayette County; Cottondale, Tuscaloosa County, Ala.

Collections: U. S. National Museum; New York Botanical Garden.

POSITION UNCERTAIN.

Genus TRICALYCITES Hollick.

[Torrey Bot. Club Bull., vol. 21, p. 63, pl. 180, fig. 8, 1894.]

Tricalycites papyraceus Hollick.

Plate XXVIII, figures 1–5.

Tricalycites papyraceus Hollick, Torrey Bot. Club Bull., vol. 21, p. 63, pl. 180, fig. 8, 1894; New York Acad. Sci. Ann., vol. 11, p. 61, pl. 3, fig. 6, 1898; idem, p. 423, pl. 37, figs. 1, 2; New York Bot. Garden Bull., vol. 2, p. 405, pl. 41, fig. 3, 1902; The Cretaceous flora of southern New York and New England, p. 109, pl. 5, figs. 8–12, 1906; New York State Mus. Fifty-fifth Ann. Rept., p. r51, 1903.

Smith, On the geology of the Coastal Plain of Alabama, p. 348, 1894.

Newberry, The flora of the Amboy clays, p. 132, pl. 46, figs. 30–38, 1896.

Berry, Torrey Bot. Club Bull., vol. 31, p. 81, pl. 1, fig. 4, 1904; New Jersey Geol. Survey Bull. 3, p. 221, 1911.

Well-defined organisms, apparently dicotyledonous in their affinities and involucral or

fructicose in their nature. They consist of a central nucleus, which is generally of small size, 1 to 3 millimeters in diameter, borne at the apex of a stout peduncle or stalk, 2 to 5 millimeters in length. To this nucleus usually three membranous wings are connate. These wings usually diverge from each other at angles of about 45°, although in some specimens they are almost parallel in their orientation; they are broadly linear, obovate or ovate in outline, with broadly rounded, almost truncate tips, and narrowed somewhat toward the base, the lateral wings being usually somewhat asymmetric and in typical material somewhat shorter and broader than the median wing; they are marked by fine, approximately parallel longitudinal veins, converging toward the base, which fork and anastomose, ultimately ending in the margins. In size they range from 0.5 centimeter to 2.5 centimeters in length by 2 to 10 millimeters in width. Both Hollick and Newberry call attention to the somewhat greater length of the middle wing, which is, however, far from being a constant character, for some specimens fail to show it, all of the wings being of approximately similar size, or the central wing may even be much smaller, as it is in some of the Alabama material figured, where along with the normal forms there occur others with all the wings directed upward and the central one only about half the size of the laterals. Most of the Alabama forms, however, are normal, as described above.

The botanic relation of these curious objects remains unknown, although they are probably comparable to the bracts so largely developed in some of the Juglandaceae, as, for example, in *Engelhardtia* and *Oreomunnea*, or to certain of the winged fruits to be found among the modern Sapindaceae. The writer has compared the fossils with a large amount of recent material in the New York Botanical Garden and the United States National Herbarium and feels some confidence in the belief that they may represent fruits of some Cretaceous member of the family Dipterocarpaceae. Superficially, the venation appears to consist of slightly diverging, approximately parallel, longitudinal striations. The Alabama material, however, shows clearly that these veins fork and anastomose, as shown in the figure reproduced from a photograph, which has been carefully verified from a large number of specimens, thus allying these fossils with such a modern genus as *Vatica*. Exact correspondence between these remote ancestral forms and any of the modern genera, which are all confined to the Eastern Hemisphere, is hardly to be expected.

In the abundant remains from Tottenville, Staten Island; Gay Head and Nashaquitsa, Marthas Vineyard; and Glen Cove, Long Island, Hollick has described another species, *Tricalycites major*,[1] based on forms which are usually two-winged and which have a larger nucleus, the wings reaching a length of 4 centimeters and a width of 1.3 centimeters. The same author has described similar but smaller remains from Marthas Vineyard as *Calycites obovatus*,[2] and still smaller remains from Montauk Point, Long Island, as *Calycites alatus*.[3] Though perhaps from the standpoint of the paleobotanist these segregations are permissible or even desirable, it may be doubted if they express real specific distinctions and not merely individual variations. There is certainly a suggestion in the forms from the Tuscaloosa formation of Alabama, which occur with the normal *Tricalycites papyraceus*, that the central wing may be more or less abortive or completely so, thus giving some terms of the series leading to *Tricalycites major* or to the almost identical smaller forms which are referred to *Calycites obovatus* and *C. alatus*.

Tricalycites papyraceus is abundant in the middle part of the Raritan formation at Woodbridge, N. J., and also occurs in the upper part of the Raritan formation at South Amboy, N. J. It occurs sparingly in the Magothy formation at Cliffwood Bluff, N. J., and is abundant in the insular Cretaceous floras along the southern coast of New England and is very common in the lower part of the Tuscaloosa formation in the Alabama area. It is also common in the Woodbine sand at Arthurs Bluff, Lamar County, Tex.

Occurrence: Tuscaloosa formation, Shirleys Mill and Glen Allen, Fayette County; big gully on the Snow place, Tuscaloosa County, Ala.

Collections: U. S. National Museum.

[1] Hollick, Arthur, The Cretaceous flora of southern New York and New England: U. S. Geol. Survey Mon. 50, p. 108, pl. 8, figs. 13–22, 1907.
[2] Idem, p. 109, pl. 5, fig. 23.
[3] Idem, fig. 24.

Calycites sexpartitus Berry, n. sp.

Plate XXIX, figure 8.

Calyx-like organisms consisting of a central poorly preserved disk about 1 millimeter in diameter surrounded by six radiating rigid lanceolate segments about 7 millimeters in length and 1.25 millimeters in maximum width, the whole borne on a long, slender curved stalk, about 1 centimeter in length.

These peculiar specimens apparently represent persistent coriaceous floral organs of unknown affinity. Superficially they resemble the Paleozoic *Asterophyllites*. Forms of *Calycites* are known from the Raritan formation of the northern Atlantic coast, the Dakota sandstone of the West, and the Middendorf arkose member of the Black Creek formation of South Carolina, but none previously described are similar to this Tuscaloosa species.

Occurrence: Tuscaloosa formation, big gully on the Snow place, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Carpolithus floribundus Newberry.

Plate XXIX, figure 1.

Carpolithus floribundus Newberry, U. S. Geol. Survey Mon. 26, p. 133, pl. 46, figs. 17–21, 1896.
Hollick, The Cretaceous flora of southern New York and New England, p. 110, pl. 7, figs. 20, 21, 1906.
Berry, New Jersey Geol. Survey Bull. 3, p. 216, 1911.

Capsules (?) broadly ovate in outline and elliptical in cross section (probably as a result of compression during fossilization), in size ranging from 5 to 8 millimeters in length by 3 to 6 millimeters in diameter. They seem to be dehiscent and they are five-valved according to Newberry. I am not sure that this dehiscence may not be a result of compression, for some of them are preserved entire, and then they have a pointed apex. They occur singly or in pairs, and Newberry figured one specimen in which the axis is apparently dichotomously branched. In some specimens there are traces of what appear to be persistent calyx lobes.

These objects occur in considerable abundance in the middle part of the Raritan formation of New Jersey and somewhat doubtfully identified specimens are recorded by Hollick from the Magothy formation on Marthas Vineyard. They are not uncommon in the basal clays of the Tuscaloosa formation near Shirleys Mill. Their botanic relationship is unknown, although they suggest various modern members of the orders Geraniales, Rhamnales, and Parietales.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collections: U. S. National Museum; the types are at the New York Botanical Garden.

Carpolithus tuscaloosensis Berry, n. sp.

Fruits of unknown affinity, disk shaped, about 1 centimeter in diameter by about 3 millimeters thick, one surface comparatively flat, the other elevated. Edges thin. Peduncle in center of one side.

These peculiar fruits are given a name because of their abundance in the lower part of the Tuscaloosa formation. They are of unknown affinity, were previously undescribed, and are unlike any fruits known to me, although they suggest those of the genus *Paliurus*. They are doubtless more or less flattened, but it is believed that in life they were disk-shaped rather than spherical, for several show a peduncular scar in the center of the disk. If they had been drupelike their natural position of rest would have been with stalk on one side at or near the flattened edge. They were of considerable consistency, for they are represented when fossilized by a compact button of structureless lignite.

Occurrence: Tuscaloosa formation, big gully on the Snow place; roadside southwest of Northport; near Jones Ferry, Black Warrior River, Tuscaloosa County, Ala.

Collection: U. S. National Museum.

Phyllites shirleyensis Berry, n. sp.

Plate XXIX, figure 3.

Leaf of relatively small size, broadly lanceolate in general outline, with an acutely pointed, not extended apex and a similarly acutely pointed, somewhat decurrent base. Length about 4 centimeters. Maximum width, midway between the apex and the base, about 1.7 centimeters. Margins entire. Texture subcoriaceous. Petiole elongated, stout, and curved, about 3.5 centimeters in length. Midrib slender. Secondaries very thin, mostly immersed, parallel with the lower lateral margins, camptodrome.

This is a form of unknown botanic affinity, apparently not previously described. It is

unfortunately based on the single specimen figured.

Occurrence: Tuscaloosa formation, Shirleys Mill, Fayette County, Ala.

Collection: U. S. National Museum.

Phyllites pistiaeformis Berry, n. sp.

Plate XXIX, figure 2.

Leaves of small size, elliptical in general outline, with a broadly rounded apex and a cuneate decurrent base. Length about 3 centimeters. Maximum width, in middle part of the leaf, about 2 centimeters. Margins entire but somewhat irregular. Texture coriaceous. Petiole short and broad. Midrib stout proximad, becoming thin distad, curved. Secondaries thin, ascending, camptodrome, mostly immersed in the leaf substance.

These small leaves are of unknown relationship. They are named in allusion to their resemblance to the somewhat later *Pistia nordenskioldi* (Heer) Berry, which is so abundant in the Black Creek formation of North Carolina. Any close relationship is, however, entirely problematic.

Occurrence: Tuscaloosa formation, Glen Allen, Fayette County, Ala.; cut on Southern Railway, 1⅝ miles east of Iuka, Tishomingo County, Miss.

Collection: U. S. National Museum.

Halymenites major Lesquereux.

Halymenites major Lesquereux, The Tertiary flora, p. 38, pl. 1, figs. 7, 8, 1878.

These very abundant objects, frequently considered to represent fossil fucoids, are abundant in the western United States in sandy beds ranging in age from the Colorado group to the Eocene. They were long thought to be typical of the Fox Hills sandstone, in which they are abundantly developed, but are now known from both older and younger beds and characterize sandy ferruginous sediments.

Typical material is abundant in the Coffee sand member of the Eutaw formation and also at different horizons in the Ripley formation in western Tennessee. Generally, however, these objects are very friable, and the collected specimens represent only the beds enumerated below.

Occurrence: Eutaw formation (Coffee sand member), Coffee Bluff, Hardin County, Tenn. Ripley formation (McNairy sand member), McNairy County, Tenn.

Collection: Johns Hopkins University.

Phyllites asplenioides Berry, n. sp.

Plate XXXIII, figures 1–3.

Fronds large in size, lax in habit but apparently of a thinly coriaceous texture. Apparently entire or with only a shallowly lobate margin. Reniform or broadly obovate in outline. Minimum length and width, over 15 centimeters. Midrib consisting of a wide, flat mass of veins formed by the approximation and subparallel proximad course of all the veins of the frond. These veins are numerous, diverge at acute angles and fork dichotomously two or three times, most of the dichotomies being near the point of their divergence. Thenceforth they are mostly subparallel, here and there coalescing to form a much-elongated netted venation.

This peculiar form is so striking a type and one moreover so totally unlike anything that I have encountered in the Upper Cretaceous that it can not be omitted from any discussion of our Upper Cretaceous floras, although its botanic affinity is more or less problematic.

Certain beds in the clays of the Eutaw formation at Coffee Bluff are packed with the broken remains of these fronds, and it has been impossible to determine conclusively their exact size and form. Two of the most complete specimens are figured on the accompanying plate. The apparently flabellate segments appear to be the result of splitting and most of them are clearly due to slight offsets in the clay after deposition. Only three possible botanic relationships seem suggestive. The material might represent some lax monocotyledonous leaf of unknown affinity similar to *Nitophyllum beaumontanum* described by Bureau [1] from the Lutetian of France; it might represent some hitherto unknown type of Mesozoic cycadophyte; or it may be a true pteridophyte. I incline to the interpretation

[1] Bureau, E., Études sur la flore fossile du calcaire grossier parisien, p. 235, 1838. Considered of an algal nature by this author.

that it represents the simple tufted fronds of a gigantic asplenioid fern like some of the modern forms referred to *Diplazium* or to the large and reniform fronded existing scolopendriums of the section *Schaffneria* of Fée, such as *Scolopendrium delavayi* Franch, of the mountains of Farther India and Yunnan, or *Scolopendrium nigripes* (Fée) Hooker, of southern Mexico and Guatemala. Rather similar but equally indefinite remains were described from the Eocene at Green River, Wyo., and named by Lesquereux [1] *Musophyllum complicatum* from their fancied resemblance to the leaves of the existing monocotyledonous genus *Musa*.

The present material comes from a slightly higher clay lens in the Coffee sand than that from which the remainder of the Coffee Bluff plants were obtained and was collected by Bruce Wade in the autumn of 1916.

Occurrence: Eutaw formation (Coffee sand member), Coffee Bluff, Hardin County, Tenn.

Collection: Johns Hopkins University.

[1] Lesquereux, Leo, The Tertiary flora, p. 96, pl. 15, figs. 1–6, 1878.

PLATES V–XXXIII.

PLATE V.

Page.

FIGURE 1. *Sphaerites alabamensis* Berry, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34794). 49

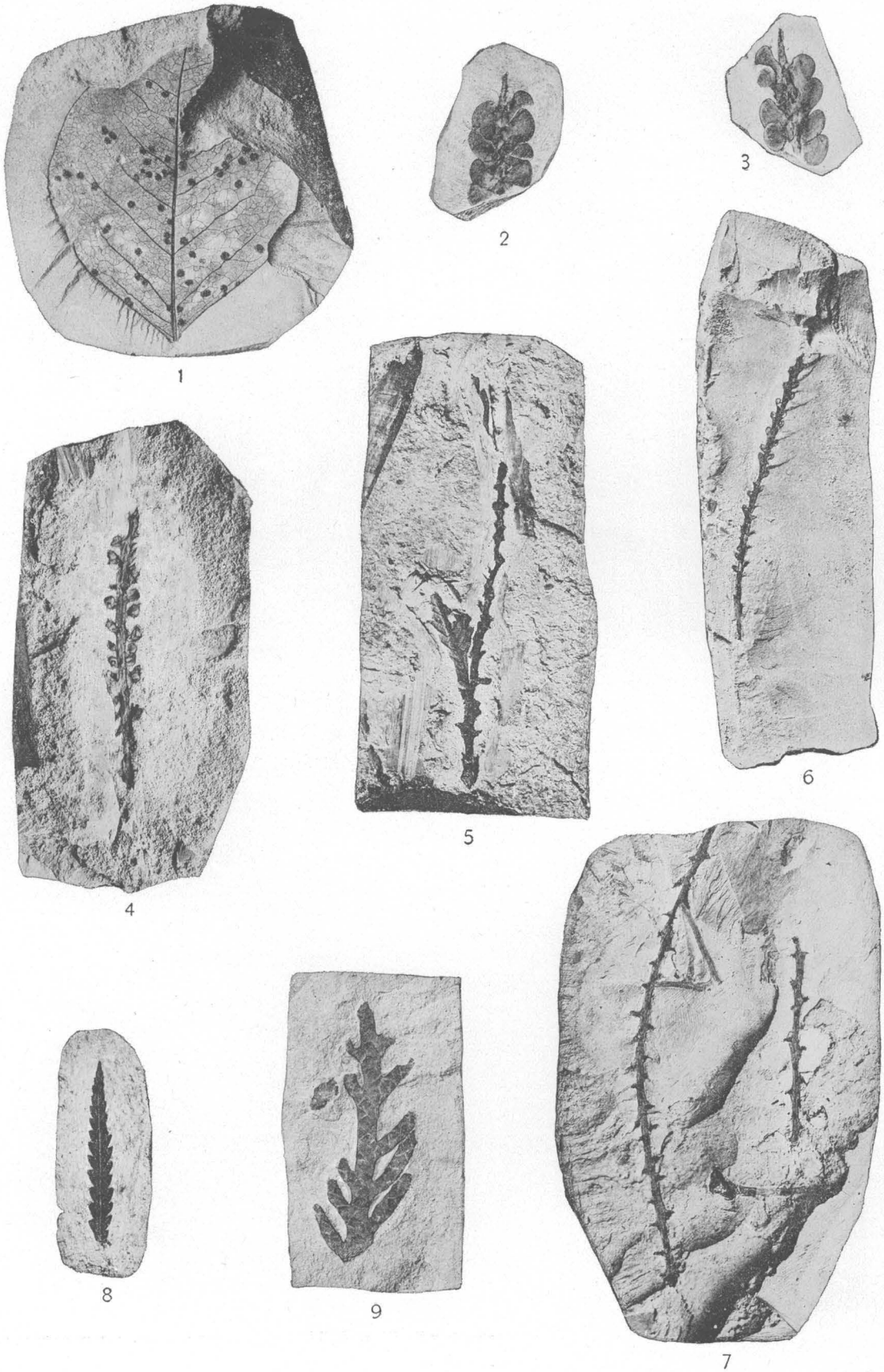
FIGURES 2, 3. *Jungermannites cretaceus* Berry, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. Nos. 34795–34796) 49

FIGURES 4–7. *Lycopodites tuscaloosensis* Berry, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. Nos. 34797–34800) 50

FIGURE 8. *Cladophlebis alabamensis* Berry, from gully on Snow place, Tuscaloosa County, Ala. (U. S. Nat. Mus. Cat. No. 34801) 51

FIGURE 9. *Brachyphyllum macrocarpum formosum* Berry, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34802) 59

All specimens are from the Tuscaloosa formation.



FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.

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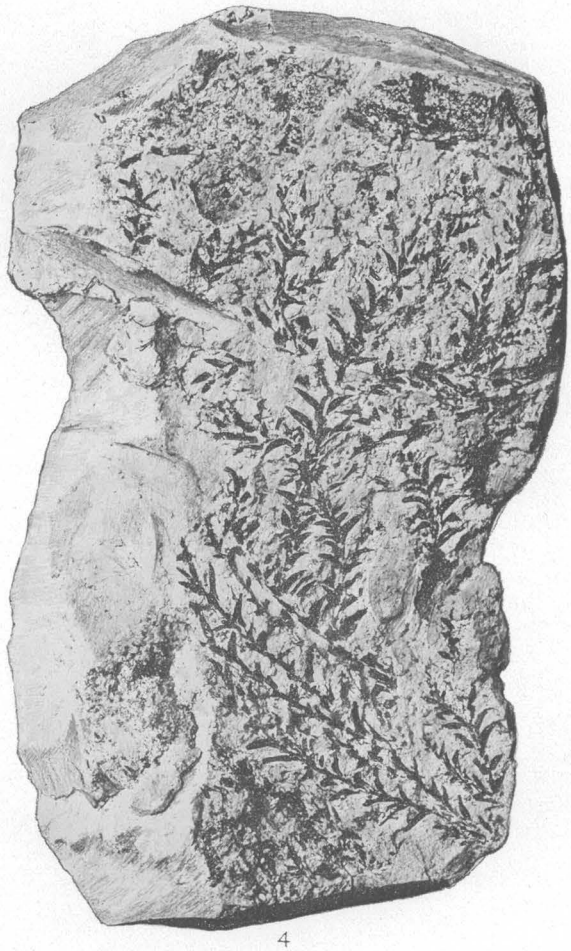

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FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.

PLATE VI.

PLATE VII.

Page.

FIGURES 1–10. *Androvettia carolinensis* Berry 62

1–3. Fragments of foliage from the Tuscaloosa formation in Tishomingo County, Miss., natural size. (U. S. Nat. Mus. Cat. Nos. 34807–34809).

4. Fragment from the Black Creek formation of North Carolina, natural size.

5. Specimen shown in figure 4, × 4.

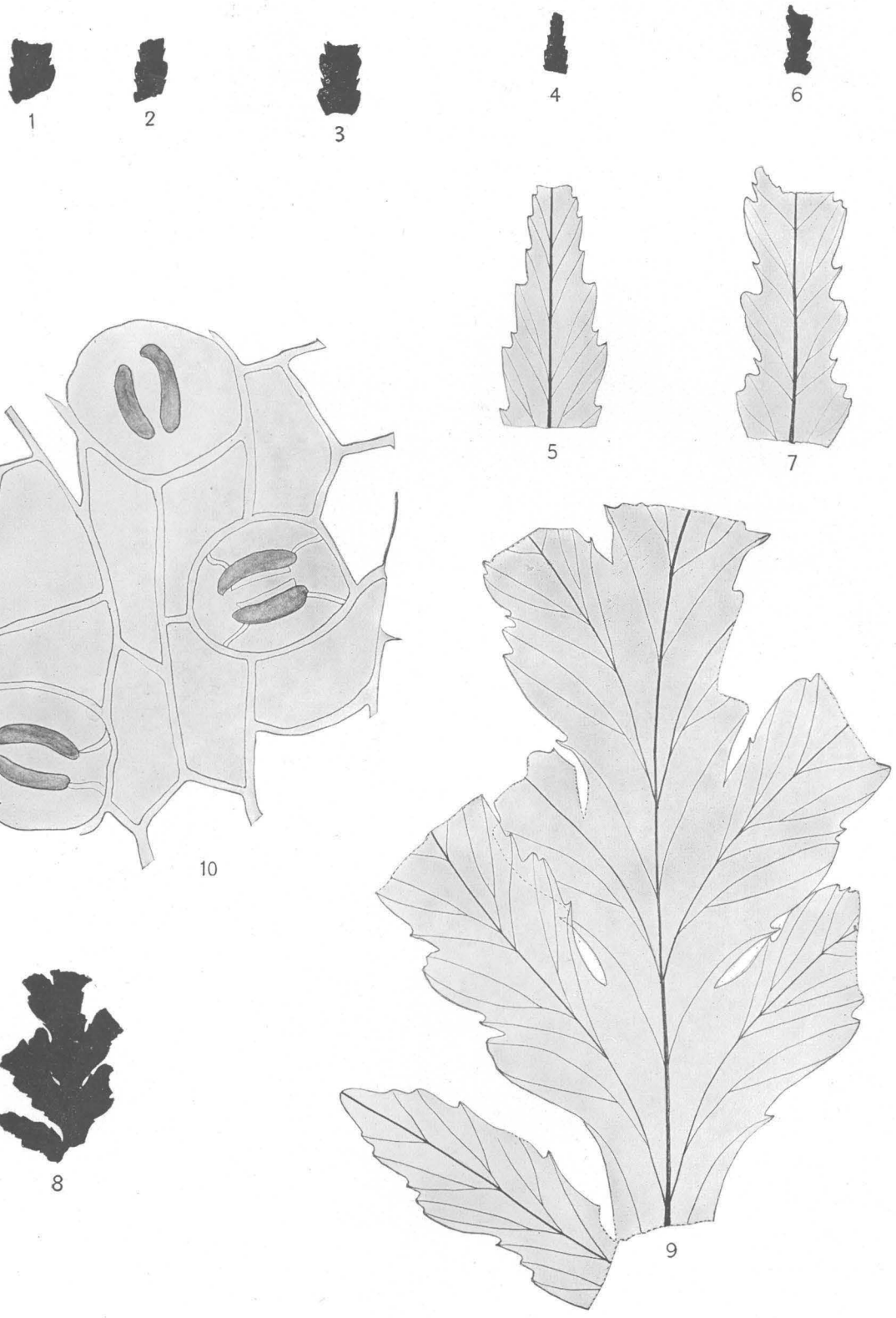
6. Another small specimen from North Carolina, natural size.

7. Specimen shown in figure 6, × 4.

8. A larger twig from North Carolina, natural size.

9. Specimen shown in figure 8, × 4.

10. Photomicrograph showing epidermal cells and stomata, × 385.



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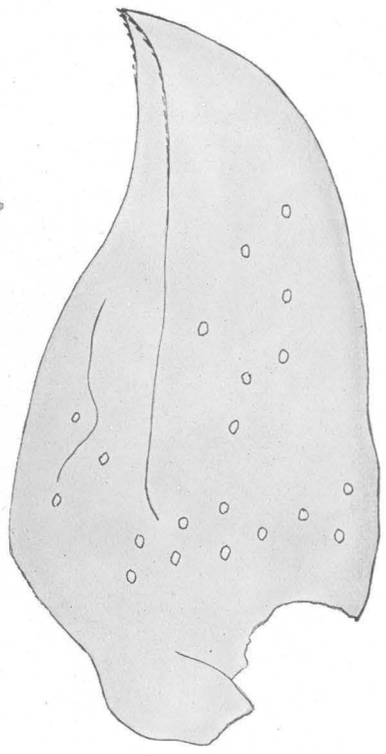

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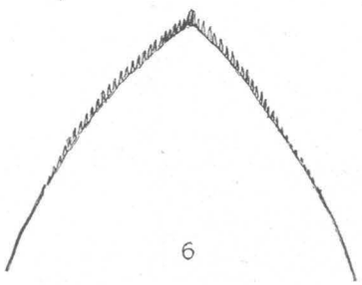

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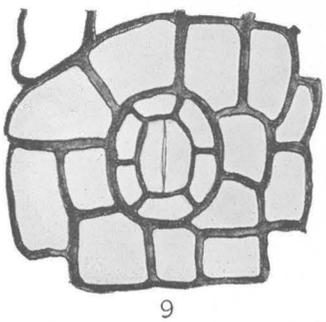

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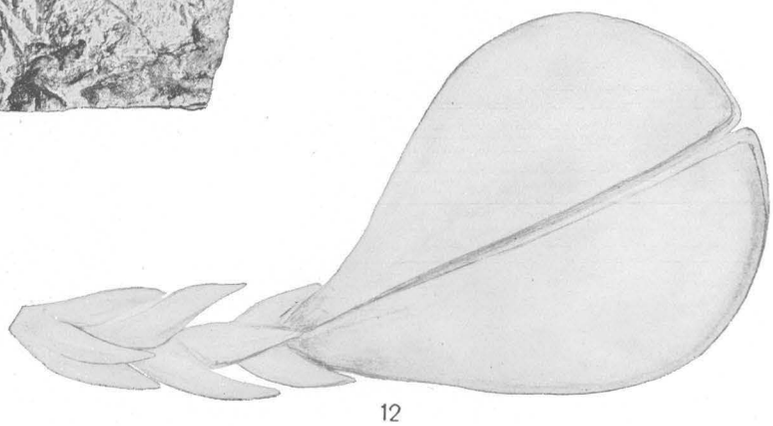


12

FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.

PLATE VIII.

Page.

FIGURES 1–12. *Widdringtonites subtilis* Heer, from the Tuscaloosa formation of Alabama..... 67

1. Specimen from gully on Snow place, Tuscaloosa County, Ala. (U. S. Nat. Mus. Cat. No. 34810).
2. Twig from specimen illustrated in figure 1, showing dimorphism, × 5.
3. Terminal-flattened twig from gully on Snow place, Tuscaloosa County, Ala., × 5 (U. S. Nat. Mus. Cat. No. 34811).

4, 5. Leaves from same, × 10 (U. S. Nat. Mus. Cat. Nos. 34812, 34813).

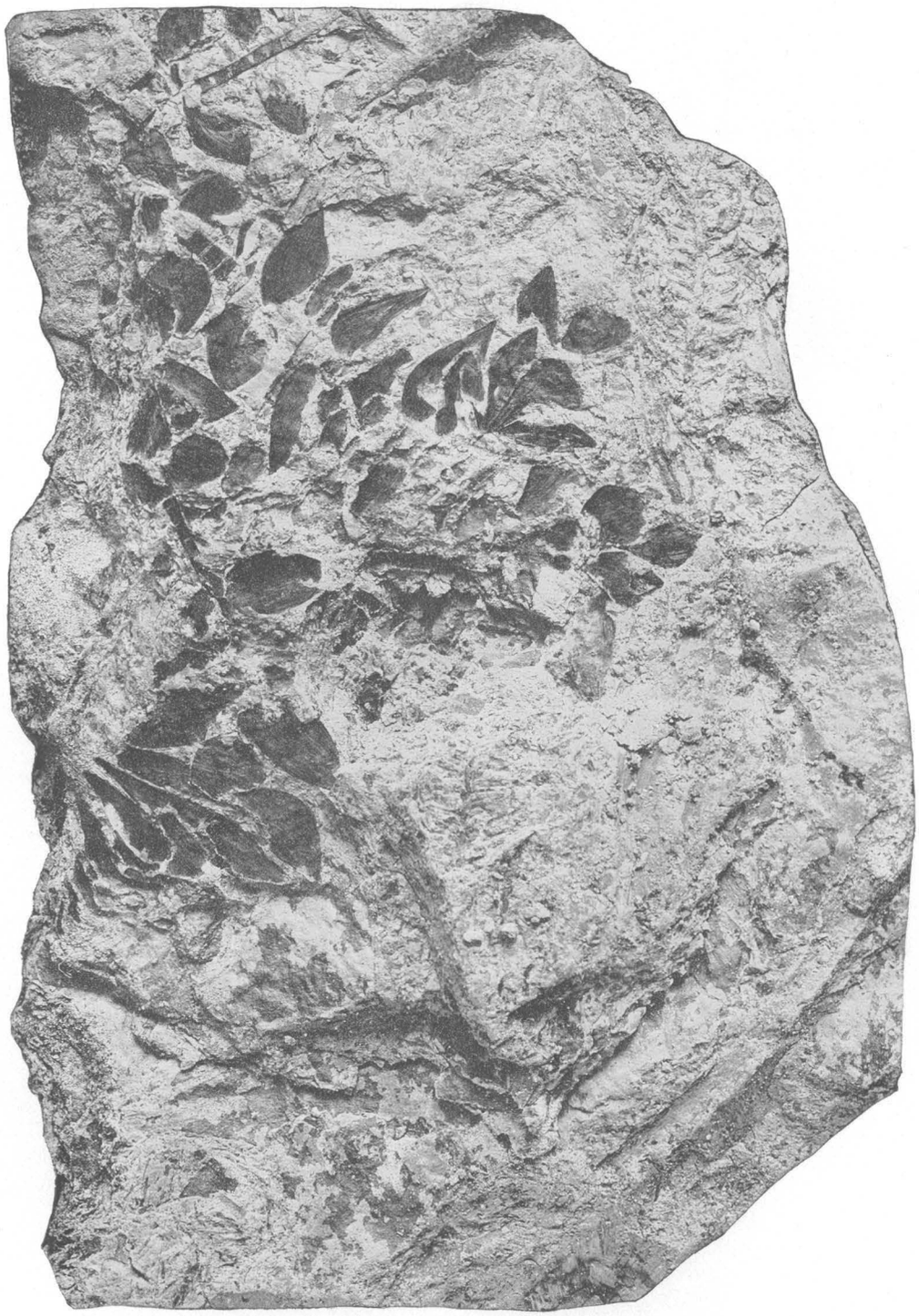
6. Sketch of tip of leaf illustrated in figure 5 showing marginal spines, × 50.
7. Another leaf, × 10 (U. S. Nat. Mus. Cat. No. 34814).
8. Sketch of leaf illustrated in figure 7 showing location of stomata, × 50.
9. Drawing of epidermal preparation from preceding (fig. 8) showing stoma, × 205.
10. Specimen from Shirleys Mill, Fayette County, Ala., with elongated leaves (U. S. Nat. Mus. Cat. No. 34815).
11. Cone-bearing specimen from gully on Snow place, Tuscaloosa County, Ala. (U. S. Nat. Mus. Cat. No. 34816).
12. Cone from specimen shown in figure 11, × 10.

PLATE IX.

Page.

Portion of a large branch of *Araucaria bladenensis* Berry, from the Eutaw formation at Havana, Hale County, Ala. (U. S. Nat. Mus. Cat. No. 34817)..... 61

FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.



FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.

PLATE X.

PLATE XI.

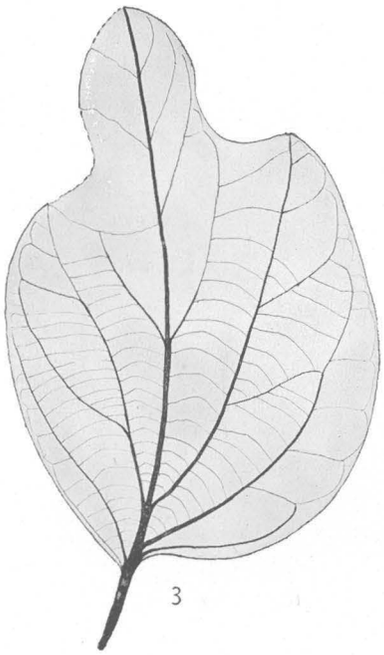
Page.

FIGURE 1. *Sabalites* sp. Berry, from the Ripley formation at Camden, Tenn. (U. S. Nat. Mus. Cat. No. 34819). 72

FIGURE 2. *Myrica ripleyensis* Berry, from the Ripley formation 13 miles northwest of Camden, Benton County, Tenn. (U. S. Nat. Mus. Cat. No. 34820) 74

FIGURE 3. *Ficus fontainii* Berry, from the Tuscaloosa formation at Cottondale, Tuscaloosa County, Ala. (U. S. Nat. Mus. Cat. No. 34821) 82

FIGURE 4. *Myrcia havanensis* Berry, from the Ripley formation at Camden, Benton County, Tenn. (U. S. Nat. Mus. Cat. No. 34822) 125



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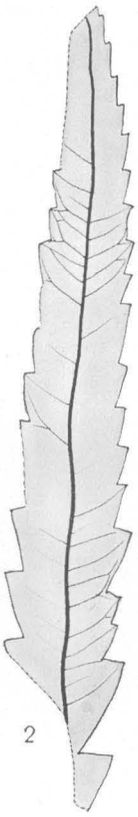

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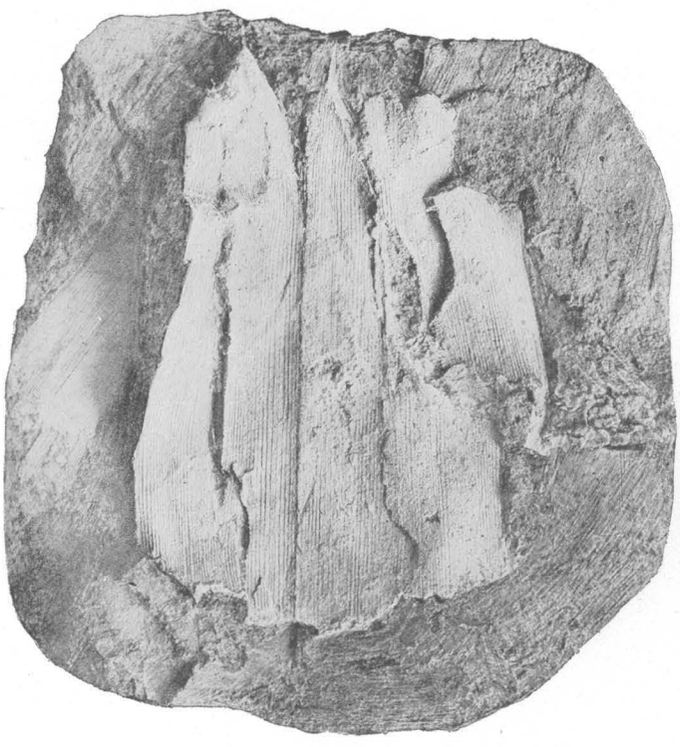

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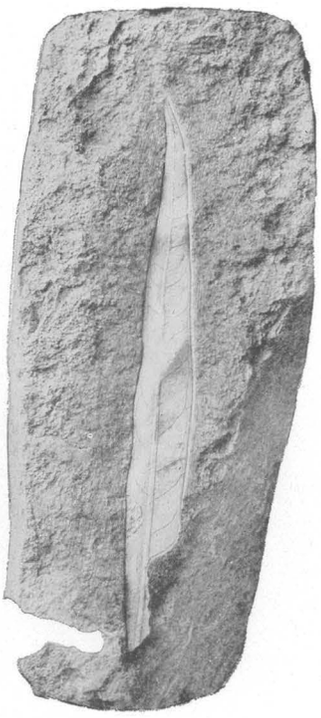

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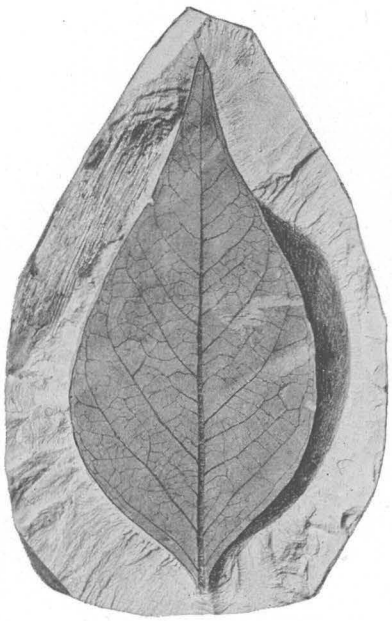
FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.



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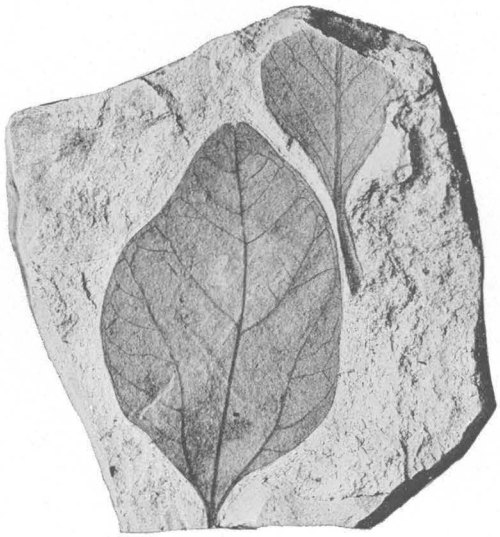

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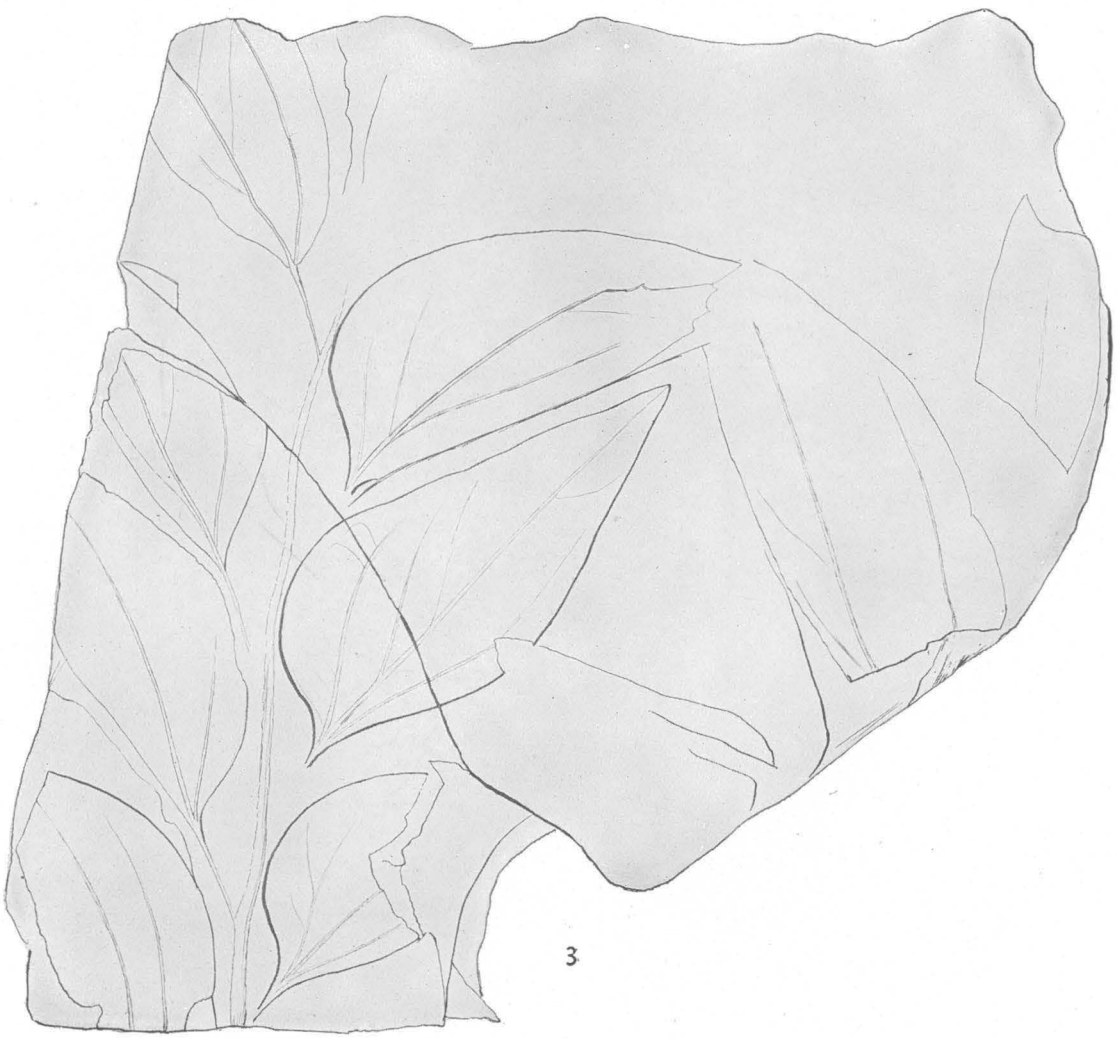

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FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.

PLATE XII.

Page.

FIGURE 1. *Ficus inaequalis* Lesquereux, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34823) 80

FIGURE 2. *Ficus woolsoni* Newberry, from Glen Allen, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34824). 81

FIGURE 3. *Piperites tuscaloosensis* Berry, from Tuscaloosa, Tuscaloosa County, Ala. (U. S. Nat. Mus. Cat. No. 34825)..... 72

All specimens are from the Tuscaloosa formation.

PLATE XIII.

Page.

FIGURE 1. *Doryanthites cretacea* Berry, from the Eutaw formation at Havana, Hale County, Ala. (U. S. Nat. Mus. Cat. No. 34826) 70

FIGURE 2. *Populites tuscaloosensis* Berry, from the Tuscaloosa formation at Glen Allen Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34827) 77

FIGURE 3. *Salix flexuosa* Newberry, from the Tuscaloosa formation at Maplesville, Chilton County, Ala. (U. S. Nat. Mus. Cat. No. 34828) 75

FIGURE 4. *Myrica emarginata* Heer, from the Tuscaloosa formation at Cottondale, Tuscaloosa County, Ala. (U. S. Nat. Mus. Cat. No. 34829) 73

FIGURE 5. *Myrica dakotensis minima* Berry, from the Tuscaloosa formation at Glen Allen, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34830) 74

FIGURE 6. *Ficus daphnogenoides* (Heer) Berry, from the Tuscaloosa formation at Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34831) 80

FIGURE 7. A small form of the same species from the Tuscaloosa formation at Glen Allen, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34832) 80

FIGURE 8. *Ficus shirleyensis* Berry, from the Tuscaloosa formation at Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34833) 81

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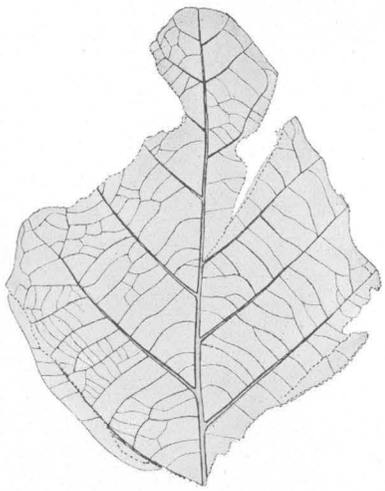

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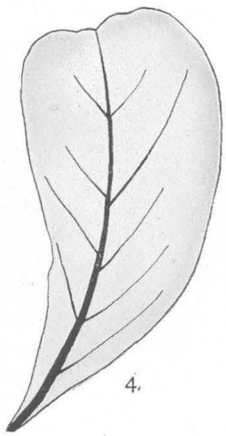

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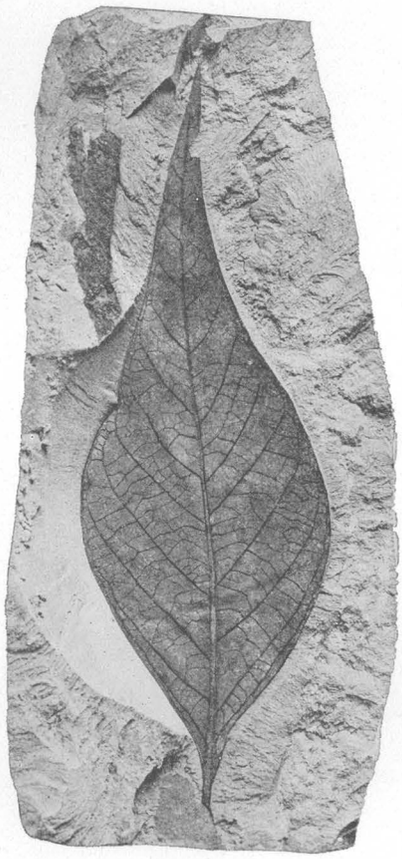

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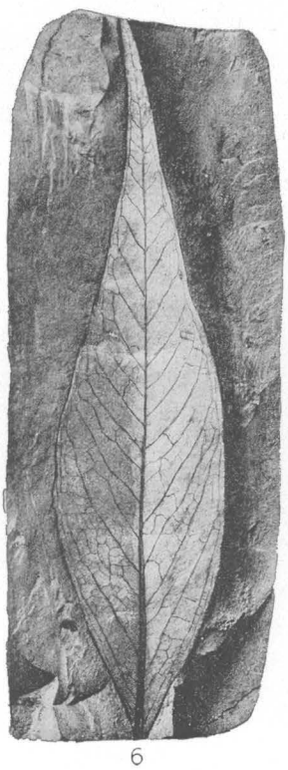

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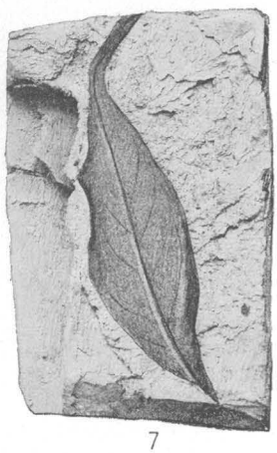

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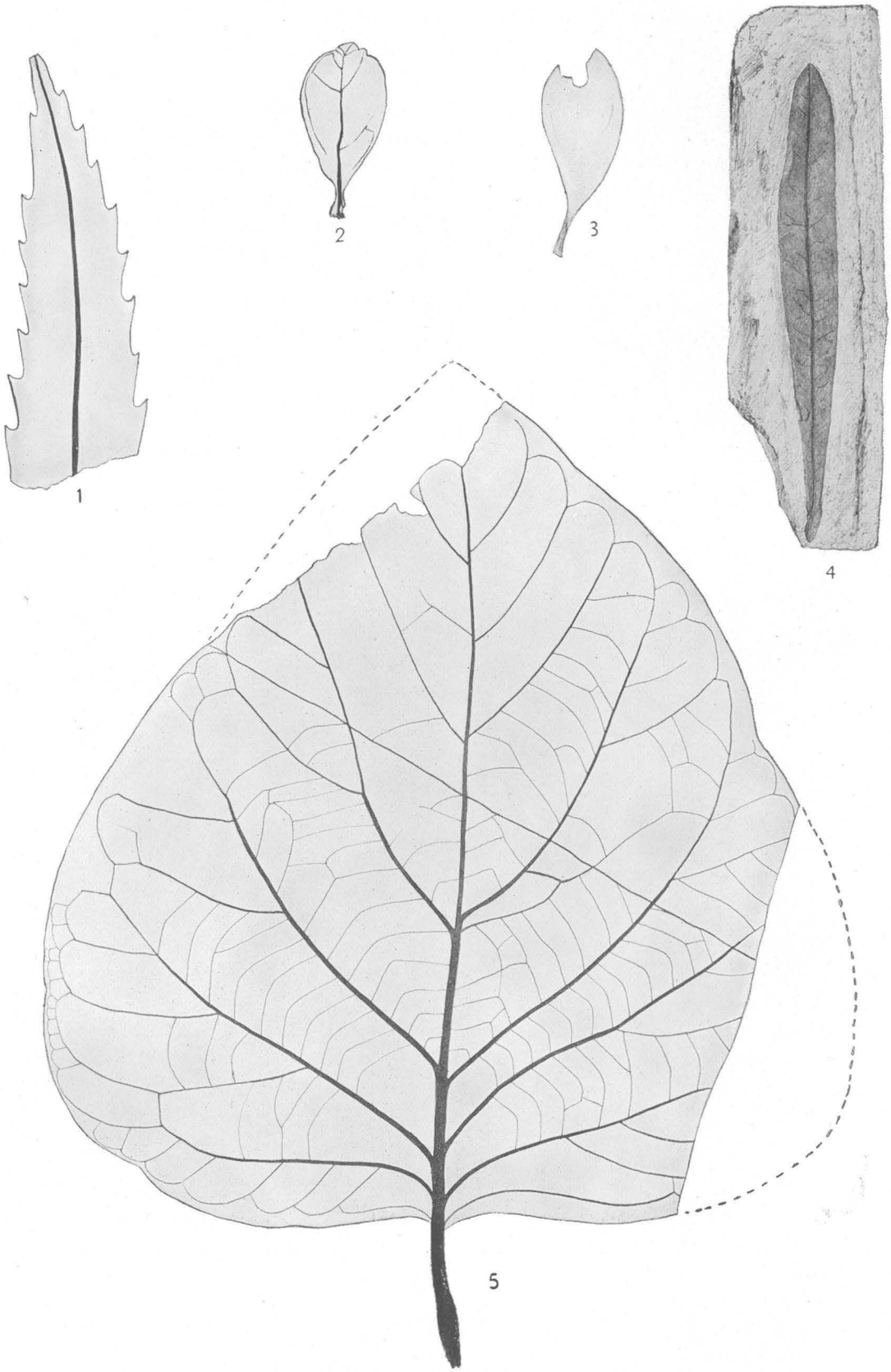
FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.



FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.

PLATE XIV.

All specimens are from the Tuscaloosa formation.

PLATE XV.

Page.

FIGURES 1–5. *Platanus shirleyensis* Berry, from the Tuscaloosa formation at Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. Nos. 34839–34843)..... 83

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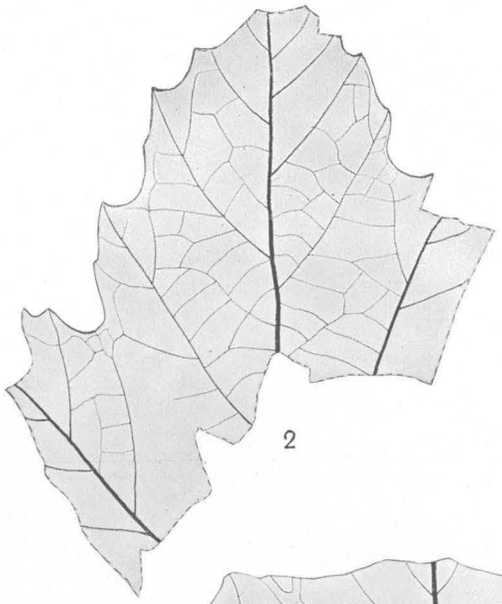

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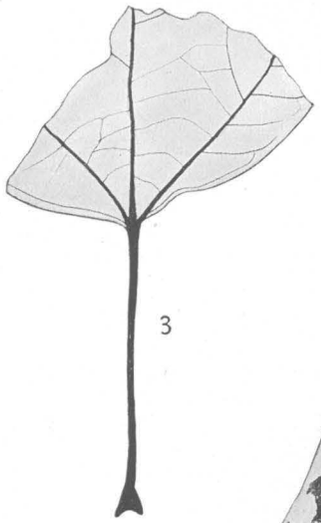

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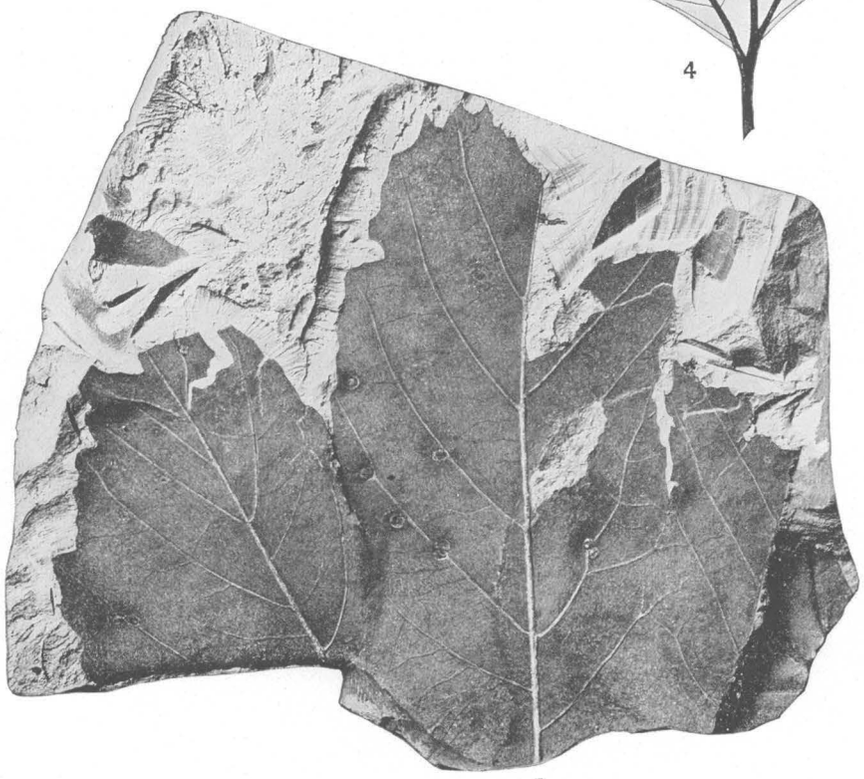

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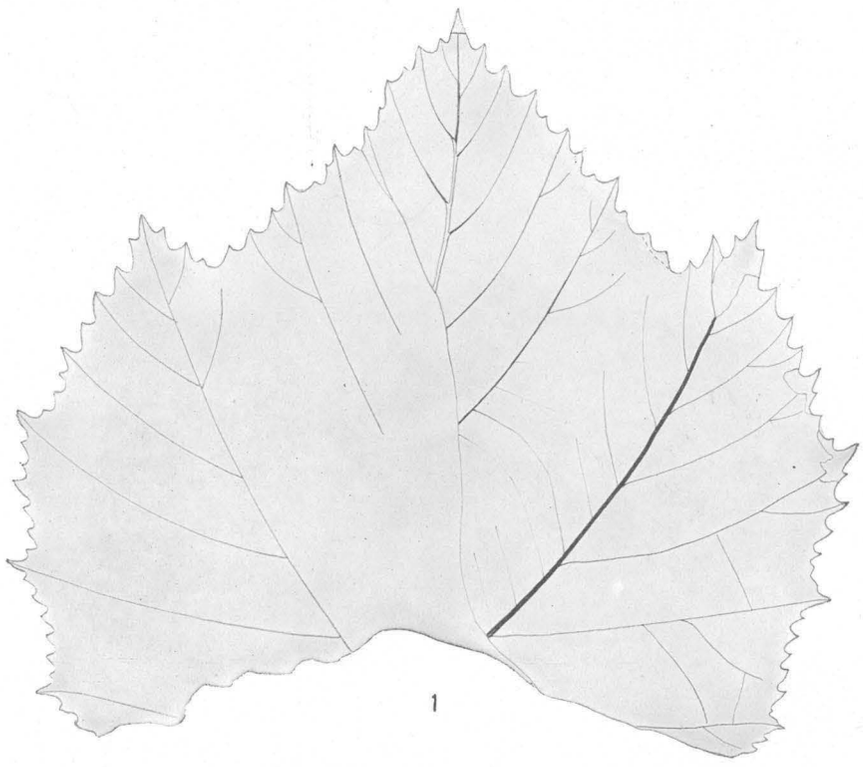

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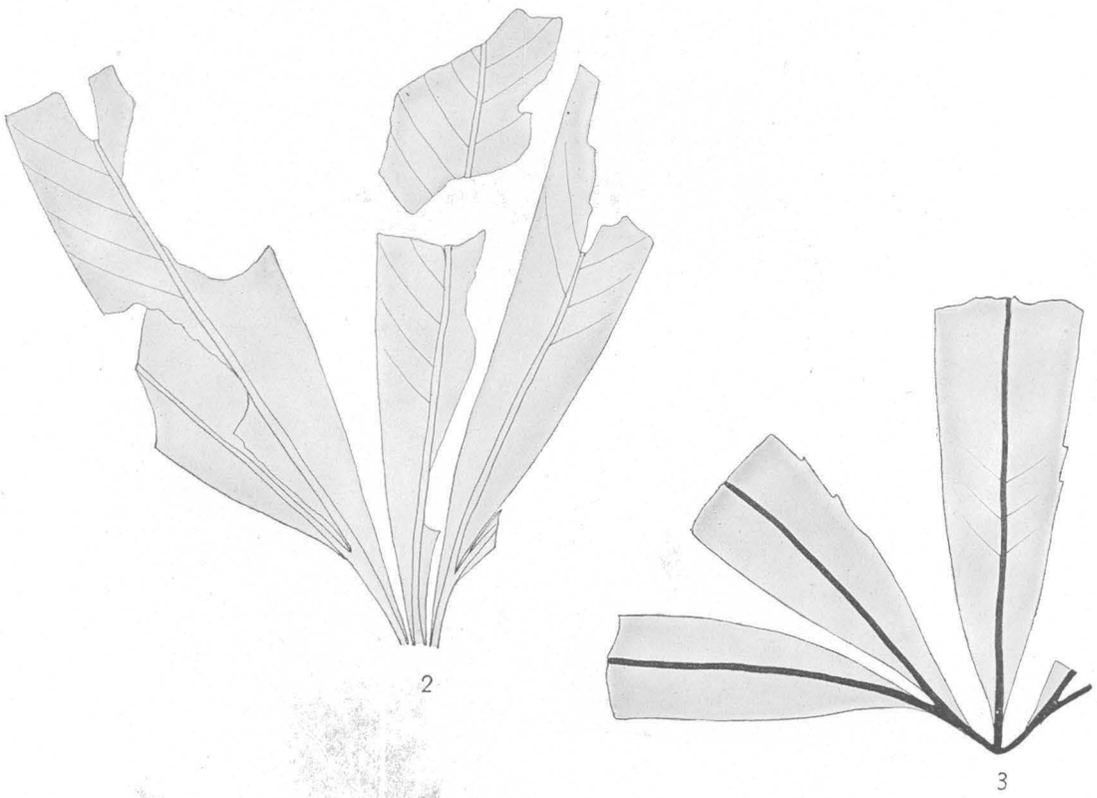


2 3

FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.

PLATE XVI.

Page.

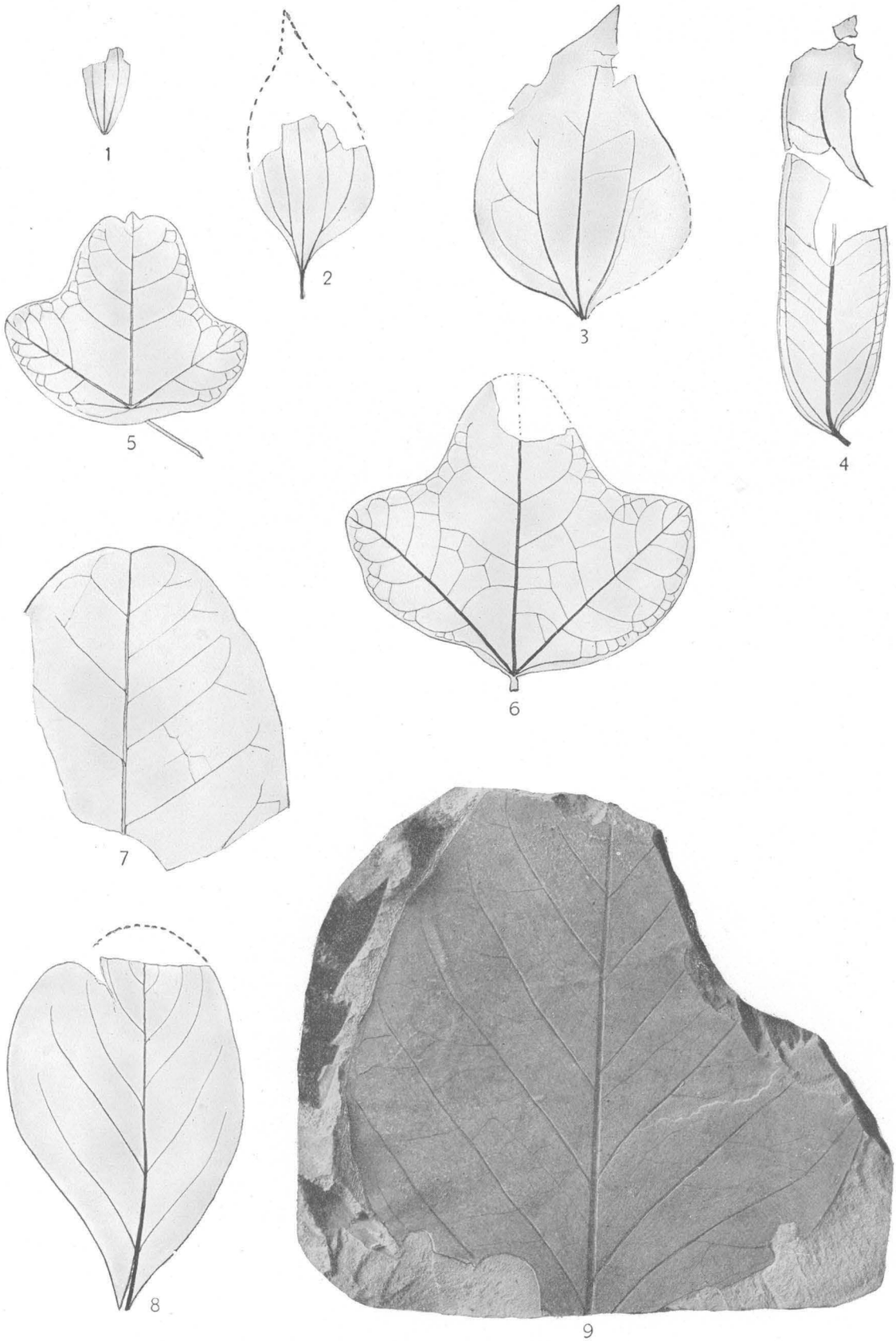
FIGURE 1. *Platanus asperaeformis* Berry, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34844)..... 83

FIGURES 2, 3. *Dewalquea smithi* Berry, from Whites Bluff, Greene County, Ala. (U. S. Nat. Mus. Cat. Nos. 34845, 34846)..... 86

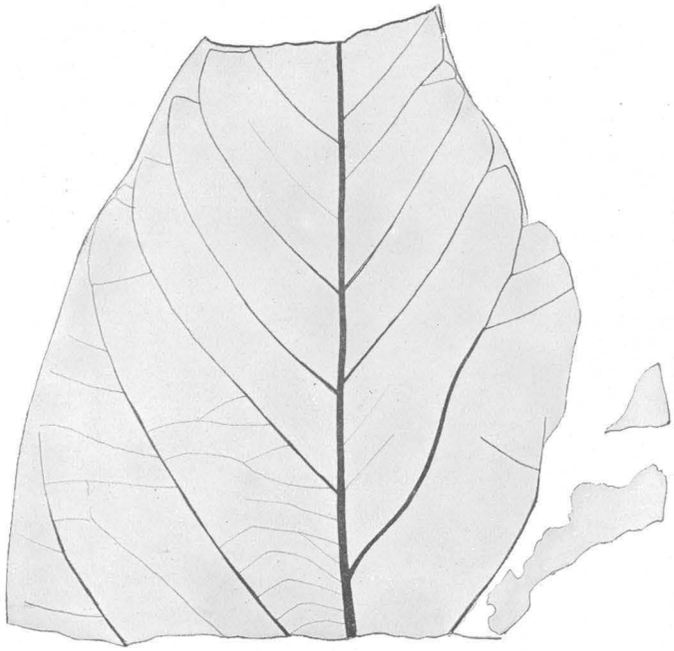
All specimens are from the Tuscaloosa formation.

PLATE XVII.

All specimens are from the Tuscaloosa formation.



FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.



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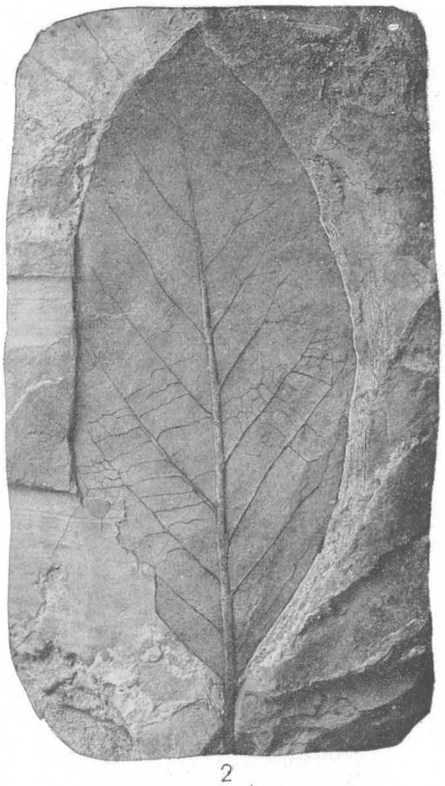

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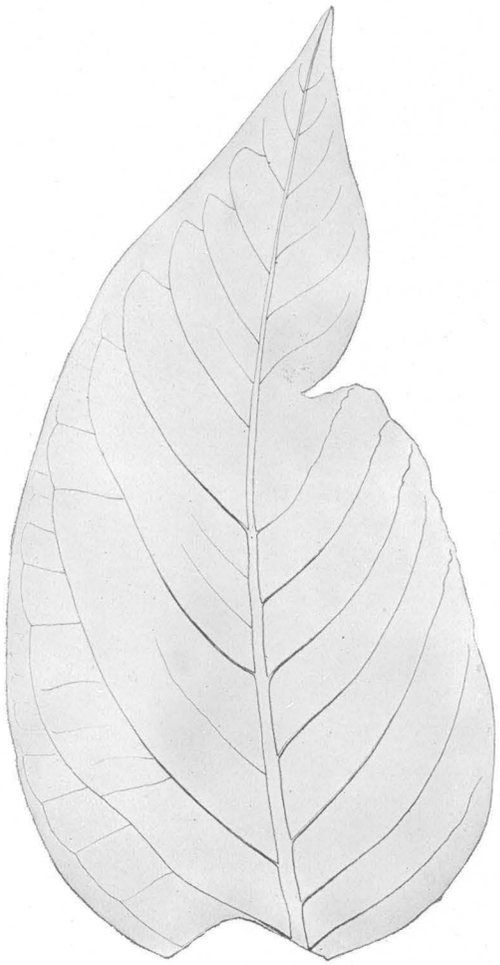

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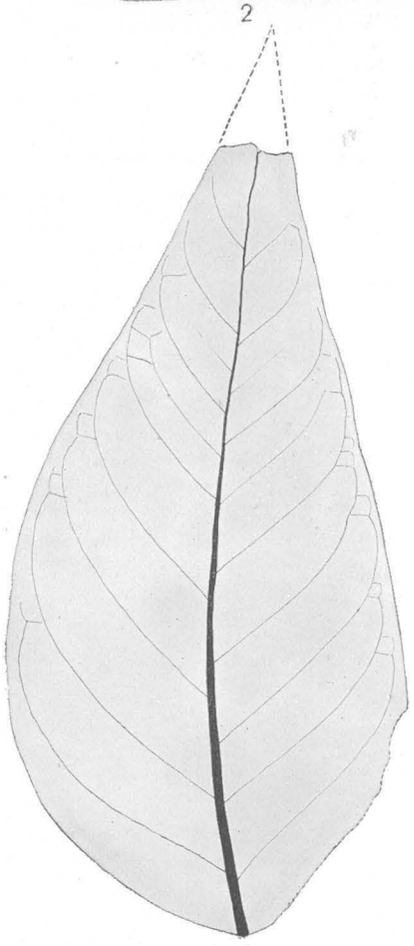

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FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.

PLATE XVIII.

Page.

FIGURE 1. *Magnolia capellinii* Heer, from Cottondale, Tuscaloosa County, Ala. (U. S. Nat. Mus. Cat. No. 34856). 89

FIGURE 2. *Magnolia boulayana* Lesquereux, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34857)..... 90

FIGURES 3, 4. *Magnolia speciosa* Heer..... 88

3. Specimen from Glen Allen, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34858).

4. Specimen from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34859).

All specimens are from the Tuscaloosa formation.

PLATE XIX.

Page.

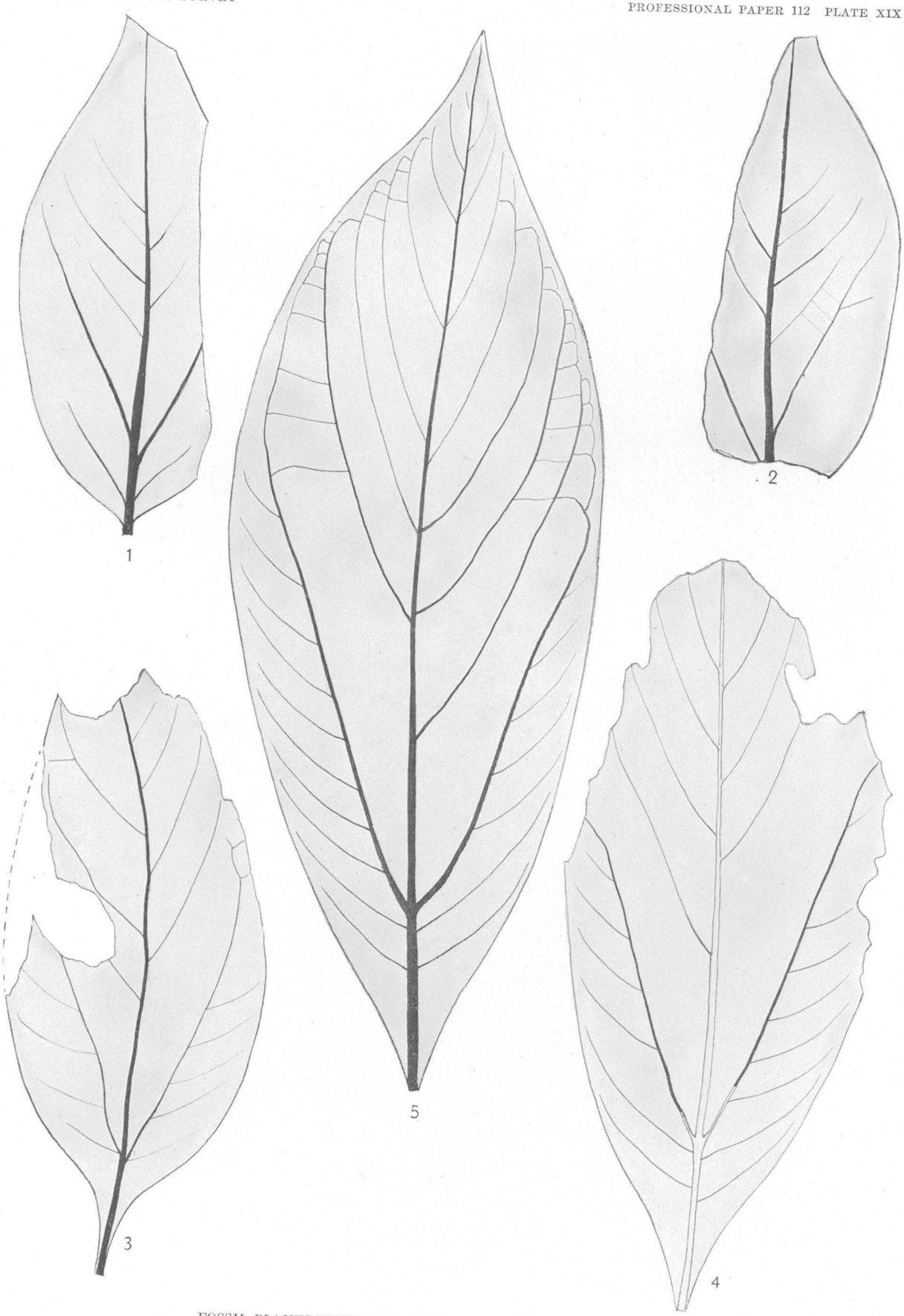
FIGURES 1, 2. *Oreodaphne shirleyensis* Berry, from Shirleys Mill, Fayette County Ala. (U. S. Nat. Mus. Cat. Nos. 34860, 34861) 119

FIGURES 3–5. *Oreodaphne alabamensis* Berry 119

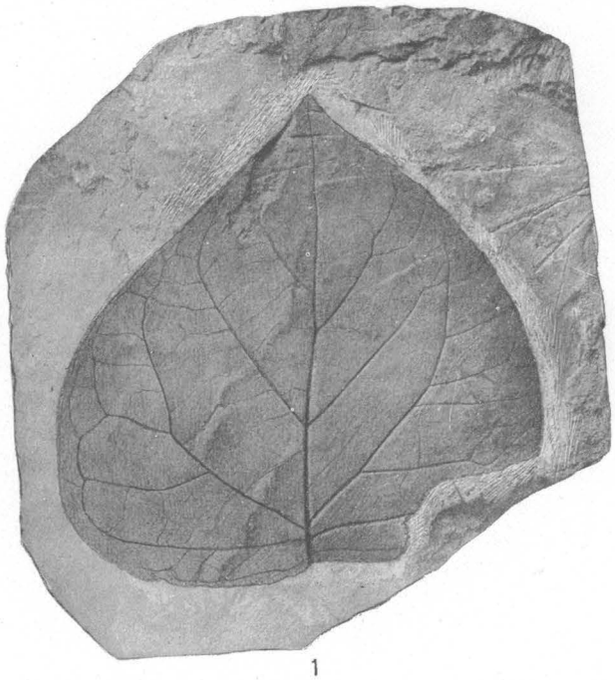
3, 4. Specimen from Cottondale, Tuscaloosa County, Ala. (U. S. Nat. Mus. Cat. Nos. 34862 34863).

5. Restoration from specimens shown in figures 3 and 4.

All specimens are from the Tuscaloosa formation.



FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.



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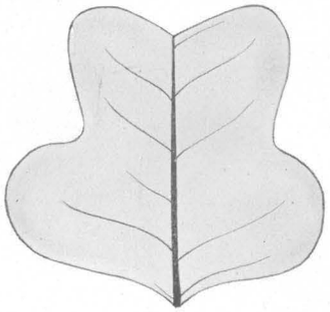

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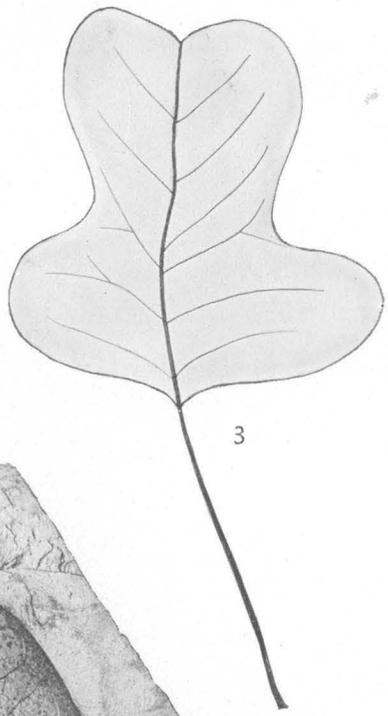

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4

FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.

PLATE XX.

Page.

FIGURE 1. *Menispermites integrifolius* Berry, from Cottondale, Tuscaloosa County, Ala. (U. S. Nat. Mus. Cat. No. 34864) 94

FIGURE 2. *Liriodendron meekii* Heer, from Cottondale, Tuscaloosa County, Ala. (type crushed)..... 92

FIGURE 3. *Liriodendron tulipifera* Linné, a living form, introduced for comparison.

FIGURE 4. *Magnolia newberryi* Berry, from Glen Allen, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34865).. 89

All the fossils are from the Tuscaloosa formation.

PLATE XXI.

Page.

FIGURE 1. *Laurophyllum nervillosum* Hollick, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34866) 123

FIGURE 2. *Persea valida* Hollick, from Cottondale, Tuscaloosa County, Ala. (U. S. Nat. Mus. Cat. No. 34867) 119

FIGURE 3. *Malapoenna cretacea* (Lesquereux) Knowlton, from Cottondale, Tuscaloosa County, Ala. (U. S. Nat. Mus. Cat. No. 34868) 121

FIGURE 4. *Malapoenna cottondalensis* Berry, from Cottondale, Tuscaloosa County, Ala. (U. S. Nat. Mus. Cat. No. 34869) 121

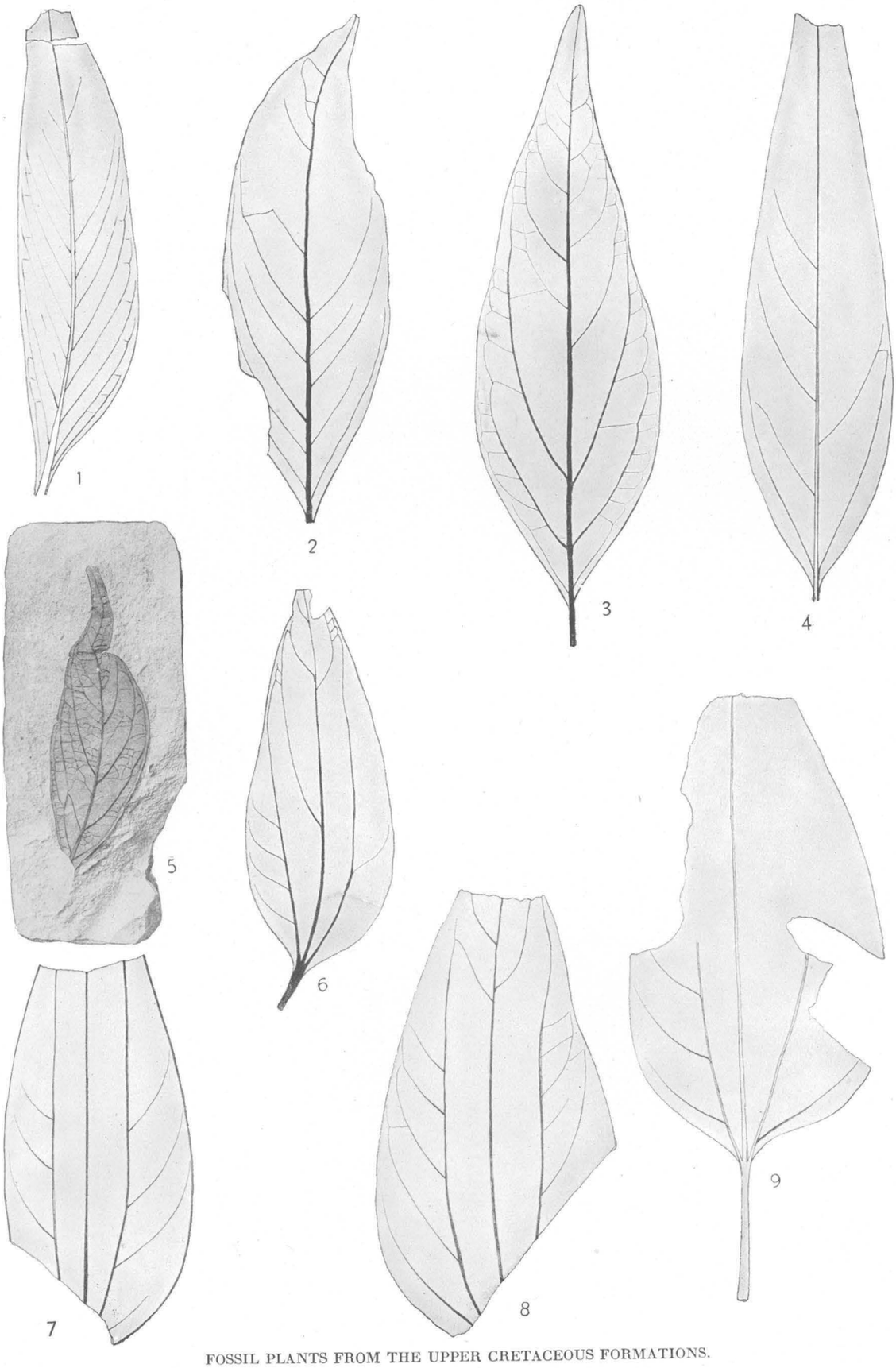
FIGURE 5. *Malapoenna falcifolia* (Lesquereux) Knowlton, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34870) 122

FIGURES 6–9. *Cinnamomum newberryi* Berry 118

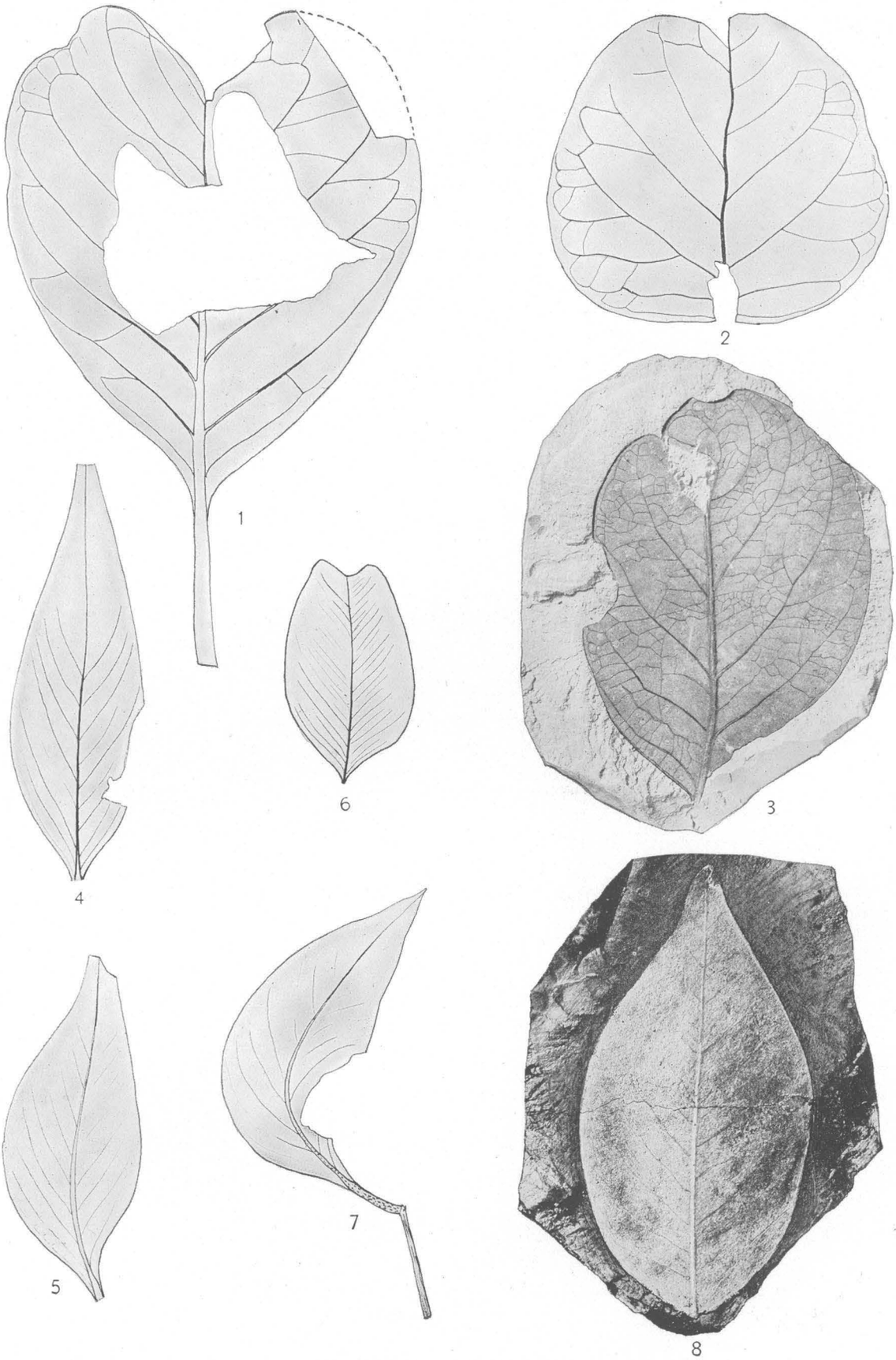
6. Specimen from Glen Allen, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34871).

7–9. Specimen from Cottondale, Tuscaloosa County, Ala. (U. S. Nat. Mus. Cat. Nos. 34872–34874).

All specimens are from the Tuscaloosa formation.



FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.



FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.

PLATE XXII.

Page.

FIGURE 1. *Capparites cynophylloides* Berry, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34875) 95

FIGURES 2, 3. *Capparites orbiculatus* Berry, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. Nos. 34876, 34877) 96

FIGURES 4, 5. *Inga cretacea* Lesquereux, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. Nos. 34878, 34879) 96

FIGURE 6. *Liriodendropsis simplex* (Newberry) Newberry, from Glen Allen, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34880) 101

FIGURE 7. *Phaseolites formus* Lesquereux, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34881) 101

FIGURE 8. *Cassia vaughani* Berry, from Glen Allen, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34882) 100

All specimens are from the Tuscaloosa formation.

PLATE XXIII.

Page.

FIGURE 1. *Paleocassia laurinea* Lesquereux, from the Tuscaloosa formation at Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34883) 100

FIGURE 2. *Hymenaea fayettensis* Berry, from the Tuscaloosa formation at Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34884) 97

FIGURE 3. *Colutea obovata* Berry, from the Tuscaloosa formation at Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34885) 101

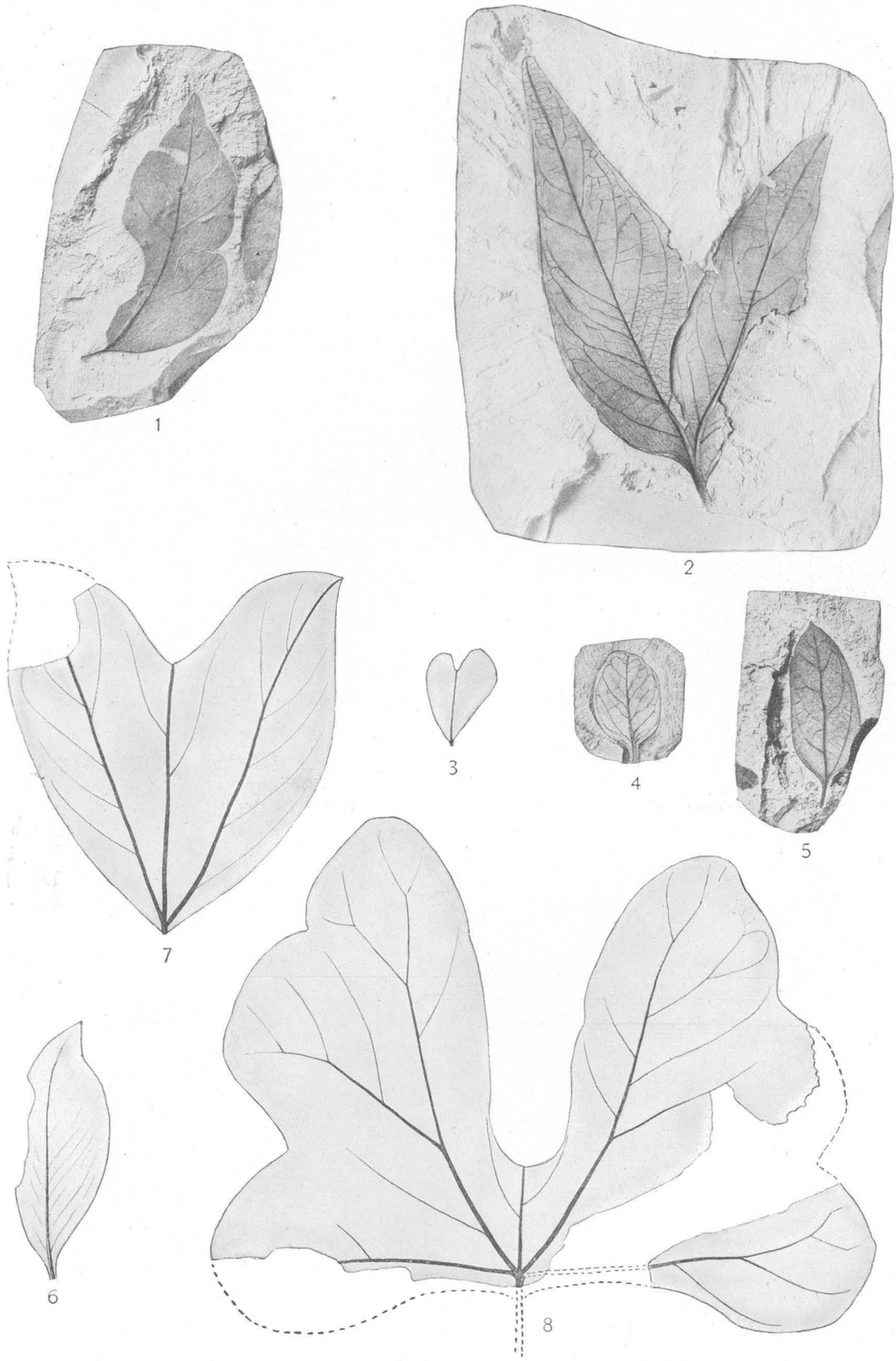
FIGURE 4. *Leguminosites shirleyensis* Berry, from the Tuscaloosa formation at Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34886) 104

FIGURE 5. *Leguminosites ingaefolia* Berry, from the Tuscaloosa formation at Glen Allen, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34887) 103

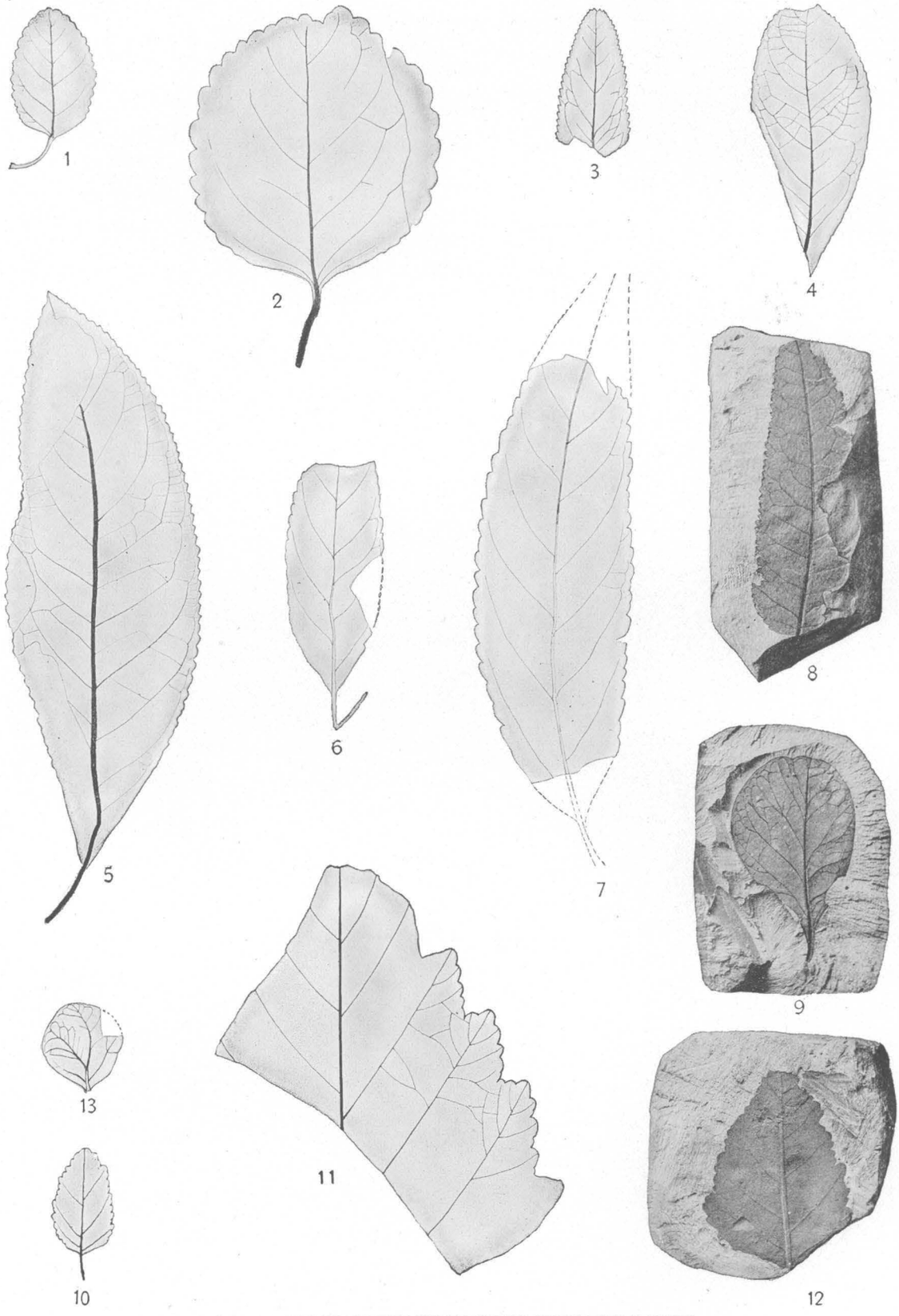
FIGURE 6. *Leguminosites tuscaloosensis* Berry, from the Tuscaloosa formation at Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 3488) 104

FIGURE 7. *Bauhinia ripleyensis* Berry, from the Ripley formation on Cowikee Creek, Barbour County, Ala. (U. S. Nat. Mus. Cat. No. 34889) 100

FIGURE 8. *Bauhinia alabamensis* Berry, from the Eutaw formation at Havana, Hale County, Ala. (U. S. Nat. Mus. Cat. No. 34890) 99



FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.



FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.

PLATE XXIV.

Page.

FIGURES 1, 2. *Celastrophyllum crenatum ellipticum* Berry, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. Nos. 34891, 34892) 110

FIGURE 3. *Celastrophyllum shirleyensis* Berry, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34893) 107

FIGURE 4. *Celastrophyllum brittonianum* Hollick, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34894) 110

FIGURE 5. *Celastrophyllum grandifolium* Newberry, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34895) 108

FIGURES 6, 7. *Celastrophyllum carolinensis* Berry, from gully on Snow place, Tuscaloosa County, Ala. (U. S. Nat. Mus. Cat. Nos. 34896, 34897) 109

FIGURE 8. *Celastrophyllum shirleyensis* Berry, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34898) 107

FIGURE 9. *Celastrophyllum gymindaefolium* Berry, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34899) 111

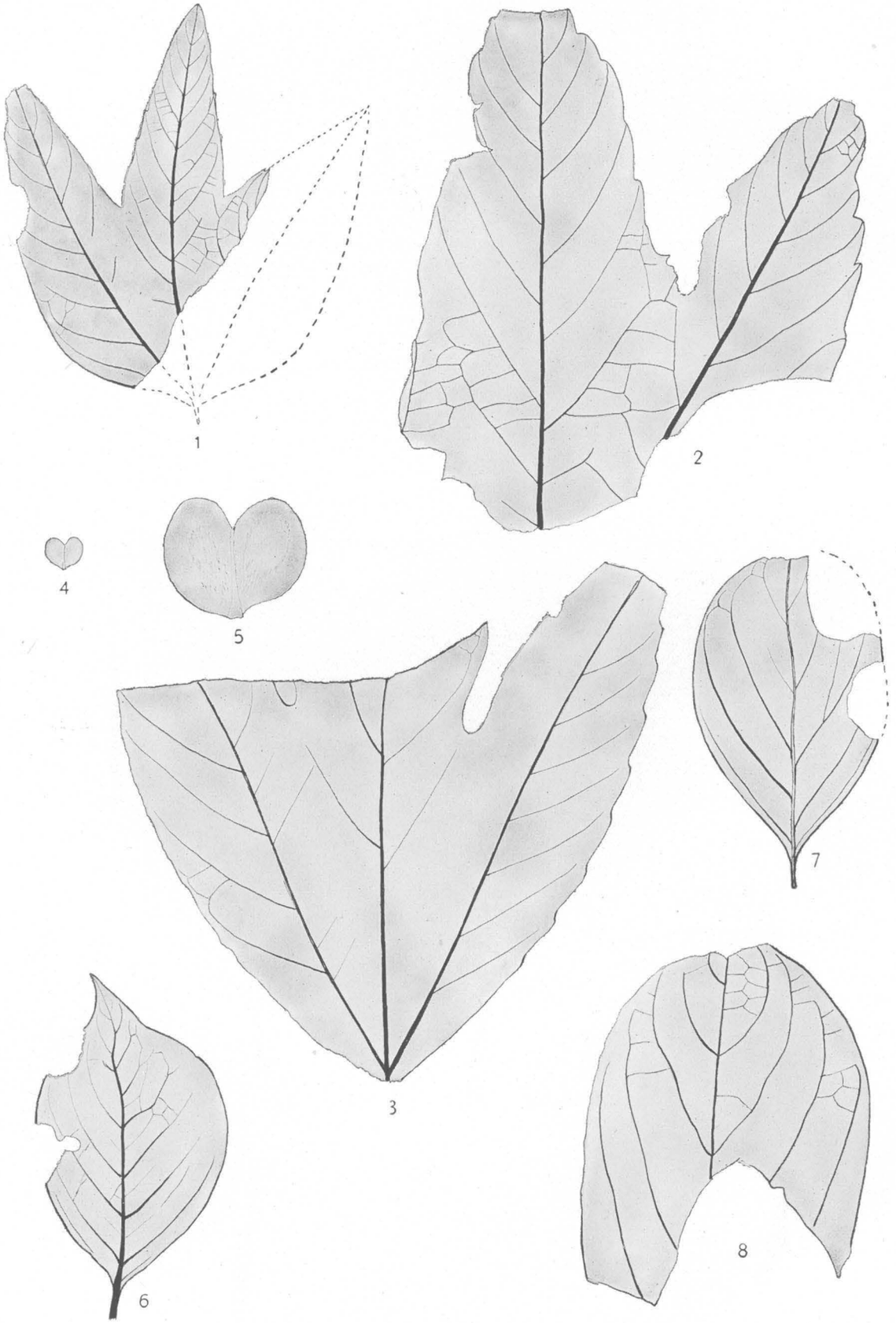
FIGURES 10–12. *Celastrophyllum alabamensis* Berry, from a locality near Centerville, Bibb County, Ala. (U. S. Nat. Mus. Cat. Nos. 34900–34902) 110

FIGURE 13. *Celastrophyllum praecrassipes* Berry, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34903) 111

All specimens are from the Tuscaloosa formation.

PLATE XXV.

FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.



FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.

PLATE XXVI.

Page.

FIGURES 1–3. *Aralia cottondalensis* Berry, from Cottondale, Tuscaloosa County, Ala. (U. S. Nat. Mus. Cat. Nos. 34912–34914) 128

FIGURES 4, 5. *Panax cretacea* Heer 128

4. Specimen from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34915).

5. Specimen shown in figure 4, × 4.

FIGURE 6. *Nyssa snowiana* Lesquereux, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34916). 129

FIGURES 7, 8. *Cornophyllum obtusatum* Berry, from Cottondale, Tuscaloosa County, Ala. (U. S. Nat. Mus. Cat. No. 34917; specimen shown in fig. 8 has been destroyed) 129

All specimens are from the Tuscaloosa formation.

PLATE XXVII.

Page.

FIGURES 1–3. *Sapindus variabilis* Berry, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. Nos. 34918–34920) 111

FIGURE 4. *Diospyros rotundifolia* Lesquereux, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34921) 135

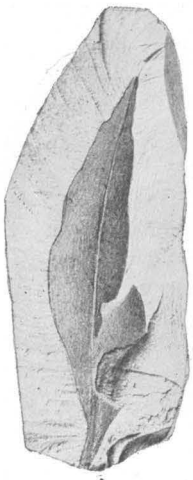
FIGURE 5. *Diospyros amboyensis* Berry, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34922). 134

FIGURE 6. *Andromeda wardiana* Lesquereux, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34923) 132

FIGURE 7. *Andromeda grandifolia* Berry, a small form from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34924) 131

FIGURE 8. *Dermatophyllites acutus* Heer, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34925) 132

All specimens are from the Tuscaloosa formation.



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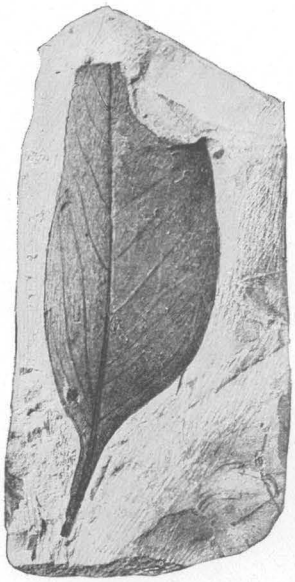

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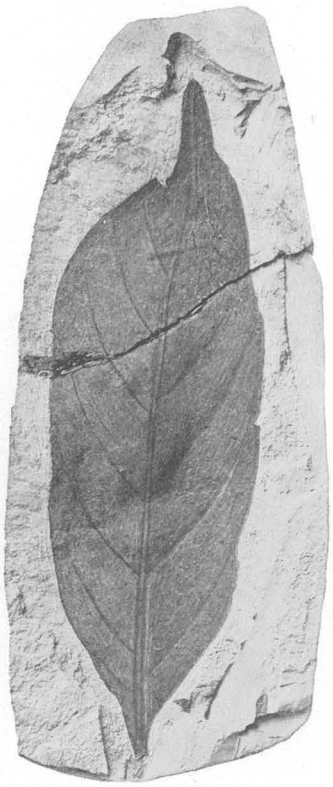

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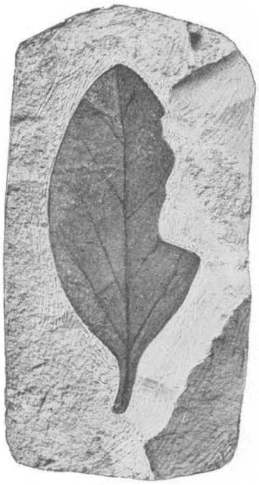

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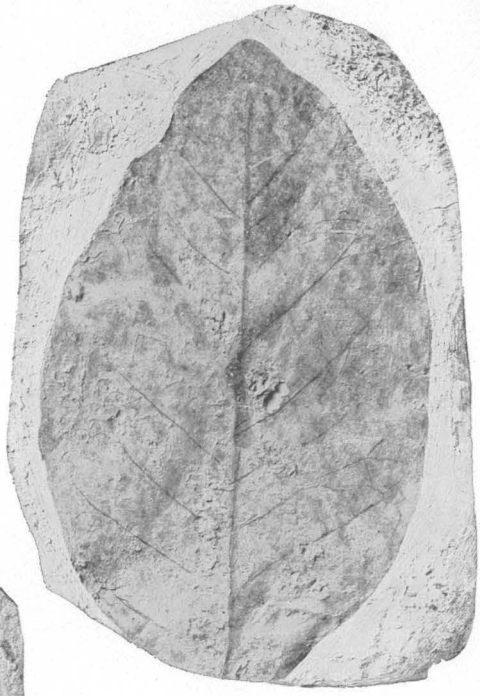

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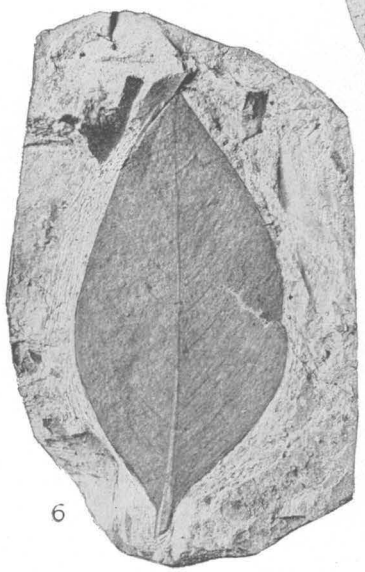

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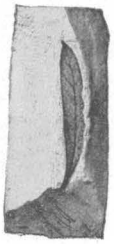

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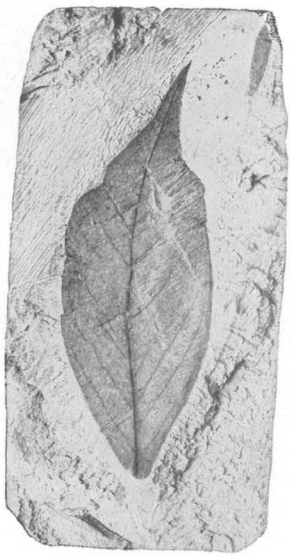

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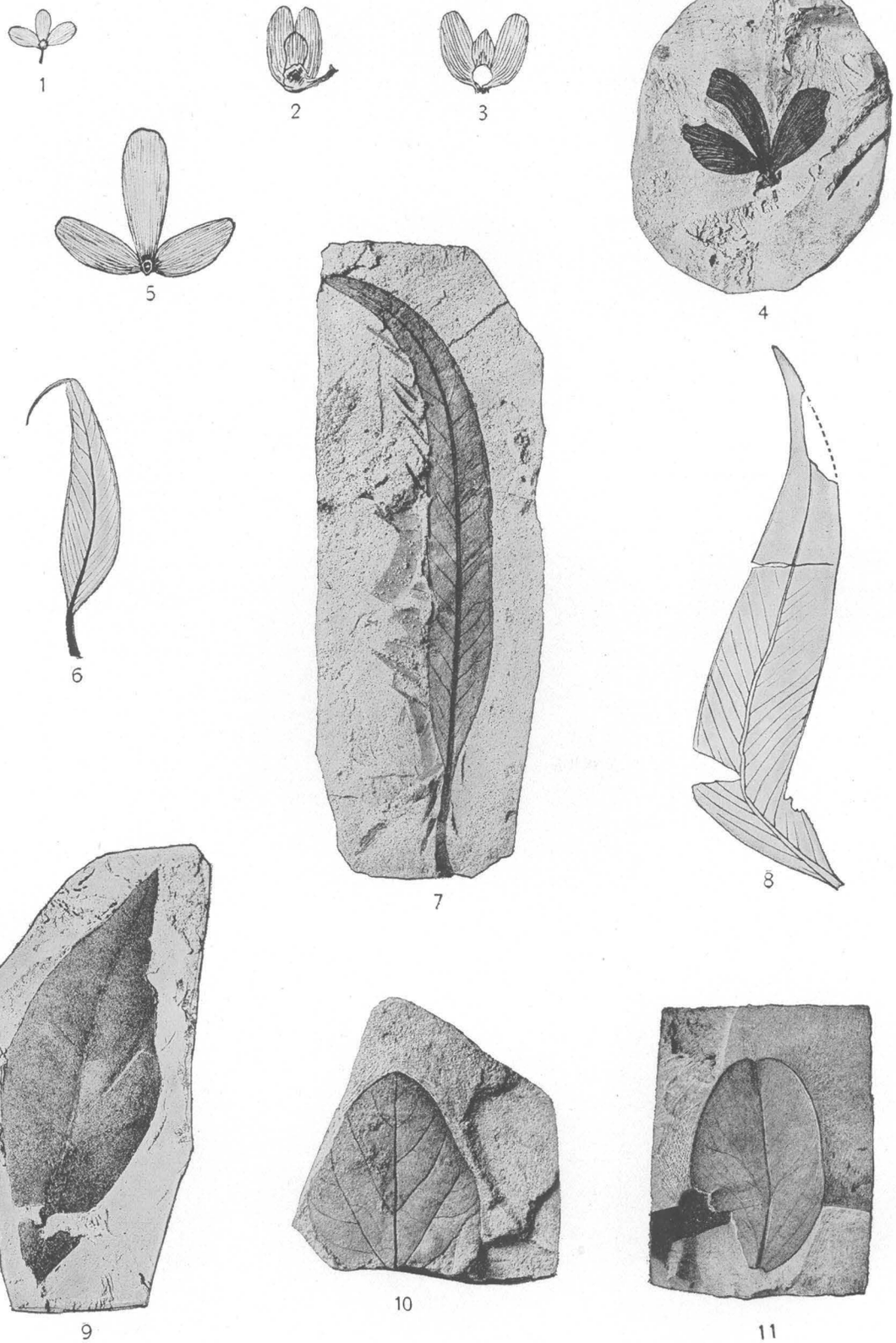
FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.



FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.

PLATE XXVIII.

Page.

FIGURES 1–5. *Tricalycites papyraceus* Newberry, from the Tuscaloosa formation at Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. Nos. 34926–34930) 137

FIGURE 6. *Eugenia tuscaloosensis* Berry, from the Tuscaloosa formation at Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34931) 125

FIGURE 7. *Myrcia havanensis* Berry, from the Eutaw formation at Havana, Hale County, Ala. (U. S. Nat. Mus. Cat. No. 34932) 125

FIGURE 8. *Eucalyptus geinitzi* (Heer) Heer, from the Tuscaloosa formation in gully on Snow place, Tuscaloosa County, Ala. (U. S. Nat. Mus. Cat. No. 34933) 126

FIGURE 9. *Conocarpites formosus* Berry, from the Tuscaloosa formation at Glen Allen, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34934) 127

FIGURE 10. *Eorhamnidium cretaceum* Berry, from the Tuscaloosa formation at Cottondale, Ala. (U. S. Nat. Mus. Cat. No. 34935) 113

FIGURE 11. *Sapotacites shirleyensis* Berry, from the Tuscaloosa formation at Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34936) 135

PLATE XXIX.

Page.

FIGURE 1. *Carpolithus floribundus* Newberry, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34937) 131

FIGURE 2. *Phyllites pistiaeformis* Berry, from a locality near Iuka, Tishomingo County, Miss. (U. S. Nat. Mus. Cat. No. 34938) 140

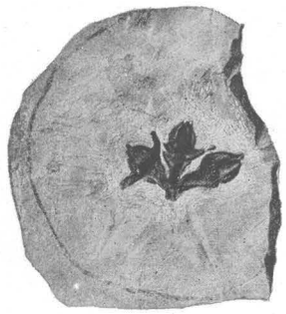
FIGURE 3. *Phyllites shirleyensis* Berry, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34939). 139

FIGURES 4–6. *Sapotacites shirleyensis* Berry, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. Nos. 34940–34942) 135

FIGURE 7. *Sapotacites ettingshauseni* Berry, from Shirleys Mill, Fayette County, Ala. (U. S. Nat. Mus. Cat. No. 34943) 135

FIGURE 8. *Calycites sexpartitus* Berry, from gully on Snow place, Tuscaloosa County, Ala. (U. S. Nat. Mus. Cat. No. 34944) 139

All specimens are from the Tuscaloosa formation



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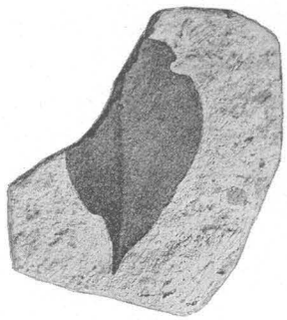

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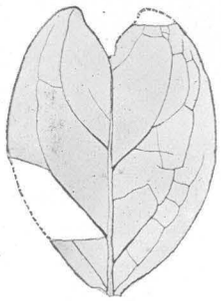

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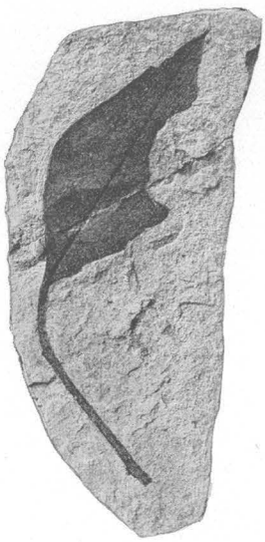

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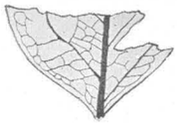

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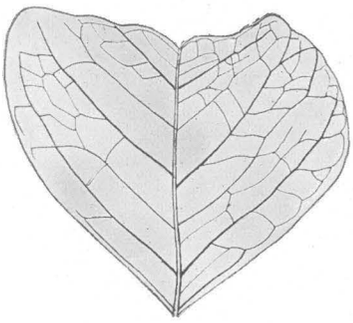

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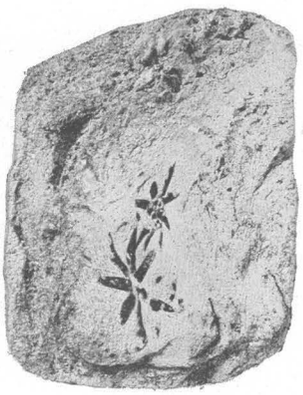

8

FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.

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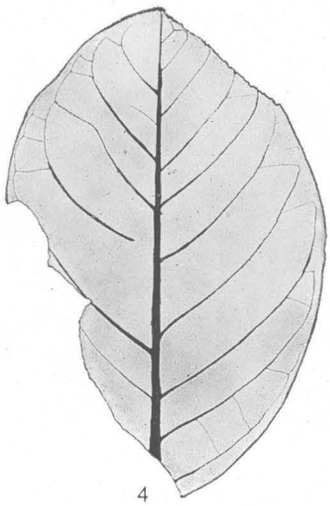

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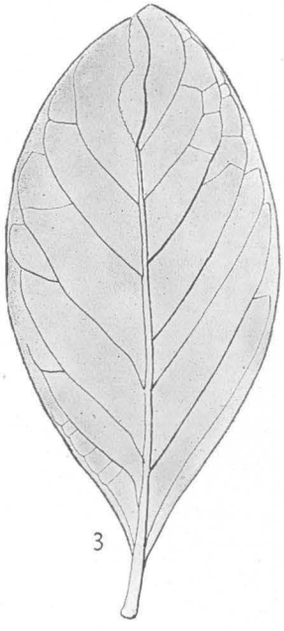

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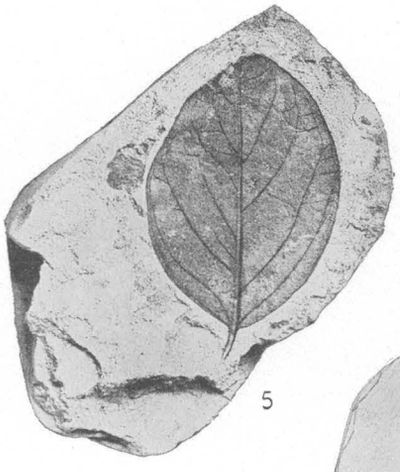

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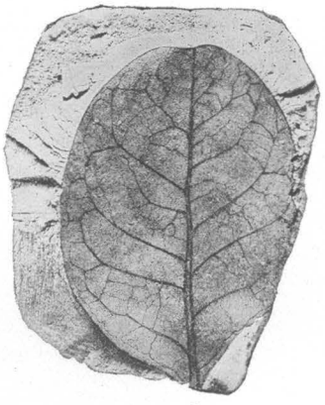

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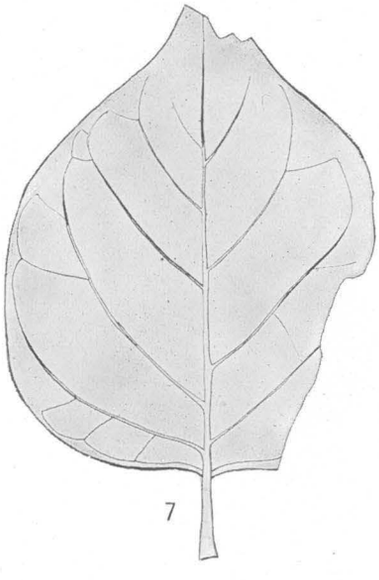


7

8

FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.

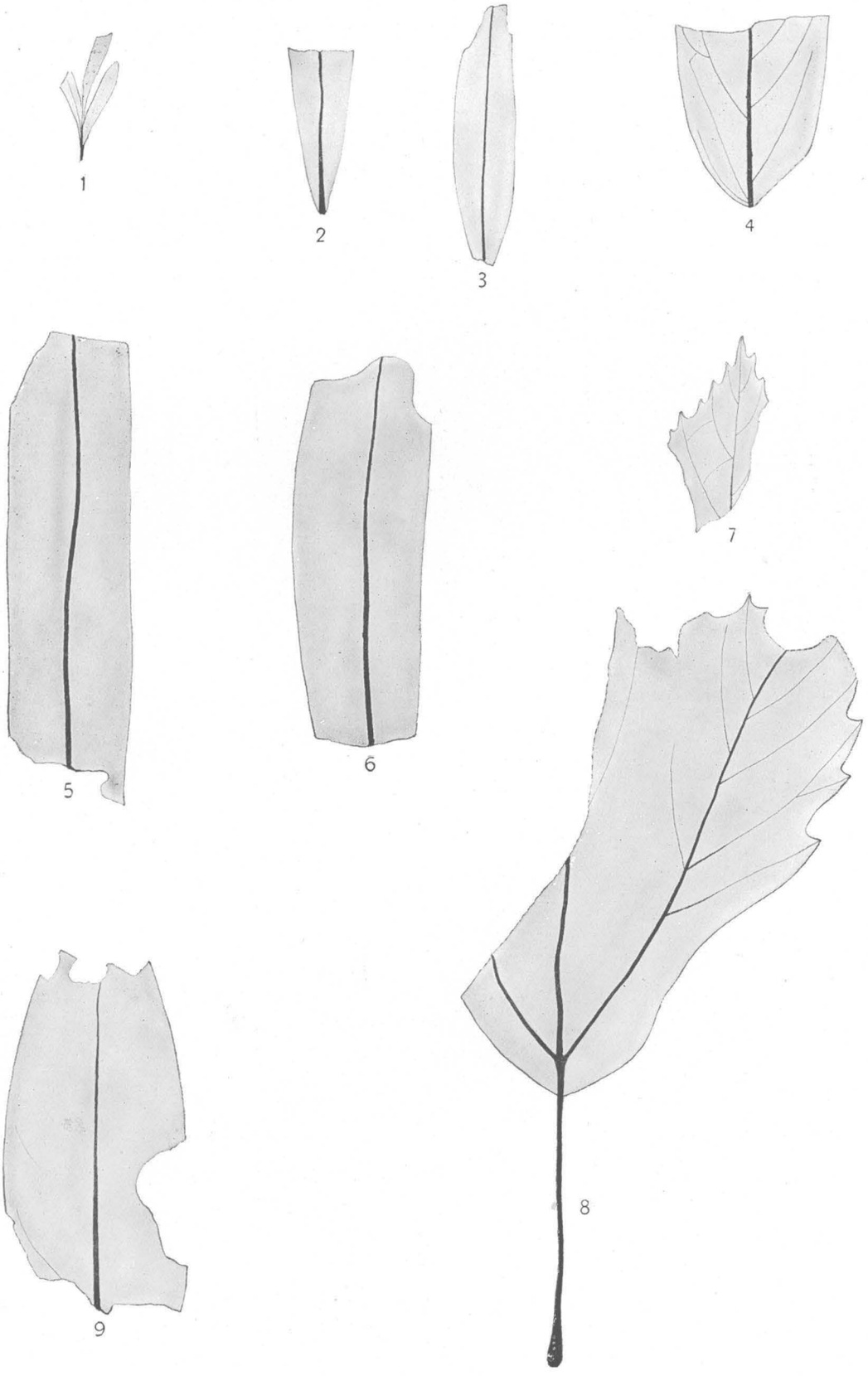
PLATE XXX.

PLATE XXXI.

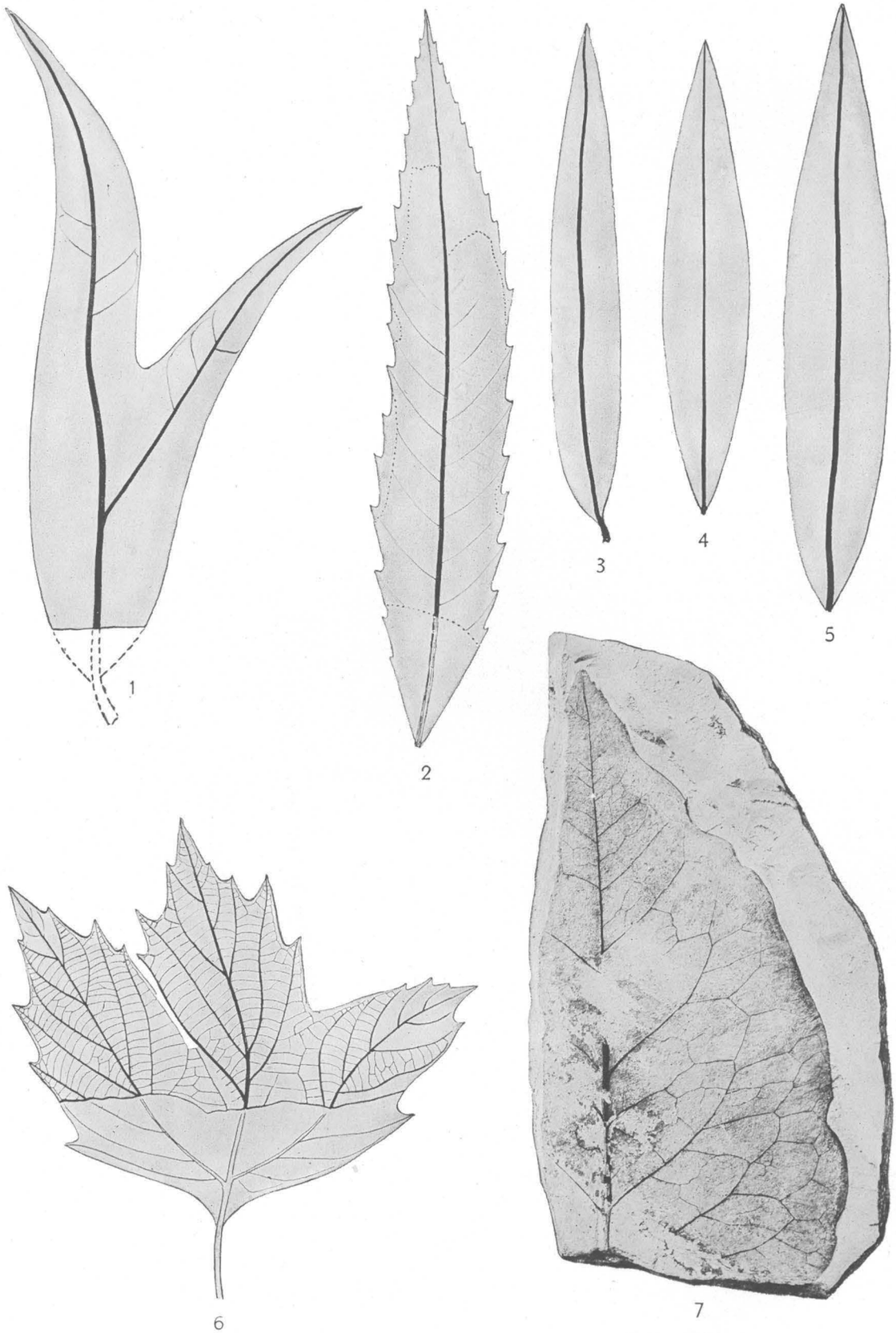
Page.

FIGURE 1. Undeterminable fern pinna (U. S. Nat. Mus. Cat. No. 34953).
FIGURES 2, 3. Undeterminable leaf of *Salix* or *Laurus* (U. S. Nat. Mus. Cat. Nos. 34954, 34955).
FIGURE 4. Undeterminable leaf of *Sapindus* (U. S. Nat. Mus. Cat. No. 34956).
FIGURES 5, 6. Undeterminable leaf, possibly of *Myrica* (U. S. Nat. Mus. Cat. Nos. 34957, 34958).
FIGURES 7, 8. *Platanus* sp. (U. S. Nat. Mus. Cat. Nos. 34959, 34960)..... 85
FIGURE 9. Undeterminable leaf, possibly of *Laurus* (U. S. Nat. Mus. Cat. No. 34961).

All specimens are from the Ripley formation on Cowikee Creek, Barbour County, Ala.



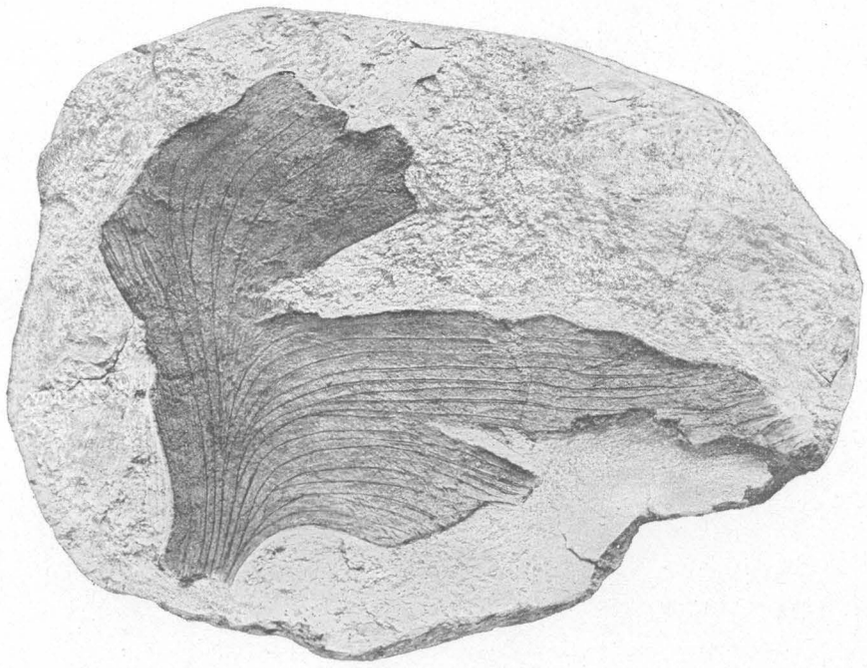
FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.



FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.

PLATE XXXII.

PLATE XXXIII.



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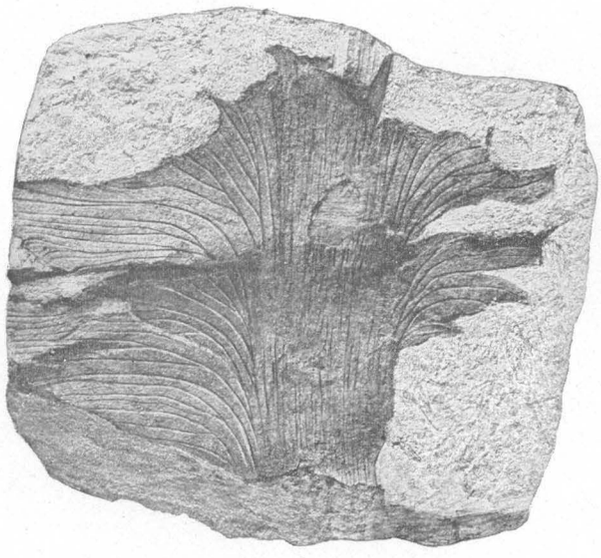

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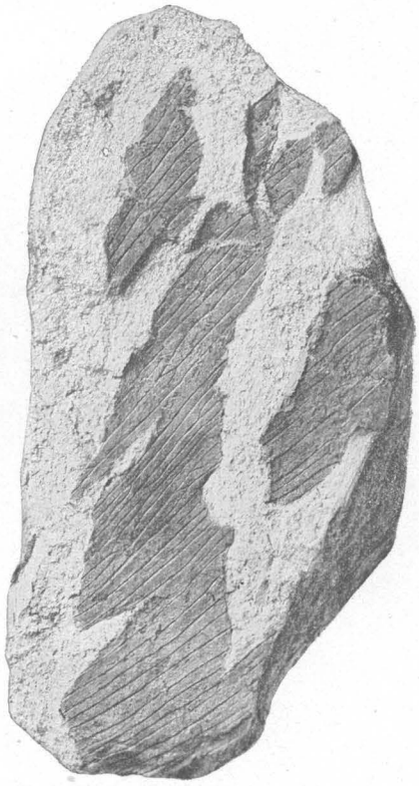

3

FOSSIL PLANTS FROM THE UPPER CRETACEOUS FORMATIONS.

INDEX.

Names in *italic* are synonyms; figures in **black face** indicate descriptions; figures in *italic* indicate illustrations.

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