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THE UPPER CRETACEOUS AND EOCENE FLORAS OF SOUTH CAROLINA AND GEORGIA

BY

EDWARD WILBER BERRY

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THE UPPER CRETACEOUS AND EOCENE FLORAS OF SOUTH CAROLINA AND GEORGIA.

By Edward Wilber Berry.

THE UPPER CRETACEOUS FLORA OF SOUTH CAROLINA.

INTRODUCTION.

The following report is the first systematic account of fossil plants from the State of South Carolina. It describes a considerable flora, which clearly demonstrates the Upper Cretaceous age of the deposits in which it is found and which serves to correlate these deposits with the Upper Cretaceous of adjacent States both to the north and to the south.

The present study should be regarded as preliminary in nature, for it is probable that when the Coastal Plain of the State is exhaustively studied many new localities for fossil plants will be discovered and many new species will be added to the Cretaceous flora; not uncommonly Upper Cretaceous floras consist of two or three hundred species. What is already known of the flora of the Middendorf arkose member of the Black Creek formation renders it certain that if additional plant-bearing outcrops are discovered they will yield a large variety of beautifully preserved leaf impressions.

The writer is under obligations to Mr. Earle Sloan, formerly State geologist of South Carolina, and to the United States National Museum for various collections; to Mr. T. W. Vaughan, of the United States Geological Survey, under whom the work has been prosecuted; and especially to Mr. L. W. Stephenson, of the United States Geological Survey, for the care and intelligence with which he has collected fossil plants in this area.

HISTORICAL SKETCH.

The distinction of definitely recognizing the occurrence of the Cretaceous in North America belongs to Lardner Vanuxem,[1] at one time professor of chemistry in the College of South Carolina, who announced its presence in 1829, although John Finch five years earlier had pointed out that part of the "alluvial formation" of Maclure was probably of newer "Secondary" age.[2] In the paper announcing Vanuxem's thesis several Cretaceous localities are mentioned in South Carolina, including Mars Bluff on Peedee River. A number of references to the Cretaceous of the State are contained in the works of Morton, Hodge, and others. Lyell visited the State in 1841–42 and recognized the Eocene age of certain calcareous rocks which had previously been included in the Cretaceous.

At the time of Lyell's visit, or a little later, geologists were well acquainted with the Cretaceous area extending from Cape Fear River in North Carolina to Peedee and Lynches rivers in South Carolina, as is witnessed by Henry D. Rogers's address before the Association of American Geologists and Naturalists at Washington in 1844.[3] All the preceding contributions, however, as well as the descriptions of Cretaceous deposits included by Prof. Tuomey in his Geology of South Carolina, refer exclusively to the fossiliferous marine Cretaceous, which nearly coincides with the present Peedee sand. The large area of Lower Cretaceous beds, as well as the deposits of most of the Black Creek formation, including the Middendorf arkose

[1] Vanuxem, Lardner, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, 1829, pp. 59–71; Am. Jour. Sci., 1st ser., vol. 16, 1829, pp. 254–256.
[2] Finch, John, Am. Jour. Sci., 1st ser., vol. 7, 1824, pp. 31–43.
[3] Rogers, H. D., Am. Jour. Sci., 1st ser., vol. 47, 1844, p. 252.

member, were regarded by Tuomey as of Eocene age and are designated on his geologic map "Sand hills" and "Red Hill area."

South Carolina is not mentioned in Prof. Ward's exhaustive paper on the geographic distribution of fossil plants, published in 1889;[1] nevertheless, a perusal of the older literature shows that the earlier geologic workers occasionally encountered vegetable fossils. They were content, however, merely to mention the fact or to identify the fossils with leaves of trees in the existing flora which they were thought to resemble. For example, Michael Tuomey, in his admirable report on the geology of South Carolina,[2] speaks of "impressions of leaves, in a purplish clay" near Fort Motte on Congaree River and on the same page mentions having encountered—

> on the road, near the head branches of Halfway Swamp, thick beds of sand, containing water-worn nodules of marl and a log of silicified wood, of considerable size. Immediately beneath this is a bed of yellow, tenacious clay, with partings of fine sand and scales of mica. Between the laminæ of the clay we found very distinct impressions of the leaves of the oak, beech, and willow, with their most minute veins preserved. This, and the locality already described, are the only ones known where fossil vegetable remains have been found in the Eocene of the United States, with the exception of silicified wood and lignite, which are everywhere abundant.

This locality is in Orangeburg County and the horizon may possibly represent an Eocene leaf-bearing layer instead of the Cretaceous, for the Claiborne Eocene transgresses the Upper Cretaceous in northern Orangeburg County, and there are no recent records or collections of leaf impressions from this area. On page 154 of the same work, and again on page 211, Tuomey lists silicified wood, lignite, Quercus leaves, Fagus leaves, and Salix, erroneously classing the containing deposits as lower Eocene in age.

Lieber in his first annual report[3] gives considerable attention to what he calls the "brown coal of the Cheraws." He suggests its economic possibilities and records the "bituminized trunk of a tree in a lignite bed," figuring the trunk in his Plate II, figure 8. Lieber also regards these Upper Cretaceous beds as of Eocene age.

More recently Darton made a brief reconnaissance across the State and in a short paper published in 1895[4] records that "plant remains were observed at many points." He made no collections, however, and mentions no localities, and the remark quoted may be taken as one of a general nature. In 1904 Earle Sloan, until recently State geologist of South Carolina, published a report on the clays of that State that shows a most intimate acquaintance with all parts of its Coastal Plain. Fossil leaves are mentioned from three sections of the State,[5] near Aiken, near Middendorf, and at Rocky Point. This report is entirely economic in character, and the author merely records the presence of "dicotyledonous leaves" or identifies them from their resemblance to those of modern species as the leaves of the "elm, ash, cypress, willow, bay, cane, and pine." The containing beds, however, are correctly identified as of Cretaceous age. In 1907 the present writer[6] recorded nine species of characteristic Upper Cretaceous plants from Rocky Point, in Sumter County, contained in the collections of the geological department of Johns Hopkins University. At that time the original collector was not known, but it subsequently developed that the plants had been collected in 1895 by Prof. L. C. Glenn.

In the spring of 1897 Profs. Ward and Glenn visited South Carolina and made large collections from the Rocky Point locality and a small collection from the locality near Darlington. The important localities near Middendorf and in Aiken County had meanwhile been discovered by Earle Sloan, who sent collections from these areas to Prof. Ward. These collections, however, were never studied. In 1906 the writer, in company with L. W. Stephenson, made a canoe trip from Cheraw to the mouth of Peedee River, after which Mr. Stephenson spent considerable time in the eastern part of the State. In 1907 the writer paid a brief visit to the Congaree-Wateree area and collected from the Rocky Point locality. In a canoe trip down

[1] Ward, L. F., Eighth Ann. Rept. U. S. Geol. Survey, pt. 2, 1889, pp. 663–960.
[2] Tuomey, Michael, Report on the geology of South Carolina, Columbia, 1848, p. 150.
[3] Lieber, O. M., Report on the survey of South Carolina, 2d edition, 1858, p. 94.
[4] Darton, N. H., Bull. Geol. Soc. America, vol. 7, 1896, p. 517.
[5] Sloan, Earle, A preliminary report on the clays of South Carolina, ser. 4, Bull. South Carolina Geol. Survey No. 1, 1904, pp. 26, 76, 104.
[6] Berry, E. W., Johns Hopkins Univ. Circ., new ser., No. 7, 1907, p. 81.

Congaree River during the same year a small collection from the banks of that river was made by Profs. B. L. Miller and M. W. Twitchell. In the spring of 1908 Mr. Stephenson spent some time in the State, making collections from the Black Creek formation of the eastern part of the State as well as from deposits near Middendorf and Langley. Subsequently Mr. Stephenson and the writer made extensive collections from Cretaceous beds near Middendorf and Langley. In 1910 Earle Sloan sent the writer a collection from Miles Mill in Aiken County. All these collections have come into the hands of the writer and are the basis of the present report. The identifiable material is deposited in the United States National Museum.

GEOLOGY OF CRETACEOUS DEPOSITS OF SOUTH CAROLINA.

The Cretaceous deposits of South Carolina form a belt of varying width extending entirely across the State east-northeast and west-southwest. This belt is narrow toward the Georgia line, being only about 20 miles in width at Savannah River, but widens northeast of Black River to nearly 100 miles. Both Lower and Upper Cretaceous deposits are represented.

LOWER CRETACEOUS SERIES.

On the southeastern margin of the crystalline rocks of the Piedmont Plateau, at an elevation of 400 to 500 feet or slightly more, lies a series of white and colored clays, in many places pure kaolins, and of arkosic, locally micaceous, coarse or fine sands with clay balls and, toward the base, subangular pebbles. The deposits are in a few localities lignitic, but no recognizable plant fossils have been collected. The beds dip 50 or 60 feet to the mile toward the southeast and have an estimated thickness of 200 to 300 feet. They constitute the "Hamburg phase" of Sloan, which in the Aiken area is separated by a local unconformity into two divisions, called by Sloan "Lower Hamburg" and "Upper Hamburg." They appear to be continuous with the Patuxent ("Cape Fear") formation of North Carolina and thus to represent the basal formation of the Potomac group of the Maryland-Virginia area. To the southwest they appear to be continuous with the Lower Cretaceous deposits of Georgia, which have been erroneously correlated with the Tuscaloosa formation (Upper Cretaceous) of Alabama by the Georgia Geological Survey. According to the evidence afforded by poorly preserved plants, however, the Lower Cretaceous deposits of Georgia and Alabama appear to be younger than the Patuxent formation of the type region.

UPPER CRETACEOUS SERIES.

BLACK CREEK FORMATION.

Middendorf arkose member.—A somewhat similar series of cross-bedded, varicolored, micaceous, and in many places arkosic sands, containing pebbles, clay balls, and local deposits of nearly pure kaolin unconformably overlies the Lower Cretaceous deposits. These beds, which are here called Middendorf arkose member, are between 100 and 200 feet in thickness and consist to a large extent of reworked Lower Cretaceous materials. They can be traced interruptedly nearly across the State, being transgressed by the Eocene at several points southwest of Lynches River and either replaced by partly contemporaneous deposits of a different character or transgressed by later Cretaceous in the northeastern part of the State. These beds, which constitute the Middendorf formation of Sloan, in places carry a rich and varied fossil flora of Upper Cretaceous age. Along the landward margin of their outcrop their lithologic features are in marked contrast with the characteristic beds of the Black Creek formation, but farther southward, for example, in the Congaree River valley, the Middendorf member commonly exhibits micaceous, lignitic sandy phases, and dark laminated argillaceous phases exactly similar to those of the typical Black Creek but less extensively developed. On the other hand, the Black Creek formation as developed in North Carolina contains a great thickness of light and highly colored cross-bedded sands similar to those of the Middendorf member of South Carolina, and it there covers the time interval of the Middendorf member. The Middendorf therefore has been adopted by the Survey as a member of the Black Creek formation.

Other deposits.—In part later than the Middendorf member and in part contemporaneous with it is a series of dark laminated clays (shales) with sand partings and lenses of micaceous fine-grained sands. These clays, which constitute the Black Creek formation of Sloan, are confined to the eastern part of the State, covering the southern half of Marlboro County, the northwestern part of Marion County, the northern part of Florence County, nearly all of Darlington County, and the southeastern part of Lee County, their areal outcrop being terminated abruptly by the transgression of the Eocene in south-central Lee County. These beds are extensively developed in North Carolina, where they attain great thickness. The lower part of these beds probably represents most, if not all, of the Middendorf sedimentation, as well as that of the period intervening between the close of the Middendorf and the beginning of the Peedee. Fossil plants of genera and species similar to those described from the North Carolina area have been collected from a number of localities in Chesterfield, Florence, and Darlington counties, but the exposures throughout this area are few and poor, owing to the flatness of the country, which is uniformly covered with a mantle of Pleistocene in addition to patches of Eocene and Miocene deposits. The area occupied by these deposits of the Black Creek formation in South Carolina has not been very extensively examined for fossil collections because there is no reason to believe that their flora differs in any respect from that found in the Black Creek formation in the North Carolina area, where the exposures are more plentiful.

As previously mentioned, the Middendorf member in the Congaree Valley contains lenses of micaceous lignitic sands and dark laminated clays like those of the typical Black Creek, indicating that at times the conditions which led to this great thickness of deposits along the north border of South Carolina prevailed farther toward the southwest. Like the Black Creek deposits of North Carolina, these beds of South Carolina are in places glauconitic, and pellets of amber are widely distributed in them.

PEEDEE SAND.

A series of compact sands, in many places fossiliferous, less commonly calcareous, and somewhat glauconitic, conformably [1] overlies the Black Creek formation where it is not transgressed by the Eocene. These sands constitute the Peedee sand, or the "Burches Ferry marls" of Sloan. They extend northeasterly into North Carolina. They are typically marine deposits, carrying the *Belemnitella americana* fauna, and are correlated with the Monmouth formation of the Northern Atlantic Coastal Plain and with the typical Ripley of northeastern Mississippi. They are not known to contain fossil plants in the South Carolina area and are confined to the eastern part of the State, where they are widely distributed, though commonly hidden by various Tertiary or Pleistocene deposits.

DESCRIPTION OF PLANT LOCALITIES.

To supplement the foregoing brief outline of the Cretaceous as developed in South Carolina, a few words may be devoted to the 11 different exposures where fossil plants have been collected.

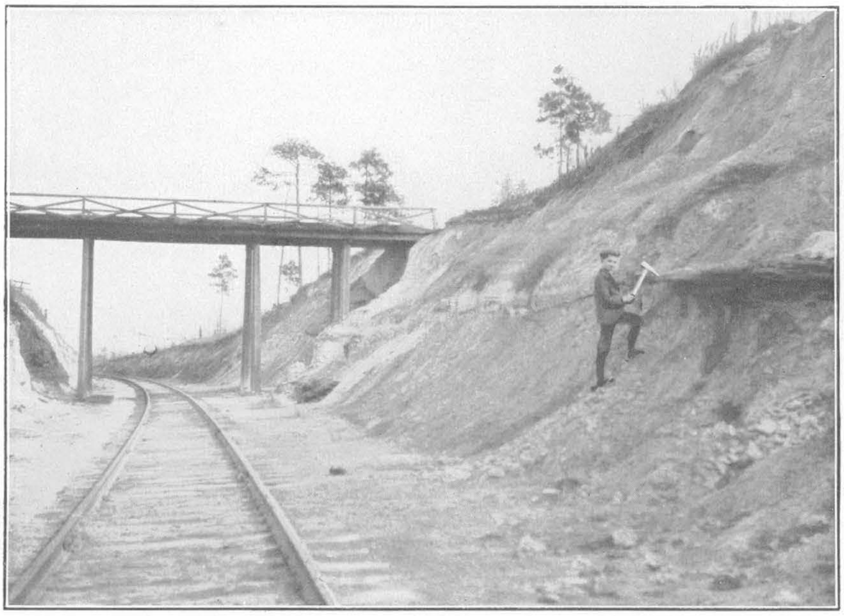
Localities referred to the Middendorf arkose member of the Black Creek formation are first considered, after which those in the other deposits of the Black Creek formation, in the order of their geographic succession to the southwest, are taken up.

1. Near Middendorf (*Field No. 3.7*).—This locality is near the Seaboard Air Line Railway, about 2 miles northeast of the town of Middendorf and immediately west of overhead wagon bridge 366. It is just south of the Camden wagon road and about 5 miles east of Big Black Creek. (See Pl. I, *A*.) The following section is exposed in the railroad cut:

Section exposed in railroad cut 2 miles northeast of Middendorf.

	Feet.
1. Surficial sandy loam, sand, and clay	4–10
2. Clay lens containing leaves	0–4
3. Cross-bedded arkosic sands, variegated in color	4–10

[1] Stephenson records an unconformity, presumably local, in Darlington County (unpublished notes).



A.

B.

PLANT-BEARING CLAY IN MIDDENDORF ARKOSIC MEMBER, BLACK CREEK FORMATION.

A, Near Middendorf, Chesterfield County, S. C.; *B*, Near Langley, Aiken County, S. C.

The leaves are found beneath a ferruginous crust about 3 inches thick, which is local and occurs only above the middle portion of the clay lens. They are for the most part replacements by ferric oxide and make very handsome specimens, the rusty red leaf contrasting against the background of light-buff kaolin, for the bright red of the freshly collected material fades only slightly in drying out. Toward each end of the cut the Pleistocene-Middendorf contact passes downward and disappears below the level of the track. The Middendorf member in this vicinity consists for the most part of sands, with the exception of the one prominent clay lens.

This is the most prolific locality for fossil plants in South Carolina, having furnished 41 of the recorded species. Most of these are splendidly preserved. The following species occur at the Middendorf locality:

Acaciaphyllites grevilleoides Berry.
Andromeda euphorbiophylloides Berry.
Andromeda novæcæsareæ Hollick.
Brachyphyllum macrocarpum Newberry.
Cæsalpinia middendorfensis Berry.
Calycites middendorfensis Berry.
Celastrophyllum crenatum Heer.
Cinnamomum middendorfensis Berry.
Citrophyllum aligerum (Lesquereux) Berry.
Crotonophyllum panduræformis Berry.
Diospyros primæva Heer.
Eucalyptus geinitzi (Heer) Heer.
Eucalyptus wardiana Berry.
Ficus atavina Heer.
Ficus celtifolius Berry.
Ficus crassipes Heer.
Ficus krausiana Heer.
Ficus stephensoni Berry.
Juglans arctica Heer.
Laurus plutonia Heer.
Laurophyllum elegans Hollick.
Laurophyllum nervillosum Hollick.
Leguminosites middendorfensis Berry.
Lycopodium cretaceum Berry.
Magnolia capellinii Heer?
Magnolia obtusata Heer.
Magnolia tenuifolia Lesquereux?
Momisia carolinensis Berry.
Moriconia americana Berry.
Onoclea inquirenda (Hollick) Hollick.
Pachystima? cretacea Berry.
Pinus raritanensis Berry.
Potamogeton middendorfensis Berry.
Proteoides lancifolius Heer.
Proteoides parvula Berry.
Quercus pseudowestfalica Berry.
Salix flexuosa Newberry.
Salix lesquereuxii Berry.
Salix pseudohayei Berry.
Sequoia reichenbachii (Geinitz) Heer.
Widdringtonites subtilis Heer.

By far the most abundant form is *Sequoia reichenbachii* (Geinitz) Heer, of which whole leafy branches, many with their cones attached, are present.

2. Rocky Point (Field No. 3.1).—This locality is one-half mile northeast of Sumter Junction, on the Camden division of the Southern Railway, along the eastern scarp of the Wateree Swamp, about 2½ miles east of the river and a short distance east of Beach Creek. The following section is exposed:

Section exposed at Rocky Point.

	Feet.
Pleistocene:	
Sand, coarse, reddish, argillaceous, more or less cemented, with iron crusts below	6
Pack sand, fine, light gray, stratified, becoming more ferruginous below	15–18
Eocene:	
Clay, brownish, laminated, with partings of light-gray sand	6–8
Upper Cretaceous (Middendorf arkose member of Black Creek formation):	
Sand, coarse, white and yellow, ferruginous, becoming very coarse below	5–6
Clay, lens, brownish, laminated	1
Sand, very coarse, ferruginous	4–5
Similar materials, more or less indurated	3–4
Clay, interlaminated, brownish, and clay ironstone with abundant leaf impressions	2
Sand, coarse, brown	2
Clay, laminated, brown, and clay ironstone crusts	3–4
Clay, more massive, weathering to reddish and purple	4–5
Sand, light drab, fine, with some clay laminæ and a few thin ferruginous crusts	10
Clay, light drab	10

The railroad at this point is 115 feet above sea level.

The following 26 species of fossil plants occur at this locality:

Andromeda grandifolia Berry.
Andromeda parlatorii Heer.
Arundo grœnlandica Heer?
Carex clarkii Berry.
Celastrophyllum elegans Berry.
Cinnamomum newberryi Berry.
Crotonophyllum panduræformis Berry.
Cunninghamites elegans (Corda) Endlicher.
Diospyros primæva Heer.
Diospyros rotundifolia Lesquereux.
Eucalyptus geinitzi (Heer) Heer.
Ficus atavina Heer.
Ficus crassipes Heer.
Ficus krausiana Heer.
Hamamelites (?) cordatus Lesquereux.
Heterolepis cretaceus Berry.
Illicium watereensis Berry.
Magnolia capellinii Heer?
Phragmites pratti Berry.
Podozamites knowltoni Berry.
Proteoides lancifolius Heer.
Protophyllocladus lobatus Berry.
Quercus pseudowestfalica Berry.
Quercus sumterensis Berry.
Salix lesquereuxii Berry.
Widdringtonites subtilis Heer.

Of these the various species of Ficus are the most abundant, *Ficus crassipes* Heer and *Ficus krausiana* Heer being especially common and well preserved. *Andromeda grandifolia* Berry and *Protophyllocladus lobatus* Berry are also common, the other species being represented by only a few individuals. This locality stands next to that near Middendorf in the variety of forms represented, but a good many of the specimens were in a rather fragmentary condition before entombment.

3. About 25 miles below Columbia (*Field No. 3.3*).—The plants from this locality, which is on the right bank of Congaree River, in Lexington County, are represented by faint impressions in a buff, almost white, micaceous, finely arenaceous, thinly laminated clay, and only the following forms, the majority tentatively identified, are recognizable:

Cinnamomum newberryi Berry (?).
Diospyros primæva Heer (?).
Ficus crassipes Heer.
Ficus krausiana Heer (?).
Salix flexuosa Newberry (?).
Salix lesquereuxii Berry (?).

The two species of Ficus are the most common. Dark laminated lignitic sandy clays along Congaree River in this vicinity show the typical lithology of the Black Creek formation farther to the northeast.

4. Near Langley (*Field No. 3.8*).—This locality is just east of the old Augusta road, 1 mile north of the town of Langley and one-half mile west of Langley Dam, on Bighorse Creek, in Aiken County, in a shallow gully which has cut into clay of the Middendorf member to a depth of about 8 feet. The material is a massive, nearly white kaolin ("chalk"), and the leaf impressions, which are not common, are replacements by ferric oxide and show as a rich coffee color against the background of nearly white clay. (See Pl. I, *B*.)

The following 17 species have been identified from this locality:

Andromeda parlatorii Heer.
Araucaria jeffreyi Berry ?
Celastrophyllum carolinensis Berry.
Crotonophyllum panduræformis Berry.
Dewalquea smithi Berry.
Diospyros primæva Heer.
Eucalyptus geinitzi (Heer) Heer.
Ficus crassipes Heer.
Ficus stephensoni Berry.
Laurus plutonia Heer.
Leguminosites robiniafolia Berry.
Myrsine gaudini (Lesquereux) Berry.
Sabalites carolinensis Berry.
Salix flexuosa Newberry.
Salix lesquereuxii Berry.
Salix sloani Berry.
Sapindus morrisoni (Lesquereux MS.) Heer.

All are common, the Dewalquea, Diospyros, Sabalites, and the species of Salix and Ficus being most common and best preserved.

4a. Miles Mill (*Field No. 3.11*).—This locality is in northern Aiken County and has not been visited by the writer. The materials and preservation are the same as at the Langley locality, and the collection was made by Earle Sloan, former State geologist. The following species are present in the collection:

Citrophyllum aligerum Berry ?
Crotonophyllum panduræformis Berry.
Dewalquea smithi Berry.
Diospyros primæva Heer.
Quercus pseudowestfalica Berry ?
Salix lesquereuxii Berry.
Salix sloani Berry.

Of these seven species the Dewalquea is by far the most common at this locality. The Crotonophyllum is not rare, but the others are each represented by only one or two specimens.

5. *About 6 miles below Cheraw (Field No. 3.10)*.—This locality is in Chesterfield County and is represented by characteristic Black Creek materials carrying leaf remains, not in place, but washed upon a river sand bar from some undiscovered Black Creek outcrop in the vicinity. They could not have been carried far because of their character and because this point is at the exact landward margin of the Black Creek formation. Only one recognizable species, *Hedera primordialis* Saporta, is represented.

6. *About 8 miles east of Darlington (Field No. 3.2)*.—This exposure, on the west bank of Louthers Lake, one-half mile below the ferry, at a spring, shows about 18 feet of dark carbonaceous laminated clay with micaceous and locally glauconitic sand partings. About 1 foot from the top there is a 1-foot layer of lignitic sand and clay balls, and a foot or two below this layer imperfect leaf remains are plentiful. These include a Phragmites-like form and a lanceolate Ficus suggesting *Ficus crassipes* Heer, but the materials are too incomplete for identification. Amber in small drops is present at this outcrop. Louthers Lake is an oxbow of the Peedee, and the above exposure is about 6 miles west of the present river channel and near the eastern boundary of Darlington County.

7. *Right bank of Black Creek (Field No. 3.6)*.—This locality, 1½ miles east of Darlington and 750 feet south of the Cashua Ferry road bridge, shows a low exposure of characteristic Black Creek materials with poor plant remains. The only recognizable forms are *Araucaria darlingtonensis* Berry, *Ficus krausiana*, and *Strobilites anceps* Berry, although Mr. Stephenson reported seeds of Cephalotaxospermum, which were not found in the material sent in, though very probably they occur here, as they are found along Black Creek in the vicinity.

8. *Cashua Road (Field No. 3.4)*.—A low, poor exposure of a light chocolate-colored, poorly laminated clay of Black Creek age, containing abundant but much-macerated and rather faint leaf impressions appears just northeast of Darlington, near the foot of the slope leading down to Swift Creek and about 2 rods south of the road. This locality was visited by Ward and Glenn in 1897, and the small collection[1] made by them at that time was sent to Dr. Arthur Hollick at the New York Botanical Garden. The writer examined this collection in New York but failed to find any identifiable forms. The collection made by Stephenson in 1908 contains the following species:

Hedera primordialis Saporta ?
Laurophyllum nervillosum Hollick ?
Magnolia newberryi Berry ?
Myrica elegans Berry.
Proteoides lancifolius Heer ?
Rhus darlingtonensis Berry.
Salix lesquereuxii Berry ?

The last-mentioned form is the most abundant represented in the collection. In addition to plant forms indeterminable casts of invertebrates were found.

9. *Right bank of Black Creek (Field No. 3.9)*.—About 25 feet of dark carbonaceous clays interlaminated with yellowish, locally indurated, lignitic sand are exposed about 2 miles below Williamsons Bridge in Darlington County. Amber is present, and comminuted plant remains are plentiful and well distributed. The plant material is best preserved within a few feet of the base of the section, and the following forms have been recognized:

Eucalyptus angusta Velenovsky
Ficus krausiana Heer.
Myrica brittoniana Berry.

10. *Ashby's place, 3½ miles northeast of Florence (Field No. 3.5)*.—This exposure is beside a small branch flowing into Black Creek. Characteristic Black Creek materials at this point yielded the following species:

Algites americana Berry.
Araucaria bladenensis Berry.
Cephalotaxospermum carolinianum Berry.

[1] The exact locality of this collection was along a ditch north of the road, from the same outcrop.

Lignite is abundant, and the clays are full of fragments of indeterminable leaves of dicotyledons. They also contain obscure pelecypod impressions. The materials are dark, laminated, lignitic clays with micaceous sand partings and locally small clay lenses. They are exposed along the branch to a total thickness of 25 or 30 feet, separated into two nearly equal divisions by an intercalated lens of greenish-gray or yellowish rather fine sand with here and there small lenses of dark clay, the sand member being some 20 feet in thickness. Fossil plants occur both above and below the sand lens, detached leaves of the Araucaria being recognizable most commonly.

UPPER CRETACEOUS GEOLOGIC HISTORY OF SOUTH CAROLINA.

The geologic history of that portion of the Upper Cretaceous of South Carolina which has yielded fossil plants is not varied, although it apparently represents a considerable portion of Upper Cretaceous time as a whole. The data upon which the following brief sketch is based are both physical and biologic, and in order to avoid ambiguity of statement the Middendorf arkose member and the other deposits of the Black Creek formation are accorded more or less separate treatment. The deposits of the Middendorf member furnish satisfactory evidence of their origin, the method of their deposition, and the attendant physical conditions. Historically they represent the initial advance of the Upper Cretaceous sea over the coastal lands made up of the Lower Cretaceous arkosic sands and kaolin deposits. This advance was in point of time somewhat later than the initial sedimentation of the Tuscaloosa formation of Alabama, but was probably slightly earlier than the initial deposits of the typical Black Creek sedimentation.

Middendorf time was not of great duration, for the deposits are not thick and were for the most part formed rapidly, as evinced by the current bedding and coarseness of the sands. They represent littoral or beach deposits combined with delta deposits and with estuarine deposits in shallow bays or sounds. Geographically the conditions may be comparable with those in Albemarle and Pamlico sounds of eastern North Carolina, or less closely with those in the quiet estuaries of Chesapeake Bay, where fine-grained muds are being formed in certain areas at the present time. Topographically, however, the parallel is not so close, for the present-day topography is more mature and the relief is slight. Sections drawn across a number of recent bays and sounds along the South Atlantic and Gulf coasts show in some degree what must have been the topography in South Carolina at the beginning of Middendorf sedimentation, except that the modern shores are low. In Middendorf time the Coastal Plain was represented by a comparatively narrow strip of Lower Cretaceous deposits and the eastern flank of the Piedmont was considerably more elevated than it is to-day, so that the earlier deposits of the Middendorf, at least, are more largely sands than the deposits now forming along the seaward margin of the Coastal Plain. These conditions for the Middendorf member may be most simply illustrated by the probable history of a single valley. The Lower Cretaceous surface may be imagined to represent the emerged land surface before the depression or warping or other process that inaugurated the Upper Cretaceous cycle of deposition as it is known to-day. Terrestrial aggradation deposits would be laid down on both valley slopes, and fluviatile or lacustrine deposits would be laid down at some points along its floor. With the changes in relative level the valley would become a bay, estuary, or sound, and the quickened erosion would rapidly build out deltas or alluvial fans along its western margin. This would segregate the coarser sediments, and the finer particles, as well as a large part of the floating carbonaceous matter and minute flakes of mica, would be carried beyond the coarser materials along the shore and ultimately deposited in laminated clays of the Black Creek type. A brief study of similar physiographic deposits of the present confirms the essential correctness of this supposition. The interaction of forces would surely develop some relief of the surface of the sand flats; bars or atolls would be formed from the coarser materials and within the lagoons inclosed by them the kaolins would be deposited. That the sea did not have free access to the area is shown by the complete absence of evidence of marine life in the Middendorf member and other early Black Creek sediments. The fact that remains of terrestrial, fluviatile, or estuarine animals are not found must be attributed to the nature of the sedimentation just outlined. The streams were numerous and more or less torrential in character, piling up their sediments as a series of alluvial fans which finally merged and were completely united by the sediments of the advancing sea. The kaolins were meanwhile deposited in the sheltered basins. Deposits of this kind are rarely fossiliferous, as is evinced by the lack of fossils in other analogous series. The Lower Cretaceous of the Coastal Plain outcrops for several hundred miles along the eastern margin of the Piedmont, but it contains very few fossil plants, and after several decades of exploration not more than half a dozen scarcely determinable shells and a single fragmentary fish have been found in it.

In time the Piedmont river gradients were lessened and river and coastal swamps became more numerous. With continued subsidence such barriers as existed, whether sand bars or islands comparable to the North Carolina "banks," were submerged, and the sediments began to take on a typical marine character and to consist of laminated sands and clays with some glauconite and much vegetable débris derived for the most part from the coastal swamps. Thus sedimentation of the typical Black Creek type commenced considerably earlier toward the North Carolina border than to the southwest—in fact, there are no traces of such sediments in the Aiken area, a condition partly explained by subsequent subsidence in this area and by the profound Eocene overlap. Nevertheless, the much more extensive deposits of kaolin in the Aiken area give evidence of longer-continued, comparatively quiet nonmarine conditions.

The typical Black Creek sedimentation begins a series of deposits which in their origin, character of materials, and contained flora, are strictly comparable with the Magothy and Matawan formations of the northern Coastal Plain, the Black Creek formation of North Carolina, the Eutaw formation of Georgia, and the upper half of the Tuscaloosa formation of western Alabama. Probably also the physiography of the lands adjacent to the places where these sediments were laid down was the same in its general character. All the facts available point to the practical synchroneity of these deposits.

The relief at the beginning of Middendorf sedimentation was considerable; the Piedmont surface, deeply weathered during long ages, had been extensively stripped of the decayed rock which formed the Lower Cretaceous deposits and of the deposits representing the subsequent erosion interval. This removal was not, however, nearly so extensive as many persons have thought. A considerable elevation and erosion interval which follows is represented by the Arundel, Patapsco, and Raritan formations of the more northern Coastal Plain and by the great thickness of marine sediments of at least the upper part of the Lower Cretaceous section in the Texas region. A subsidence or warping at the close of Raritan time inaugurated the South Atlantic cycle of Upper Cretaceous time.

The dip of the Piedmont surface upon which the Lower Cretaceous rests is between 50 and 75 feet to the mile, and though the amount of subsequent warping which may have occurred is not determinable, these figures, however inadequate, furnish some basis for calculating the probable elevation of the Piedmont land surface at the commencement of the Lower Cretaceous epoch. Though the Lower Cretaceous surface suffered considerable erosion before Middendorf time, the beginning of Middendorf sedimentation indicates a second warping with more or less relative subsidence to the eastward and elevation to the westward, so that the general slope may have been nearly as great as it was at the beginning of Lower Cretaceous sedimentation in this area.

The flora as well as the physical conditions show that the Middendorf member and the lower part of the typical Black Creek deposits were formed, in part, at least, at practically the same time. The Middendorf, representing locally the initial basement sands, was probably formed in part on land, or at the point where the Cretaceous rivers reached sea level, or in the sounds or bays which are supposed to have existed. Meanwhile the typical Black Creek sediments were being deposited seaward. As subsidence continued any barriers which may have existed were submerged, especially in the Peedee area, so that practically the whole sedimentation became of the typical Black Creek type and continued long after the close of the deposition of the Middendorf member.

This report does not treat of the subsequent geologic history, which includes the deposition of the immediately succeeding Peedee sand into which the Black Creek formation finally merged and the subsequent reworking of the deposits in the gradual withdrawal of the sea to its various Tertiary and more modern levels.

SYSTEMATIC DESCRIPTION OF THE FLORA.

Phylum THALLOPHYTA.

Genus ALGITES Seward.

ALGITES AMERICANA sp. nov.

Description.—The thallus is preserved in the form of dichotomously divided branches ranging in width from 2 to 5 millimeters, thin and undulating, but evidently rather coriaceous in life, with slightly waved margins. These branches are not preserved for lengths of more than a few centimeters, in which space they are observed to divide only once or not at all. In some specimens they appear to radiate from a common center, but as their proximal parts are invariably missing this supposition can not be verified.

This species is also present in the Magothy formation of Maryland and in the Black Creek formation of North Carolina. The Maryland remains are rare and are in the form of impressions along which recent rootlets have commonly penetrated, giving some specimens the appearance of having midribs. The North Carolina remains, which are abundant in the Black Creek formation at certain localities along Black River, show considerable carbonaceous residuum, indicating that in life the thallus was of considerable consistency.

The name of the genus Algites, to which this form is referred, was proposed by Seward [1] for those fossil remains which are in all probability those of algæ but which from their nature can not be decisively assigned to any established genus.

Fossil algæ are common at some geologic horizons, but their characters are generally ill defined, especially when preserved as impressions, so that comparisons with modern genera altogether lack certainty. As pointed out by Seward for the type of this genus, *Algites valdensis* of the English Wealden, these forms suggest various modern genera, such as Chondrus, Zonaria, Dictyota, and others.

Occurrence.—Black Creek formation, 3 or 4 miles northeast of Florence (Ashby place), Florence County. (Collected by L. W. Stephenson.)

Collections.—U. S. National Museum.

Phylum PTERIDOPHYTA.

Order FILICALES.

Family POLYPODIACEÆ.

Genus ONOCLEA Linné.

ONOCLEA INQUIRENDA (Hollick) Hollick.

Plate II, figures 7 and 8.

Osmunda obergiana Heer, Flora fossilis arctica, vol. 3, Abth. 2, 1874, p. 98 (pars), Pl. XXVI, fig. 9d (non figs. 9–9b; Pl. XXXII, fig. 7a).
Caulinites inquirendus Hollick, Bull. New York Bot. Garden, vol. 3, 1904, p. 406, Pl. LXX, fig. 3.
Onoclea inquirenda Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 32, Pl. I, figs. 1–7.

Description.—Remains of this form appear in fragments of fertile fronds, not showing any of the laminæ, which appears to be reduced to short pinnate branches bearing one or more

[1] Seward, A. C., Wealden flora, pt. 2, 1894, p. 4.

spheroidal bodies which are interpreted as sori. These are uniformly 1.5 millimeters or slightly less in diameter.

This species was originally described by Hollick and referred to the genus Caulinites, but was subsequently removed to the ferns because of its close resemblance to the modern genus Onoclea. Earlier figured forms of the same character were associated by Heer with his species *Osmunda obergiana* because they were found in the same beds with the fronds of this species, although they were not found in organic union with the fronds. These fruits are much more like those of the modern forms of Onoclea than they are like those of Osmunda, and they are identical with the type form of the species to which the writer has referred them.

The Long Island and Marthas Vineyard forms have these sori in a single row on each side of an axis and some of the South Carolina specimens seem to have a similar arrangement; others have them definitely in threes, one terminal and two lateral. This latter arrangement also prevails exclusively in the Greenland specimens and in similar material from the Magothy formation of Maryland. This variation is of minor importance and is mentioned simply because it is believed that the grouping in threes is the normal arrangement and that it has been obscured during fossilization in the specimens where it is not clear.

As here understood, this species ranges from the Atane beds of Greenland southward in the Magothy formation of Marthas Vineyard, Long Island, and Maryland, to the locality in South Carolina.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Order LYCOPODIALES.

Family LYCOPODIACEÆ.

Genus LYCOPODIUM Linné.

LYCOPODIUM CRETACEUM Berry.

Plate II, figures 1–6.

Lycopodium cretaceum Berry, Am. Jour. Sci., 4th ser., vol. 30, 1910, pp. 275, 276, figs. 1–6.

Description.—These remains consist of fruiting spikes, which are common at the Middendorf locality, 17 specimens having been collected. Spikes loosely imbricated, of modified foliage leaves or bracts. The largest spike, 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, though in the impressions preserved in the clays of the Middendorf member it appears to be globular.

Fossil remains of foliage resembling that of the modern club mosses have been frequently described, either as Lycopodium or Lycopodites Brongniart, but the majority of such determinations lack certainty in that they show neither anatomical nor fruiting characters, so that the present species is of great interest as the only post-Paleozoic fossil known to the writer which is referable with absolute certainty to the genus Lycopodium. No remains of foliage have been discovered in these clays which can be correlated with these fruiting spikes.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Phylum SPERMOPHYTA.

Class GYMNOSPERMÆ.

Order CYCADALES (?).

Family CYCADACEÆ (?).

Genus PODOZAMITES F. Braun.

PODOZAMITES KNOWLTONI Berry.

Plate IV, figure 5.

Zamites angustifolius Eichwald, Lethæa rossica, vol. 2, 1860, p. 39, Pl. II, fig. 7.
Podozamites angustifolius Schimper, Paléontologie végétale, vol. 2, 1872, p. 160 (non Schenk).
Podozamites angustifolius Heer, Flora fossilis arctica, vol. 4, Abth. 1, 1876, p. 36, Pls. VII, figs. 8-11, and VIII, figs. 2e, 5.
Podozamites angustifolius Heer, idem, Abth. 2, 1876, p. 45, Pl. XXVI, fig. 11.
Podozamites angustifolius Heer, idem, vol. 5, Abth. 2, 1878, p. 22, Pl. V, figs. 11b, 12.
Podozamites angustifolius Lesquereux, The Cretaceous and Tertiary floras, 1883, p. 28.
Podozamites angustifolius Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 27, Pl. I, fig. 4.
Podozamites angustifolius Newberry, The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896,[1] p. 44: Pl. XIII, figs. 1, 3, 4 (non fig. 2).
Podozamites angustifolius Moller, Kgl. Svensk. Vetensk. Akad., Handl., vol. 9, 1903, Pl. I, figs. 8-12, 17b.
Podozamites knowltoni Berry, Bull. Torrey Bot. Club, vol. 36, 1909, p. 247.
Podozamites knowltoni Berry, idem, vol. 37, 1910, p. 182.

Description.—Leaflets elongate, linear-lanceolate in outline, falcate in the single nearly complete South Carolina specimen, 5 to 15 centimeters in length by 0.6 to 1.3 centimeters in greatest width. Base narrowed to a short or obsolete petiole. Apex long pointed. Veins straight and parallel, gradually dying out as they are encroached upon by the narrowing margins, that is, running to the margins and not converging appreciably toward the tip. At 4 centimeters above the base they are 20 in number, and at 2 centimeters below the tip of the specimen figured they are 16 in number.

Fragments of the leaf tissue preserved show that the leaf was comparatively thick and smooth on one surface, presumably the upper, with veins prominent on the other surface. Epidermis seems to be composed of small cells. Holes in a single, more or less imperfect row between the veins may represent stomata that are apparently confined to the lower (?) surface. The outlines of the internal tissue (mesophyll) show large cells longitudinally elongated. This species is suggestive of *Nageiopsis longifolia* Fontaine, of the Lower Cretaceous of Maryland and Virginia, and it may also be compared with a variety of so-called species of Podozamites founded upon detached leaflets of doubtful attribution.

In 1872 Schimper referred the *Zamites angustifolius* of Eichwald to the genus Podozamites, overlooking the fact that four years earlier Schenk had described and named a *Podozamites angustifolius*. The natural impulse would be to dedicate the species here described to Eichwald, but Eichwald has already had a species of Podozamites named for him, in consequence of which the name *Podozamites knowltoni* has been proposed in honor of Dr. F. H. Knowlton, of the United States National Museum. This species has a wide range, both geologically and geographically. It is common in the Jurassic of high latitudes in Russia, Siberia, Bornholm, and Spitzbergen, and it is found in the Upper Cretaceous as indistinguishable remains widely distributed in America, being common in the Dakota sandstone of the West, the Raritan formation of New Jersey, and the Black Creek formation of North Carolina.

Occurrence.—Middendorf arkose member of Black Creek formation, Rocky Point, Sumter County. (Collected by L. W. Stephenson.)

Collections.—U. S. National Museum.

[1] Although the date on the title-page of this work is 1895, it was not actually published until 1896.

Order CONIFERALES.

Family TAXACEÆ.

Genus PROTOPHYLLOCLADUS Berry.

PROTOPHYLLOCLADUS LOBATUS Berry.

Plate II, figures 9–13.

Thinnfeldia sp. nov. Berry, Johns Hopkins Univ. Circ., new ser., No. 7, 1907, p. 81.
Protophyllocladus lobatus Berry, Bull. Torrey Bot. Club, vol. 38, 1911, p. 403.

Description.—Leaves (phylloclads) of large size, lanceolate or oval in general outline, either entire with crenate margins, rounded apex, and narrowly cuneate base or compound through the development of opposite lateral lobes. Axial vascular strand very stout below, becoming very thin and finally disappearing by repeated branching apically. When the leaves are lobate, subordinate opposite vascular strands form the axis of the lobes, and these also are generally, but not invariably, lost before reaching the tips of the lobes by giving off innumerable secondary branches. Margins in all specimens are rather remotely undulate crenate, and the tips are all rounded. Secondaries numerous and thin, diverging from the main axis of the phylloclad or the axis of the lobes at very acute angles, curving outward, some simple but many dichotomously forked, and a few several times forked. Lobes when present are separated by cuneate, narrowly rounded sinuses which terminate some distance from the main axis. The largest specimen, which is still incomplete both at the apex and at the base, measures 8 centimeters in length and 5 centimeters from tip to tip of the lower lobes, the entire upper portion measuring about 1.5 centimeters in width.

These remains are superficially like fern fronds, especially in specimens which are compound, and were it not for the presence in the Cretaceous of other phyllocladus-like remains with a demonstrated gymnospermous structure (for example, Androvettia) their reference to this genus would seem hazardous. The entire specimens are strikingly like some of the forms of *Protophyllocladus subintegrifolius* (Lesquereux) Berry of the Raritan and Magothy formations, or like *Protophyllocladus polymorphus* (Lesquereux) Berry from higher western American horizons, and even the compound specimens have an unlobed apical portion of comparable length which is also similar in appearance to the two species just mentioned. The compound forms are superficially like *Thinnfeldia rhomboidalis* Ettingshausen,[1] the type of the genus Thinnfeldia, whose systematic position has been the occasion of so much controversy and which has been variously regarded as a fern, as a cycad, and as a conifer. The present species shows important differences, however, aside from being much younger, and it is confidently believed to be unrelated to the various older Mesozoic species of Thinnfeldia which have been described.

It may also be compared with various forms from the Upper Cretaceous of Dalmatia discussed at great length by Kerner,[2] who refers them to the genus Pachypteris, which he regards as cycadaceous in nature.

The present species is believed to be closest to *Protophyllocladus subintegrifolius*, a species which is abundant in the Atane beds of Greenland, the Dakota sandstone of Kansas and Nebraska, the Raritan formation of New Jersey, and the Magothy formation from Marthas Vineyard to New Jersey, and which commonly assumes a sublobate form. This is especially shown in unreported collections made by the writer in the Magothy formation of New Jersey. The South Carolina form is common, mostly as fragmentary specimens, at Rocky Point, to which locality it appears to be confined in South Carolina. Regarding the systematic position the writer is confident, despite certain criticisms, that Protophyllocladus is referable to the Taxaceæ. The species is also found in the Magothy formation of Maryland.

Occurrence.—Middendorf arkose member of Black Creek formation, Rocky Point, Sumter County. (Collected by L. C. Glenn, Ward and Glenn, and E. W. Berry.)

Collections.—U. S. National Museum; Johns Hopkins University.

[1] Ettingshausen, C. von, Abhandl. K.-k. geol. Reichsanstalt, vol. 1, pt. 3, No. 3, 1852, p. 2, Pl. I, figs. 4–7.
[2] Kerner, F. von, Jahrb. K.-k. geol. Reichsanstalt, vol. 45, 1896, p. 39.

Genus CEPHALOTAXOSPERMUM Berry.

CEPHALOTAXOSPERMUM CAROLINIANUM Berry.

Plate III, figure 4.

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

Description.—Drupaceous fruits, solitary (?), sessile or with an extremely short and stout peduncle, ovoid, 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 Gingkoales; its surface mammillated much as in *Podocarpus elongata* but less markedly so. Bony endocarp ovate-acuminate, immersed in the apical part of the exocarp. Evidently the drupaceous fruit of some Cretaceous member of the Taxaceæ 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 millimeters to 13 millimeters, averaging about 10 millimeters; breadth 5 millimeters 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 histological 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 have also been collected in the extension of this formation near Florence, S. C., and in the lower part of the Eutaw formation in Hale County, Ala.

Fruits referable to the Taxaceæ 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 the 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] describes from the Patoot beds (Senonian) of Greenland a leafy twig with a large solitary fruit, which he calls *Cephalotaxites insignis*, an identification which Solms-Laubach[2] seems to consider probable. Bertrand[3] has described carbonized seeds from the Aachenian of Tournay, Belgium, under the name of *Vesquia tournaisii*, which he considers, because of the arrangement of the vascular bundles, as intermediate between Tumion and Cephalotaxus. It certainly seems to be not without significance 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 general features which seem to indicate a closer relation with Cephalotaxus than with Podocarpus are the absence of the thickened peduncle of the latter and the presence in the same beds with these seeds of foliage described by the writer as *Tumion carolinianum*,[5] which is of the same type as that of Cephalotaxus and may not improbably have been the foliage of the tree which bore the very abundant fruits named Cephalotaxospermum.

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[1] Heer, Oswald, Flora fossilis arctica, vol. 7, 1883, p. 10, Pl. LIII, fig. 12.
[2] Solms-Laubach, Fossil botany, 1891, p. 61.
[3] Bertrand, C. E., Bull. Soc. bot. France, vol. 30, 1883, p. 293.
[4] Lesquereux, Leo, in Hayden's Ann. Rept. for 1874, 1876, p. 337, Pl. IV, fig. 8; The Cretaceous and Tertiary floras, 1883, p. 33, Pl. I, fig. 8.
[5] Berry, E. W., Am. Jour. Sci., 4th ser., vol. 25, 1908, pp. 382-386 figs. 1-3.

The modern genus Cephalotaxus Siebold and Zuccarini, 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 Brongniart. Fruits of three species of Cephalotaxus, apparently identified correctly, are described by Kinkelin[1] from the upper Pliocene deposits of the Main Valley in Germany.

Occurrence.—Black Creek formation, 3½ miles northeast of Florence (Ashby place), Florence County. (Collected by L. W. Stephenson.)

Collections.—U. S. National Museum.

Family ARAUCARIACEÆ.

Genus ARAUCARIA Jussieu.

ARAUCARIA BLADENENSIS Berry.

Plate III, figures 6 and 7.

Araucaria bladenensis Berry, Bull. Torrey Bot. Club, vol. 35, 1908, p. 255, Pls. XII, XIII, and XIV, figs. 1–3.

Description.—Foliage dense; phyllotaxy spiral; leaves decurrent, coriaceous, ovate-lanceolate, about 1.6 by 0.8 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 to 2.8 centimeters in length by 0.5 to 1.2 centimeters in width, averaging 1.6 by 0.8 centimeters, 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 in a short distance to a thickened cuspidate tip; phyllotaxy spiral; leaf substance represented by a sheet of lignite about 0.5 millimeter thick, in which the veins are immersed. These veins average 14 to 16 in number, although some specimens may have as many as 20. They are stout, incurved at the base (forking not observed), becoming parallel and running directly upward until they abut against the leaf margin; that is, they are not convergent toward the tip of the leaf. Although their megascopic appearance is lifelike, their microscopic structure is not preserved.

From one or two places where the specimens are in a more argillaceous matrix it has been possible to get rather inferior specimens showing the arrangement and outlines of the stomata. These 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 generally four. Aside from these facts no other details can be made out.

This species is most remarkably similar to the recent *Araucaria bidwilli* of the Australian region. The resemblance is even closer than the reproductions indicate, a dried herbarium specimen of the latter and a twig of the former when preserved as a brownish impression being practically indistinguishable.

This resemblance in form, habit, and stomatal characters, reenforced 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[2] from the "Cliffwood clay" of New Jersey. The leaves of this form 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 of *Araucaria bladenensis* any specimens had approached *Araucarites ovatus* in size, the writer would be disposed to consider them variants of a single species. As the case stands, it seems better to keep them distinct, for the leaves in the material from the southern Coastal Plain are sufficiently and uniformly different 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.

[1] Engelhardt, Hermann, and Kinkelin, F., Abhandl. Senckenb. naturf. Gesell., vol. 29, No. 3, 1908, p. 194, Pl. XXIII, figs. 9–13.
[2] Hollick, Arthur, Trans. New York Acad. Sci., vol. 16, 1897, p. 128, Pl. XII, figs. 3a, 4.

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.[1] This is strikingly similar to the American species in every respect, and is likewise closely allied, in appearance at least, to the recent *Araucaria bidwilli* of Australia.

Kerner[2] records *Pachyphyllum* (*Pagiophyllum*) *rigidum* Saporta and *Pachyphyllum* (*Pagiophyllum*) *araucarinum* Saporta from the Cenomanian of Lesina, an island in the Adriatic off the coast of Dalmatia, both being originally Jurassic species from the French Corallian of Verdun. Both are very similar to the American species and are of about the same age. The probable identity of Cenomanian and Corallian species seems to the writer extremely doubtful, and in his opinion both Kerner's species should undoubtedly be considered new species of Araucaria, nearly related to, if not identical with, such Cretaceous forms as *Araucaria bladenensis* or *Araucaria toucasi*.

The present 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 at the single locality cited. So far as observed, the leaves are always found detached at this outcrop, indicating a large amount of maceration and trituration. They are, however, entirely characteristic.

This species has also been found in the upper part of the Tuscaloosa formation of western Alabama, in the Eutaw formation of western Georgia, and at a somewhat younger horizon near Buena Vista, Ga.

Recently Wieland[3] has described a distinct but comparable species, *Araucaria hatcheri*, from the "Ceratops beds" of Wyoming.

Occurrence.—Black Creek formation, 3½ miles northeast of Florence (Ashby place), Florence County. (Collected by L. W. Stephenson.)

Collections.—U. S. National Museum.

ARAUCARIA DARLINGTONENSIS sp. nov.

Plate III, figure 1.

Description.—Seed obovate in outline with broadly rounded apex, straight lateral margins, and somewhat narrowed rounded base, 1.25 centimeters in length and 0.75 centimeter in width across the widest part, 0.50 centimeter wide at base.

This species is based upon the single detached seed figured, which is undoubtedly that of an araucarian conifer. From its size and geologic position it seems probable that it may be a seed of the cone scales described as *Araucaria jeffreyi* Berry, which in turn are probably the cone scales of the leafy twigs described as *Araucaria bladenensis* Berry. No other araucarian remains are, however, associated with this seed at this locality.

Occurrence.—Black Creek formation, right bank of Black Creek, 1½ miles east of Darlington, Darlington County. (Collected by L. W. Stephenson.)

Collections.—U. S. National Museum.

ARAUCARIA JEFFREYI Berry (?).

Araucaria jeffreyi Berry, Bull. Torrey Bot. Club, vol. 35, 1908, p. 258, Pl. XVI.

Description.—Cone scales deciduous, rhomboidal, straight sided, thin margined, the apex broadly rounded, with long central apical spur; scales divided by transverse furrow into "ligule" and scale proper; single seeded.

This species was based upon a considerable number of large single-seeded cone scales preserved as impressions and associated with *Araucaria bladenensis* at Big Bend and near the Atlantic Coast Line Railroad bridge over Black River, at points 92 and 87⅝ miles above Newbern on Neuse River, and at Parker Landing on Tar River, all localities in the Black Creek formation of North Carolina. The specimens from Tar River differ somewhat from the others and

[1] Saporta, G. de, Le monde des plantes, 1879, p. 198, fig. 27.
[2] Kerner, F. von, Jahrb. K.-k. geol. Reichsanstalt, vol. 45, 1896, p. 49, Pl. IV, figs. 1, 3.
[3] Wieland, G. R., Bull. Geol. Survey South Dakota No. 4, Rept. for 1908, 1910, p. 80, fig. 2.

approximate more nearly the shape of the foliage leaves of *Araucaria bladenensis*, but the scales in general are somewhat variable, as indeed they are from different positions on a single modern Araucaria cone, and it seems likely that they all belong to one species.

The scales are rhomboidal, the thin lateral margins straight to the point of greatest width, then more or less rounded, produced medially into a long and narrow point. This point is more than a centimeter long in two specimens which still lack the terminal portion. In some specimens the scales are obviously divided by a transverse furrow into the scale proper and the so-called "ligule." They are all preserved as impressions with fragments of lignite representing the scale substance. Except that they do not appear to have been as thick, they are strictly comparable with the typical scales of *Araucaria bidwilli*. In general outline they are also comparable with the scales of *Araucaria cookii* of the Eutacta section of the genus. Seeds have also been found in the Carolina material at this level. From the structure as disclosed in the present impressions it seems obvious that the scales were single-seeded, as in the modern genus, and, taken in conjunction with the foliage just described as *Araucaria bladenensis*, they furnish conclusive evidence of the abundant presence in the middle part of the Cretaceous of eastern North America of true Araucarieæ, thus still further increasing the parallel between the middle Cretaceous floras of this country and those of Europe. Many remains of cones and cone scales have been described as species of Araucarieæ, but it seems scarcely worth while to enumerate them here.

The South Carolina occurrence is based on a single poorly preserved and doubtfully determined specimen. This species also occurs in Georgia.

The Georgia material is neither abundant nor well preserved, but the identifications are unquestionable. A single scale was collected from the Eutaw formation at Chimney Bluff on Chattahoochee River, where it was associated with the abundant leafy twigs of *Araucaria bladenensis* Berry. A single entirely characteristic specimen obtained near Byron, Georgia, is apparently from a higher horizon in the Cretaceous.

Araucaria jeffreyi is extremely close to a form from the Turonian of Priesen, Bohemia, described and named *Araucaria friči* by Velenovsky.[1]

Occurrence.—Middendorf arkose member of Black Creek formation near Langley, Aiken County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Family **BRACHYPHYLLACEÆ**.

Genus **BRACHYPHYLLUM** Brongniart.

BRACHYPHYLLUM MACROCARPUM Newberry.

Plate III, figure 2.

Moriconia cyclotoxon Debey and Ettingshausen, Heer, Flora fossilis arctica, vol. 7, 1883, Pl. LIV, fig. 1c (non Heer's other figures).
Thuites crassus Lesquereux, The Cretaceous and Tertiary floras, 1884, p. 32.
Brachyphyllum crassum Lesquereux, Proc. U. S. Nat. Mus., vol. 10, 1887, p. 34.
Brachyphyllum crassum Lesquereux, The flora of the Dakota group, Mon. U. S. Geol. Survey, vol. 17, 1892, p. 32, Pl. II, fig. 5 (non Tenison-Woods, 1883).
Brachyphyllum macrocarpum, Newberry, MSS. name mentioned in footnote. The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 51.
Brachyphyllum sp., Knowlton, Bull. Geol. Soc. America, vol. 8, 1897, pp. 137, 140.
Brachyphyllum macrocarpum Knowlton, Bull. U. S. Geol. Survey No. 163, 1900, p. 29, Pl. IV, figs. 5, 6.
Brachyphyllum macrocarpum Hollick, Bull. New York Bot. Garden, vol. 3, 1904, p. 406, Pl. VII, figs. 4, 5.
Brachyphyllum macrocarpum Berry, Bull. Torrey Bot. Club, vol. 32, 1905, p. 44, Pl. II, fig. 9.
Brachyphyllum macrocarpum Berry, idem, vol. 33, 1906, p. 168, Pl. IX.
Brachyphyllum macrocarpum Berry, Ann. Rept. State Geologist, New Jersey, for 1905, 1906, p. 139.
Brachyphyllum macrocarpum Hollick and Jeffrey, Am. Naturalist, vol. 40, 1906, p. 200.
Brachyphyllum macrocarpum Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 44, Pl. III, figs. 9 and 10.

[1] In Frič, Archiv naturw. Landesdurchforschung Böhmen, vol. 9, No. 1, 1893, p. 129, text fig. 177.

Description.—Stout twigs with club-shaped, primately arranged branches, covered with large, thick, rhomboidal squamate, densely crowded, appressed leaves, attached by practically their whole ventral surface. Phyllotaxy spiral. Leaf surface more or less striated, the striæ converging toward the obtuse apex. Cones not positively determined.

Brachyphyllum is chiefly an older Mesozoic type, but it remains abundant through the Lower Cretaceous, two species having been described from the Potomac group of Maryland and Virginia. It is a waning type in the Upper Cretaceous, where it is represented by the species here discussed and by a variety (see p. 106) which persists as high as the lower Senonian. It is widely distributed and is recorded from Long Island, Staten Island, New Jersey, Delaware, Maryland, North Carolina, Georgia, and Alabama [1] in the East and from the Dakota sandstone of Kansas and the Montana group of Wyoming in the West. It is probably represented in the Patoot beds of Greenland by the material which Heer erroneously refers to Moriconia. Though it is not recorded from Europe, Velenovsky has described remains from the Cenomanian of Bohemia which appear to be identical with the American representatives, referring them to the Jurassic genus Echinostrobus of Schimper.[2] Hollick and Jeffrey have recently shown, from specimens from Staten Island with structure preserved, that this species is related to the subfamily Araucarieæ.

This species is extremely common in the upper part of the Raritan formation at South Amboy, N. J., and in its eastward extension on Staten Island, but has not been collected from any of the plant-bearing horizons of the lower part of the Raritan. Newberry describes large cones which he found associated with these twigs and which he thought were related to them, although this seems improbable. The cones are poorly preserved and their affinities can not be made out. They are very different from previously described cones of Brachyphyllum, and the work of Hollick and Jeffrey would seem to indicate that the present species had small cones. The cones described by Newberry, though here retained in the synonymy of this species, are comparable to the abundant cones from the older Potomac of Maryland which are referred to the form genus Abietites. The single characteristic fragment figured is all that represents this species in the South Carolina Cretaceous, but as it is common in homotaxial deposits in Georgia and Alabama and has also been found in the Black Creek formation of North Carolina no uncertainty is attached to the identification of even such meager material.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Family PINACEÆ.

Genus PINUS Linné.

PINUS RARITANENSIS Berry.

Pinus sp. Newberry, The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 47, Pl. IX, figs. 5–8.
Pinus raritanensis Berry, Bull. Torrey Bot. Club, vol. 37, 1910, p. 189.

Description.—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 of poorly preserved winged seeds. Similar remains occur in the Magothy formation of New Jersey and in the Black Creek formation of North Carolina. They are too indefinite to have much stratigraphic value and are of slight botanic interest beyond showing the presence of a pinelike form along the Upper Cretaceous Atlantic coast. In this connection attention should be called to structural material of Pinus from the Raritan formation on Staten Island, N. Y., described by Hollick and Jeffrey [3] as *Pinus triphylla*, which may be identical with the present form.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

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[1] A number of these records are unpublished.

[2] Velenovsky, J., Die Gymnospermen der böhmischen Kreideformation, 1885, p. 16, Pl. VI, figs. 3, 6–8; Květena českého cenomanu, 1889, p. 9, Pl. I, figs. 11–19; Pl. II, figs. 1, 3.

[3] Mem. New York Bot. Garden, vol. 3, 1909, p. 14, Pls. III, figs. 6 and 7 (?), and XXII, fig. 1.

Family TAXODIEACEÆ.

Genus SEQUOIA Endlicher.

SEQUOIA REICHENBACHI (Geinitz) Heer.[1]

Plate IV, figures 1–4.

Araucarites reichenbachi Geinitz, Characteristik der Schichten und Petrefakten des sächs.-böhmischen Kreidegebirges, No. 3, 1842, p. 98, Pl. XXIV, fig. 4.
Cryptomeria primæva Corda, in Reuss, Versteinerungen der böhmischen Kreideformation, Abth. 2, 1846, p. 89, Pl. XLVIII, figs. 1–11.
Geinitzia cretacea Endlicher, Synopsis coniferarum, 1847, p. 281.
Sequoia reichenbachi Heer, Flora fossilis arctica, vol. 1, 1868, p. 83, Pl. XLIII, figs. 1d, 2b, and 5a.
Sequoia reichenbachi Heer, idem, vol. 3, 1874, pp. 77, 101, and 126; Pls. XII, figs. 7c and 7d; XX, figs. 1–8; XXVIII, fig. 2; XXXIV, fig. 1; XXXVI, figs. 1–8; and XXXVII, figs. 1 and 2.
Sequoia reichenbachi Lesquereux, The Cretaceous flora, 1874, p. 51, Pl. I, figs. 10–10b.
Sequoia reichenbachi Heer, Flora fossilis arctica, vol. 6, Abth. 2, 1882, p. 52, Pl. XXVIII, fig. 7.
Sequoia reichenbachi Fontaine, The Potomac or younger Mesozoic flora: Mon. U. S. Geol. Survey, vol. 15, 1890, p. 243, Pls. CXVIII, figs. 1 and 4, and CXIX, figs. 1–5, etc.
Sequoia couttsiæ Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 30, Pl. I, fig. 5.
Sequoia reichenbachi Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p, 35, Pl. II, fig. 4.
Sequoia reichenbachi Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 30, Pl. I, fig. 18.
Sequoia reichenbachi Nathorst, in Felix and Lenk, Beiträge zur Geologie und Paleontologie der Republik Mexico, 1893, pt. 2, no. 1.
Sequoia reichenbachi Newberry, The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 49, Pl. IX, fig. 19.
Sequoia reichenbachi Berry, Bull. New York Bot. Garden, vol. 3, 1903, p. 59, Pl. XLVIII, figs. 15–18.
Sequoia reichenbachi Berry, Bull. Torrey Bot. Club, vol. 31, 1904, p. 69, Pl. IV, fig. 8.
Sequoia reichenbachi Berry, idem, vol. 32, 1905, p. 44, Pl. I, fig. 3.
Sequoia reichenbachi Knowlton, Bull. U. S. Geol. Survey, No. 257, 1905, p. 157, Pl. XIV, figs. 3–5.
Sequoia reichenbachi Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 42, Pls. II, fig. 40, and III, figs. 4, 5.
Sequoia reichenbachi Knowlton, Smithsonian Misc. Coll., quarterly issue, vol. 4, 1907, p. 126, Pl. XII, figs. 7 and 8.
? *Geinitzia reichenbachi* Hollick and Jeffrey, Mem. New York Bot. Garden, vol. 3, 1909, p. 38, Pls. V, figs. 7–10; VIII, figs. 3 and 4; XVI, figs. 2–4; XVII, figs. 1–4; XVIII, figs . 1–4.

Description.—The following description was written by Heer in 1868: "S. ramis elongatis, foliis decurrentibus, patentibus, falcato-incurvis, rigidis, acuminatis."

This species has a recorded range on this continent from the 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. Many investigators have held 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 remarkable memoir recently published Hollick and Jeffrey[2] have described the anatomy of some twigs of the *Sequoia reichenbachi* type from the Raritan formation of Staten Island. According to these authors their results indicate that these remains 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 these authors were under the necessity of finding Araucarian characters in certain associated cone scales of the sequoia type, as these supposed Araucarian twigs are frequently found with Sequoia-like cones attached to them. They refer these cone scales to new genera which they term Eugeinitzia and Pseudogeinitzia, although the evidence for an Araucarian affinity is in the writer's opinion 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 at the Magothy-Middendorf-late Tuscaloosa horizon, apparently identical in character and commonly cone-

[1] Only representative citations, chiefly American, of this widespread and persistent species are given.
[2] Mem. New York Bot. Garden, vol. 3, 1909, p. 38, Pl. V et seq.

bearing, the cones being small prolate spheroids consisting of relatively few peltate umbilicate, sequoia-like scales.

This species is confined to the Middendorf locality in South Carolina, where it is excessively abundant and commonly cone-bearing. Sequoia twigs are very resistant to maceration and are in many places about the last vegetable remains to disintegrate in marine waters; nevertheless, the excellent preservation at Middendorf of leafy branches of large size with cones attached indicates quiet water and nearness to place of growth. The species is rare in the Raritan formation but common in later Upper Cretaceous outcrops in New Jersey, Delaware, Maryland, North Carolina, Georgia, and Alabama.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Genus CUNNINGHAMITES Presl.

CUNNINGHAMITES ELEGANS (Corda) Endlicher.

Cunninghamia elegans Corda, in Reuss, Versteinerungen der böhmischen Kreideformation, pt. 2, 1846, p. 93, Pl. XLIX, figs 29–31.
Cunninghamites elegans (Corda) Endlicher, Synopsis Coniferarum, 1847, p. 305.
Cunninghamites elegans Heer, Die Flora von Moletein in Mähren, 1869, p. 12, Pl. I, fig. 14.
Cunninghamites elegans Schimper, Paléontologie végétale, vol. 2, 1870, p. 259.
Cunninghamites squamosus Hosius and Von der Marck (non Heer), Die Flora der Westfälischen Kreideformation, Palæontographica, vol. 26, 1880, p. 179, Pl. XXXVII, figs. 137, 138.
Cunninghamites squamosus var. *densifolia* Hosius and Von der Marck, idem, figs. 139–141.
Cunninghamites squamosus var. *linearis* Hosius and Von der Marck, idem, p. 180, fig. 142.
Cunninghamites elegans Heer, Flora fossilis arctica, vol. 7, 1883, p. 17, Pl. LIII, fig. 1.
Cunninghamia elegans Velenovsky, Die Gymnospermen der böhmischen Kreideformation, 1885, p. 14, Pl. IV, fig. 5; Pl. V, figs. 1, 7; Pl. VI, fig. 5.
Cunninghamites elegans Hosius and Von der Marck, Nachtrag, Palæontographica, vol. 31, 1885, p. 227.
Cunninghamia elegans Velenovsky, Sitzungsber. K. böhmischen Gesell., 1886, 1887, p, 634, figs. 1–5.
Cunninghamia elegans Kerner, Jahrb. K.-k. geol. Reichsanstalt, vol. 45, 1896, pt. 1, Pl. IV, fig. 4.
Cunninghamites elegans Newberry, The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 48, Pl. V. figs. 1–7.
Cunninghamites elegans Hollick, Trans. New York Acad. Sci., vol. 16, 1897, p. 129, Pl. XI, fig. 2.
Cunninghamites (?) sp., Knowlton, Bull. U. S. Geol. Survey No. 163, 1900, p. 29, Pl. V, fig. 3.
Cunninghamites elegans (?) Fliche, Bull. Soc. sci. Nancy, 1900, p. 10, Pl. I, fig. 1.
Cunninghamites elegans Hollick, Bull. New York Bot. Garden, vol. 2, 1902, p. 402, Pl. XLI, fig. 11.
Cunninghamites elegans Berry, idem, vol. 3, 1903, p. 64.
Cunninghamites elegans Zeiller, Annales des mines, March, 1905, p. 15, Pl. VII, fig. 4.
Cunninghamites elegans Knowlton, Bull. U. S. Geol. Survey No. 257, 1905, p. 135, Pl. XV, fig. 1.
Cunninghamites elegans Hollick, Mon. U. S. Geol. Survey, vol. 50, 1907, p. 41, Pl. III, fig. 1.
Cunninghamites elegans Berry, Bull. Torrey Bot. Club, vol. 31, 1904, p. 70, Pl. III, figs. 7–9, 11.

Description.—The following is the description by Corda in 1846:

C. ramis gracilibus teretibus, pulvinulis foliorumr homboideo-hexagonis, longitudinaliter carinatis; cicatricibus terminalibus oblique-transversis; foliis hamato-arrectis, attenuatis, integerrimus, acutis, medio nervo tenui simplici.

The type locality for this handsome species was the "*Untern Quader von Masseno bei Schlan in Böhm.*" Since its description by Corda it has been recorded from a number of European and American localities. Abroad it is found from the Cenomanian to the Emscherian in Bohemia, Moravia, Westphalia, Dalmatia, and Bulgaria. In America it occurs in the Magothy formation from Marthas Vineyard to New Jersey, ranging northward to the Patoot beds of Greenland. In the West it has been found in the Montana group, both in Montana and in Wyoming. Exceptionally large forms of this species are abundant in the upper beds of Black Creek formation of North Carolina, and the species is also present at a somewhat higher Upper Cretaceous horizon near Byron, Ga. Abroad the species has been recorded by Schenk from the Urgonian and by Fliche from the Barremian, but the latter identification is probably and the former almost certainly incorrect.

The South Carolina material is scanty and fragmentary. It comes from the Rocky Point locality and is queried because the ferruginous replacement renders the identification uncertain. The remains are those of long, rather slender, curved leaves of the *Cunninghamites elegans* type, the single specimen and its counterpart representing the distal portion of a twig about the normal size for this species but somewhat smaller than the specimens from the Black Creek formation of North Carolina.

The genus Cunninghamites was proposed in 1838 by Presl[1] in Sternberg's great work, and *Cunninghamites oxycedrus* from the Quader of Niederschoena in Saxony was designated the type by Brongniart[2] in 1849. Several fossil species of Cunninghamites have been described, and recently structural material of a cone very close to that of the existing Cunninghamia has been described[3] from the Upper Cretaceous of Japan. The existing species of Cunninghamia, two in number, inhabit the subtropical uplands of the Orient.

Occurrence.—Middendorf arkose member of Black Creek formation, Rocky Point, Sumter County. (Collected by L. F. Ward and L. C. Glenn.)

Collections.—U. S. National Museum.

Family CUPRESSEACEÆ.

Genus WIDDRINGTONITES Endlicher.

WIDDRINGTONITES SUBTILIS Heer.

Plate II, figures 14–17.

Widdringtonites subtilis Heer, Flora fossilis arctica, vol. 3, Abth. 2, 1874, p. 101, Pl. XXVIII, fig. 1, *b*.
Widdringtonites subtilis Heer, idem, vol. 6, Abth. 2, 1882, Pls. VII, figs. 13 and 14, and XXVIII, fig. 4, *b*.
Widdringtonites subtilis Newberry, The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 57, Pl. X, figs. 2–4.
Widdringtonites reichii Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 58, Pl. III, fig. 8.
Widdringtonites subtilis Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 45, Pl. IV, figs. 2–5.
Widdringtonites reichii Berry, Johns Hopkins Univ. Circ., new ser., No. 7, p. 81, 1907.
Widdringtonites subtilis Berry, Bull. Torrey Bot. Club, vol. 39, 1912, pp. 341–348, Pls. XXIV, XXV.

Description.—This species was described from the Atane beds of Greenland by Heer in 1874. His material was, however, extremely limited. 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). It may be questioned if some of the coniferous material described by Velenovsky from the Bohemian Cretaceous under other names should not be compared with the present form. It is even more slender than *Widdringtonites reichii*, with much shorter twigs, which have the appearance of having been somewhat lax in habit. The leaves are usually more elongated, close set, and appressed, narrowly lanceolate, straight and scalelike; they are said by Heer to be somewhat spread and falcate proximad. Remains of this latter sort occur in the Tuscaloosa formation of Alabama and the Magothy formation of Maryland.

Newberry mentions a vague cone about 1 centimeter in diameter as included in the Raritan material. The writer has not seen this specimen but has found a number of poorly preserved detached cones among the abundant remains of this species in the Cretaceous beds of South Carolina and a number of specimens with attached cones from the Tuscaloosa formation in western Alabama, where this species is exceedingly abundant at certain localities. These cones are terminal, roughly spheroidal in outline, and apparently consist of four thick scales with wide blunt tips and somewhat extended bases. They are closely comparable to the cones from the Cretaceous of eastern Europe ascribed to *Widdringtonites reichii* by Velenovsky and Krasser. (See Pl. II, figs. 18 and 19.) These authors refer this form directly to the genus

[1] Sternberg, Kaspar, Flora der Vorwelt, vol. 2, Nos. 7 and 8, 1838, p. 203.
[2] Brongniart, Tableau, 1849, p. 68.
[3] Stopes and Fujii, Phil. Trans. Roy. Soc. London, vol. 201 B, 1910.

Widdringtonia, and it would seem that the cones attached to the Alabama specimens of *Widdringtonites subtilis* conclusively demonstrate its relationship with some of the modern species included in the genus Callitris by Eichler.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County; Rocky Point, Sumter County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Genus **MORICONIA** Debey and Ettingshausen.

MORICONIA AMERICANA Berry.

Plate VII, figures 1–4.

Moriconia cyclotoxon Berry, Bull. New York Bot. Garden, vol. 3, 1903, p. 65, Pls. XLIII, fig. 4, and XLVIII, figs. 1–4 (non Debey and Ettingshausen).
Moriconia cyclotoxon Berry, Bull. Torrey Bot. Club, vol. 31, 1904, p. 70; vol. 33, 1906, pp. 165–167.
Moriconia americana Berry, idem, vol. 37, 1910, pp. 20, 186.

Description.—Leafy twigs, apparently deciduous in habit, bifacial, phylloclad-like, consisting of cyclically arranged reduced leaves. Along the main axis on each flat face of the branch these leaves are relatively and closely appressed, with a narrow base and a broad semicircular apex. The corresponding lateral pairs of leaves are thin and pointed and transversely compressed. In the axis of each of these marginal leaves is a reduced branch flattened in the same plane as the main branch, so that the whole arrangement is strictly opposite and distichous. These reduced lateral branches have leaves of the same character and arrangement as those of the main branch. The bifacial leaves are, however, somewhat smaller and blunter and the marginal leaves are broader and less acute. In a short distance they become smaller distad, generally not more than five or six pairs being required to complete the blunt lateral reduced twigs. The main vascular axis is stout and in some specimens a vascular axis can be made out in the lateral branches. The leaves do not show any veins. The texture was apparently coriaceous, but from the appearance of the majority of specimens the leaves were thin. No structural material or indications of fruits or fruiting characters have been discovered. This species, formerly confused with *Moriconia cyclotoxon* of Debey and Ettingshausen, differs from the latter, which is the type and only other known species of the genus, in being more phylloclad-like and strictly comparable to a cupressineous genus like Libocedrus. It is also about twice as large, the lateral twigs are more reduced, and the main axis is invariably leafy. It differs also in its geologic range, the two species not being anywhere contemporaneous in America, although the type in Europe extends as high as the later larger form of America.

Superficially these remains closely resemble fragments of fern fronds. In fact, Debey, the original discoverer, always insisted that they were ferns and Heer described the earliest collected and poorly preserved remains from Greenland as a species of Pecopteris. There can be no doubt, however, of their gymnospermous nature. For stratigraphic determinations they are one of the most characteristic fossil plants known, as the geometrically arranged outlines of the leaves is recognizable with certainty in the smallest fragment.

They are strikingly like the curious genus Androvettia, which was recently described by Hollick and Jeffrey [1] and referred by them to the Araucarieæ, although Moriconia has, on the evidence of the foliar characters, been invariably referred to the Cupressineæ. The present species is common at the Middendorf locality in South Carolina and is a characteristic post-Raritan species in the Atlantic Coastal Plain, having been recorded by the writer from numerous localities in the Magothy formation of New Jersey, Delaware, and Maryland, and from the Black Creek formation in North Carolina. *Moriconia cyclotoxon*, the type of the genus, is confined to the Raritan in this country, although it is found in both the Atane and Patoot beds of western Greenland and came originally from the Senonian of Prussia.

Occurrence.—Middendorf arkose member of the Black Creek formation, near Middendorf, Chesterfield County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

[1] Hollick, Arthur, and Jeffrey, E. C., Mem. New York Bot. Garden, vol. 3, 1909, p. 22, Pl. III, figs. 1–5, etc.

CONIFERÆ INCERTÆ SEDIS.

Genus STROBILITES Lindley and Hutton.

STROBILITES ANCEPS sp. nov.

Plate III, figure 5.

Description.—Cone a prolate spheroid in shape, about 3 to 4 centimeters in length by 2.4 centimeters in diameter, made up of spirally arranged, rather thick, flat, obovate scales. The condition of preservation of these cones, of which two were collected, is such that their generic or even tribal affinity can not be determined; hence they are referred to the comprehensive form genus Strobilites. They are not of the Sequoia or Widdringtonia type and resemble certain cones of the Pinus more than they do any of the other coniferous genera represented by foliage in the South Carolina Cretaceous. They are similar to the much more elongated cones from the Lower Cretaceous of the Atlantic Coastal Plain, which have been referred to the form genus Abietites, and are not at all like the assorted conelike remains described by Hollick and Jeffrey from the Raritan formation as forms of Strobilites. As regards size the South Carolina cones are comparable to *Strobilites inquirendus* Hollick from the Magothy formation of New Jersey, but the preservation of the latter is so poor that the specimens are almost valueless.

A comparison which is entitled to some weight may be made with the cones described by Ettingshausen from the Upper Cretaceous of Saxony and identified as *Cunninghamites sternbergii*.[1] Whatever may be the true botanic affinity of these fossils, they are almost certainly cogeneric with those from South Carolina with which they are in close agreement.

Occurrence.—Black Creek formation, right bank of Black Creek, 1½ miles east of Darlington, Darlington County. (Collected by L. W. Stephenson.)

Collections.—U. S. National Museum.

Genus HETEROLEPIS gen. nov.

HETEROLEPIS CRETACEUS sp. nov.

Plate III, figure 3.

Description.—Cone scale of large size, about 3 centimeters in length, with a stout, woody axis 5 millimeters wide at the base and 1.3 centimeters wide where it expands to form a bosslike, slightly umbilicate tip which is evenly rounded, forming a right angle with the axis; in outline almost circular, with a slightly irregular striated margin, 1.7 centimeters in diameter.

This species is based upon the single specimen figured, which is so characteristic that it is likely to be a valuable stratigraphic fossil, although its botanic affinity can not be determined. It may be cycadaceous or it may belong to a large-coned species comparable with the remains commonly referred to Sequoia or Geinitzia.

Occurrence.—Middendorf arkose member of Black Creek formation, Rocky Point, Sumter County. (Collected by L. C. Glenn.)

Collections.—U. S. National Museum.

Class ANGIOSPERMÆ.

Subclass MONOCOTYLEDONÆ.

Order NAIADALES.

Family NAIADACEÆ.

Genus POTAMOGETON Linné.

POTAMOGETON MIDDENDORFENSIS sp. nov.

Plate IV, figure 6.

Description.—Leaves of small size, entire, obovate lanceolate or spatulate in outline, about 4 centimeters in length by 1.45 centimeters in greatest width, which is in the apical half of the leaf. Petiole short and broad. Venation fine, immersed, acrodrome.

[1] Ettingshausen, C. von, Die Kreideflora von Niederschoena in Sachsen, 1867, p. 12, Pl. I, figs. 4–6.

This species is based upon the single specimen figured and its counterpart, which may be interpreted as the remains of two leaves in juxtaposition or of a single leaf in which the upper and lower cuticle has parted company. The latter appears to be the most reasonable explanation. The species was evidently aquatic, and it is very close to certain modern species in this genus. It also suggests the genus Pistia, of which a typical species is common in the Black Creek formation of North Carolina. It is quite distinct from the latter, however, and seems to be an immersed leaf of a Potamogeton in the sum of its characters.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Order POALES.

Family POACEÆ.

Genus ARUNDO Linné.

ARUNDO GRŒNLANDICA Heer (?).

Plate IV, figure 7.

Arundo grœnlandica Heer, Flora fossilis arctica, vol. 3, Abth. 2, 1874, p. 104, Pl. XXVIII, figs. 8–11.
Arundo grœnlandica Heer, idem, vol. 6, Abth. 2, 1882, p. 57, Pl. XVII, fig. 10.
Arundo grœnlandica Heer, idem, vol. 7, 1883, p. 18, Pl. LIV, figs. 1–3.

Description.—Fragments of long, linear, pointed leaves, about 2.5 centimeters in greatest width. Primaries numerous, parallel, fine, about 2.5 millimeters apart, separated by numerous very fine parallel secondaries; the central primary apparently somewhat enlarged to form a midrib.

In the Greenland material this species included culms as well as leaf fragments. The South Carolina material is queried because it differs from the type in having a midrib, which is not, however, so prominent a feature as the drawings indicate, having been accentuated by the method of preservation, replacement by iron oxide. It may be compared with various described fragments of monocotyledonous leaves referred to this genus and to Phragmites and a variety of other genera of the Poales. There is the further possibility that these remains may represent fragments of the rays of some palm. They are of slight botanic interest but are present in well-marked specimens at the Rocky Point locality and may be found to possess considerable stratigraphic value.

Occurrence.—Middendorf arkose member of Black Creek formation, Rocky Point, Sumter County. (Collected by L. C. Glenn.)

Collections.—U. S. National Museum.

Genus PHRAGMITES Trinius.

PHRAGMITES PRATTII Berry.

Phragmites sp. Berry, Bull. Torrey Bot. Club, vol. 34, 1907, p. 190, Pl. XI, fig. 5.
Phragmites prattii Berry, idem, vol. 37, 1910, p. 191.

Description.—Parallel-veined, monocotyledonous leaf fragments, indicating grasslike leaves 1 centimeter or more in width, having about ten equal parallel veins and a few fine transverse veinlets. Leaf substance thin.

This species is strictly comparable with a large number of fossils that have been referred to Phragmites, which must be regarded as purely a form genus for the reception of fragments of the leaves of grasses or sedges. The present species, which has been detected at a number of localities in the Black Creek formation of North Carolina, has been collected only at the Rocky Point locality in South Carolina, where small fragments are common. It occurs also in the basal beds of the Eutaw formation along Chattahoochee River.

Occurrence.—Middendorf arkose member of Black Creek formation, Rocky Point, Sumter County. (Collected by L. F. Ward and L. C. Glenn.)

Collections.—U. S. National Museum.

Family CYPERACEÆ.

Genus CAREX Linné.

CAREX CLARKII Berry.

Carex clarkii Berry, Am. Naturalist, vol. 39, 1905, p. 347, fig. 1.
Carex clarkii Berry, Ann. Rept. State Geologist New Jersey for 1905, 1906, pp. 138–141.
Carex clarkii Berry, Bull. Torrey Bot. Club, vol. 33, 1906, p. 169.
Carex clarkii Berry, Johns Hopkins Univ. Circ., new ser., 1907, No. 7, p. 81.

Description.—Leaf fragments, the largest being 6 centimeters in length, varying in width from 1.5 millimeters to 4 millimeters, averaging between 2 millimeters and 3 millimeters, slightly keeled, becoming thicker and narrower proximad. Midrib moderately prominent. Lateral veins, which are parallel with it, very fine and scarcely discernible except in the larger specimens.

In common with other fossil remains of grasses and sedges this species has no botanic value except as an indication of the presence of plants of these families. It has, however, like so many fossils of vague botanic affinities, considerable stratigraphic value, as it is found to characterize the Magothy formation at a large number of outcrops from New Jersey to Maryland. The South Carolina remains are not abundant and are confined to the Rocky Point locality.

Occurrence.—Middendorf arkose member of Black Creek formation, Rocky Point, Sumter County. (Collected by L. C. Glenn.)

Collections.—U. S. National Museum.

Order ARECALES.

Family PALMÆ.

Genus SABALITES Saporta.

SABALITES CAROLINENSIS sp. nov.

Plates V and VI.

Description.—A fan palm with very large flabellate leaves. Rays numerous, keeled proximad, becoming nearly flat distad, ultimately splitting more or less. Petiole not preserved in any of the collected material, which includes abundant but fragmentary specimens. Primaries stout and prominent, as much as 1.2 centimeters apart in the largest specimen. Secondaries usually seven in number between each pair of primaries, with which they are approximately parallel; thin, connected by numerous ill-defined cross veinlets.

This was evidently a very large Sabal-like leaf, of which the largest collected specimens are those figured. All the material comes from the single locality near Langley, though very small fragments of what appears to belong to a palm have been detected at several other localities in the South Carolina Cretaceous. These may represent this species, but they are too unrepresentative to be even tentatively identified with it.

The enormous number of existing palms, which includes considerably more than one thousand species, is about equally divided between the oriental and occidental tropics, with many monotypic genera, showing well the marked effects of geographic distribution and isolation on the formation of species. There are no outlying forms, the highest northern latitude reached being about 43° in Europe and the highest southern latitude about 45° in New Zealand.

Lesquereux writing in 1878 [1] records fossil palms in 52° north latitude in both America and Europe. Since then remains have been described from as far north as 80° (Grinnell Land, Spitzbergen), and two fine species are recorded from the earlier Tertiary of Greenland (latitude 70°). A variety of Paleozoic remains has been referred to the Palmæ, these remains ranging in their botanic affinities from Stigmaria trunks to Cordaitean leaves and fruits. The nature of the latter was first rightly conjectured by Brongniart in 1828. With the marvelous increase, during the last 25 years, in knowledge of the vegetation of the Paleozoic, it can now be positively affirmed that palms are unknown from pre-Mesozoic formations.

[1] The Tertiary flora, 1878, p. 109.

Stenzel, who has recently monographed [1] the fossil palm wood of the world, finds the oldest known wood to come from the Turonian of France (one species), the succeeding Senonian terrane yielding six species. At the beginning of the Tertiary period the species became numerous.

Undoubted remains of palm leaves occur somewhat earlier, the middle part of the Cretaceous, in the light of present knowledge, marking the introduction of the type. The Cenomanian of Europe has furnished undoubted palm leaves (upper Cenomanian of Tiefenfurth in Silesia), and Stur [2] has described fruit from that horizon in Bohemia. Fliche has described three species in two genera from a similar horizon in France.[3] The Senonian deposits show species in a variety of genera. It is in the Tertiary, however, that palms become greatly developed and widespread, and the numerous species found on evidence afforded by stems, leaves, petioles, fruits, and even flowers are referable to a large number of genera (Geonoma, Manicaria, Calamopsis, Thrinax, Phœnix, Nipa, Chamærops, Oreodoxites, Sabal, Iriartea, Latanites, and the like). In this country the earliest known remains are those small fragments of striated leaves, of a rather doubtful nature, which Lesquereux described [4] as *Flabellaria minima* from the Dakota sandstone.[5]

The Montana group of Senonian age has furnished Knowlton [6] with the undoubted remains of a large palmetto-like form (Sabalites),[7] and the Laramie formation furnishes a number of species, some of which, represented by both leaves and fruit, continue into the Eocene.

The present species may be compared with *Sabalites magothiensis* Berry,[8] which is found in the Magothy formation from Raritan Bay in New Jersey to Severn River in Maryland. The two species are entirely distinct, however, and the South Carolina form is much better characterized and represented by more complete material.

Occurrence.—Middendorf arkose member of Black Creek formation, near Langley, Aiken County. (Collected by Earle Sloan, E. W. Berry, and L. W. Stephenson.)

Collections.—U. S. National Museum.

Subclass DICOTYLEDONÆ.

Order JUGLANDALES.

Family JUGLANDACEÆ.

Genus JUGLANS Linné.

JUGLANS ARCTICA Heer.

Plate VIII, figures 1 and 2.

Juglans arctica Heer, Flora fossilis arctica, vol. 6, Abth. 2, 1882, p. 71, Pls. XL, fig. 2; XLI, fig. 4c; XLII, figs. 1–3, and XLIII, fig. 3.

Juglans arctica Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 68, Pls. XIX, fig. 3, and XXXIX, fig. 5.

Juglans arctica Newberry, The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 62, Pl. XX, fig. 2.

Juglans arctica Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 58, Pl. III, fig. 7.

Ficus atavina Hollick, Trans. New York, Acad. Sci., vol. 11, 1902, p. 103, Pl. IV, fig. 5.

Juglans arctica Berry, Ann. Rept. State Geologist New Jersey for 1905, 1906, p. 139, Pl. XXI, fig. 1.

Juglans arctica Berry, Bull. Torrey Bot. Club, vol. 33, 1906, p. 170.

Juglans arctica Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 54, Pl. IX, figs. 6–8.

Description.—The following is the description of Heer, written in 1882:

I. Nuce ovali, 34 mm. longa, 17 mm. lata; foliis magnis, foliolis ovalibus, basi inæquilateralibus, integerrimis, nervo medio valido, nervis secundariis angulo semirecto egredientibus, curvatis.

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[1] Beitr. Pal. v. Geol. Oesterr.-Ungarn., 1904, pp. 1–182, Pls. I–XXII.
[2] Verhandl. K.-k. Geol. Reichsanstalt Wien, 1873.
[3] Études sur la flore fossile de l'Argonne, 1896.
[4] Cretaceous flora: 1874, p. 56, Pl. XXX, fig. 6.
[5] It is now definitely decided that Hollick's supposed palm, Serenopsis, from the Cretaceous of Long Island, is a Nelumbo.
[6] Bull. U. S. Geol. Survey No. 163, 1900, p. 32.
[7] Dawson has also described a Sabal from the Upper Cretaceous at Nanaimo.
[8] Torreya, vol. 5, 1905, p. 32.

The leaves of this species vary considerably in size and outline, as might be expected in this genus. Heer's type material is somewhat imperfect and some of it is difficult to distinguish from some of the forms referred to the same author's *Juglans crassipes*, although the latter is on the whole a much larger less oblong form with a narrower base. *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. Size varies 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 confirm their reference to this genus. A single leaf is recorded from the Raritan formation of New Jersey, and the species also occurs in beds of this age on Staten Island. With these exceptions the species is confined to later horizons, occurring in the Magothy formation on Marthas Vineyard, Block Island, and in New Jersey, in the Black Creek formation of North Carolina, and in the Middendorf arkose member of the Black Creek formation of South Carolina. In the West this species occurs in the Dakota sandstone of Kansas. Its occurrence in South Carolina is based on the basal halves of characteristic inequilateral leaves of rather small size.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County, Rocky Point, Sumter County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Order MYRICALES.

Family MYRICACEAE.

Genus MYRICA De Candolle.

MYRICA BRITTONIANA Berry.

Plate VII, figures 17 and 18.

Myrica heerii Berry, Am. Naturalist, vol. 37, 1903, p. 682, figs. 7, 8 (non Boulay).
Myrica brittoniana Berry, Bull. Torrey Bot. Club, vol. 32, 1905, p. 46.

Description.—Leaves elongate-lanceolate in outline, 13 to 14 centimeters long by 2.7 centimeters in greatest width, which is in the middle part of the leaf. Apex elongated, narrowed, bluntly pointed. Base attenuated. Margin entire, or entire below and undulate or distantly and obtusely toothed above. Texture coriaceous. Petiole and midrib fairly stout. Secondaries thin, immersed, generally obsolete, branching from the midrib at rather large angles, comparatively straight, camptodrome.

This striking species was described by the writer in 1903 from the Magothy formation of New Jersey, to which it has been heretofore confined. Fragmentary leaves are, however, present in the deposits along Black Creek in South Carolina. The form is somewhat similar to species of the Dakota sandstone *Myrica aspera* Lesquereux.[1]

Occurrence.—Black Creek formation, right bank of Black Creek, 2 miles below Williamson's bridge, Florence County, (Collected by L. W. Stephenson.)

Collections.—U. S. National Museum.

MYRICA ELEGANS Berry.

Plate IX, figure 4.

Myrica elegans Berry, Bull. Torrey Bot. Club, vol. 34, 1907, p. 191, Pl. XI, figs. 1–4, 6.

Description.—Leaves ovate-lanceolate in outline, variable in size, ranging from 3.2 to 9.5 centimeters in length by 1.5 to 3 centimeters in greatest width, which is midway between the apex and the base. Like the living species of Myrica the margin is variable, ranging from forms in which it is rather angularly crenate with an approach to serrate in some of the teeth, through forms in which the crenations become more and more rounded, until the extreme of variation

[1] Lesquereux, Leo, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, p. 66, 1892, Pl. II, fig. 11.

in this direction shows relatively broad leaves with deeply scalloped subcrenate margins. Midrib straight and fairly stout. Secondaries numerous, 5 to 17 pairs, relatively stout and prominent on the lower surface of the leaf, subopposite or alternate, equidistant and parallel, branching from the midrib at angles of more than 45°, approaching 90° in some specimens. They are nearly straight and craspedodrome, running to the marginal teeth. Tertiaries usually not seen because of the coarse matrix. Some transverse veinlets are discernible, as well as curved branches from the distal part of the secondaries, which run to the subordinate teeth of the marginal scallops when these are developed. Apex pointed. Base cuneate and generally with an entire margin. Texture subcoriaceous.

This species is markedly distinct from any other Cretaceous Myrica. It is very abundant in the Black Creek formation of the upper Cape Fear River in North Carolina, but has only been found at Darlington in the South Carolina area, and there in a much macerated condition. Although the resemblance is not close, *Myrica elegans* is more like *Myrica præcox,* described by Heer from the Patoot beds of Greenland, than it is like any other species with which it has been compared. The latter is a smaller leaf with a rounded apex, and the wide marginal crenations lack the crenulations of the Carolina species.

Occurrence.—Black Creek formation, near Darlington, Darlington County. (Collected by L. W. Stephenson.)

Collections.—U. S. National Museum.

Order SALICALES.

Family SALICACEÆ.

Genus SALIX Linné.

SALIX FLEXUOSA Newberry.

Plates VII, figures 14–16, and XI, figure 1.

Salix flexuosa Newberry, Notes on the later extinct floras of North America: Ann. Lyc. Nat. Hist. New York, vol. 9, 1868, p. 21.
Salix flexuosa Newberry, Illustrations of Cretaceous and Tertiary plants, 1878, Pl. I, fig. 4.
Salix protexfolia linearifolia Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 49, Pl. LXIV, figs. 1–3.
Salix protexfolia flexuosa Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 50, Pl. LXIV, figs. 4, 5.
Salix protexfolia flexuosa Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 50, Pl. CLXXIV, fig. 5.
Salix protexfolia flexuosa Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 59, Pl. IV, fig. 5a.
Salix flexuosa Berry, Ann. Rept. State Geologist, New Jersey, for 1905, 1906, p. 145.
Salix flexuosa Berry, Bull. Torrey Bot. Club, 1906, vol. 33, p. 171.
Salix protexfolia flexuosa Berry, Bull. New York Bot. Garden, vol. 3, 1903, p. 67, Pl. XLVIII, fig. 12, Pl. LII, fig. 2.
Salix protexfolia linearifolia Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 52, Pl. VIII, fig. 12.
Salix protexfolia flexuosa Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 51, Pls. VIII, figs. 5, 6a, XXXVII, fig. 8b.

Description.—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 greatest width. Margin entire. Midrib stout below, tapering above, commonly somewhat flexuous. Secondaries more or less remote, about ten alternate pairs, branching from the midrib at angles varying from 35° to 45°, camptodrome, of fine caliber, in many specimens often obsolete.

This species was described by Newberry from the Dakota sandstone in 1868. Lesquereux subsequently made it one of the varieties of his *Salix protexfolia,* although it is obviously entitled to independent specific rank. It is of rare occurrence in the Raritan formation, where it first appears in the uppermost beds at South Amboy, N. J., and is preeminently a species which characterizes the Magothy and homotaxial horizons to the southward. It is recorded in beds of Magothy age from Marthas Vineyard to the Potomac. It occurs in the Black Creek formation of North Carolina and at a large number of localities in the Tuscaloosa formation in the western part of Alabama.

In South Carolina it has been found in considerable abundance in the Middendorf arkose member of the Black Creek formation entirely across the State, and fragments which have been doubtfully identified as this species are present well toward the top of the Cretaceous on Congaree River.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County; near Langley, Aiken County; right bank of Congaree River, about 25 miles below Columbia, Lexington County. (Collected by E. W. Berry, L. W. Stephenson, B. L. Miller, and M. W. Twitchell.)

Collections.—U. S. National Museum.

Salix lesquereuxii Berry.

Plate VII, figures 11-13.

Salix proteæfolia Lesquereux, Am. Jour. Sci., 2d ser., vol. 46, 1868, p. 94 (non Forbes).
Salix proteæfolia Lesquereux, The Cretaceous flora, 1874, p. 60, Pl. V, figs. 1-4.
Salix proteæfolia Lesquereux, in Cook and Smock, Report on the clay deposits of Woodbridge, South Amboy, and other places in New Jersey, 1878, p. 29.
Salix proteæfolia Lesquereux, The Cretaceous and Tertiary floras, 1883, p. 42, Pls. I, figs. 14-16, and XVI, fig. 3.
Salix proteæfolia Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 49.
Salix proteæfolia longifolia Lesquereux, idem, 1892, p. 50, Pl. LXIV, fig. 9.
Salix proteæfolia longifolia Bartsch, Bull. Lab. Nat. Hist., Univ. Iowa, vol. 3, 1896.
Proteoides daphnogenoides Newberry, The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 72 (pars), Pl. XXXII, fig. 11.
Dewalquea groenlandica Newberry, idem, p. 129 (pars), Pl. XLI, fig. 12.
Salix proteæfolia Newberry, idem, p. 66, Pl. XVIII, figs. 3, 4.
Salix proteæfolia Kurtz, Revista Mus. La Plata, 1902, vol. 10, p. 51.
Salix proteæfolia Berry, Ann. Rept. State Geologist, New Jersey, for 1905, 1906, p. 139.
Salix proteæfolia Berry, Bull. Torrey Bot. Club, vol. 33, 1906, p. 171, Pl. VII, fig. 2.
Salix proteæfolia Berry, idem, vol. 36, 1909, p. 252.

Description.—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*, the largest being 1.2 centimeters long. Midrib stout below, tapering above. Secondaries numerous, sometimes as many as twenty pairs; they branch from the midrib at angles of about 45° and are parallel and camptodrome.

This is an exceedingly variable species, 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 the latter, as is well shown by examination of the leaves which he figures on Plate I of his "Cretaceous and Tertiary floras." These leaves 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 easily seen secondaries and a longer petiole.

This species is an exceedingly abundant Cretaceous type in both the East and the West. In the Atlantic Coastal Plain it ranges from the base of the Raritan formation to the top of the Tuscaloosa formation and is abundant in the Magothy, Black Creek, and Tuscaloosa formations. 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.

It is abundant in South Carolina in both the Middendorf member and other deposits of the Black Creek formation.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County, near Langley and Miles Hall, Aiken County; Rocky Point, Sumter County; right bank of Congaree River, about 25 miles below Columbia, Lexington County. Other deposits of the Black Creek formation near Darlington, Darlington County. (Collected by E. W. Berry, L. W. Stephenson, B. L. Miller, M. W. Twitchell, and Earle Sloan.)

Collections.—U. S. National Museum.

SALIX PSEUDOHAYEI Berry.

Plate X, figure 8.

Salix sp. Newberry, The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 68, Pl. XLII, figs. 6–8.
Salix pseudohayei Berry, Bull. Torrey Bot. Club, 1909, vol. 36, p. 251.

Description.—Leaves small, relatively short and broad, ovate-lanceolate, uniformly about 3 centimeters in length by 1.1 to 1.4 centimeters in greatest width, which is about halfway between the apex and base or lower apex acuminate. Base rounded. Margin entire. Petiole short. Midrib slender and slightly curved. Secondaries fine, obscured in some specimens, five or six pairs, alternate, camptodrome, branching from the midrib at an angle of about 45° and curving upward.

This species is not uncommon in the Raritan formation of New Jersey, although Prof. Newberry fails to mention the exact localities from which he collected it. Later material has come from the lower part of the Raritan at Milltown, N. J. It has been compared with the Dakota sandstone species, *Salix hayei* Lesquereux, and with the Arctic Tertiary *Salix ræana* Heer, both of which it resembles in general appearance. The leaf from the Dakota sandstone, however, is coriaceous, with a coarse venation, blunt apex, and more narrow pointed base, and is seen to be quite different from the eastern species when careful comparisons are made.

The single specimen figured is all that represents this species in the South Carolina Cretaceous. It is in every respect identical with the type material from New Jersey.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

SALIX SLOANI sp. nov.

Plate VIII, figures 10–12.

Description.—Leaves lanceolate in outline, large and elongated, 13 centimeters or more in length by 1.6 to 3 centimeters in greatest width, which is about halfway between the apex and the base, the leaf tapering gradually and equally distad and proximad to the narrowly acute and extended apex and base. The margin is entire for a short distance below, above which it is beset with short, triangular, generally obtusely pointed, somewhat aquiline teeth, separated by rounded sinuses. Midrib stout. Secondaries very numerous, thin, approximately parallel, branching from the midrib at wide angles, 60° to 70°, at intervals of 2 to 3 millimeters, extending outward with only a slight upward curve to a point near the margin and then curving upward and extending for a greater or less distance almost parallel with the latter, giving off short tertiary branches to the marginal teeth. Tertiaries fine, exceedingly numerous, transverse, parallel at nearly right angles to the midrib.

This very striking and exceedingly distinct and characteristic species is not rare at the locality near Langley, though few complete leaves are found. It has not been detected elsewhere in the Atlantic Coastal Plain. It is much like certain modern species of Grevillea and other antipodean members of the family Proteaceæ, but may be compared with a number of existing species of Salix, as, for example, *Salix fluviatilis* Nuttall. It is believed to be referable with certainty to this genus and is one of the most ancient forms known which show decisive characters identical with those of modern willow leaves. The most nearly related fossil species, one perfectly distinct, however, is *Salix eutawensis* Berry,[1] which has been recorded from the Black Creek formation in North Carolina and from the Eutaw formation in western Georgia.

Occurrence.—Middendorf arkose member of Black Creek formation, near Langley and Miles Hall, Aiken County. (Collected by L. W. Stephenson, E. W. Berry, and Earle Sloan.)

Collections.—U. S. National Museum.

[1] Berry, Bull. Torrey Bot. Club, vol. 37, 1910, p. 193, Pl. XXII.

Order FAGALES.

Family FAGACEÆ.

Genus QUERCUS Linné.

QUERCUS SUMTERENSIS sp. nov.

Plate X, figures 9 and 10.

Description.—Leaves large, linear, acuminate, coriaceous, entire, with a broadly cuneate base. Length about 15 to 16 centimeters. Greatest width 3 centimeters. Petiole short and stout, midrib stout. Secondaries thin, branching from the midrib at angles of 45° or more, taking a rather straight course almost to the margin and then turning sharply upward. Tertiaries obsolete, as are also the secondaries in some specimens.

This species is clearly referable to the willow or laurel oaks and is markedly distinct from any species hitherto described, although it resembles in general outline some of the lanceolate Cretaceous species of Ficus. It is not uncommon at the Rocky Point locality, to which it is thus far confined. It is not unlike some of the leaves of the modern *Quercus rudkini,* a hybrid of *Quercus marylandica* and *phellos.*

Occurrence.—Middendorf arkose member of Black Creek formation, Rocky Point, Sumter County. (Collected by L. F. Ward and L. C. Glenn.)

Collections.—U. S. National Museum.

QUERCUS PSEUDOWESTFALICA sp. nov.

Plate IX, figure 5.

Description.—Leaves of medium size, relatively small for this genus, ovate in general outline, with an acuminate apex and a cuneate base. Texture coriaceous. Length about 9.5 centimeters. Greatest width about 4 centimeters near the middle of the leaf. Margin with large serrate teeth separated by broadly rounded sinuses. Midrib stout. Secondaries thin, approximately parallel, about seven subopposite pairs, branching from the midrib at angles of about 45°, slightly curved, craspedodrome, ending in the marginal teeth, of which there is one to each secondary. Petiole not preserved.

This species evidently belongs to the group of the chestnut oaks, not differing materially from certain leaves which may be collected from the existing *Quercus michauxii, prinus,* or *prinoides* of eastern North America. Among fossil species it is very similar to some of the varieties of *Quercus westfalica* figured by Hosius and von der Marck [1] from the Senonian of Westphalia, and it is especially close to one of the Bohemian leaves which Velenovsky [2] refers to this species. Heer [3] records this same species from the Atane beds of Greenland, but his specimens are too fragmentary for any great certainty of identification. Another leaf which is very similar is one from Kieslingswalde in Silesia, which Velenovsky identifies with his *Quercus pseudodrymeja,*[4] although it is more probably referable to *Quercus westfalica.*[5] No Atlantic Coastal Plain species is closely similar to *Quercus pseudowestfalica,* although *Quercus eoprinoides* Berry [6] from the Magothy formation in New Jersey is remotely related to it, as is also *Quercus raritanensis* Berry [7] from the Raritan formation of that State.

A form which is closely related to the Carolina species, however, is *Quercus dakotensis* Lesquereux.[8] It is of about the same size and outline, but differs in having less prominent teeth and in the details of its tertiary venation.

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[1] Palæontographica, vol. 26, 1880, p. 161, Pls. XXIX, figs. 52–63; XXX, figs. 64–75.
[2] Velenovsky, J., Die Flora der böhmischen Kreideformation, pt. 2, 1883, p. 17, Pl. II, fig. 23.
[3] Flora fossilis arctica, vol. 6, Abth. 2, 1882, p. 67, Pl. XV, figs. 5–7.
[4] Op. cit., figs. 21, 22.
[5] Op. cit., pt. 4, 1885, p. 13, Pl. VII, fig. 10.
[6] Berry, E. W., Bull. Torrey Bot. Club, vol. 31, 1904, p. 74, Pl. IV, fig. 11.
[7] Idem, vol. 36, 1909, p. 249.
[8] Lesquereux, Leo, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 56, Pl. VII, fig. 4.

Quercus pseudowestfalica has been found in only the Middendorf member of the Black Creek formation of South Carolina. It has also been doubtfully determined from the Black Creek formation at Court House Bluff in North Carolina.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County; Rocky Point, Sumter County, and Miles Mill, Aiken County. (Collected by E. W. Berry, L. W. Stephenson, and Earle Sloan.)

Collections.—U. S. National Museum.

Order URTICALES.

Family ULMACEÆ.

Genus MOMISIA F. G. Dietrich.

MOMISIA CAROLINENSIS sp. nov.

Plate XII, figure 5.

Description.—Leaves entire below, more or less dentately toothed apically, ovate in outline, 6 or 7 centimeters in length by 2.5 centimeters in greatest width. Apex narrowed and pointed. Base cuneate, not quite equilateral, finally decurrent on the stout petiole, which is short, 6 or 7 millimeters in length. Midrib stout below, becoming thin distad. Basal secondaries, constituting the lateral primaries, subopposite, branching from a point at or near the base of the midrib at acute angles, long, nearly straight, ascending, camptodrome. Upper secondaries remote, thin, camptodrome.

This species of a quasi triple-veined leaf seems allied to the existing species of Momisia, of which no fossil forms are known except a single species from the Eocene of Georgia described recently by the writer. Leaves of this character are commonly referred to the genus Cinnamomum or at least to the Lauraceæ, but the botanical affinity of this form seems to be with certain tropical Ulmaceæ. The existing species of Momisia number a score or more forms of the American tropics. They are closely related to Celtis and are even made a subgenus of Celtis by Engler. These leaves differ from the described species of Cinnamomum and its allies in their toothed margins and in the character of their tertiary venation, and may be considered the Cretaceous representative of the Claiborne species of Momisia.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

Family ARTOCARPACEÆ.

Genus FICUS Linné.

FICUS ATAVINA Heer.

Plate X, figure 11.

Ficus protogæa Heer, Flora fossilis arctica, vol. 3, Abth. 2, 1874, p. 108, Pls. XXIX, fig. 2b, and XXX, figs. 1–8. (von Ettingshausen.)

Ficus protogæa Schenk, Palæontographica, vol. 23, 1875, p. 169, Pl. XXIX, fig. 12.

Ficus atavina Heer, Flora fossilis arctica, vol. 6, Abth. 2, 1882, p. 69, Pls. XI, figs. 5b, 7b, 8b; XVII, fig. 8b; XIX, fig. 1b; and XX, figs. 1, 2.

Ficus atavina Heer, idem, vol. 7, 1883, p. 26.

Ficus atavina? Lesquereux, Proc. U. S. Nat. Mus., vol. 10, 1887, p. 40.

Ficus protogæa Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 51, Pl. CLXXV, fig. 4.

Ficus atavina Berry, Bull. Torrey Bot. Club, vol. 31, 1904, p. 75, Pls. I, figs. 8, 9, and III, fig. 6.

Ficus atavina Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 58, Pl. X, figs. 5, 6 (not fig. 4, which is referable to *Juglans elongata*).

Description.—Leaves entire, broadly oblong-lanceolate in outline, large in size, the South Carolina leaves measuring about 20 centimeters in length by 3.5 centimeters in greatest width, which is about halfway between the apex and the base. Apex and base equally acute. Midrib very stout. Texture coriaceous. Secondaries numerous, parallel, branching from the midrib at angles of more than 45°, camptodrome. Tertiaries rarely seen, forming small four or five sided areoles.

This large fig leaf stands about midway between *Ficus krausiana* and *Ficus crassipes,* and may possibly represent the somewhat narrower, more elongated leaves of the former species. It was described originally from Greenland as *Ficus protogæa* Heer, a preoccupied name, and was subsequently renamed by its describer. It has been recorded by Hollick from Marthas Vineyard and Long Island, from what are apparently Magothy deposits, and by the writer from the Magothy formation of New Jersey. Lesquereux recorded it from the far West (Utah), but the writer has not seen his material and queries the citation, for the species appears to be confined in this hemisphere, at least, to eastern North America. The range was possibly extended to Europe, because Schenk identifies it in the Gosau beds of the northern Tyrol. It has not heretofore been discovered in Alabama or in deposits of the southern Atlantic Coastal Plain.

Occurrence.—Middendorf arkose member of Black Creek formation, Rocky Point, Sumter County; near Middendorf, Chesterfield County. (Collected by L. F. Ward, L. C. Glenn, L. W. Stephenson, and E. W. Berry.)

Collections.—U. S. National Museum.

Ficus celtifolius sp. nov

Plate XII, figure 4.

Description.—Leaves small, entire, elliptical-ovate in outline with an obtusely pointed apex and a broadly rounded base. Petiole short, about 0.6 centimeter in length, relatively stout. Midrib stout. Secondaries stout, remote, three or four pairs, the lower pair opposite, diverting from the midrib just below its base and functioning as lateral primaries, the balance alternate. All branch from the midrib at angles of about 45° and are camptodrome some distance from the margin. Tertiaries distinct, the inner transverse, the peripheral camptodrome in uniform broad arches.

This species, which is obviously unlike any previously described Ficus, is the sole representative of the palmately veined figs found in South Carolina, although the somewhat similar species *Ficus woolsoni* Newberry and *Ficus ovatifolia* Berry occur in either the Black Creek formation of North Carolina or the Tuscaloosa formation of Alabama. It is especially characterized by the prominence of its secondary and tertiary venation, and is very similar to certain modern species of Celtis with entire margins, as, for example, *Celtis crassifolia* Lamarck, and *Celtis reticulata* Torrey. It is also similar to a number of Tertiary species of Ficus and not unlike a very much larger undescribed species of Ficus present in clays of the Tuscaloosa formation of western Alabama.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

Ficus crassipes (Heer) Heer.

Plates X, figure 12, and XII, figures 8–10.

This species is described in the section of this report dealing with the Upper Cretaceous flora of Georgia, pages 110–111. It is common in South Carolina, especially at the Rocky Point locality, from which the figured specimens were collected. It is especially characteristic of the post-Raritan and pre-Montana horizons of eastern North America.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County; near Langley, Aiken County; Rocky Point, Sumter County; right bank of Congaree River about 25 miles below Columbia, Lexington County. (Collected by E. W. Berry, L. F. Ward, L. C. Glenn, B. L. Miller, and M. W. Twitchell.)

Collections.—U. S. National Museum.

FICUS KRAUSIANA Heer.

Plate XI, figures 4–7.

Ficus krausiana Heer, Neue Denkschr. Schw. Gesell., vol. 23, 1869, p. 15, Pl. V, figs. 3–6.
Ficus beckwithii Lesquereux, The Cretaceous and Tertiary floras, 1883, p. 46, Pls. XVI, fig. 5, and XVII, figs. 3 and 4.
Ficus suspecta Velenovsky, Die Flora der böhmischen Kreideformation, pt. 4, 1885, p. 10, Pl. V, figs. 6, 9.
Ficus atavina Heer? Hollick, Trans. New York Acad. Sci., vol. 2, 1892, p. 103, Pl. IV, figs. 4, 6.
Ficus krausiana, Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 81, Pl. I, fig. 5.
Ficus beckwithii Lesquereux, idem., vol. 17, 1892, p. 80.
Ficus krausiana Hollick, Bull. Geol. Soc. America, vol. 7, 1895, p. 13.
Ficus krausiana Hollick, Annals New York Acad. Sci., vol 11, 1898, p. 59, Pl. III, fig. 1.
Ficus krausiana Berry, Bull. Torrey Bot. Club, 1906, vol. 33, p. 172.
Ficus krausiana Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 58, Pls. IX, fig. 9, and X, figs. 1–3.

Description.—The following is Heer's description of this species, written in 1869:

F. foliis lanceolatis, integerrimus, utrinque attenuatis, nervo medio valido, nervis secundis numerosis, camptodromis, subtillissimis.

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. Texture coriaceous or subcoriaceous. Length about 17 centimeters. Greatest width about 4 centimeters.

This species was described by Heer from Moletein in Moravia (Cenomanian), and it has been subsequently identified from a large number of American localities. In the West it occurs in the Dakota sandstone of Kansas and Colorado; in the East it is common from Marthas Vineyard and Block Island to Alabama and is present between these limits in Maryland, North Carolina, and South Carolina. These occurrences are all in beds of the Magothy or homotaxial formations, the only uncertain occurrence being that at Tottenville, Staten Island, where the morainic material containing this species may possibly have been derived from the Raritan, although this is considered doubtful.

Associated with this species at the type locality in Moravia are similar leaves which were described by Prof. Heer as a different species, *Ficus mohliana.* These are somewhat larger with a more sparse secondary venation. It seems probable that these merely represent the somewhat larger leaves of *Ficus krausiana,* but they are not united with it in view of the lack of positive evidence, because *Ficus mohliana* has priority and this would involve the change of name of this well-known type and horizon marker. In both North and South Carolina fruits are found associated with this species, but whether they are related to it or to some of the other rather numerous species of Ficus which occur at the same localities can not be determined.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County (?); Rocky Point, Sumter County; right bank of Congaree River, about 25 miles below Columbia, Lexington County (?). Other deposits of the Black Creek formation, Black Creek, Florence County. (Collected by L. F. Ward, L. C. Glenn, E. W. Berry, L. W. Stephenson, and M. W. Twitchell.)

Collections.—U. S. National Museum.

FICUS STEPHENSONI Berry.

Plate XII, figures 1–3.

Ficus stephensoni Berry, Bull. Torrey Bot. Club, vol. 37, 1910, p. 194, Pl. XXIII, figs. 2, 3.

Description.—Leaves variable in size, ranging from 6 to 18 centimeters in length and from 2.3 to 6.4 centimeters in greatest width, broadly lanceolate-ovate, tapering equally from the middle toward both ends but more fully rounded at the base and more slender toward the tip, especially in the smaller leaves. Midrib broad. Secondaries very slender, leaving the midrib at wide angles which become as great as 90° in some of the larger specimens, very numerous, 2 to 4 millimeters apart, parallel, almost straight to the marginal vein, which is well marked and about 1 millimeter distant from the margin, with which it is parallel. Veinlets largely at right angles to the secondaries and not especially well shown. Petiole stout.

This is an exceedingly well-marked species of Ficus and is very close to various existing species in form and venation characters, as is well shown by a comparison with the leaves of *Ficus elastica* Roxburg. It is probable, however, that the texture of the fossil species was less coriaceous, for all the larger leaves are considerably macerated.

It is believed that the larger forms represent the normal size of the leaves in this species and that the smaller leaves, which occur only in material from South Carolina, represent abortive leaves which fell before reaching maturity, as is so common in the modern allied species.

Some authors refer leaves of this type to the genus Eucalyptus, with which genus the venation has much in common. In point of size the Carolina leaves are comparable with those of such a species as *Eucalyptus latifolia* Hollick from Glen Cove, Long Island, but the secondaries are less regular and only about half as numerous in the latter species, and there seems to be little doubt of the propriety of referring the present species to the genus Ficus.

It is very similar to a variety of closely related Upper Cretaceous species of Ficus of the type of the existing *Ficus elastica* Roxburg and its allies, commonly cultivated as ornamental shrubs and trees under the name of "rubber plants." The comparable fossil forms include *Ficus glascoeana* Lesquereux,[1] with which there is a possibility that the present species may be identical, as it is very similar in outline and venation, except that the figures of the Kansas leaves (types 478 and 532a, Museum of Comparative Zoology) do not show any marginal vein, although Lesquereux mentions one in his description. The latter species has been detected southward along the western shore of the Mississippi embayment in the Woodbine sand of Texas and is of a more coriaceous texture, with more obtuse tip, and with the secondaries joining the midrib at an angle of 60°. Another very similar species is *Ficus atavina* Heer,[2] which ranges from the Atane and Patoot beds of western Greenland southward along the Atlantic Coastal Plain to Marthas Vineyard, Glen Cove, Long Island, and Cliffwood, N. J. All the occurrences are probably of Magothy age.

The North Carolina leaf has full-rounded basal margins, which are rather straight in *Ficus atavina;* its secondaries, which are twice as numerous as in *Ficus atavina,* are less ascending. The marginal vein is also closer to the margin. Another species, perhaps identical with the previous one, is *Ficus peruni* Velenovsky,[3] from the Cretaceous of Bohemia, which differs from the North Carolina leaf in the same respects in which *Ficus atavina* Heer differs. Velenovsky points out the great similarity between *Ficus peruni* and *Eucalyptus geinitzii* Heer, a similarity which is more striking in the forms he has referred to this species of Eucalyptus than in the leaves usually so identified by other paleobotanists.

Ficus stephensoni was recently described by the writer[4] from material collected in the Black Creek formation at Court House Bluff on Cape Fear River in North Carolina. It is found to be equally abundant in clays of the Middendorf member of the Black Creek formation across the State of South Carolina, but has not been certainly detected elsewhere in the Atlantic Coastal Plain, though doubtful remains which may represent this species are present in the collections from clays of the Tuscaloosa formation of western Alabama.

Occurrence.—Middendorf arkose member of Black Creek formation, Middendorf, Chesterfield County; near Langley, Aiken County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

[1] Lesquereux, Leo, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 76, Pl. XIII, figs. 1, 2.
[2] Flora fossilis arctica, vol. 3, Abth. 2, 1874, p. 108, Pls. XXIX, fig. 2b, and XXX, figs. 1-8.
[3] Die Flora der böhmischen Kreideformation, pt. 3, 1884, p. 16 (41), Pl. IV (12), figs. 1-3. Compare his fig. 2 with Berry, Bull. Torrey Bot. Club, vol. 31, 1904, Pl. III, fig. 6.
[4] Loc. cit.

Order PROTEALES.

Family PROTEACEÆ.

Genus PROTEOIDES Heer.

PROTEOIDES LANCIFOLIUS Heer.

Plate X, figure 1.

Proteoides lancifolius Heer, Zur Kreideflora von Quedlinburg, 1871, p. 12, Pl. III, figs. 5, 6.
Proteoides lancifolius Lesquereux, The Cretaceous and Tertiary floras, 1883, p. 50.
Proteoides lancifolius Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 90, Pls. XV, fig. 5, and I, fig. 8.

Description.—Leaves entire, lanceolate, commonly falcate in outline, with a narrowed attenuated apex and a narrowed decurrent base, about 10 centimeters in length by 1.4 centimeters in greatest width, which is in the basal half of the leaf. Petiole stout. Midrib stout below, rapidly narrowing upward. Secondaries very numerous, approximately parallel, many obsolete, branching from the midrib at acute angles of less than 45°. These are connected by branches or tertiaries in the irregular manner characteristic of the venation of existing Proteaceæ. Texture coriaceous.

This species was origially described from the Cretaceous of Blankenburg, Saxony, by Heer. Lesquereux recorded it from the Dakota sandstone and it is not uncommon in the South Carolina Cretaceous, the latter remains being identical with the Dakota sandstone specimens and identical with the type material except that in some of the leaves of the South Carolina specimens the upper secondaries are depicted as open and camptodrome, subtending a wider angle with the midrib, a character different from that shown in the lower secondaries of the same specimens. All the observed characters are identical with those of various existing genera of the Proteaceæ, as, for example, the genus Protea. The present species does not differ to any extent from the Dakota sandstone species, *Proteoides acuta* Heer and *Proteoides grevilliæformis* Heer, the latter the type of the genus. The genus Proteoides does not contain many described species and is confined to pre-Montana deposits in North America, although it ranges upward into the Senonian of Europe.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County; Rocky Point, Sumter County. Other deposits of the Black Creek formation, near Darlington, Darlington County. (Collected by E. W. Berry, L. C. Glenn, and L. W. Stephenson.)

Collections.—U. S. National Museum.

PROTEOIDES PARVULA sp. nov.

Plate X, figure 5.

Description.—Leaves of small size, lanceolate in outline, entire, somewhat falcate, with equally acute apex and base, 2 centimeters in length by 4.5 millimeters in greatest width, which is about halfway between the apex and the base. Midrib thin, somewhat flexuous. Secondaries fine, immersed, and mostly obsolete, numerous, ascending, irregularly anastomosing.

This species is one of the smallest which has been referred to this genus, and except for its size is very similar to *Proteoides lancifolius* Heer, which occurs at the same locality—in fact, it may simply be a juvenile form of the latter. This can only be determined by a larger amount of comparative material than is available at the present time.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

Order RANALES.

Family RANUNCULACEÆ (?).

Genus DEWALQUEA Saporta and Marion.

DEWALQUEA SMITHI Berry.

Plate VIII, figures 3-9.

Dewalquea smithi Berry, Torreya, vol. 10, 1910, p. 36, fig. 1.

Description.—Leaves palmately decompound, the petiole dividing into three principal branches, the angle of divergence varying from 20° to 60° and the two lateral branches forking at an acute angle 1 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. Greatest width 2 to 4 centimeters. Margin entire or serrate, usually entire below and serrate in the apical three-fourths, some specimens having large

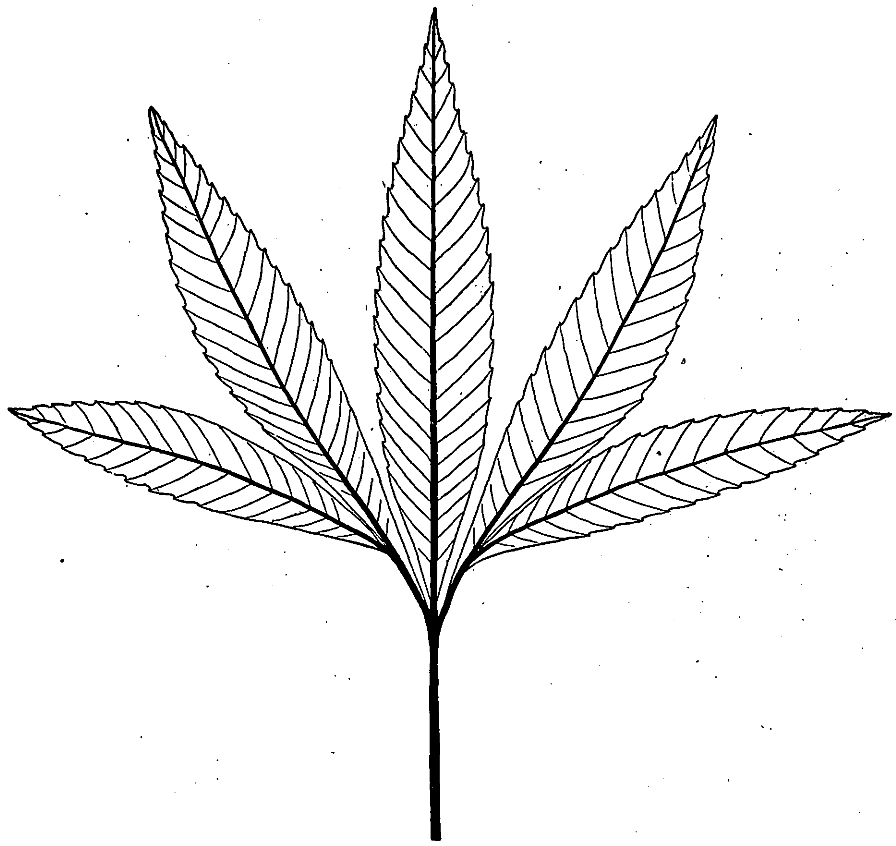

FIGURE 1.—Restoration of *Dewalquea smithi* Berry, from the Tuscaloosa formation of western Alabama.

aquiline-serrate teeth. Midrib stout. Secondaries regular, subopposite, parallel; about 20 pairs, branching from the midrib at angles varying from 45° to 70°, generally about 50°, curving upward and running to the marginal teeth or camptodrome. The base of the leaflet extends downward 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 in 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. Marginal and venation characters as in the outer leaflets. This handsome species, of which a restoration is shown in figure 1, is abundantly represented at the locality near Langley, mostly by terminal leaflets, a number of which are reproduced in Plate VIII, figures 3–9. It is common in the Tuscaloosa formation at Whites Bluff, on the right bank of Warrior River 309 miles above Mobile, Ala., a small collection of fossil plants from this outcrop containing no less than 27 specimens of this form. Several of these were complete and were sketched at the time they were collected, which proved fortunate, as the extremely arenaceous matrix did not withstand shipment very well. The museum material, though considerably broken, shows several entire detached leaflets and three or four basal parts of the leaf showing the mode of division of the petiole.

The genus Dewalquea was founded by Saporta and Marion in 1874 [1] 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, including another species from the German Senonian, *Dewalquea insignis*, described by Hosius and Von der Marck; [2] two species from the Cenomanian of Bohemia, *Dewalquea coriacea* and *Dewalquea pentaphylla*, described by Velenovsky; [3] two American species from the Dakota sandstone, *Dewalquea dakotensis* and *Dewalquea primordialis*, described by Lesquereux,[4] both of which are fragmentary and of uncertain relationship; a species from the Raritan formation of New Jersey, *Dewalquea trifoliata*, described by Newberry; [5] and a species described by Heer [6] from Greenland, *Dewalquea groenlandica*, and subsequently recorded from Staten Island, New Jersey, North Carolina, and Alabama.

Hosius and Von der Marck [7] record the Eocene species from the Senonian of Westphalia, but the remains are not of this species, being fragments of *Dewalquea haldemiana*, which is common at that horizon. The European species *Dewalquea insignis* is recorded by Heer [8] both from the Atane and Patoot beds of Greenland and by Hollick [9] from the Cretaceous of Staten Island, but both of these determinations are based upon fragments of single leaves and are, in the writer's judgment, entirely untrustworthy. Attention should also be called to the possibility of *Celastrus arctica* Heer [10] representing the leaflets of a Dewalquea. This 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 no better discussion of it is extant than that given by Saporta and Marion,[11] who, after comparing these leaves with those of Ampelopsis, Arisæma, Anthurium (Araceæ), and other genera, arrive at the conclusion that they are prototypes of the tribe Helleboreæ of the Ranunculaceæ.

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* described by Velenovsky from the Cenomanian of Bohemia.

As previously mentioned, this species shows both entire and serrated forms. It is remarkable that where this genus has been found in any abundance, two species are usually described,

[1] Saporta, G. de, and Marion, A. F., Essai sur l état de la végétation à l'époque des marnes heersiennes de Gelinden: Mém. cour. et des Sav. étrang. Acad. roy. Belgique, vol. 37, p. 55. 1874.
[2] Hosius and Von der Marck, Palæontographica, vol. 26, 1880, p. 172, Pl. XXXII, figs. 111–113; XXXIII, fig. 109; XXXIV, fig. 110; and XXXV, fig. 123.
[3] Die Flora der böhmischen Kreideformation, pt. 3, 1884, pp. 11, 14, Pls. I, figs. 1–9; II, fig. 2; and VIII, figs. 11, 12.
[4] The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 211, Pl. LIX, figs. 5, 6. Geol. and Nat. Hist. Survey Minnesota, vol. 3, 1893, p. 18, Pl. A, fig. 10.
[5] Newberry, J. S., The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 129, Pl. XXII, figs. 4–7.
[6] Heer, Oswald, Flora fossilis arctica, vol. 6, Abth. 2, 1882, p. 87, Pls. XXIX, figs. 18, 19; XLII, figs. 5, 6; XLIV, fig. 11.
[7] Op. cit., p. 50.
[8] Op. cit., vol. 6, Abth. 2, 1882, p. 86, Pls. XXV, fig. 7; XXXIII, figs. 14–16; idem, vol. 7, 1883, p. 37, Pls. LVIII, fig. 3; LXII, fig. 7.
[9] The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 106, Pl. VIII, fig. 24.
[10] Op. cit., vol. 7, 1883, p. 40, Pl. LXI, figs. 5d, 5e.
[11] Op. cit., pp. 55–61.

one entire and one with toothed margins. Thus in Germany *Dewalquea haldemiana* is entire, whereas *Dewalquea insignis* is toothed, and probably both are the leaves of the same plant. In Bohemia *Dewalquea pentaphylla* is entire and *Dewalquea coriacea* is toothed. As for the Alabama plant, it is believed that the entire and serrate leaves are specifically identical, for the material shows a great many gradations in the size of the teeth and great variability regarding the proportion which the entire part of the margin bears to the toothed part on single leaflets.

Occurrence.—Middendorf arkose member of Black Creek formation, near Langley and Miles Mill, Aiken County. (Collected by L. W. Stephenson, E. W. Berry, and Earle Sloan.)

Collections.—U. S. National Museum.

Family MAGNOLIACEÆ.

Genus MAGNOLIA Linné.

MAGNOLIA CAPELLINII Heer (?).

Plate X, figure 3.

This species, which is confined to the Middendorf arkose member of the Black Creek formation in South Carolina, is described in the section of this report dealing with the Upper Cretaceous flora of Georgia, pages 112–113.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County; Rocky Point, Sumter County. (Collected by L. C. Glenn, L. W. Stephenson, and E. W. Berry.)

Collection.—U. S. National Museum.

MAGNOLIA NEWBERRYI Berry (?).

Magnolia longifolia Hollick, Trans. New York Acad. Sci., vol. 12, 1892, p. 36, Pl. III, fig. 9.
Magnolia longifolia Smith, On the geology of the Coastal Plain of Alabama, 1894, p. 348.
Magnolia longifolia Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 422, Pl. XXXVII, fig. 3.
Magnolia longifolia Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 66, Pl. XX, figs. 2, 3 (non Sweet, 1826).
Magnolia longifolia Newberry, The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 76, Pls. LV, figs. 3 and 5, and LVI, figs. 1–4.
Magnolia newberryi Berry, Bull. Torrey Club, vol. 34, 1907, p. 195, Pl. XIII, fig. 6.

Description.—Leaves mostly of large size, ovate to oblong in outline, about 20 centimeters in length by 9 to 10 centimeters in 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 four, five, or six sided areoles, quite prominent in some specimens.

This is the largest magnolia of the Raritan formation, the leaves of which are said by Newberry to reach a length of 30 centimeters or more. It is common at the Woodbridge locality and has also been reported from Staten Island and Marthas Vineyard, from the Tuscaloosa formation in Alabama, and from the Black Creek formation in North Carolina. 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 that it has in the latter species. Its occurrence in the South Carolina Cretaceous is based upon doubtfully determined material from the locality near Darlington, but it must almost certainly have been a member of the South Carolina flora, for it has been detected in homotaxial deposits both north and south of this area. (Collected by L. W. Stephenson.)

Occurrence.—Black Creek formation, near Darlington, Darlington County.

Collections.—U. S. National Museum.

MAGNOLIA OBTUSATA Heer.

Magnolia capellinii Heer, Flora Fossilis Arctica, vol. 3, Abth. 2, 1874, Pl. XXXIII, fig. 4 (non other citations of this species).
Magnolia obtusata Heer, idem, vol. 6, Abth. 2, 1882, p. 90, Pls. XV, fig. 12, and XXI, fig. 3.
Magnolia obtusata Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 201, Pl. LX, figs. 5, 6.
Magnolia obtusata Berry, Bull. New York Bot. Garden, vol. 3, 1903, p. 76, Pl. XLVII, fig. 4.
Magnolia obtusata Berry, idem, vol. 37, 1910, p. 23.

Description.—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 is also a member of the Tuscaloosa flora in western Alabama. The South Carolina specimens are few in number and come from but a single locality.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

MAGNOLIA TENUIFOLIA Lesquereux (?).

Plate IX, figures 2 and 3.

Magnolia tenuifolia Lesquereux, Am Jour. Sci., 2d ser., vol. 46, 1868, p. 100.
Magnolia tenuifolia Lesquereux, The Cretaceous flora, 1874, p. 92, Pl. XXI, fig. 1.
Magnolia tenuifolia Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 198, Pl. XXIV, fig. 1.
Magnolia tenuifolia Berry, Bull. New York Bot. Garden, vol. 3, 1903, p. 77, Pl. XLVII, fig. 10.
Magnolia tenuifolia Hollick, idem, vol. 3, 1904, p. 413, Pl. LXXIII, fig. 2.
Magnolia tenuifolia Berry, Bull. Torrey Bot. Club, vol. 31, 1904, p. 76, Pl. I, fig. 7.
Magnolia tenuifolia Berry, idem, vol. 33, 1906, p. 174, Pl. VII, fig. 1.
Magnolia tenuifolia Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 64, Pls. XVII, fig. 1; XVIII, figs. 4, 5.

Description.—Leaves large, entire, oblong-ovate in outline, with a very stout petiole and midrib. Length, about 20 centimeters. Greatest width, which is about halfway between the apex and the base, about 8 centimeters. Apex bluntly pointed. Base cuneate, pointed. Secondaries open, approximately parallel, inequidistant, camptodrome.

The presence of this species in South Carolina Cretaceous is based upon the doubtfully determined fragments figured. The leaf in life was such a large one that most of the occurrences are based upon mere fragments. It was described originally from the Dakota sandstone and has subsequently been recorded from the Magothy formation on Marthas Vineyard and Long Island and in New Jersey and Delaware.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

Genus ILLICIUM Linné.

ILLICIUM WATEREENSIS sp. nov.

Plate XIV, figure 8.

Description.—Leaves entire, lanceolate in outline, with the apex and the base acutely and equally pointed. Length about 9.5 centimeters. Greatest width 1.9 centimeters, in the middle part of the leaf. Midrib narrow but prominent. Secondaries numerous, parallel, branching from the midrib at angles of about 45°, camptodrome.

This species may be compared with a variety of described species in unrelated genera, as, for example, Nyssa, Daphne, Apocynum, Andromeda, and various lauraceous genera, but it is believed to have more in common with the Ranalian genus Illicium, in which only one other Cretaceous species, *Illicium deletum* Velenovsky,[1] from the Cenomanian of Bohemia, is known. The latter is very similar to the South Carolina leaf, differing merely in having fewer secondaries and more open secondary venation. A number of Tertiary species of Illicium are known, and the modern forms, which are seven or eight in number, inhabit the warmer parts of eastern North America and eastern Asia.

Occurrence.—Middendorf arkose member of Black Creek formation, Rocky Point, Sumter County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Order ROSALES.

Family HAMAMELIDACEÆ.

Genus HAMAMELITES Saporta.

HAMAMELITES? CORDATUS Lesquereux.

Plate X, figure 2.

Hamamelites? cordatus Lesquereux, The Cretaceous and Tertiary floras, 1883, p. 71, Pl. IV, fig. 3.
Hamamelites? cordatus Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 139.

Description.—Leaves large, elliptical in outline. Length about 10 centimeters. Greatest width 6 to 7 centimeters; near the middle part of the leaf. Apex unknown. Base cordate. Margin undulate to dentate or serrate with shallow teeth. Midrib stout. Secondaries stout, numerous, approximately parallel, branching from the midrib at angles of 45° or more, nearly straight, at right angles to the secondaries. Texture coriaceous.

The genus Hamamelites was founded by Saporta in 1865 upon foreign early Tertiary material, and to it Lesquereux referred five species from the Dakota sandstone, which exhibited a combination of the characters of Hamamelis, Alnus, Viburnum, and other genera. Subsequently one of these was referred to Quercus. All were founded upon rather sparse material, particularly *Hamamelites? cordatus*. Its occurrence in South Carolina is based upon the single imperfect specimen figured, which is very similar to the figured type from the West. It shows part of the margin, the characteristic venation, and half of the typical cordate base. That Hamamelis-like forms were present at this time is shown by the presence of wood of this type described by Lignier in 1907 as Hamamelidoxylon from the Cenomanian of France.

Occurrence.—Middendorf arkose member of Black Creek formation, Rocky Point, Sumter County. (Collected by L. C. Glenn.)

Collections.—U. S. National Museum.

Family MIMOSACEÆ.

Genus ACACIAPHYLLITES gen. nov.

ACACIAPHYLLITES GREVILLEOIDES sp. nov.

Plate IX, figures 9 and 10.

Description.—Leaves or leaflets of small size, entire, oblong-elliptical in outline, about 2 centimeters in length by 0.5 to 0.65 centimeters in greatest width, which is at the middle part of the leaf. Apex and base equally rounded. Petiole very short and relatively stout, about 1.5 millimeters in length. Midrib thin, very much attenuated distad. Secondaries fine, numerous, approximately parallel, branching from the midrib at acute angles; long, ascending, apparently camptodrome, connected at irregular intervals by cross branchlets of the same caliber.

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[1] Velenovsky, J., Die Flora der böhmischen Kreideformation, pt. 3, 1884, p. 4, Pl. III, fig. 5.

This species is believed to show undoubted characters which ally it with the genus Acacia and is certainly referable to the families Mimosaceæ or Cæsalpiniaceæ, although suggesting the family Proteaceæ. It is totally unlike any known fossil American species but resembles certain of the Bohemian Cretaceous leaves referred by Velenovsky [1] to Grevillea or Grevilleophyllum, although, as has been said, it is here considered leguminous.

These small leaves are not uncommon at the locality near Middendorf, to which they are confined. Their small size has enabled complete specimens to be preserved, and though they are thin they appear to have had a resistant epidermis of thick-walled cells, greatly resembling a number of typical existing acacias.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

Genus CÆSALPINIA Linné.

CÆSALPINIA MIDDENDORFENSIS sp. nov.

Plate X, figure 7.

Description.—Leaves compound. Leaflets entire, elliptical in outline, with a broadly rounded apex and a slightly broader, rounded, markedly inequilateral base, 1.5 centimeters in length by 0.9 centimeter in greatest width, which is at the middle or below. Midrib slender and curved in the single complete leaflet collected. Secondaries few and thin, four or five pairs, branching from the midrib at a wide angle, more than 45°, camptodrome.

This is a well-marked species, clearly referable to some member of the Cæsalpiniaceæ with compound leaves, usage sanctioning the reference of leaflets of this sort to the genus Cæsalpinia, with the leaflets of which they agree closely. Only two other Cretaceous species are known, both from the Raritan formation in New Jersey. With the smaller of these, *Cæsalpinia cookiana* Hollick,[2] the South Carolina form is closely comparable, but it differs in its more elongate inequilateral outline and more numerous secondaries.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

Genus LEGUMINOSITES Bowerbank.

LEGUMINOSITES MIDDENDORFENSIS sp. nov.

Plate VIII, figure 13.

Description.—Leaves or leaflets ovate-lanceolate in outline, with a pointed apex and rounded base, 3 centimeters in length by 1.4 centimeters in greatest width, which is in the middle part of the leaf. Midrib thin. Secondaries thin, open, five or six pairs, slightly curved, ascending at angles of 45 to 50°.

This species is of rare occurrence and vague relationship, although it seems to be most closely related to the leguminous leaves usually referred to the form-genus Leguminosites.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

LEGUMINOSITES ROBINIIFOLIA Berry.

Plate IX, figure 11.

Leguminosites robiniifolia Berry, Bull. Torrey Bot. Club, vol. 37, 1910, p. 196.

Description.—Leaflets sessile, ovate to ovate-elliptical in outline. Length about 2.5 centimeters. Greatest width, 1.3 to 1.5 centimeters, at a point slightly nearer the base than

[1] Die Flora der böhmischen Kreideformation, pt. 2, 1883, p. 3, Pl. I, figs. 6–10.

[2] Newberry, J. S., The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 94, Pl. XLII, figs. 49, 50.

the apex. Both the apex and the base are obtusely rounded, the base broadly and the apex more narrowly. Midrib fairly stout. Secondaries consist of about five alternate to opposite pairs, slender, regularly curved, and approximately parallel, branching from the midrib at angles of about 45° or slightly more, camptodrome.

This well-marked species is entirely distinct from previously described forms and is remarkably close to the leaves of the existing *Robinia pseudacacia* Linné of the eastern United States, which fact has led to the specific name chosen for it. It was described recently by the writer from material collected from the Black Creek formation at Court House Bluff on Cape Fear River in North Carolina.

Occurrence.—Middendorf arkose member of Black Creek formation, near Langley, Aiken County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

Order **GERANIALES.**

Family **RUTACEÆ.**

Genus **CITROPHYLLUM** Berry.

CITROPHYLLUM ALIGERUM (Lesquereux) Berry.

Ficus aligera Lesquereux, Mon. U. S. Geol. Survey, vol. 17, 1892, p. 84, Pl. X, figs. 3–6.
Ficus aligera Berry, Ann. Rept. State Geologist, New Jersey, for 1905, 1906, p. 139.
Ficus aligera Berry, Bull. Torrey Bot. Club, vol. 33, 1906, p. 172.
Citrophyllum aligerum Berry, idem, vol. 36, 1909, p. 258, Pl. XVIIIa, figs. 1–8.

Description.—The following description is given in the reference last cited:

Leaves small, elliptical to ovate or ovate-lanceolate, coriaceous, varying from 2.5 to 6 centimeters in length by 1.8 to 3.2 centimeters in breadth. Margin entire, occasionally slightly undulate. Apex rounded or obtusely acuminate. Base rounded, subtruncate, or cuneate. Petiole stout, 0.7 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 nine alternate pairs, branching from the midrib at angles of from 45 to 50°, parallel, camptodrome.

These curious leaves (morphologically leaflets) were described by Lesquereux in 1892 from the Dakota sandstone as a species of Ficus and compared with *Ficus bumelioides* Ettingshausen and *Ficus mudgei* Lesquereux, neither 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 part of the Raritan formation of South Amboy, N. J. They exhibit considerable variety in outline, but all have exactly the same aspect and conspicuous, more or less alate petioles. They appear to be closely related to the leaves of the modern genus Citrus. The latter 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 the latter and comparing them with the fossils the conclusion seems to be irresistible that they are related, and the writer consequently referred the fossils to a new genus with a name that emphasized this relationship to the modern genus. All the more complete leaves of this species were figured by the writer in 1909, as well as some recent Citrus leaves for comparison with them. 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 the genus previous to the middle part of the Cretaceous. The modern leaves abscise 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 is the most difficult argument to combat. However, modern leaves are sometimes shed in their entirety, and we are justified in assuming the occasional fall of leaves before maturity when the abscission layer of cells had not yet become weakened. The cause might be violent winds, the passage of large animals like some of the Cretaceous dinosaurs, or weakened conditions resulting from attacks of insects, or of fungous diseases. The species is also found in the Magothy, Tuscaloosa, and Dakota formations.

The South Carolina occurrence of this species is based upon the incomplete but characteristic leaves and tends to confirm the doubtful identification of this form in the Black Creek formation of North Carolina.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County; Miles Mill, Aiken County. (Collected by E. W. Berry and Earle Sloan.)

Collections.—U. S. National Museum.

Order EUPHORBIALES.

Family EUPHORBIACEÆ.

Genus CROTONOPHYLLUM Velenovsky.

CROTONOPHYLLUM PANDURÆFORMIS sp. nov.

Plate VII, figures 5–10.

Description.—Leaves of variable size, entire and ovate-lanceolate or irregular panduriform in 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; it may be wanting on both sides and the leaf be ovate-lanceolate in outline, as it often is in the only other known species of the genus. This is the habit of a number of specimens from the Miles Mill locality. Apex bluntly pointed. Base slightly recurrent 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 which case 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 South Carolina Cretaceous, though they are generally incomplete. They are wholly unlike any known American Cretaceous leaves, although they suggest the leaf described from the Upper Cretaceous of Vancouver Island by Dawson as *Liriodendron succedens*.[1] In the writer's opinion Dawson's leaf is not a Liriodendron, but as Dawson's figures are inaccurate, and as the writer has not seen the original material, his opinion is not conclusive. The genus Crotonophyllum was proposed by Velenovsky for leaves from the Cenomanian of Vyserovic, Bohemia, which are very similar to the present species. A single species, *Crotonophyllum cretaceum*,[2] was described and compared with the existing species of Croton, but as the discussion is in Bohemian the description is not readily accessible to English readers. The illustrations, however, are ample and depict a leaf which is surely congeneric with the South Carolina fossils.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County; near Langley and Miles Mill, Aiken County; Rocky Point, Sumter County. (Collected by L. W. Stephenson, E. W. Berry, and Earle Sloan.)

Collections.—U. S. National Museum.

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[1] Trans. Roy. Soc. Canada, vol. 11, sec. 4, 1894, p. 62, Pl. VIII, fig. 26.
[2] Velenovsky, J., Květena českého cenomanu, 1889, p. 20, Pl. V, figs. 4–11.

Order SAPINDALES.

Family SAPINDACEÆ.

Genus SAPINDUS Linné.

SAPINDUS MORRISONI Heer.

Plate IX, figure 6.

Sapindus morrisoni Heer (Lesquereux MS.), Flora fossilis arctica, 1882, vol. 6, Abth. 2, p. 96, Pls. XL, fig. 1; XLI, fig. 3; XLIII, figs. 1a, 1b; and XLIV, figs. 7 and 8.
Sapindus morrisoni Heer, idem, vol. 7, 1883, p. 39, Pl. LXV, fig. 5.
Sapindus morrisoni Lesquereux, The Cretaceous and Tertiary floras, 1883, p. 83, Pl. XVI, figs. 1 and 2.
Sapindus morrisoni Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 158, Pl. XXXV, figs. 1 and 2.
Sapindus morrisoni Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 422, Pl. XXXVI, fig. 4.
Sapindus morrisoni Knowlton, Twenty-first Ann. Rept. U. S. Geol. Survey, 1901, p. 317, pt. 7.
Sapindus morrisoni Berry, Bull. New York Bot. Garden, vol. 3, 1903, p. 83, Pl. XLVII, figs. 2 and 3.
Sapindus morrisoni Berry, Bull. Torrey Bot. Club, vol. 31, 1904, p. 78.
Sapindus morrisoni Berry, Ann. Rept. State Geologist New Jersey for 1905, 1906, pp. 138 and 139.
Sapindus morrisoni Hollick, Mon. U. S. Geol. Survey, vol. 50, 1907, p. 90, Pl. XXXIII, figs. 16–20.

Description.—Leaves pinnately compound. Leaflets large, subcoriaceous, entire, lanceolate in outline, about 10 to 15 centimeters in length or in a few specimens larger, by 2 to 3 centimeters in greatest width. Base cuneate or rounded, generally inequilateral. Midrib stout. Secondaries stout, bowed, rather open, approximately parallel, camptodrome.

These leaflets are usually found detached, as in the few specimens found near Langley, S. C., although some of the material from the west shows the habit. This species was described by Lesquereux and named in allusion to the type locality. As Lesquereux's report on Cretaceous and Tertiary floras was not published promptly, it happened that Heer had meanwhile published this species, based on Greenland material and identified by means of some of the plates of Lesquereux's work which the latter had sent to him, so that the species must be credited to Heer. It occurs at both the Atane and Patoot horizons in Greenland and is a common form in the Woodbine sand of Texas, which is regarded as the southern equivalent of the Dakota sandstone. In the east it is probably confined to post-Raritan deposits, although there is some doubt regarding the age of the morainic material on Staten Island from which it has been recorded by Hollick. It is common in the Magothy formation of New Jersey, but has not heretofore been recorded from the southern Coastal Plain, although it will probably be found to be a member of the Tuscaloosa flora when the Alabama collections are thoroughly studied.

Occurrence.—Middendorf arkose member of Black Creek formation, near Langley, Aiken County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

Family CELASTRACEÆ.

Genus PACHYSTIMA Rafinesque.

PACHYSTIMA? CRETACEA sp. nov.

Plate X, figure 6.

Description.—Leaves of small size, oblong or obovate in outline, with a rounded apex and a narrowed descending base, about 2 centimeters in length by 3 millimeters in greatest width. Texture coriaceous. Petiole short and stout. Midrib stout. Secondaries numerous, fine, immersed, ascending.

This species is totally unlike any described fossil forms and closely resembles the leaves of the existing species of Pachystima, of which only two are known, one from the East and one from the Rocky Mountain area. They are shrubs of dry situations with evergreen, more or less revolute leaves. The writer feels much doubt about this identification, and it is possible that this species represents the excessively narrowed leaves of *Acaciaphyllites grevilleoides* Berry collected from the same locality. Pachystima is unknown in the fossil state elsewhere except for a recently described species from the Miocene of Florissant, Colo.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

Genus CELASTROPHYLLUM Goeppert.

CELASTROPHYLLUM ELEGANS Berry.

Plate XIV, figure 11.

Celastrophyllum elegans Berry, Bull. New York Bot. Garden, vol. 3, 1903, p. 84, Pl. XLIII, fig. 6.
Celastrophyllum elegans Berry, Bull. Torrey Bot. Club, vol. 32, 1905, p. 46, Pl. II, fig. 1.

Description.—Leaves obovate in outline with a broadly rounded apex and cuneate pointed base, 6 to 8 centimeters in length by 2 centimeters or slightly more in greatest width, which is in the middle part of the leaf. Margin entire below with undulate shallow teeth above. Secondaries numerous, branching at angles of more than 45°, rather straight, parallel, camptodrome.

This species is quite distinct from any other species of Celastrophyllum, although it shows some points of similarity with the abundant Raritan and Dakota species. It was described from the Magothy formation of New Jersey, the occurrence in South Carolina being the first recorded outside of the type area. It is rare in South Carolina and not especially well preserved, the material differing from the type in the somewhat more numerous secondaries.

Occurrence.—Middendorf arkose member of Black Creek formation, Rocky Point, Sumter County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

CELASTROPHYLLUM CRENATUM Heer.

Celastrophyllum crenatum Heer, Flora fossilis arctica, vol. 7, 1883, p. 41, Pl. LXII, fig. 21.
Celastrophyllum crenatum Smith, On the geology of the Coastal Plain of Alabama, 1894, p. 348.
Celastrophyllum crenatum Newberry, The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 99, Pl. XLVIII, figs. 1–19.
Celastrophyllum crenatum Berry, Bull. Torrey Bot. Club, vol. 34, 1907, p. 197, Pl. XIII, fig. 5.

Description.—Leaves very variable in size, 2 to 8 centimeters in length by 1 to 5 centimeters in width, ovate or eliptical in outline, broadly rounded above, narrowed and generally inequilateral below. Margins entire below, coarsely toothed above, with somewhat variable, rounded, crenate, or crenato-dentate teeth. A few specimens are entire throughout and some have a markedly inequilateral base. Midrib fairly 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 by Heer from the Patoot beds of Greenland and unfortunately only a single small leaf was figured. The Raritan leaves, which are abundant, grade into much larger forms that are also present in the Black Creek formation of North Carolina and the Tuscaloosa formation of Alabama.

The species is rare in South Carolina, fragmentary specimens being sparsely represented in the Middendorf collections. The genus is characteristic of the late Lower Cretaceous and early Upper Cretaceous of eastern North America and is not known anywhere from beds of Montana or Senonian age.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

Celastrophyllum carolinensis sp. nov.

Plate XIII, figures 1-5.

Description.—Leaves lanceolate in outline, with a pointed apex and a cuneate base, about 14 centimeters in length by 2.9 centimeters in greatest 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, a few craspedodrome in the upper part of the leaf, sending tertiary branches into the marginal teeth. Margin entire for a short distance at the base, above which it is crenate or biconvex, the teeth large and interspersed with smaller subordinate teeth of the same character. Leaf substance thin.

This striking form is rather common at the locality near Langley, but all the leaves are much broken, though fragments of all parts of the leaf are present, and fully warrant the restoration shown in figure 5 of the plate.

This species has been compared with a very large amount of existing material in the herbaria of the New York Botanical Garden and the United States National Museum. It shows analogies with a variety of existing genera, as for example, Cunonia, Clerodendron, Symplocos, Ternstromia, Callicarpa, Panax, and other forms, but is believed to find its nearest relatives among the Celastraceæ. 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. *quercinea* Velenovsky), Myrica (cf. *serrata* Velenovsky), Quercus, and Fraxinus.

Occurrence.—Middendorf arkose member of Black Creek formation, near Langley, Aiken County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

Family ANACARDIACEÆ.

Genus RHUS Linné.

Rhus darlingtonensis sp. nov.

Plate IX, figures 7 and 8.

Description.—Leaflets large, broadly ovate in outline, with an obtusely pointed apex and a rounded base, about 9 or 10 centimeters in length by 4.5 centimeters in greatest width, which is the middle or lower half of the leaf. Texture subcoriaceous. Margin dentate, crenate, or scalloped, with subordinate crenulations. Midrib straight, fairly stout. Secondaries consisting of about nine subopposite or alternate pairs, branching from the midrib at obtuse angles of about 60°, approximately parallel, slightly curved, craspedodrome, terminating in the main marginal teeth and sending short outwardly and downwardly directed branches to the subordinate teeth. Bulk of tertiaries transverse.

This large and evidently handsome species is based upon abundant, but very poorly preserved material, the two best specimens being those figured. In general appearance it suggests the less elongate and broader leaves of *Myrica elegans* Berry, but it is a much larger and broader leaf with more open secondaries.

Five Cretaceous species of Rhus have been described, three from the Dakota sandstone and two from Europe, one of the latter being also recorded from Glen Cove, Long Island, by Hollick. The South Carolina species is very different from all these and is much more modern in appearance, suggesting a number of Tertiary species of Rhus and closely resembling the larger, less

[1] Velenovsky, J., Die Flora der böhmischen Kreideformation, pt. 2, 1883, p. 3, Pl. I, figs. 6-10.
[2] Idem, pt. 3, 1884, p. 11, Pls. I, figs. 1-9; II, fig. 2.

elongate leaves of the existing *Rhus glabra* Linné; in fact, leaves of the latter can be selected which, except for the more acute teeth, are exactly like this Cretaceous form.

Occurrence.—Black Creek formation, near Darlington, Darlington County. (Collected by L. W. Stephenson.)

Collections.—U. S. National Museum.

Order THYMELEALES.

Family LAURACEÆ.

Genus LAURUS Linné.

LAURUS PLUTONIA Heer.

Plates XI, figure 2, and XIII, figure 6.

Laurus plutonia Heer, Flora fossilis arctica, vol. 6, Abth. 2, 1882, p. 75, Pls. XIX, figs. 1d, 2–4; XX, figs. 3a, 4–5; XXIV, fig. 6b; XXVIII, figs. 10 and 11; and XLII, fig. 4b.
Laurus plutonia Heer, idem, vol. 7, 1883, p. 30, Pls. LVIII, fig. 2, and LXII, fig. 1a.
Laurus plutonia Velenovsky, Die Flora der böhmischen Kreideformation, pt. 3, 1884, p. 1, Pl. IV, figs. 2–4.
Laurus plutonia Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 91, Pls. XIII, figs. 5 and 6, and XXII, fig. 5.
Laurus plutonia Lesquereux, Geol. and Nat. Hist. Survey Minnesota, vol. 3, pt. 1, 1895, p. 14, Pls. A, fig. 6, and B, fig. 5.
Laurus plutonia Newberry, The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 85, Pl. XVI, figs. 10 and 11.
Laurus plutonia Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 60, Pl. IV, figs. 6 and 7
Laurus plutonia ? Gould, Am. Jour. Sci., 4th ser., vol. 5, 1898, p. 175.
Laurus plutonia Berry, Bull. New York Bot. Garden, vol. 3, 1903, p. 79, Pl. L, figs. 9–11
Laurus plutonia Berry, Bull. Torrey Bot. Club, vol. 31, 1904, p. 77, Pl. III, fig. 1.
Laurus plutonia Berry, idem, vol. 33, 1906, p. 178.
Laurus plutonia Berry, Ann. Rept. State Geologist New Jersey for 1905, 1906, pp. 138 and 139.
Laurus plutonia Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 80, Pls. XXVII, figs. 9 and 11, and XXVIII, figs. 1 and 2.

Description.—Leaves lanceolate in outline, usually tapering almost equally in both directions but some specimens less acute at the base. Length, 7 to 11 centimeters; greatest width, 1.5 to 2.5 centimeters. Midrib fairly 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. Prof. Newberry subsequently recorded specimens from the Raritan formation of New Jersey without giving any specific localities. Those figured show leaves which are relatively wider than is usual with leaves of this species, but these are comparable with some of Heer's Greenland specimens.[1] Entirely typical leaves occur in the top layer of the Raritan at the Hylton pits in southwestern New Jersey.

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. Some of these records the writer believes to be not altogether above question, however, among those of which doubt is felt being the identifications of the forms from the Cenomanian of Bohemia by Velenovsky.

It is evidently a rare plant in the Raritan but becomes abundant in immediately succeeding floras, being common in that of the Dakota sandstone and in the Magothy formation 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 South Atlantic Coastal Plain. Supposed fruits are figured by Heer.[2] In South Carolina this species is represented by typical leaves that are not at all uncommon. It has not been detected in the North Carolina Cretaceous, although it ranges from the base to the top of the Tuscaloosa formation in Alabama.

[1] Op. cit., vol. 6, Abth. 2, 1882, Pls. XX, figs. 5 and 11.

[2] Op. cit., Pl. XLII, fig. 4b.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County; near Langley, Aiken County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

LAURUS ATANENSIS nom. nov.

Plate XIII, figure 7.

Laurus angusta Heer, Flora fossilis arctica, vol. 6, Abth. 2, 1882, p. 76, Pls. XX, figs. 1b and 7, and XLIII fig. 1c (non Rafinesque).
Laurus angusta Heer, idem, vol. 7, 1883, p. 30, Pl. LVII, fig. 1b.
Laurus angusta Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 93, Pl. XVI, fig. 7.
Laurus angusta Hollick, Bull. New York Bot. Garden, vol. 3, 1904, p. 408, Pl. LXX, figs. 10 and 11.
Laurus angusta Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 81, Pl. XXVII, figs. 11 and 12.

Description.—Leaves entire, linear-lanceolate, tapering about equally to the acuminate apex and base. Length, 12 centimeters or less; some of Heer's Greenland material ranging considerably under this dimension. Width, about 1.5 centimeters. Midrib relatively thin. Secondaries thin, somewhat widely separated, branching from the midrib at acute angles, 45° or less, nine to twelve alternate pairs, finally ascending along the margin, camptodrome. Tertiaries forming the characteristic areolation of the genus.

Heer originally compared this species with *Laurus plutonia,* pointing out that it was more linear and acuminate. He also remarks that it is somewhat smaller, but this generalization has been found not to hold good, even for the Greenland material. The primaries are sparser and more ascending than in *Laurus plutonia* and the more linear form gives the leaf a decidedly different aspect. There can be no doubt that the two are perfectly distinct species, naturally possessing certain lauraceous characters in common.

Heer's name for this species is preoccupied by that given by Rafinesque to an existing species, so that a new name is necessary, the one proposed being given in allusion to the type locality.

Laurus atanensis was described from the Atane beds of Greenland and was subsequently recorded from the Patoot beds. Lesquereux identified it from the Dakota sandstone of Kansas and Hollick has recorded it from the clays of Northport, Long Island, which are probably of Magothy age. It has not been detected from the southern Atlantic Coastal Plain, although it may well be present in the unstudied collections from the Magothy formation of Maryland and from the Tuscaloosa formation of Alabama.

Occurrence.—Middendorf arkose member of Black Creek formation, Rocky Point, Sumter County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Genus LAUROPHYLLUM Goeppert.

LAUROPHYLLUM ELEGANS Hollick.

Plate XII, figure 6.

Laurus plutonia Hollick, Trans. New York Acad. Sci., vol. 11, 1892, p. 99, Pl. III, figs. 3 and 4.
Laurus plutonia Hollick, idem, vol. 12, 1893, p. 236, Pl. VI, fig. 1 (non Heer).
Proteoides daphnogenoides Hollick, Annals New York Acad. Sci., vol. 2, 1898, p. 420, Pl. XXXVI, fig. 2 (non Heer).
Laurophyllum elegans Hollick, The Cretaceous flora of New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 81, Pl. XXVII, figs. 1–5.
Laurophyllum elegans Berry, Bull. Torrey Bot. Club, vol. 37, 1910, pp. 26, 198.

Description.—Leaves elongate-lanceolate, somewhat flexuous, about 12 or 13 centimeters in length by about 2 centimeters in greatest width, which is about midway between the apex and the base; from this point they narrow gradually apically into an attenuated acuminate, usually curved tip, and basally into a long, narrowly cuneate base. Midrib and petiole stout. Secondaries numerous, usually less close and somewhat coarser than in *Laurophyllum nervil-*

losum, branching from the midrib at an acute angle below, which becomes more open above the base of the leaf; they are usually more curved than in *Laurophyllum nervillosum* and more distinctly camptodrome. Tertiaries transverse throughout.

These leaves were recorded originally by Hollick as *Laurus plutonia* Heer and were later compared with *Laurus angusta* Heer, which latter species they resemble more than they do the former. In outline they are not unlike *Laurophyllum angustifolium* Newberry, from the Raritan formation of Woodbridge, N. J., but differ decidedly in venation. They are also similar but quite distinct from *Laurophyllum nervillosum* Hollick, of the East, and *Laurophyllum reticulatum* Lesquereux, of the Dakota sandstone.

The type was obtained from transported materials associated with the terminal moraine, from which numerous specimens have been collected. Those from Tottenville, Staten Island, are undoubtedly of Raritan age, but those from Glen Cove may have come originally from the Magothy formation, although they are probably Raritan. The species is certainly known from the upper part of the Raritan at South Amboy, N. J., and is common in the Magothy formation of Maryland. It is sparsely represented in the Black Creek formation of North Carolina and is not uncommon near Middendorf, the latter specimens being slightly broader and consequently having fewer secondaries ascending than the type specimens.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

Laurophyllum nervillosum Hollick.

Plate XII, figure 7.

Proteoides daphnogenoides Hollick, Annals New York Acad. Sci., vol. 2, 1898, p. 420, Pl. XXXVI, figs. 1 and 3 (non Heer).

Laurophyllum nervillosum Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 82, Pl. XXVII, figs. 6, 7.

Laurophyllum nervillosum Berry, Bull. Torrey Bot. Club, vol. 36, 1909, p. 255.

Description.—Leaves of comparatively large size, oblong-lanceolate in outline, 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 terminal moraine at Tottenville, Staten Island, and undoubtedly represents transported Raritan materials. It is also present in the lower part of the Raritan formation at Milltown, N. J., and is not uncommon in the South Carolina Cretaceous. It is somewhat like *Laurophyllum lanceolatum* Newberry, but has a markedly different venation and a less lanceolate outline. It is also quite close to *Laurophyllum elegans* Hollick, which is, however, a more slender lanceolate leaf, having narrowly produced apex and base and a somewhat coarser venation, with camptodrome secondaries, less close and more curved.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. Black Creek formation, near Darlington, Darlington County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

Genus CINNAMOMUM Blume.

Cinnamomum newberryi nom. nov.

Plate IX, figures 12 and 13.

This species is described in the section of this report dealing with the Upper Cretaceous flora of Georgia (pp. 117–118). The South Carolina remains referred to it are few and poor, and include fragments of rather large leaves from Rocky Point and doubtfully determined fragments from the banks of Congaree River.

Occurrence.—Middendorf arkose member of Black Creek formation, Rocky Point, Sumter County; right bank of Congaree River, about 25 miles below Columbia, Lexington County. (Collected by E. W. Berry, B. L. Miller, and M. W. Twitchell.)

Collections.—U. S. National Museum.

CINNAMOMUM MIDDENDORFENSIS sp. nov.

Plates VIII, figure 14, and IX, figure 1.

Description.—Leaves lanceolate in outline, somewhat widened toward the acute base. Length 8 to 10 centimeters; greatest width, 1.7 to 2.4 centimeters in the basal half of the leaf, the margins narrowing gradually upward to produce the very much extended, acutely pointed apex. Primaries three, from the top of the petiole, the midrib being slightly the more prominent. Angles of divergence acute, 20° to 25°. The lateral primaries assume a course approximately parallel to the midrib about half way between the latter and the margins and extend well into the tip of the leaf, finally joining a short, upwardly curving secondary from the midrib. Tertiaries numerous, transverse, nearly straight, and parallel. From the extreme base on either side a marginal vein extends upward from one-third to one-half the distance to the apex, joining the ends of the transverse tertiaries which extend outward from the lateral primaries, above which upwardly curved camptodrome secondaries are given off. Texture coriaceous.

This is an exceedingly well-marked and handsome species, entirely distinct from any Cretaceous forms hitherto described. It is a typical Cinnamomum in all its characteristics, although it may be compared with a variety of tropical genera such as Leucosyke and Zizyphus. It bears some resemblance to the Bohemian Cenomamian forms described by Velenovsky [1] as *Cocculus cinnamomeus* and is strikingly like certain existing Oriental species of Cinnamomum, as, for example, *Cinnamomum chinense* Blume or *Cinnamomum albiflorum* Rees. It is also close to various Tertiary species referred to this genus.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

Order MYRTALES.

Family MYRTACEÆ.

Genus EUCALYPTUS L'Héritier.

EUCALYPTUS ANGUSTA Velenovsky.

Plate XIV, figure 2.

Eucalyptus angusta Velenovsky, Die Flora der böhmischen Kreideformation, pt. 4, 1885, p. 3, Pl. III, figs. 2–12.
Eucalyptus angusta Velenovsky, Květena českého cenomanu, 1889, p. 21, Pl. VI, fig. 1.
? *Eucalyptus angusta* Saporta, Flore fossile du Portugal, 1894, p. 207, Pl. XXXVI, fig. 12.
Eucalyptus angusta Berry, Bull. Torrey Bot. Club, vol. 36, 1909, p. 260, Pl. XVIII, fig. 5.

Description.—The following is Velenovsky's description of this interesting species:

Blätter lineal, schmal lineallanzettlich, in der Mitte oder in der unteren Hälfte am breitesten, ganzandig, vorne in eine sehr lange Spitze vorgezogen und mit einem harten Dorn beendet. Der Primärnerv gerade, ziemlich stark, zur Spitze hin verdünnt. Die Secundärnervenahlrich, unter spitzen Winkeln entspringend, am Rande durch einen Saumnerv untereinander verbunden. Der Blattsteil gerade, etwa 1 cm. lang, stark.

This species is exceedingly common at a number of localities in the Perucer-schichten of Bohemia (Cenomanian), where Velenovsky subsequently found fruit-bearing twigs which he described and figured in 1889 and which, it would seem, conclusively establish the botanic relations of these leaves.

[1] Velenovsky, J., Die Flora der böhmischen Kreideformation, pt. 4, 1885, p. 4 (65), Pl. VIII (31), figs. 16–21.

Subsequently Saporta recorded this species from the Albian beds of Portugal; the latter material is, however, rather incomplete and open to question. Recent collections in our Atlantic Coastal Plain show that this species was present in considerable abundance on this side of the Atlantic at the same time that it flourished in Europe. It has been collected from the upper part of the Raritan formation at South Amboy, N. J., where it is common, and from the Black Creek formation of South Carolina, where it is associated with *Araucaria bladenensis* Berry just as it is in Georgia. It may be somewhat more fully characterized as follows: Leaves alternate or scattered, mostly elongated, linear-lanceolate, many falcate, 4.5 to 15 centimeters in length by 5 to 13.5 millimeters in width, with an attenuated acute tip and a narrowly cuneate base declining to the short and stout petiole. Midrib moderately stout below, becoming attenuated above. Secondaries very numerous, fine, and close, about 1 millimeter apart, parallel, rather straight; they branch from the midrib at acute angles of about 30° or slightly less and run with slight curvature to join the well-marked but fine marginal hem, which shows in all the American material and in most of the illustrations of the foreign material.

In all respects this is one of the most characteristically Eucalyptus-like species of the many which have been identified as such; and its totality of characters, combined with the presence of attached fruits in the Bohemian material, which are not unlike some of those of modern forms, renders the identification very satisfactory.

Occurrence.—Black Creek formation, right bank of Black Creek, below Williamson's bridge, Florence County. (Collected by L. W. Stephenson.)

Collections.—U. S. National Museum.

EUCALYPTUS GEINITZI (Heer) Heer.

Plates XIII, figures 8–12, and XIV, figure 1.

Myrtophyllum geinitzi Heer, Flora von Moletein, 1872, p. 22, Pl. XI, fig. 3, 4.
Myrtophyllum geinitzi Heer, Flora fossilis arctica, vol. 3, Abth. 2, 1874, p. 116, Pl. XXXII, figs. 14–17.
Eucalyptus geinitzi Heer, idem, vol. 6, Abth. 2, 1882, p. 93, Pls. XIX, fig. ic, and IV, fig. 1, 13.
Eucalyptus geinitzi Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 138, Pl. XXXVII, fig. 20.
Myrtophyllum warderi Lesquereux, idem, 1892, p. 136, Pl. LIII, p. 53, fig. 10.
Eucalyptus? angustifolia Newberry, The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 111, Pl. XXXII, figs. 1, 6, and 7 (non Desvaux 1822).
Eucalyptus geinitzi Newberry, idem, 1896, p. 110, Pl. XXXII, figs. 2 and 12 (non figs. 15, 16).
Eucalyptus geinitzi Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 60, Pl. IV, figs. 1–3.
Eucalyptus geinitzi Berry, Bull. New York Bot. Garden, vol. 3, 1903, p. 87, Pl. LIII, fig. 3.
Eucalyptus? angustifolia Hollick, idem, vol. 3, 1904, p. 408, Pl. LXX, figs. 8 and 9.
Eucalyptus geinitzi Berry, Bull. Torrey Bot. Club, vol. 31, 1904, p. 78, pl. IV, fig. 5.
Eucalyptus geinitzi Berry, idem, vol. 33, 1906, p. 180.
Eucalyptus geinitzi Berry, idem, vol. 34, 1907, p. 201, Pl. XV, fig. 4.
Eucalyptus geinitzi Berry, Johns Hopkins Univ. Circ., new ser., No. 7, 1907, p. 81.
Eucalyptus geinitzi Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 96, Pl. XXXV, figs. 1–8, 10–12.
Myrtophyllum warderi Hollick, idem, p. 97, Pl. XXXV, fig. 13.
Eucalyptus angustifolia Hollick, idem, 1907, p. 95, Pl. XXXV, figs. 9, 14, and 15.

Description.—Leaves lanceolate in outline, broadest near the middle and almost equally tapering 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 of the lower surface of the leaf. Secondaries numerous, thin, branching from the midrib at acute angles, about 45°, and running with only 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 an especially wide range. It was described originally from the Cenomanian of Moravia, and has since been recorded from a number of other European localities, from the Atane beds of Greenland and the Dakota sandstone of the West, and from Marthas Vineyard to Alabama along the Atlantic Coast. The South Carolina material is abundant and characteristic, and is certainly identical with the type, whatever may be thought of some of the leaves which have been identified with this species.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County; near Langley, Aiken County; Rocky Point, Sumter County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

EUCALYPTUS WARDIANA Berry (?).

Plate XIV, figures 3 and 4.

Eucalyptus ? dubia Berry, Bull. New York Bot. Garden, vol. 3, 1903, p. 87, Pl. LII, fig. 1 (non Ettingshausen).
Eucalyptus wardiana Berry, Bull. Torrey Bot. Club, vol. 32, 1905, p. 47.
Eucalyptus wardiana Berry, idem, vol. 33, 1906, p. 180.
Eucalyptus wardiana Berry, Ann. Rept. State Geologist New Jersey for 1905, 1906, pp. 138, 139, and 141.

Description.—Leaves entire, linear-lanceolate in outline, with an acute apex and cuneate base, about 10 or 12 centimeters in length by 1 to 1.6 centimeters in greatest width. Petiole stout, of considerable length. Midrib stout. Secondaries numerous, approximately straight and parallel, branching from the midrib at angles of 45° to 50°, their ends connected by a marginal vein, which is straight and close to the margin, with which it is parallel. This species was originally described by the writer from New Jersey, and is found to a characteristic species of the Magothy formation in that State as well as in Delaware and Maryland. It is very similar to the upper Raritan species, *Eucalyptus linearifolia* Berry (*Eucalyptus nervosa* Newberry), and probably the forms from the Tuscaloosa formation of Alabama correlated by Ward with the latter species are referable to this species. The South Carolina remains agree with the type material from New Jersey better than is indicated by the figures, for the type figures are not accurate.

This species may also be compared with the contemporaneous *Eucalyptus angusta* Velenovsky, which is, however, a smaller, falcate, less linear leaf with still more numerous and more ascending secondaries.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

Order UMBELLALES.

Family ARALIACEÆ.

Genus HEDERA Linné.

HEDERA PRIMORDIALIS Saporta.

Hedera primordialis Saporta, Le monde des plantes, 1879, p. 200, figs. 29, 1 and 2.
Hedera primordialis Velenovsky, Die Flora der böhmischen Kreideformation, pt. 1, 1882, p. 19, Pls. VIII, fig. 7; IX, figs. 4 and 5; and X, figs. 3 and 4.
Hedera primordialis Newberry, The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 113, Pls. XIX, figs. 1 and 9 and XXXVII, figs. 1–7.
Hedera primordialis Berry, Bull. Torrey Bot. Club, 1907, vol. 34, p. 201, Pl. XVI.

Description.—Leaves elliptical, reniform or cordate in outline, very variable in size and shape. Length 3 to 12 centimeters, width 3.2 to 12 centimeters, generally broader than long. Apex rounded or obtusely pointed, in some specimens slightly emarginate. Margin somewhat irregular but entire. Base varies from truncate to deeply cordate. Petiole long and stout, generally not preserved. Venation palmate from the top of the petiole. Primaries range in number from three to seven, usually five or seven, of which the midrib is the stoutest, especially in the smaller leaves. The lowest pair of primaries, which are approximately parallel with the basal margins of the leaf, are smaller in size than the others and should be regarded as secondaries. The primaries are then normally five in number, curved and camptodrome.

This species was figured by Saporta in 1879 from the Cenomanian of Bohemia and described three years later by Velenovsky from the same horizon. Heer identified rather fragmentary remains from the Atane beds of Greenland with this species, which is also abundant in the Raritan formation of Woodbridge, N. J., and in the Black Creek formation of North Carolina. It varies greatly in size and appearance, some of the smaller specimens from abroad suggesting the genus Cercis, whereas the smaller Raritan leaves suggest somewhat the genus Ficus. Of these variable specimens the writer is disposed to consider as typical those shown in Velenovsky's Plate X, figure 4, and Saporta's figure 2, as well as various Woodbridge specimens, which are, however, mostly incomplete.

This is a remarkably widespread species, and is better characterized where it does occur than is usual in cosmopolitan types. Although the modern representation of this genus is reduced to two species in Europe and northern Africa and a third in Japan, it seems to have been a more or less prominent type in the Cretaceous and Tertiary floras of the globe. In addition to the present species, which has the wide range previously mentioned, 8 or 10 additional Cretaceous species, mostly American, are known. The Eocene, both of America and Europe, furnishes six or eight species, the Oligocene of Europe and the Arctic regions one or two species, and the Miocene and Pliocene two or three additional. The modern Old World *Hedera helix* Linné is recorded from the Pleistocene (Interglacial) of England, Italy, and the Paris basin, and one of the upper Miocene species appears also to have survived into the Italian Pleistocene. Although so abundant in our Cretaceous floras, it is not a native plant in the existing flora of North America.

Occurrence.—Black Creek formation, Peedee River, about 6 miles below Cheraw, Chesterfield County; near Darlington, Darlington County. (Collected by E. W. Berry and L. W. Stephenson.)

Collections.—U. S. National Museum.

Order ERICALES.

Family ERICACEÆ.

Genus ANDROMEDA Linné.

ANDROMEDA NOVÆCÆSAREÆ Hollick.

Plate XIV, figures 5 and 6.

Andromeda novæcalcareæ Smith, On the geology of the Coastal Plain of Alabama, 1894, p. 348.
Andromeda novæcæsareæ Hollick, in Newberry, The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 121, Pl. XLII, figs. 9–12, 28–31.
Andromeda novæcæsareæ Berry, Bull. Torrey Bot. Club, vol. 33, 1906, p. 181.
Andromeda novæcæsareæ Berry, idem, vol. 34, 1907, p. 204.

Description.—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 varies from 0.9 to 1.3 centimeters. Venation where visible shows numerous parallel, camptodrome, relatively long and thin secondaries which branch from the midrib at an acute angle. Though the majority of these leaves are equally acuminate at both ends, there is a great deal of variation in this respect, and a considerable number of specimens which are relatively broader, especially in the upper half, exhibit a well-marked tendency toward an obtusely rounded apex, in which the termination of the midrib shows 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 from the southern Coastal Plain seeming to have more commonly than those from New Jersey an obtusely rounded apex.

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 genera, and with a marine fauna.

It also occurs in clays of the Middendorf member of the Black Creek formation of South Carolina and in the Tuscaloosa formation of Alabama, and was one of the few leaves which successfuly resisted maceration in the shallow shoreward deposits known as the Cusseta sand member of the Ripley formation of Georgia, occurring at Buena Vista in association with *Araucaria bladenensis* just as it does along Black River in North Carolina.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

ANDROMEDA GRANDIFOLIA Berry.

Plate XIV, figure 10.

Andromeda latifolia Smith, On the geology of the Coastal Plain in Alabama, 1894, p. 348.
Andromeda latifolia Newberry, The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 120, Pls. XXXIII, figs. 6–8, 10 (non fig. 9); XXXIV, figs. 6–11; and XXXVI, fig. 10 (non Wright).
Andromeda latifolia Hollick, Bull. New York Bot. Garden, vol. 3, 1904, p. 416, Pl. LXXIX, fig. 3.
Andromeda latifolia Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 100, Pl. XXXIX, fig. 1.
Andromeda grandifolia Berry, Bull. Torrey Bot. Club, vol. 34, 1907, p. 204, Pl. XV, fig. 3.

Description.—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 unsymmetrical margin. Apex obtusely pointed or in some specimens rounded. Base somewhat wedge-shaped. Midrib and petiole very stout. Secondaries relatively few, six to eight pairs, stout and flexuous, branching from the midrib at an acute angle 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 not uncommon 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, the two leaves figured on Plate XIV showing the average shape, with a length of about 10 centimeters and a width of about 5 centimeters.

Occurrence.—Middendorf arkose member of the Black Creek formation, Rocky Point, Sumter County. (Collected by L. F. Ward and L. C. Glenn.)

Collections.—U. S. National Museum.

ANDROMEDA EUPHORBIOPHYLLOIDES sp. nov.

Plate XIV, figure 7.

Description.—Leaves small, entire, obovate-lanceolate, with a broadly rounded apex and a narrowed cuneate base, about 5.3 centimeters in length by 1.25 centimeters in greatest width, which is in the apical half of the leaf. Petiole short and stout. Midrib stout. Secondaries numerous, approximately parallel, thin, branching from the midrib at acute angles, long, ascending, camptodrome. Texture coriaceous.

This species in its size, outline, and venation is referable to the genus Andromeda, greatly resembling some of the obovate leaves of the contemporaneous *Andromeda novæcæsareæ* Hollick, differing in its more elongate form and straighter, more produced base. It also resembles some of the leaves of the Dakota sandstone referred by Lesquereux[1] to his species *Eugenia primæva* but is more oblanceolate, with less full margins and straighter secondaries. It also resembles, especially in its general form, certain curious leaves described by Saporta from the Cenomanian

[1] The flora of the Dakota group: Mon. U. S. Geol. Survey, Vol. 17, 1899, p. 137, Pl. LIII, fig. 7.

of Portugal[1] and from the Turonian of France,[2] which are made the basis of a new genus, Euphorbiophyllum, and referred to the family Euphorbiaceæ.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

ANDROMEDA PARLATORII Heer.

Andromeda parlatorii Heer, Phyllites crétacées du Nebraska, 1866, p. 18, Pl. I, fig. 5.
Prunus ? parlatorii Lesquereux, Am. Jour. Sci., 2d ser., vol. 46, 1868, p. 102.
Leucothoe parlatorii Schimper, Paléontologie végétale, vol. 3, 1874, p. 11.
Andromeda parlatorii Heer, Flora fossilis arctica, vol. 3, Abth. 2, 1874, p. 112, Pl. XXXII, figs. 1 and 2.
Andromeda parlatorii Lesquereux, The Cretaceous flora, 1874, p. 88, Pls. XXIII, figs. 6 and 7, and XXVIII, fig. 15.
Andromeda parlatorii Heer, idem, vol. 6, Abth. 2, 1882, p.79, Pls. XXI, figs. 1b and 11, and XLII, fig. 4c.
Andromeda parlatorii Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 115, Pls. XIX, fig. 1, and LII, fig. 6.
Andromeda parlatorii Smith, On the geology of the Coastal Plain of Alabama, 1894, p. 348.
Andromeda parlatorii Newberry, The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 120, Pls. XXXI, figs. 1–7, and XXXIII, figs. 1, 2, 4, and 5.
Andromeda parlatorii Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 420, Pl. XXXVII, figs. 1–4.
Andromeda parlatorii Berry, Bull. New York Bot. Garden, vol. 3, 1903, p. 97, Pl. L, figs. 1–4.
Andromeda parlatorii Berry, Bull. Torrey Bot. Club, vol. 31, 1904, p. 79, Pl. I, figs. 1 and 2.
Andromeda parlatorii Berry, idem, vol. 33, 1906, p. 181.
Andromeda parlatorii Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 101, Pl. XXXIX, figs. 2–5.
Andromeda parlatorii Berry, Bull. Torrey Bot. Club, vol. 34, 1907, p. 203, Pl. XV, fig. 2.
Andromeda parlatorii Berry, Johns Hopkins Univ. Circ., new ser., No. 7, 1907, p. 81.

Description.—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. 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 angle which the secondaries form with the midrib and consequently in their length and degree of curvature. Some of the specimens are much like the small leaves of *Andromeda grandifolia* Berry, but are not so slender nor so attenuated apically as the normal leaves of that species.

This species was first described by Heer in one of the earliest published accounts of the flora of the Dakota sandstone, 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 Raritan formation of New Jersey, the Magothy formation of Marthas Vineyard, New Jersey, Delaware, and Maryland, the Black Creek formation of North Carolina, and the Tuscaloosa formation of western Alabama.

In South Carolina this species has not been found in any abundance, a fact explained entirely by accidents of preservation.

The genus Andromeda of Linné has been much segregated by subsequent taxonomists, and this tendency to segregation is reflected in Schimper's proposal to refer this species to the genus Leucothoe. However, the more comprehensive name has obvious advantages for the paleobotanist where it is impossible to discriminate between the various ericaceous genera with any degree of accuracy.

Occurrence.—Middendorf arkose member of Black Creek formation, near Langley, Aiken County; Rocky Point, Sumter County (?). (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

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[1] Saporta, G. de, Flore fossile du Portugal, 1894, p. 218, Pl. XXXIX, fig. 23.
[2] Saporta, G. de, Évolution des Phanérogames, vol. 2, 1885, p. 117, fig. 125 C.

Order PRIMULALES.

Family MYRSINACEÆ.

Genus MYRSINE Linné.

MYRSINE GAUDINI (Lesquereux) Berry.

Plate XIV, figure 9.

Myrsinites ? gaudini Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 115, Pl. LII, fig. 4.
Myrsine elongata Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 54, Pl. CLXXVII, fig. 2.
Myrsine elongata Newberry, The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 122, Pl. XXII, figs. 1-3.
Myrsine elongata Hollick, Annals New York Acad. Sci., vol. 11, 1898, p. 420, Pl. XXXVIII, figs. 3, 4b, and 4c.
Myrsine elongata Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 102, Pls. VIII, fig. 1b, and XXXIX, figs. 13 and 14.
Myrsine gaudini Berry, Bull. Torrey Bot. Club, vol. 36, 1909, p. 262.

Description.—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, abruptly diminishing in caliber. Secondaries numerous, eight to ten pairs, alternate, branching from the midrib at angles of 40° to 45°, camptodrome. When the 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 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 the Tuscaloosa formation of Alabama. It is not abundant in the South Carolina Cretaceous, being present only in Aiken County. The figured specimen is typical and extremely close to the type, being a trifle more elongated, as are also the leaves of this species from the northern Atlantic Coastal Plain.

Occurrence.—Middendorf arkose member of Black Creek formation, near Langley, Aiken County. (Collected by L. W. Stephenson and E. W. Berry.)

Collections.—U. S. National Museum.

Order EBENALES.

Family EBENACEÆ.

Genus DIOSPYROS Linné.

DIOSPYROS PRIMÆVA Heer.

Plates XI, figure 3, and XIV, figures 12 and 13.

Diospyros primæva Heer, Phyllites crétacées du Nebraska, 1866, p. 19, Pl. I, figs. 6 and 7.
Diospyros primæva Heer, Flora fossilis arctica, vol. 6, Abth. 2, 1882, p. 80, Pl. XVIII, fig. 11.
Diospyros primæva Heer, idem, vol. 7, 1883, p. 31, Pl. LXI, figs. 5a, 5b, and 5c.
Diospyros primæva Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 109, Pl. XX, figs. 1-3.
Diospyros primæva Smith, On the geology of the Coastal Plain of Alabama, 1894, p. 348.
Diospyros primæva Newberry, The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 124, Pl. XXX, figs. 1-5.
Diospyros primæva Knowlton, Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 7, 1901, p. 317, Pl. XXXIX, fig. 3.
Diospyros primæva Berry, Bull. Torrey Bot. Club, vol. 32, 1905, p. 46, Pl. II.
Diospyros primæva Berry, idem, vol. 34, 1907, p. 204.
Diospyros primæva Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey vol. 50, 1907, p. 103, Pl. XL, figs. 2 and 11.

Description.—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. Petioles rather long and very stout. Midrib also stout. Secondaries branching from the midrib usually 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 most wide-ranging form, having been identified at both the Atane and Patoot horizons in Greenland; from various localities within the Dakota sandstone, and its probable southern equivalent the Woodbine sand of Texas; and, besides the fragments from Marthas Vineyard and Long Island, which are of questionable identity, it is common in either the Raritan or Magothy or homotaxial formations from New Jersey to Alabama. It has been recorded from the Cenomanian of Saxony and the Turonian of Bohemia.

Its most marked character is the prominence of its tertiary areolation. This species is common at all leaf-bearing horizons in the South Carolina Cretaceous deposits, and the material gathered near Langley is notable for the large number of small leaves associated with those of normal size. These conform to the type in all respects except that they are more slender and acuminate, a feature to be expected in the small leaves of Diospyros, and it is believed that they are not distinct from the type. Two of these small leaves are figured, the normal-sized leaves having been amply illustrated by Newberry.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County; near Langley, Aiken County; Rocky Point, Sumter County; right bank of Congaree River, about 25 miles below Columbia, Lexington County (?). (Collected by L. W. Stephenson, E. W. Berry, Earle Sloan, B. L. Miller, and M. W. Twitchell.)

Collections.—U. S. National Museum.

DIOSPYROS ROTUNDIFOLIA Lesquereux.

Plate XIV, figure 14.

Diospyros rotundifolia Lesquereux, The Cretaceous flora, 1874, p. 89, Pl. XXX, fig. 1.
Diospyros rotundifolia Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 112, Pl. XVII, figs. 8-11.
Diospyros rotundifolia Berry, Ann. Rept. State Geologist, New Jersey, for 1905, 1906, p. 139.
Diospyros rotundifolia Berry, Bull. Torrey Bot. Club, vol. 33, 1906, p. 181.

Description.—Leaves entire, of various sizes, 4 to 10 centimeters in length by 2 to 7 centimeters in greatest width, which is in the middle part of the leaf. Outline broadly oval or elliptical. Apex broadly rounded. Base similar or somewhat narrowed and pointed. Petiole and midrib stout. Secondaries, six or seven pairs, branching from the midrib at angles of 50° to 60°, arched, camptodrome. Texture subcoriaceous. Venation less prominent than in *Diospyros primæva* Heer.

This species is a characteristic element in the post-Raritan flora of the Atlantic Coastal Plain, although at times 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.

It was originally described from the Dakota sandstone of Kansas and is common in the Magothy formation in New Jersey, Delaware, and Maryland. It has also been recorded from the Tuscaloosa formation in western Alabama. In South Carolina it has been found only at the Rocky Point locality. The material, though complete, has the venation mostly opposite, and it is possible that it may represent some orbicular leguminous leaflet instead of this species, with which, however, it agrees admirably.

Occurrence.—Middendorf arkose member of Black Creek formation, Rocky Point, Sumter County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

DICOTYLEDONÆ INCERTÆ SEDIS.

Genus CALYCITES Auct.

CALYCITES MIDDENDORFENSIS sp. nov.

Plate X, figure 4.

Description.—Calyx-like organism, with a small central disk or receptacle from which radiate five linear, apically rounded, equidistant sepals, measuring 1.1 centimeters in diameter from tip to tip. Sepals slightly narrowed proximal, 1 millimeter or a fraction more in width.

Remains of this sort are commonly referred to the form genus Calycites, as the botanic affinity of but few specimens can be determined. A considerable number of species of Calycites have been described, coming from the Raritan, Magothy, and Dakota formations. It may be questioned whether forms like those described from the Magothy of Marthas Vineyard and Long Island by Hollick should not receive some other names, for they hardly represent calices, but are obviously fruits comparable with certain modern Dipterocarpaceæ or Hippocrateaceæ. The present species is based on the single complete specimen figured.

Occurrence.—Middendorf arkose member of Black Creek formation, near Middendorf, Chesterfield County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

BOTANIC CHARACTER OF THE FLORA.

The Cretaceous flora of South Carolina as made known in the present contribution consists of 76 species, distributed among 49 genera in 36 families and 26 orders. There are represented 1 member of the phylum Thallophyta, 2 of the Pteridophyta, and 73 Spermatophyta, including 14 Gymnospermæ (1 Cycadales and 13 Coniferales) and 59 Angiospermæ (5 Monocotyledonæ and 54 Dicotyledonæ). The largest orders are the Urticales, Ranales, Thymeleales, and Sapindales, each of which has 6 species.

The largest single genus is Ficus, which is represented by 5 species, and this genus is also the most abundant individually. The genera Salix, Magnolia, and Andromeda have 4 species each; Araucaria, Celastrophyllum, and Eucalyptus have 3 each; and the following genera are represented by 2 species each: Myrica, Quercus, Proteoides, Leguminosites, Laurus, Laurophyllum, Cinnamomum, and Diospyros.

Fossil plants are very unequally represented at the 11 localities enumerated, the locality near Middendorf furnishing 42 species, whereas the locality on Black Creek below Williamsons Bridge (3.9) has furnished no positively identified forms. The bulk of the described species have come from the Middendorf arkose member of the Black Creek formation, identifiable remains being uncommon in other deposits of the Black Creek formation, although lignites, fragmentary leaves, and comminuted vegetable matter are universally distributed throughout the typical Black Creek deposits and are relatively rare in the Middendorf member. This condition is due to a certain extent to the distribution of vegetation on the near-by land and more largely to what may be termed the accidents of preservation and is paralleled by the distribution of the plants in the Black Creek formation of North Carolina, where most of the forms come from the single favorably situated locality at Courthouse Bluff on Cape Fear River. In the more distinctly marine sedimentation, more remote from the shore or from Cretaceous islands, the plant remains were much macerated and triturated before entombment. For this reason a better idea of the flora as a whole and of the accompanying physical conditions can be obtained from the Middendorf flora, of which the general botanic bearing is equally applicable to the typical Black Creek flora, although the latter indicates somewhat different ecologic grouping and considerably different conditions of deposition.

After a brief statement of the character of the South Carolina Cretaceous flora as a whole, an effort will be made to picture the environmental factors—ecologic, topographic, climatic, and edaphic—which may legitimately be deduced from the plant assemblages found fossil in the Middendorf member and the typical Black Creek deposits.

The flora as a whole furnishes a single thallophyte, which is represented by poorly preserved remains of a dichotomously branched thallus of undetermined botanic affinity. It is confined to the Black Creek formation in South Carolina, but occurs rather more abundantly at the same horizon in North Carolina and also in the Magothy flora of Maryland; it indicates marine sedimentation.

The Pteridophyta are represented by one species each of Onoclea and Lycopodium, and strangely enough both are fruit-bearing specimens, the Lycopodium closely resembling the existing members of the genus and heretofore not being certainly known from the Mesozoic. The botanic affinity of the Onoclea is not conclusively determinable, although the remains represent a type found also in the Magothy formation and in the Upper Cretaceous of Greenland.

The Cycadales are represented by a single species of Podozamites, which is confined to the Middendorf member in South Carolina, but which occurs in the Black Creek formation of North Carolina, northward to New Jersey, in the Dakota sandstone of the West, and in Europe. The remains are detached leaflets of the type usually referred to Podozamites, although the botanic affinity of many of these leaflets is not fully established.

The Coniferales are well represented. The Taxaceæ are recognized by the Cephalotaxus-like fruits which are so common in the Black Creek formation of North Carolina and which occur also in the upper part of the Tuscaloosa formation of Alabama. The other member of this family is referable to the curious fernlike genus Protophyllocladus, a characteristic Upper Cretaceous type widely distributed in North America. The species is new but occurs also in the Magothy formation of Maryland.

The Araucariaceæ, abundant in the Mesozoic though antipodean in existing flora, have three species of typical araucarias—one based on foliage, another on cone scales, and the third on seeds—but it is quite probable that all may belong to a single botanic species. The other family in this order, the Brachyphyllaceæ, is represented by the characteristic and widely distributed *Brachyphyllum macrocarpum* Newberry, which ranges from the Raritan to the Montana and which is the last survivor of a common older Mesozoic type of plant.

The Pinaceæ are represented by a species of Pinus of modern aspect and by the characteristic remains of the wide-ranging and widely distributed *Sequoia reichenbachi* (Geinitz) Heer, a species whose Raritan representative Hollick and Jeffrey propose to refer to the Araucariaceæ, although it may be noted that their argument is inconclusive. Furthermore, it seems probable that all of the forms referred to this species may not be identical. The modern oriental genus Cunninghamia is doubtfully represented by a species of Cunninghamites, which is quite widely distributed and which ranges from the Cenomanian to the Senonian abroad and probably as widely in this country. The genus Moriconia is abundantly represented in the Middendorf member, its most southerly known occurrence. From this region it ranges northward, a closely allied species occurring both in Greenland and in Europe.

The Cupresseaceæ are certainly represented by *Widdringtonites subtilis* Heer, a form which ranges from the Atane beds of Greenland southward along the Atlantic coast to Alabama. Rather characteristic, apparently four-valved cones of the Widdringtonia (Callitris) type are associated with the foliage in clays of the Middendorf member. In the Tuscaloosa formation of western Alabama this species is very common and has furnished a number of specimens with the cones attached to the leafy twigs of this type, so that the botanic affinity of this species seems to be established beyond dispute. In addition to the foregoing forms of more or less certain botanic relationship a cone is described from the Black Creek formation and a cone scale from the Middendorf member, both of unknown affinity.

The Monocotyledonæ have furnished five species, a Potamogeton, an Arundo, a Phragmites, and a Carex, waterside types whose occurrence as fossils are easily explained, as well as fragmentary remains of a large palmetto-like fan palm, Sabalites, one of the earliest known occurrences of a plant of this type. Palms appear simultaneously in the early part of the Upper Cretaceous in both Europe and America, and before its close they appear to have become numerous and diversified as well as widely distributed.

Of the Dicotyledonæ, the amentiferous families are represented by nine species. The Juglandales have a species of Juglans which ranges from Greenland to Georgia.

The Myricales have two characteristic species of Myrica, a genus of considerable importance in Upper Cretaceous floras everywhere and in more recent floras as well. The willows have four species, one peculiar to the Middendorf member and three widely distributed in beds of this or nearly the same age. The oaks have furnished two species, both clearly defined. It is singular that the oaks appear in such abundance both in this country and Europe soon after the dawn of the Upper Cretaceous. They afford one of the marks of post-Raritan floras in the Atlantic Coastal Plain.

The Urticales form one of the most abundant orders in the South Carolina Cretaceous—in point of numbers of individual specimens easily the most abundant. A single doubtful species is referred to the modern warm-temperate genus Momisia, which, except for a species recently described by the writer from the Eocene of Georgia, is unknown in the fossil state. The figs number five species, including four species with lanceolate leaves and pinnate venation and one species with shorter and broader leaves and palmate venation. One of the lanceolate figs, *Ficus stephensoni*, is new, although it occurs in North Carolina; the others are all well known and large forms of wide distribution. They are exceedingly abundant in South Carolina; both *Ficus crassipes* Heer and *Ficus krausiana* Heer occur at four localities at least and are very common at certain of these, particularly in the clay ironstones at Rocky Point. One of the few contrasts to be noted in tracing this Upper Cretaceous flora southward from Greenland is the tendency shown by a number of forms toward the development of prolonged attenuated tips. This is prominently shown in these species of Ficus, both here and in the Tuscaloosa flora of Alabama, and it has been interpreted as indicating a heavier rainfall and more humid climate than in higher latitudes. This peculiarity is not confined to the genus Ficus, but is shared by a number of other genera belonging to these floras.

Of the Proteales, the Proteaceæ, at present largely and almost exclusively developed in the Southern Hemisphere, are represented by two species of Proteoides, so called from their close affinity with the modern species of Protea. Many botanists, notably in England, have questioned such identifications, especially as made by Ettingshausen and others in studies of the Tertiary floras of Europe. Most of these identifications have a large element of certainty, however, and are paralleled and confirmed by the similar Cretaceous range and modern restriction of a large number of unrelated genera. The present place is unsuitable for controversial matter, but the writer will say that rather extensive distributional studies have served in a large measure to confirm the presence in the Cretaceous floras of North America of species of Proteaceæ, Myrtaceæ, and other types.

The order Ranales, which at the present time has received such undue prominence through the phylogenetic speculations of Wieland and Arber, is represented by six species—a Dewalquea of remarkable and striking appearance, common to the Middendorf member and to the Tuscaloosa formation of Alabama; a new species of Illicium; and four well-known species of Magnolia, two of which range northward as far as Greenland and three southward into Alabama. Magnolias are common everywhere in Upper Cretaceous floras from Greenland to Alabama.

The order Rosales has no very definite or remarkable representatives in the South Carolina Cretaceous. A form doubtfully identified as Hamamelites occurs at Rocky Point, and two leaflets are referred to Leguminosites, one as a Cæsalpinia, and one as an Acacia-like form.

The order Geraniales, though poorly represented, contains two remarkable forms, a Citrophyllum very close to the modern genus Citrus, which ranges northward as far as New Jersey, and Crotonophyllum, a genus allied to the modern genus Croton of the Euphorbiaceæ. Crotonophyllum is rather common in the Middendorf member, the only other species of the genus being a Cenomanian form from Bohemia.

The order Sapindales is a large one, represented by six species—one a Sapindus, one a form doubtfully referred to the genus Pachystima, one a large Rhus, and three species of Celastrophyllum. The last genus becomes abundant at the close of the Lower Cretaceous, with seven species in the Patapsco formation. There are no less than nine species in the Raritan formation, but this number is reduced to two in the Magothy, two in the Black Creek, and three in the Middendorf member. Celastrophyllum is unrepresented in the Montana flora of the West.

The order Thymeleales also includes six species, of which two are well-known species of Laurus, two are species of Laurophyllum confined to this horizon in the Atlantic Coastal Plain, and two are species of Cinnamomum, one being the widespread *Cinnamomum newberryi* Berry and the other new.

The order Myrtales has three species of Eucalyptus, all close to modern species. This is particularly true of *Eucalyptus angusta* Velenovsky, which is also associated with typical Eucalyptus fruits in the Cenomanian of Europe.

The order Umbellales is represented by a single species of Hedera, a form of wide distribution. The Araliaceæ, so common in homotaxial American floras, have not been detected in either the Middendorf member or other deposits of the Black Creek formation in South Carolina, though a single Aralia is found in the Black Creek formation of North Carolina and several species appear in the Tuscaloosa and Magothy formations.

The order Ericales has four species of Andromeda, one new and the other three widespread in deposits of this or nearly the same age in the Atlantic Coastal Plain.

The Primulales are represented by a single rather widespread species of Myrsine and the Ebenales by two species of Diospyros, one the relatively large-leaved *Diospyros primæva* of Heer, which ranges from Greenland to Alabama in eastern North America and from Kansas and Nebraska to Texas in the interior, and which is exceedingly common in the South Carolina Cretaceous; and the other the less common *Diospyros rotundifolia* Lesquereux of the Dakota sandstone and the Magothy formation. These leaves are certainly allied to the modern Diospyros and are associated in the Raritan formation of Maryland with characteristic fruit calices scarcely distinguishable from those of certain modern species.

PHYSICAL CONDITIONS INDICATED BY THE FLORA.

An effort to picture accurately the environment of a fossil flora is beset with unusual difficulties, as may be readily imagined, and these difficulties increase in geometric ratio to the time that has elapsed since it existed in life. Furthermore, the science of plant ecology is so recent in development that the data with which to compare fossil floras are very inadequate. Particularly is this true of the existing floras of the tropical and subtropical zones with which the Cretaceous flora is most naturally compared. The strand flora of the tropics is fairly well known, but of inland and upland floras over wide areas practically no information is available, although the Philippine Forest Service has made a most laudable beginning in this direction.

For this reason the discussion which follows probably merits more or less criticism, especially of the statements where the writer has endeavored to particularize. An effort has been made, however, to avoid purely speculative points, and it is believed that the more general statements regarding climate and other conditions of growth will stand, whatever may be the fate of the details.

As has been shown, the sediments and their contained floras indicate shallow seas and a considerable elevation and relief of the Piedmont area. River gradients were high and the streams numerous and more or less torrential in character. In the early part of the period coastal sounds or bays were present, but these were subsequently submerged and the coast line appears not to have been subsequently broken by any large reentrants, although part of the strand flora was probably a swamp flora and swamps were also present in the lower courses of the streams, especially in the later half of the period. With regard to the climatic conditions the Cretaceous floras are to a certain extent unlike those of later periods and are so far removed from the present that no very precise conclusions are possible. It is safe to assume that the climate was mild, however, for the plant grouping clearly shows this. Seasonal changes were not strongly marked, as is shown by the lack of periodic alterations (growth rings) in the petrified and lignitized woods. These have not been critically studied, nor are they included in the systematic account of the flora, but they have been examined sufficiently to corroborate the foregoing statement. That the climate was not tropical in character may be assumed from the manner in which this flora preserves its integrity when traced northward over many degrees of latitude. It is essentially a unit from Alabama to New Jersey, and preserves even in its far northern occurrence on the west coast of Greenland—though differences are perceptible—a facies remarkably similar. Even in Greenland this flora has nearly as many species which in modern floras are customarily associated with the warmer temperate and subtropical zones as in its most southerly occurrence. We may confidently assert that frosts were unknown. The trees were not all evergreen, although some were, and the leaves, from the manner in which they are found fossil, were apparently shed at maturity and not seasonally. It is believed that insolation, or the pseudoxerophytism of swamp habitats, rather than any approach to aridity, explains the presence of numerous coriaceous-leafed forms, such as the four species of Andromeda, and the abundance of Leguminosæ and of gymnosperms, many of them having reduced leaves like Brachyphyllum, Moriconia and Widdringtonites, or developing phylloclads as in the Protophyllocladus of the Middendorf member or Androvettia of the homotaxial beds of the Black Creek formation in North Carolina and the Eutaw formation in Georgia.

Sequoia in the existing flora thrives only in a belt fed by the moisture-laden winds from the Pacific. As a fossil it is excessively abundant in the Middendorf member and, in fact, in all post-Raritan deposits of the Atlantic Coastal Plain Cretaceous which furnish any flora. 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 of Alabama. Judged by the facts of the present-day geographic distribution of plants, the flora as a whole presents an antipodean facies with its species of Eucalyptus and Proteoides and its abundant Araucariaceæ, but this is only another way of emphasizing its Mesozoic character, for the abundant evidence at our command shows that all these types were practically cosmopolitan in the Mesozoic. Another feature which appears 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, eucalyptus, laurels, and araucarias would indeed be anomalous in the present flora, but these 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 if the Upper Cretaceous flora were existing at the present time it 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, Australia, and New Zealand. In the last-named locality Aralia, Laurus, Cinnamomum, Magnolia, and Sterculia are associated with Quercus, Fagus, Gleichenia, Dryopteris, and Dicksonia. In some respects the flora of New Zealand is more tropical in its facies and more like our eastern Upper Cretaceous floras than any other now existing. 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. Dicotyledonæ are numerous and varied, including between 100 and 150 species, among which forms of Myrtaceæ, Lauraceæ, and Proteaceæ, with coriaceous leaves, are prominent. The undergrowth is rich in tree ferns and various genera of Araliaceæ.

When this modern flora is compared element for element with the Coastal Plain Cretaceous flora many differences naturally become apparent; nevertheless, the resemblance between the two is remarkable. In the Upper Cretaceous flora of the Coastal Plain the narrow or scale-leafed conifers are represented by Sequoia, Moriconia, Brachyphyllum, and Widdringtonites. Dammara represents the broad-leafed araucarias; Androvettia and Protophyllocladus represent the modern Phyllocladus. The Dicotyledonæ are numerous and varied; temperate and tropical types are mixed, and there are numerous coriaceous forms belonging to a number of the same families as in the New Zealand flora. Aralias are common in both floras.

That the physical conditions approximated the foregoing outline is further indicated by the presence of many plants which normally grow in streams with considerable flow or along stream margins. There is an aquatic species, *Potamogeton middendorfensis,* which it is hard to imagine growing at sea level in the latitude of South Carolina during the Upper Cretaceous. There are two large-leafed grasses (Arundo and Phragmites) and a sedge, all strongly mesophytic types; four species of willow; and four thick-leafed laurels and two Cinnamomums, whose existing descendants flourish in humid localities, as do those of the numerous figs and magnolias. The figs are very abundant individually in the Middendorf member, especially at localities like that at Rocky Point. They are for the most part lanceolate-leafed forms and have developed to a greater or less extent long attenuated tips that are absent in the same species toward the northern limit of their range. These tips are commonly known as dripping points and are understood to indicate a considerable rainfall. They are especially noticeable in the South Carolina representatives of *Ficus crassipes* Heer. It is believed that these figs found their optimum conditions in the coastal swamps and extended from them up the river valleys to the amphitheaters toward the heads of streams, though they were not confined to such situations, as is proved by their wide geographic distribution at this time. In similar situations grew the broad-leafed gymnosperms, the palms, the entire-leafed *Quercus sumterensis*, and the various species of Proteoides, Illicium, Eucalyptus, Diospyros, Cinnamomum, Citrophyllum, Laurus, and Magnolia. The flora of the typical Black Creek deposits of South Carolina is so scanty, embracing only 17 species, that it does not in itself furnish adequate data for an attempt to picture its environment. When supplemented by the Black Creek flora of North Carolina somewhat more data are provided, but still the material is insufficient for the purposes mentioned. The occurrence of obscure remains of a marine alga, present also in North Carolina and in the Magothy of Maryland, may be noted as indicative of the presence of the sea or at least of brackish water. Lignite and amber are common, also the remains of Araucaria, Cephalotaxus-like fruits, Eucalyptus, Ficus, Myrica, and similar forms. The flora is mixed, including upland types which must have made perhaps very considerable river journeys before fossilization. Strand and swamp plants are also present, and coriaceous forms predominate, owing to their survival in agitated waters which destroyed the more delicate plant remains. The character of the fossils is a clear indication that the bays or sounds, which had been present in at least a part of the area during Middendorf time, had disappeared, and the Coastal Plain lacked large estuaries which usually afford such admirable means for fossilization. We may therefore infer that the coast line was unbroken, or that if there were estuary plant beds they have been destroyed by the erosion of the landward margin of the deposits or are not exposed at the present time. The differences in the flora between the early Middendorf and late Black Creek were probably not considerable, and physical conditions were not very dissimilar. The land had approached sea level and the ground water would be nearer the surface. The climate probably underwent no appreciable change, and the rainfall and humidity were still ample, although the writer is inclined to think that the rainfall was somewhat diminished. The natural radiation of the individual species in the floras doubtless caused great changes in distribution, and other changes were doubtless due to the fact that the area was in the direct line of migration between the north and the south, but sufficient data to illustrate these various changes have not yet been accumulated.

CORRELATION OF THE BLACK CREEK FORMATION.

In considering the correlation of the Middendorf member and the other Black Creek deposits the first question to be decided is the relation which they bear to each other. Though the writer's position on this point may be inferred from what has gone before, a few comments are necessary, as at first sight the floras apparently show considerable differences.

Of the 76 species described in the foregoing pages, 62 come from the Middendorf member and 17 from the other deposits of the Black Creek formation. Of these 76 species the following are described as new:

Acaciaphyllites grevilleoides.
Algites americana.
Andromeda euphorbiophylloides.
Araucaria darlingtonensis.
Calycites middendorfensis.
Celastrophyllum carolinensis.
Cinnamomum middendorfensis.
Crotonophyllum panduræformis.
Ficus celtifolius.
Heterolepis cretaceus.
Illicium watereensis.
Leguminosites middendorfensis.
Lycopodium cretaceum.
Momisia carolinensis.
Pachystima? cretacea.
Potamogeton middendorfensis.

Proteoides parvula.
Protophyllocladus lobatus.
Quercus sumterensis.
Quercus pseudowestfalica.
Rhus darlingtonensis.
Sabalites carolinensis.
Salix sloani.
Strobilites anceps.

Although these new species are of slight value in exact correlation, their evidence is entirely in accord with that deduced from the remainder of the flora. The bulk are from the Middendorf member, only *Algites americana*, *Araucaria darlingtonensis*, *Rhus darlingtonensis*, and *Strobilites anceps* coming from the other Black Creek deposits. Extensive collections from all parts of the Coastal Plain are undergoing elaboration by the writer, who, since the original description in manuscript, has identified *Algites americana* from the Black Creek formation of North Carolina and from the Magothy formation of Maryland, and *Protophyllocladus lobatus* from the Magothy of Maryland. *Araucaria darlingtonensis* has been shown to be closely allied to the other Black Creek araucarias, and *Andromeda euphorbiophylloides*, in all probability, occurs on the border between the Tuscaloosa and the Eutaw in Hale County, Ala. *Quercus pseudowestfalica* is now known to occur in the Black Creek formation of North Carolina, and the Sabalites is seen to be close to *Sabalites magothiensis* Berry from the Magothy formation of the northern Coastal Plain from New Jersey to Maryland. The genera Crotonophyllum and Illicium are most closely related to species described from the Cenomanian of Bohemia. None of the genera occur in the Montana flora of the west except Ficus and Salix, genera present from the Raritan to the Recent.

Only the following species are common to the Middendorf member and other deposits of the Black Creek formation in the South Carolina area:

Ficus krausiana Heer.
Laurophyllum nervillosum Hollick.
Proteoides lancifolius Heer.
Salix lesquereuxii Berry.

Although this seems a very small common element, all the forms are typical of this stage of the Cretaceous, and all except Proteoides are especially characteristic of the Magothy, Black Creek, and Tuscaloosa floras. The identity of the Middendorf and other Black Creek floras is greatly strengthened when comparisons are made with the latter flora as developed in the North Carolina area, the result showing 27 species common to the two formations.

The following Middendorf species which have not been found in the other Black Creek deposits of South Carolina occur in beds of Black Creek age in North Carolina:

Andromeda grandifolia Berry.
Andromeda novæcæsareæ Hollick.
Andromeda parlatorii Heer.
Araucaria jeffreyi Berry.
Brachyphyllum macrocarpum Newberry.
Celastrophyllum crenatum Heer.
Cinnamomum newberryi Berry.
Citrophyllum aligerum (Lesquereux) Berry.
Cunninghamites elegans (Corda) Endlicher.
Diospyros primæva Heer.
Eucalyptus geinitzi (Heer) Heer.
Ficus crassipes Heer.
Ficus krausiana Heer.
Ficus stephensoni Berry.
Juglans arctica Heer.
Laurophyllum elegans Hollick.
Leguminosites robinifolia Berry.
Magnolia capellinii Heer.
Moriconia americana Berry.
Myrsine gaudini (Lesquereux) Berry.
Phragmites pratti Berry.
Pinus raritanensis Berry.
Podozamites knowltoni Berry.
Quercus pseudowestfalica Berry.
Salix flexuosa Newberry.
Salix lesquereuxii Berry.
Sequoia reichenbachii (Geinitz) Heer.

The following species occur in the Middendorf member but have not been detected in the other Black Creek deposits, either in North or South Carolina:

Acaciaphyllites grevilleoides Berry.
Andromeda euphorbiophylloides Berry.
Arundo grœnlandica Heer.
Cæsalpinia middendorfensis Berry.
Calycites middendorfensis Berry.
Carex clarkii Berry.
Celastrophyllum carolinensis Berry.
Celastrophyllum elegans Berry.
Cinnamomum middendorfensis Berry.
Crotonophyllum panduræformis Berry.
Dewalquea smithi Berry.
Diospyros rotundifolia Lesquereux.
Eucalyptus wardiana Berry.
Ficus atavina Heer.
Ficus celtifolius Berry.
Hamamelites? cordatus Lesquereux.
Heterolepis cretaceus Berry.
Illicium watereensis Berry.
Laurophyllum nervillosum Hollick.
Laurus atanensis Berry.

Laurus plutonia Heer.
Leguminosites middendorfensis Berry.
Lycopodium cretaceum Berry.
Magnolia tenuifolia Lesquereux.
Magnolia obtusata Heer.
Momisia carolinensis Berry.
Onoclea inquirenda (Hollick) Hollick.
Pachystima? cretacea Berry.
Proteoides parvula Berry.
Protophyllocladus lobatus Berry.
Potamogeton middendorfensis Berry.
Quercus sumterensis Berry.
Sabalites carolinensis Berry.
Salix pseudohayei Berry.
Salix sloani Berry.
Sapindus morrisoni Heer.
Widdringtonites subtilis Heer.

These include 17 new species thus far confined to the Middendorf member and without value in close correlation. Of the remaining 21 species with a wider distribution 4 occur in the Raritan of New Jersey, 6 in the Tuscaloosa formation, the large number of 15 in the Magothy formation, 8 in the Dakota sandstone, and 9 in the Greenland Cretaceous. This illustrates very well the remarkable unity of this flora from Greenland to Alabama, and also indicates conclusively the practical synchroneity between the Middendorf member and the other deposits of the Black Creek formation of South Carolina.

A similar relationship is shown by the following list of North Carolina Black Creek species which have not been detected in either the Middendorf member or the other Black Creek deposits in the South Carolina area:

Acerates amboyense Berry.
Androvettia carolinensis Berry.
Araucaria clarki Berry.
Celastrophyllum undulatum Newberry.
Cinnamomum heerii Lesquereux.
Cornophyllum sp.
Cycadinocarpus circularis Newberry.
Dammara borealis Heer.
Dewalquea groenlandica Heer.
Eucalyptus attenuata Newberry.
Eucalyptus linearifolia Berry.
Ficus ovatifolia Berry.
Ficus daphnogenoides (Heer) Berry.
Gleditsiophyllum triacanthoides Berry.
Kalmia brittoniana Hollick?
Liriodendron dubium Berry.
Liriodendron cf. primævum Newberry.
Malapoenna horrellensis Berry.
Myrica cliffwoodensis Berry.
Myrsine borealis Heer.
Phaseolites formus Lesquereux.
Pisonia cretacea Berry.
Pistia nordenskioldi (Heer) Berry.
Planera cretacea Berry.
Pterospermites carolinensis Berry.
Pterospermites crednerafolia Berry.
Quercus pratti Berry.
Salix newberryana Hollick.
Salix eutawensis Berry.
Sassafras acutilobum Lesquereux.
Sequoia heterophylla Velenovsky.
Sequoia minor Velenovsky.
Tumion carolinianum Berry.

Here again the species which are not confined to North Carolina are mingled in other homotaxial deposits, such as those of the Magothy formation of the North Atlantic Coastal Plain or the Tuscaloosa formation of Alabama, with the previously enumerated forms not common to the described floras of the two States.

The conclusion seems incontrovertible that in correlation the Middendorf member and the typical Black Creek may be considered as a unit, and that within the State they confirm the field observations that the stratigraphic sequence comprises initial Middendorf sedimentation of short duration, contemporaneous Middendorf and typical Black Creek sedimentation, especially when the Peedee and Aiken areas are compared, and finally typical Black Creek sedimentation only for a considerable period. When the flora as a whole is compared with outside areas it is brought out that 32 of the species in the Black Creek formation of North Carolina are of admitted identity in South Carolina and that 26 species occur either in the Tuscaloosa formation of Alabama or the Eutaw formation of Georgia. It seems to the writer that the synchroneity between these beds and the upper part of the Alabama Tuscaloosa and the lower portion of the Eutaw must be admitted, for the close similarity in their floral characteristics is corroborated by similar lithologic characters. It is believed, however, that the lower part of the Tuscaloosa of western Alabama is older than any Upper Cretaceous of the eastern Gulf or Atlantic Coastal Plain as far north as the New Jersey-Maryland area, where the uppermost Raritan is to be considered contemporaneous with it, the rest of the Raritan formation being still older. With the Magothy flora of the northern Coastal Plain, the Middendorf flora has 35 species in common, or about 50 per cent of its total flora. That the two floras are essentially a unit seems certain. In the New Jersey area the Magothy flora is confined to the transitional beds lying above the Raritan formation and at the base of the marine series of deposits, whereas in the southern and Gulf coastal plains similar fossil plants occur in lenses or in beds interstratified with marine fossiliferous beds. This shows that the southern representative of the Magothy flora was contemporaneous with the southern representative of the Matawan fauna and makes it probable that the Magothy flora in the New Jersey-Maryland area persisted through Matawan time. The Matawan formation has yielded only one or two fossil plants—a Ficus in the clays of Woodbury, N. J., and a Dammara in Maryland—and in both areas these species occur in the Magothy formation also.

The Black Creek flora contains 17 species found in the Atane beds of Greenland and 9 found in the Patoot beds. In the Cenomanian of Europe 9 of its species are found, in the florally unfossiliferous Turonian 1 species, and in the Senonian 4 species.

The eastern Cretaceous floras above the Raritan, possibly including those of the uppermost Raritan, correspond with the flora usually known as that of the Dakota sandstone. The rocks containing them are conformably overlain by deposits carrying a marine fauna but very few fossil plants. There are 23 species common to the South Carolina Cretaceous and the Dakota sandstone. The Black Creek formation of North Carolina, out of a total of 66 species, has 20 species in common with the Dakota. The Montana group flora is entirely unlike the eastern Cretaceous floras, having scarcely a single element in common. Certain stages in the evolution of the eastern Cretaceous flora can be made out, though in general the forms have a wide stratigraphic range. This is paralleled, however, by an almost equally wide stratigraphic range of the faunas.

To render intelligible to a wider circle of readers the results of the present discussion the probable European equivalents of these floras should be indicated, although it is admitted that attempted exact correlations between geologic formations on opposite sides of the Atlantic must always be more or less untrustworthy.

In Europe there are available for comparison abundant Cenomanian floras in Portugal, France, Germany, and especially in eastern Europe (Bohemia, Dalmatia, and other regions). The Turonian of Europe, on the other hand, is for the most part lacking in fossil plants, which become abundant again in the Senonian of Prussia, Saxony, and Bohemia. Our Dakota flora has always been considered Cenomanian; most paleozoologists have considered the Benton as Turonian (a view that is widely accepted in this country at the present time); and the Montana group has been uniformly considered as representing part of the Senonian. The Atlantic Cretaceous floras have been considered Cenomanian, and the associated and overlying faunas Senonian (exclusive of the Rancocas and Manasquan faunas of New Jersey, which have been justly considered Danian by Clark and others).

In the writer's opinion no Cenomanian floras are known in America, unless the Raritan flora and that of the Washita group of the Texas and southern Arkansas area represent that stage of European geology, and the post-Raritan floras of the East[1] are for the most part of Turonian age, as is also the major part, at least, of the Dakota flora of the West.[2]

The occurrence and range of the species of the South Carolina Cretaceous which form the partial basis of the foregoing discussion are fully set forth in the accompanying tables:

Approximate equivalents of the plant-bearing Cretaceous deposits of South Carolina.

South Carolina.	North Carolina.	Western Alabama.	New Jersey-Maryland.	Europe.
Marine Cretaceous (no known flora).	Marine Cretaceous (no known flora).	Marine Cretaceous (no known flora).	Marine Cretaceous (no known flora).	Emscherian.
				?
Black Creek. / Middendorf arkose member of Black Creek	Black Creek.	Eutaw.	Matawan (Marine, with no known flora).	Turonian.
		Tuscaloosa.	Magothy.	
Hiatus.	Hiatus.	Hiatus.	Raritan.	Cenomanian.
Lower Cretaceous (no known flora).	Lower Cretaceous (no known flora).	Carboniferous.	Lower Cretaceous, Triassic, or crystalline rocks.	

[1] With the exception of the meager floras in the Ripley formation and its equivalents.
[2] Some paleontologists consider the Coastal Plain plant-bearing formations to be lower Senonian.

Distribution of Upper Cretaceous plants in South Carolina and their range elsewhere.

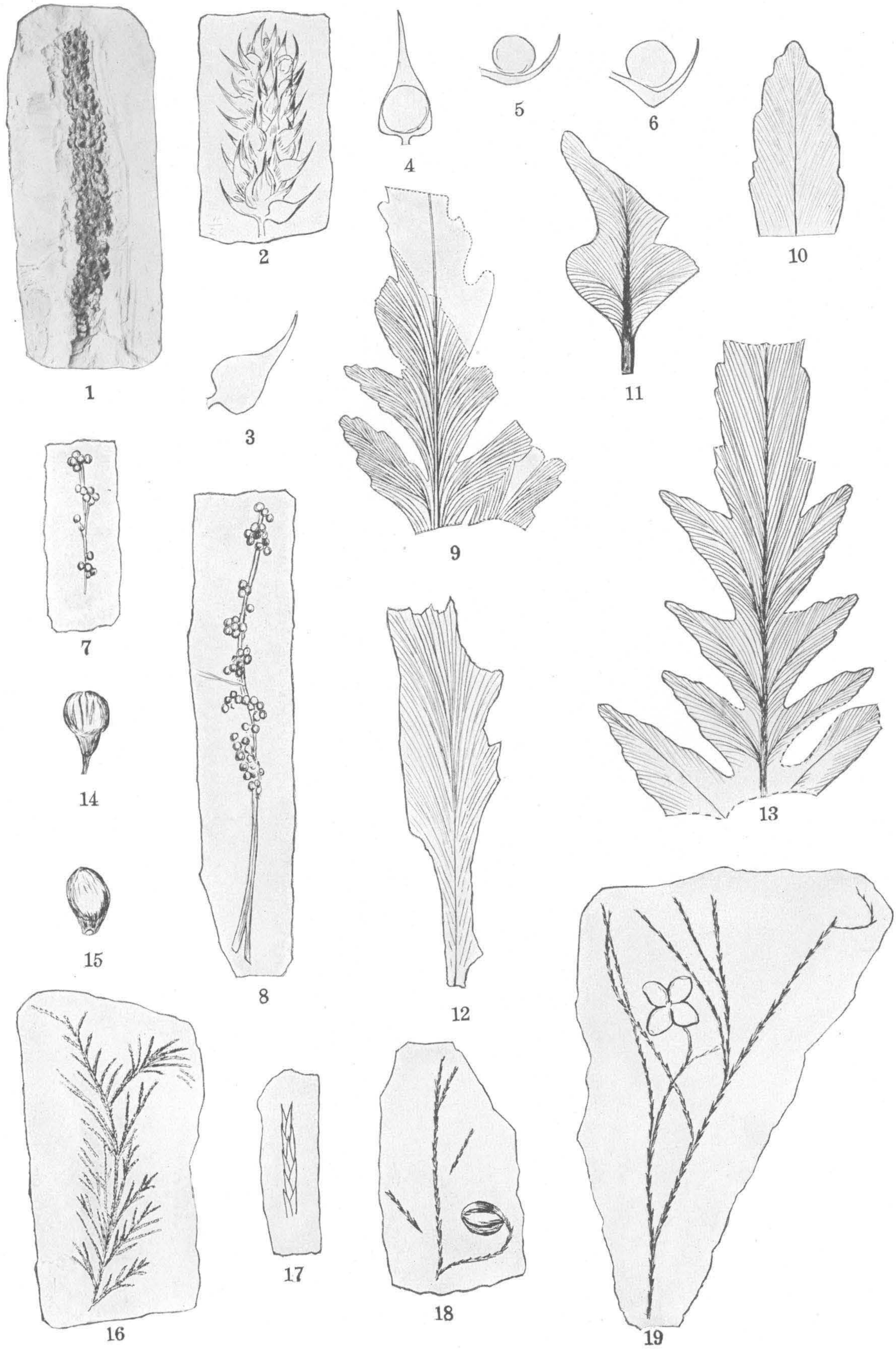
	Black Creek formation of South Carolina.										Raritan formation, New Jersey to Maryland.	Magothy formation, New Jersey to Maryland.	Black Creek formation, North Carolina.	Eutaw formation, Georgia and Alabama.	Tuscaloosa formation, Alabama.	Woodbine sand, Texas.	Dakota sandstone, western interior.	Montana Group, western interior.	Atane and Patoot beds, Greenland.	Cenomanian, Europe.	Turonian, Europe.	Senonian, Europe.
	Middendorf arkose member.					Below Cheraw.	Black Creek.	Cashua Road, Darlington.	Near Williamsons Bridge.	Ashby Place.												
	Near Middendorf.	Rocky Point.	Congaree River.	Langley.	Miles Mill.																	
Algites americana										X		X	X									
Onoclea inquirenda	X											X							X			
Lycopodium cretaceum	X														X							
Podozamites knowltoni		X									X	X					X					
Protophyllocladus lobatus		X										X										
Cephalotoxospermum carolinianum							?			X			X	X								
Araucaria bladenensis										X		X	X	X							?	
Araucaria darlingtonensis							X															
Araucaria jeffreyi				X									X	X								
Brachyphyllum macrocarpum	X										X	X	X				X			?		
Pinus raritanensis	X										X	X	X									
Sequoia reichenbachi	X										X	X	X	X	X		X	X	X	X	X	X
Cunninghamites elegans		X										X	X	X				X	X	X	X	X
Widdringtonites subtilis	X	X									X	X			X					X		
Moriconia americana	X											X	X									
Strobilites anceps							X															
Heterolepis cretaceus		X																				
Potamogeton middendorfensis	X																					
Arundo grœnlandica		X																	X			
Phragmites pratti		X											X	X								
Carex clarkii		X										X										
Sabalites carolinensis				X																		
Juglans arctica	X										X	X	X	X			X		X			
Myrica brittoniana									X			X	X									
Myrica elegans								X					X									
Salix flexuosa	X		X	X							X	X	X	X	X		X					
Salix lesquereuxii	X	X	X	X	X			X			X	X	X	X			X					
Salix pseudohayei	X										X											
Salix sloani				X	X																	
Quercus sumterensis		X																				
Quercus pseudowestfalica	X	X			X								X									
Momisia carolinensis	X																					
Ficus atavina	X	X										X					X		X		X	
Ficus celtifolius	X																					
Ficus crassipes	X	X	X	X								X	X		X		X		X			
Ficus krausiana	X	X	X				X		X			X	X		X		X			X	X	
Ficus stephensoni	X			X									X									
Proteoides lancifolius	X	X						X									X					X
Proteoides parvula	X																					
Dewalquea smithi				X	X										X							
Magnolia capellinii (?)	X	X										X	X	X	X		X		X			
Magnolia newberryi (?)								X														
Magnolia obtusata	X											X			X		X		X			
Magnolia tenuifolia (?)	X											X					X					
Illicium watereensis		X																				
Hamamelites (?) cordatus		X															X					
Acaciaphyllites grevilleoides	X																					
Cæsalpinia middendorfensis	X																					
Leguminosites middendorfensis	X																					
Leguminosites robiniifolia				X									X									
Citrophyllum aligerum	X				X						X	X	X		X		X					
Crotonophyllum panduræformis	X	X		X	X																	
Sapindus morrisoni				X								X			X	X	X		X			
Pachystima (?) cretacea	X																					
Celastrophyllum elegans		X										X										
Celastrophyllum crenatum	X										X	X	X		X				X			
Celastrophyllum carolinensis				X																		
Rhus darlingtonensis								X														
Laurus plutonia	X			X							X	X			X	X	X		X	X		
Laurus atanensis		X										X					X		X			
Laurophyllum elegans	X										X	X	X									
Laurophyllum nervillosum	X							X			X											
Cinnamomum newberryi		X	X								X	X	X	X	X	X	X		X	?		
Cinnamomum middendorfensis	X																					
Eucalyptus angusta									X		X		X	X						X		
Eucalyptus geinitzi	X	X		X							X	X	X		X	X	X		X	X	X	
Eucalyptus wardiana (?)	X											X			X							
Hedera primordialis						X		X			X		X						X	X		
Andromeda novæcæsareæ	X										X	X	X		X	X						
Andromeda grandifolia		X									X	X	X		X							
Andromeda euphorbiophylloides	X																					
Andromeda parlatorii				X							X	X	X		X		X		X			
Myrsine gaudini				X							X	X	X		X							
Diospyros primæva	X	X	X	X	X						X	X	X		X	X	X		X	X	X	
Diospyros rotundifolia		X										X			X		X					
Calycites middendorfensis	X																					

PLATE II.

PLATE II.

	Page.
FIGURES 1–6. *Lycopodium cretaceum* Berry, Middendorf	15
1. Large fruit spike.	
2. Smaller fruit spike, × 5.	
3. A single scale, × 10.	
4. Diagrammatic ventral view of sporophyll, × 10.	
5, 6. Diagrammatic view of sporophyll in median longitudinal section, × 10.	
FIGURES 7, 8. *Onoclea inquirenda* (Hollick) Hollick, Middendorf	14
FIGURES 9–13. *Protophyllocladus lobatus* Berry, Rocky Point	17
FIGURES 14–17. *Widdringtonites subtilis* Heer, Middendorf	25
14, 15. Cones.	
16. Twig.	
17. Twig enlarged.	
FIGURES 18, 19. *Widdringtonites reichii* (Ettingshausen) Heer. Cone-bearing twigs from the Cenomanian of Dalmatia, introduced for comparison.	

All the specimens except those shown in figures 18 and 19 are from the Middendorf arkose member of the Black Creek formation.



UPPER CRETACEOUS PLANTS FROM SOUTH CAROLINA.

PLATE III.

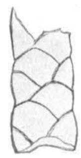
PLATE III.

Page.

FIGURE 1. *Araucaria darlingtonensis* Berry, near Darlington 20
FIGURE 2. *Brachyphyllum macrocarpum* Newberry, Middendorf 21
FIGURE 3. *Heterolepis cretaceus* Berry, Rocky Point 27
FIGURE 4. *Cephalotaxospermum carolinianum* Berry, near Florence 18
FIGURE 5. *Strobilites anceps* Berry, near Darlington 27
FIGURES 6, 7. Detached leaves of *Araucaria bladenensis* Berry, near Florence 19

The specimens shown in figures 2 and 3 are from the Middendorf arkose member of the Black Creek formation. Those shown in figures 1, 4, 5, 6, and 7 are from other beds in the Black Creek formation.


1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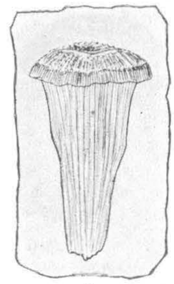
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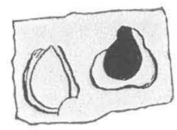
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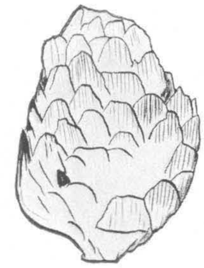
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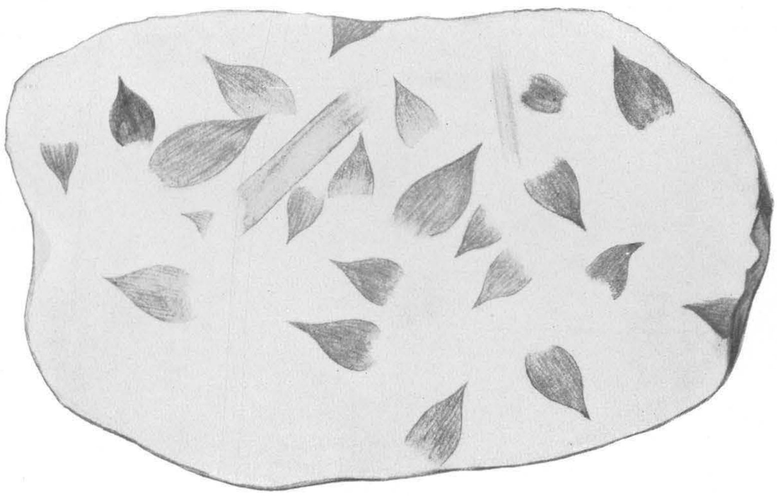
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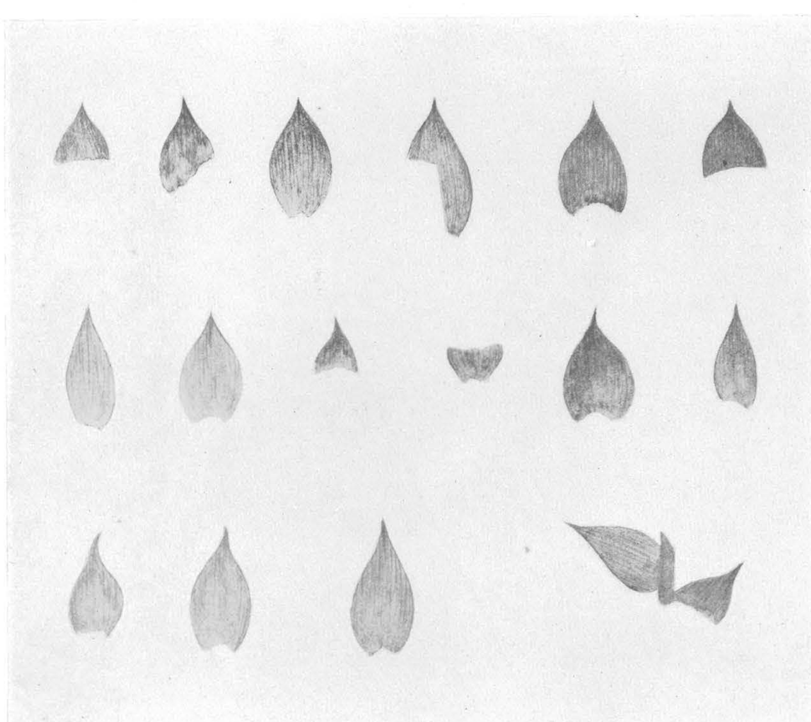
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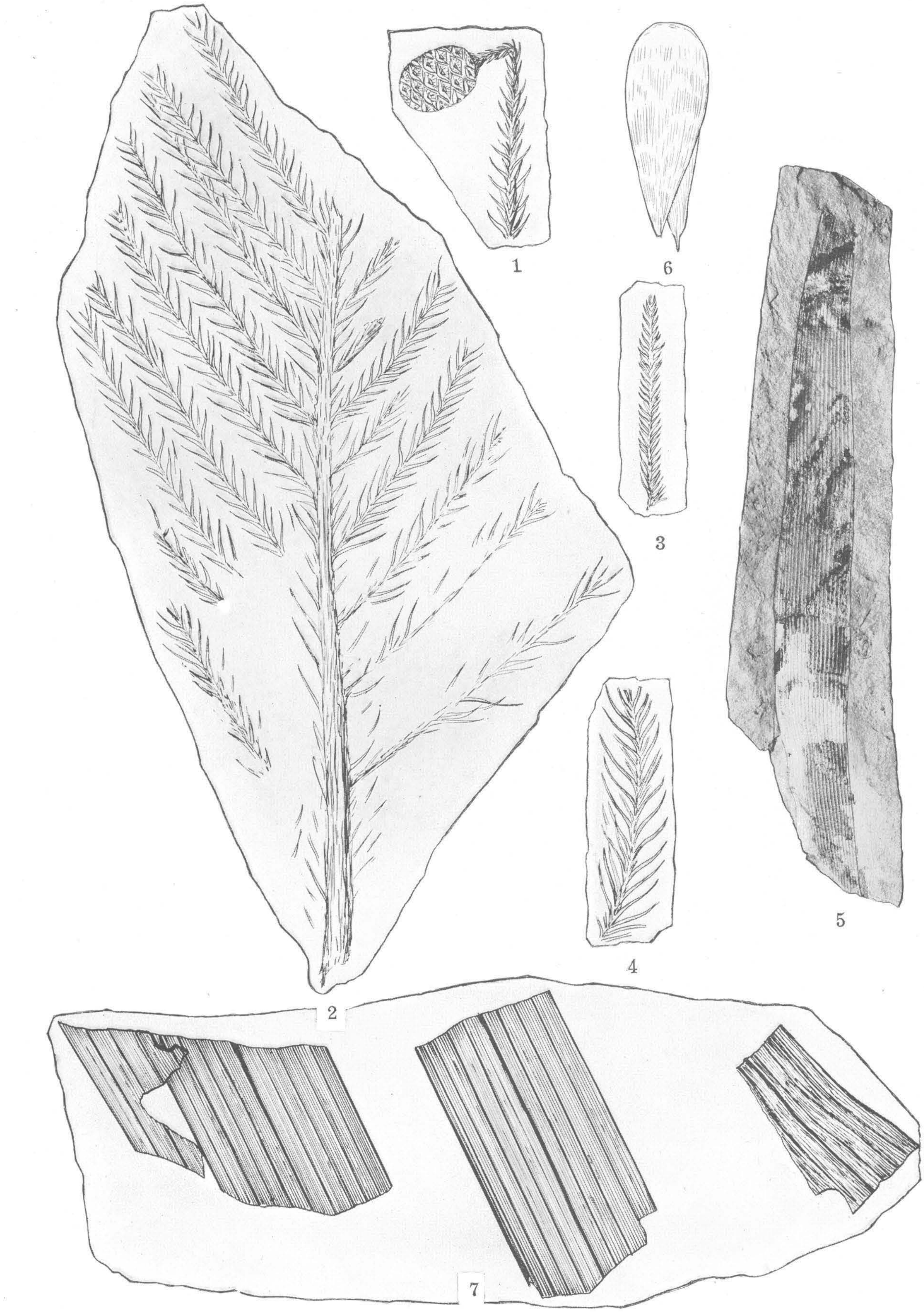
UPPER CRETACEOUS PLANTS FROM SOUTH CAROLINA.

PLATE IV.

PLATE IV.

All the specimens are from the Middendorf arkose member of the Black Creek formation.



UPPER CRETACEOUS PLANTS FROM SOUTH CAROLINA.

PLATE V.

PLATE V.

Page.

Sabalites carolinensis Berry, showing broad rays. From Middendorf arkose member of the Black Creek formation, near Langley.. 29

UPPER CRETACEOUS PLANT FROM SOUTH CAROLINA.

PLATE VI.

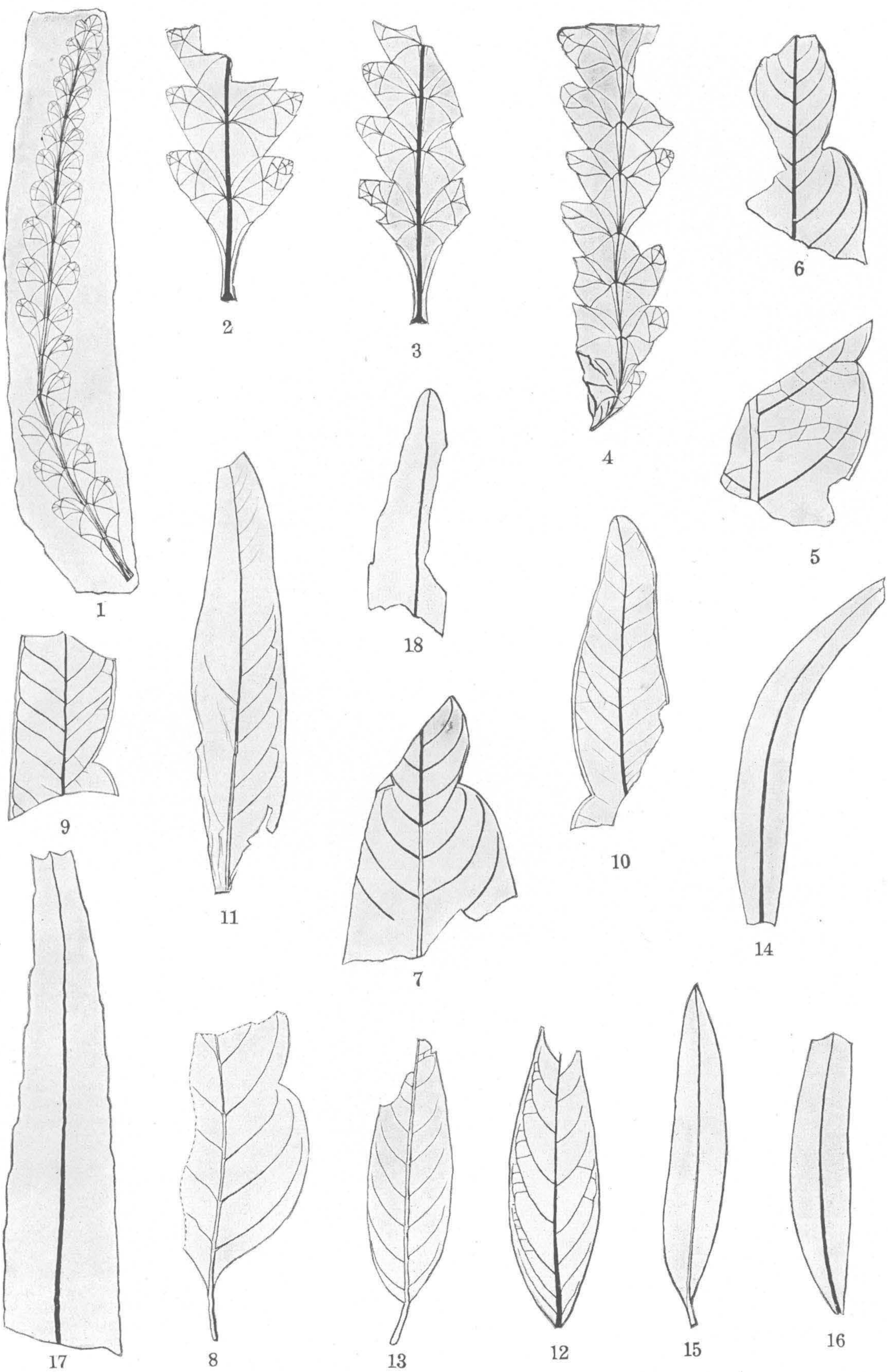
PLATE VI.

UPPER CRETACEOUS PLANT FROM SOUTH CAROLINA.

PLATE VII.

PLATE VII.

All the specimens except those shown in figures 17 and 18 are from the Middendorf arkose member of the Black Creek formation. The specimens shown in figures 17 and 18 are from other beds in the Black Creek formation.



UPPER CRETACEOUS PLANTS FROM SOUTH CAROLINA.

PLATE VIII.

PLATE VIII.

		Page.
FIGURES 1, 2.	*Juglans arctica* Heer, Rocky Point	30
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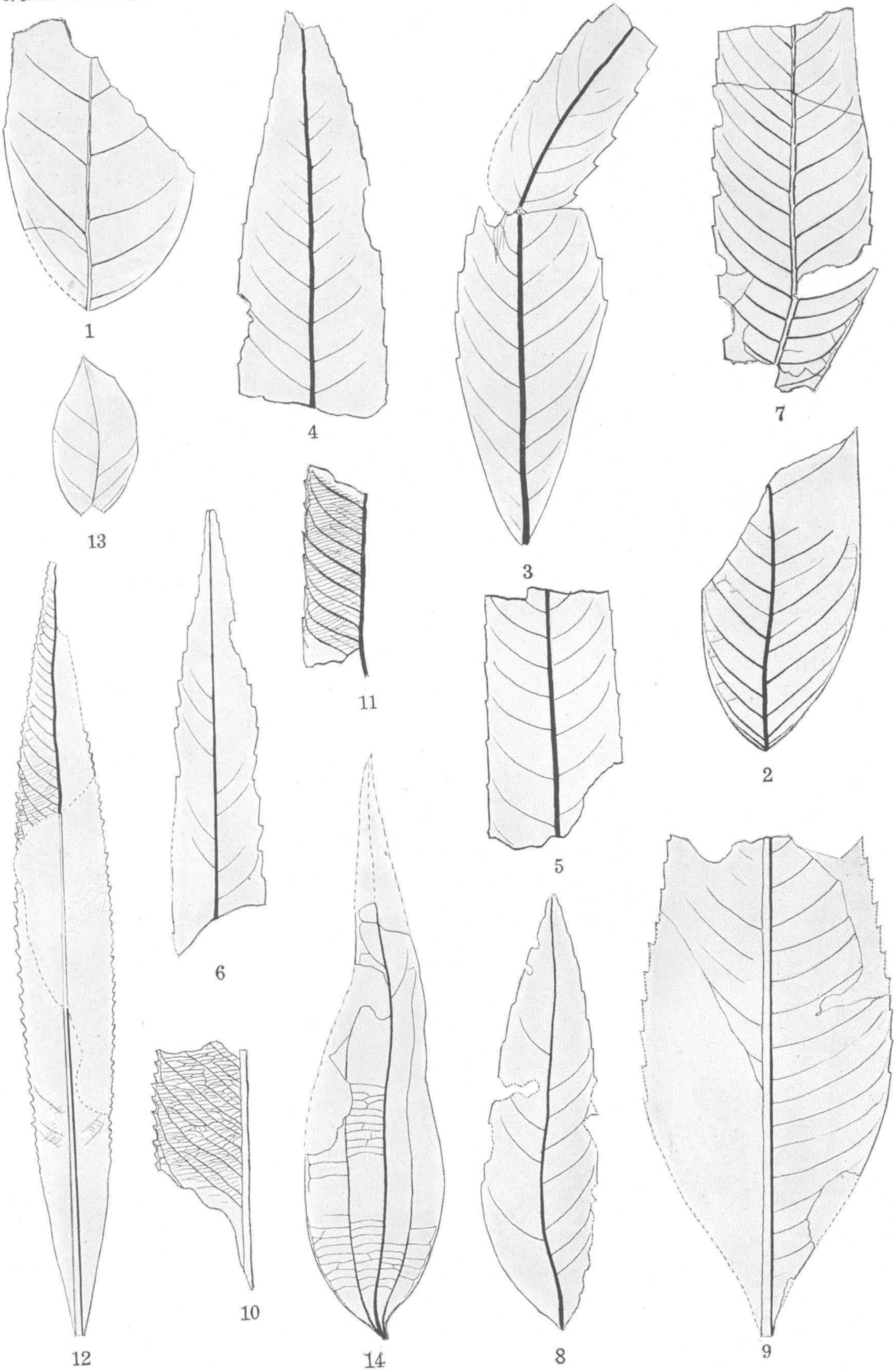
FIGURE 14.	*Cinnamomum middendorfensis* Berry, Middendorf	55

All the specimens are from the Middendorf arkose member of the Black Creek formation.



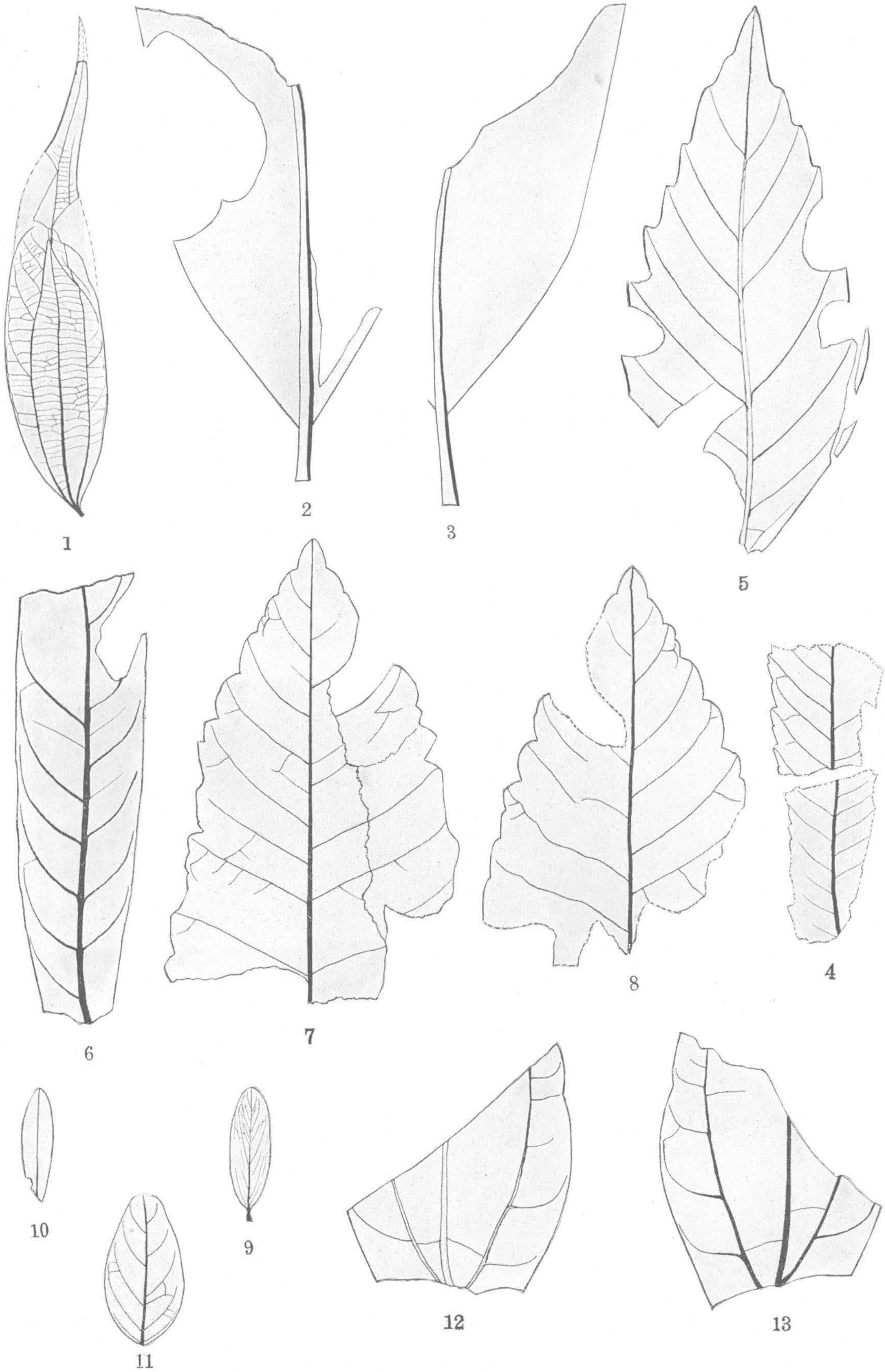
UPPER CRETACEOUS PLANTS FROM SOUTH CAROLINA.

PLATE IX.

PLATE IX.

	Page.
FIGURE 1. *Cinnamomum middendorfensis* Berry, Middendorf	55
FIGURES 2, 3. *Magnolia tenuifolia* Lesquereux (?), Middendorf	44
FIGURE 4. *Myrica elegans* Berry, near Darlington	31
FIGURE 5. *Quercus pseudowestfalica* Berry, Rocky Point	35
FIGURE 6. *Sapindus morrisoni* Heer, near Langley	49
FIGURES 7, 8. *Rhus darlingtonensis* Berry, near Darlington	51
FIGURES 9, 10. *Acaciaphyllites grevilleoides* Berry, Middendorf	45
FIGURE 11. *Leguminosites robiniifolia* Berry, Langley	46
FIGURES 12, 13. *Cinnamomum newberryi* Berry, Rocky Point	54

All the specimens except those shown in figures 4, 7, and 8 are from the Middendorf arkose member of the Black Creek formation. The specimens shown in figures 4, 7, and 8 are from other beds of the Black Creek formation.

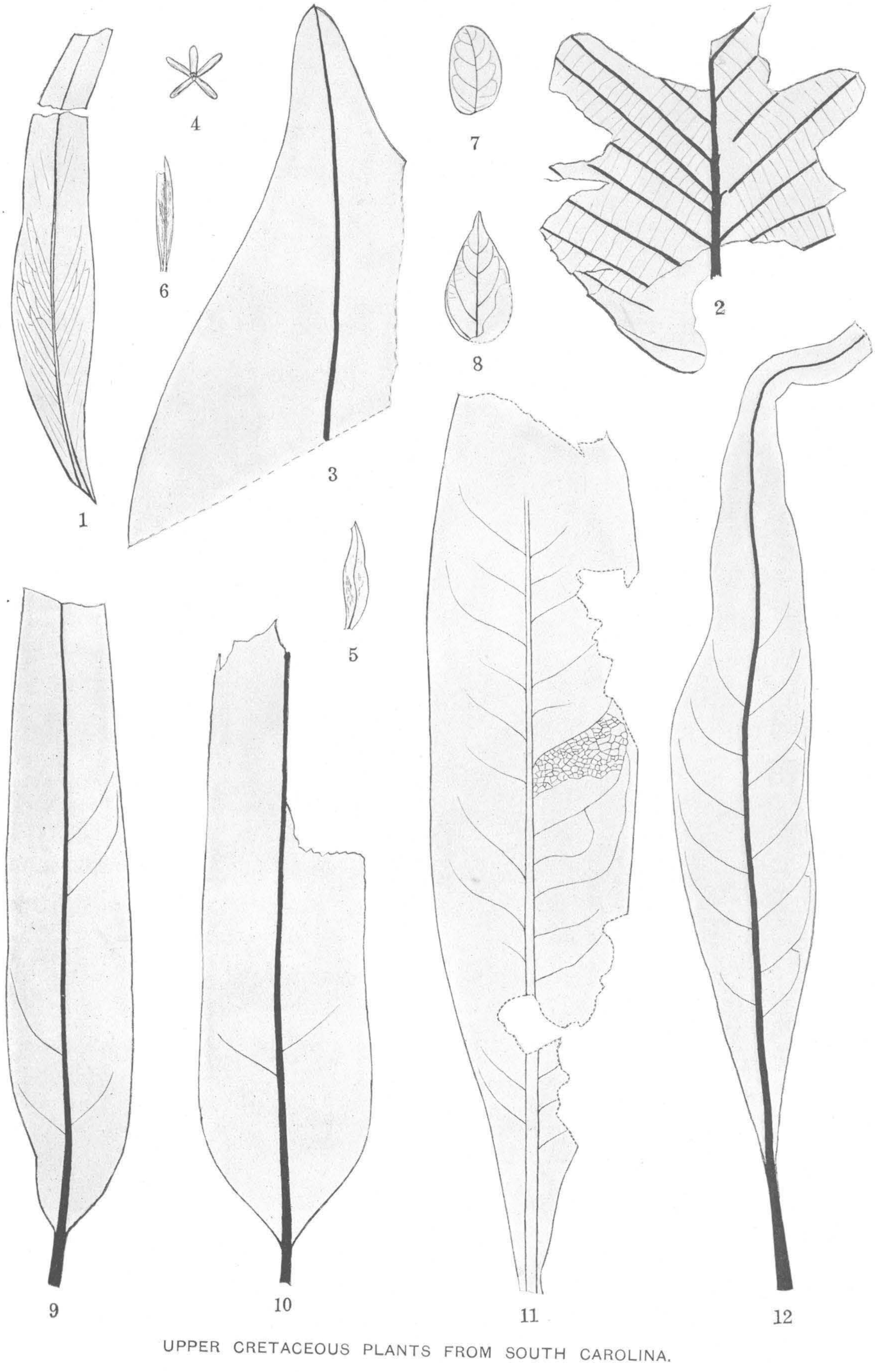


UPPER CRETACEOUS PLANTS FROM SOUTH CAROLINA.

PLATE X.

PLATE X.

All the specimens are from the Middendorf arkose member of the Black Creek formation.

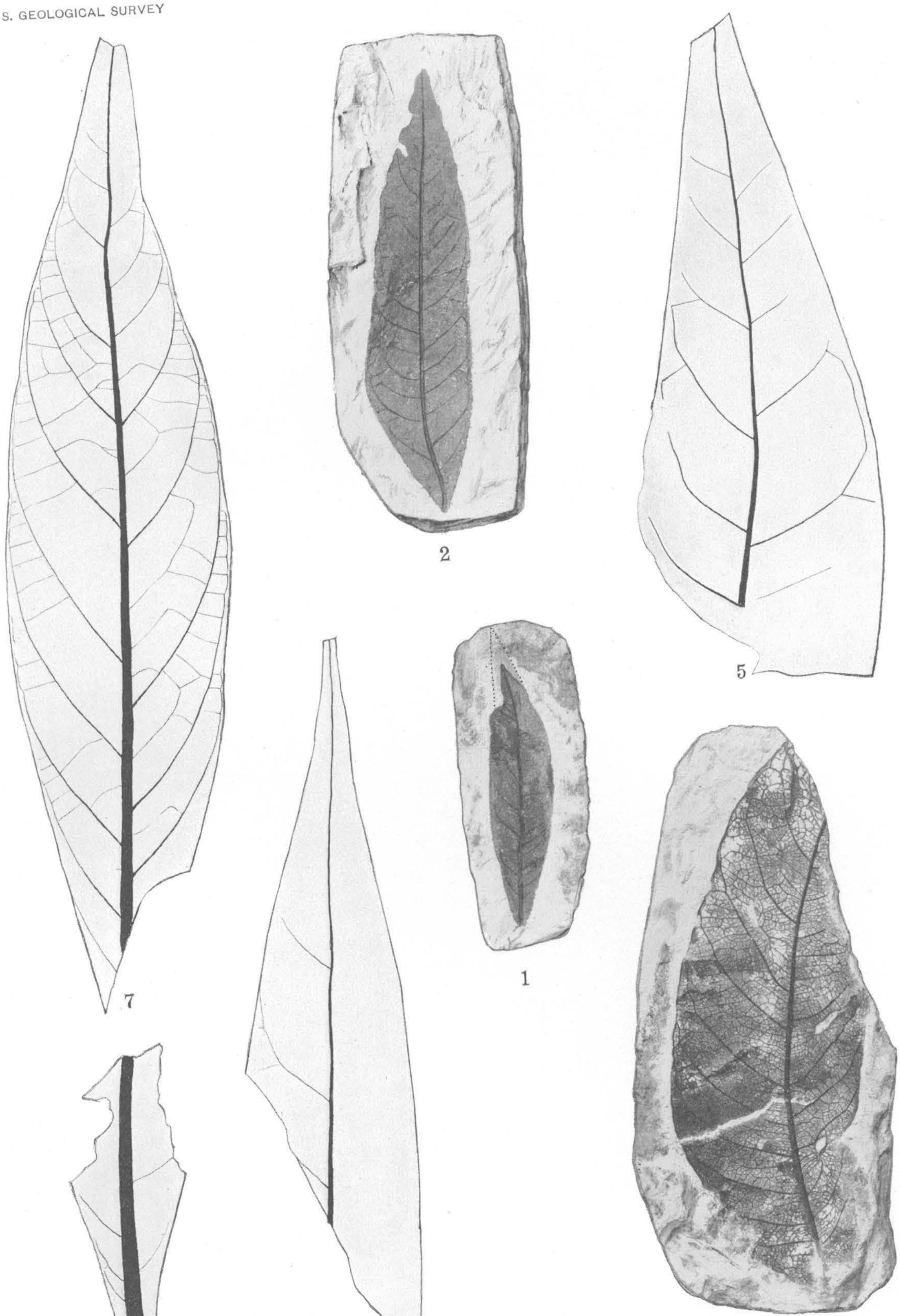


UPPER CRETACEOUS PLANTS FROM SOUTH CAROLINA.

PLATE XI.

PLATE XI.

All the specimens are from the Middendorf arkose member of the Black Creek formation.

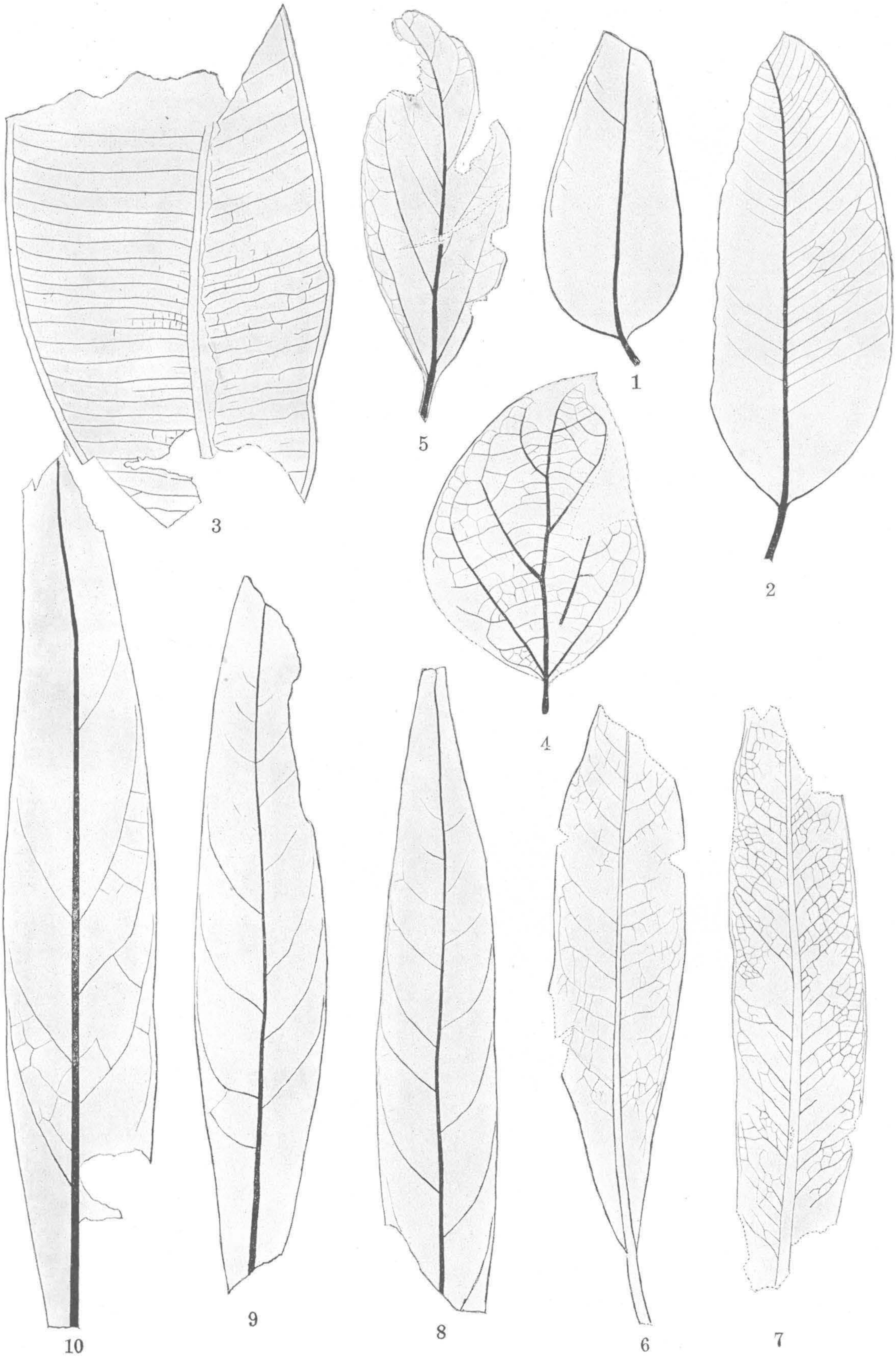


UPPER CRETACEOUS PLANTS FROM SOUTH CAROLINA.

PLATE XII.

PLATE XII.

All the specimens are from the Middendorf arkose member of the Black Creek formation.

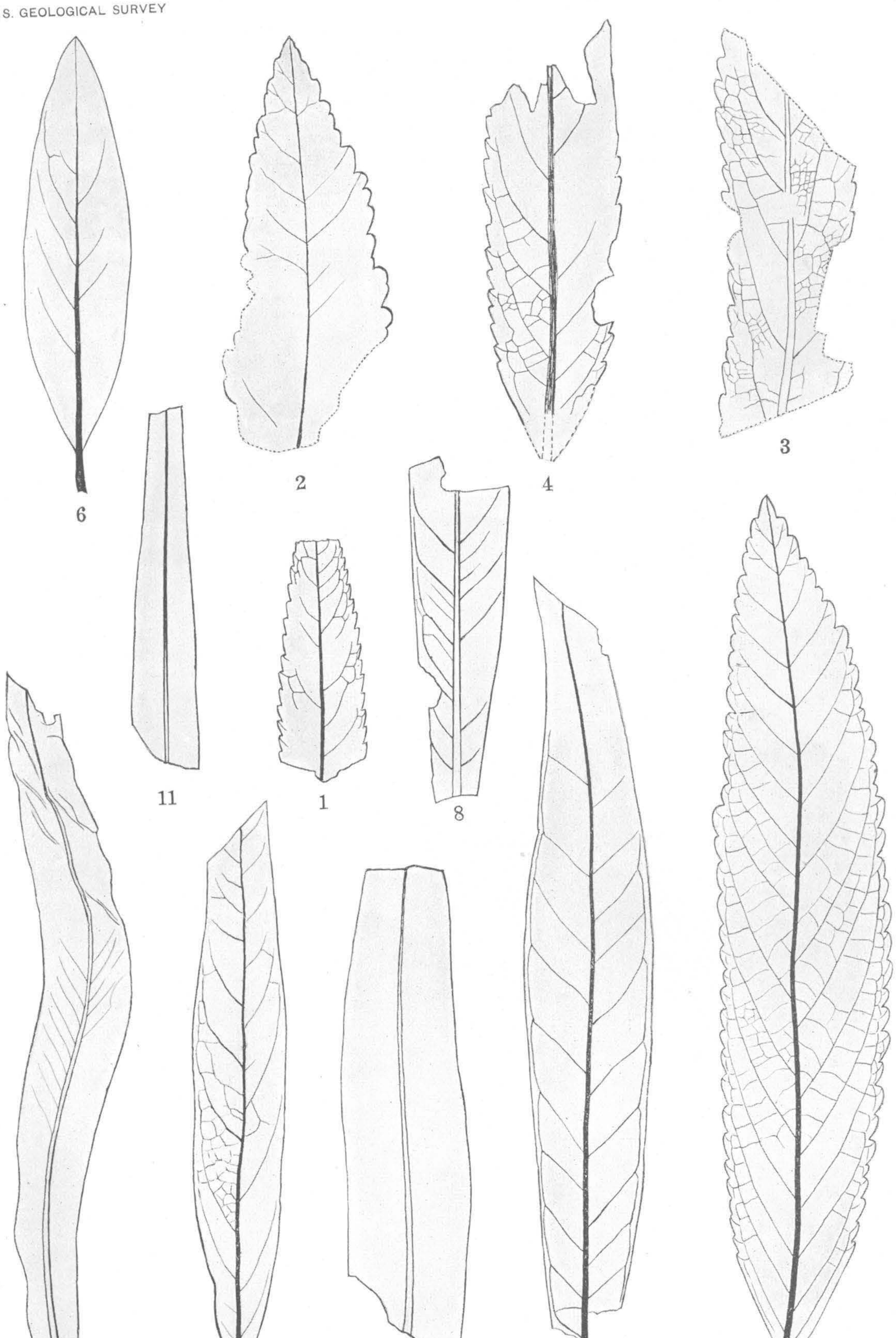


UPPER CRETACEOUS PLANTS FROM SOUTH CAROLINA.

PLATE XIII.

PLATE XIII.

All the specimens are from the Middendorf arkose member of the Black Creek formation.

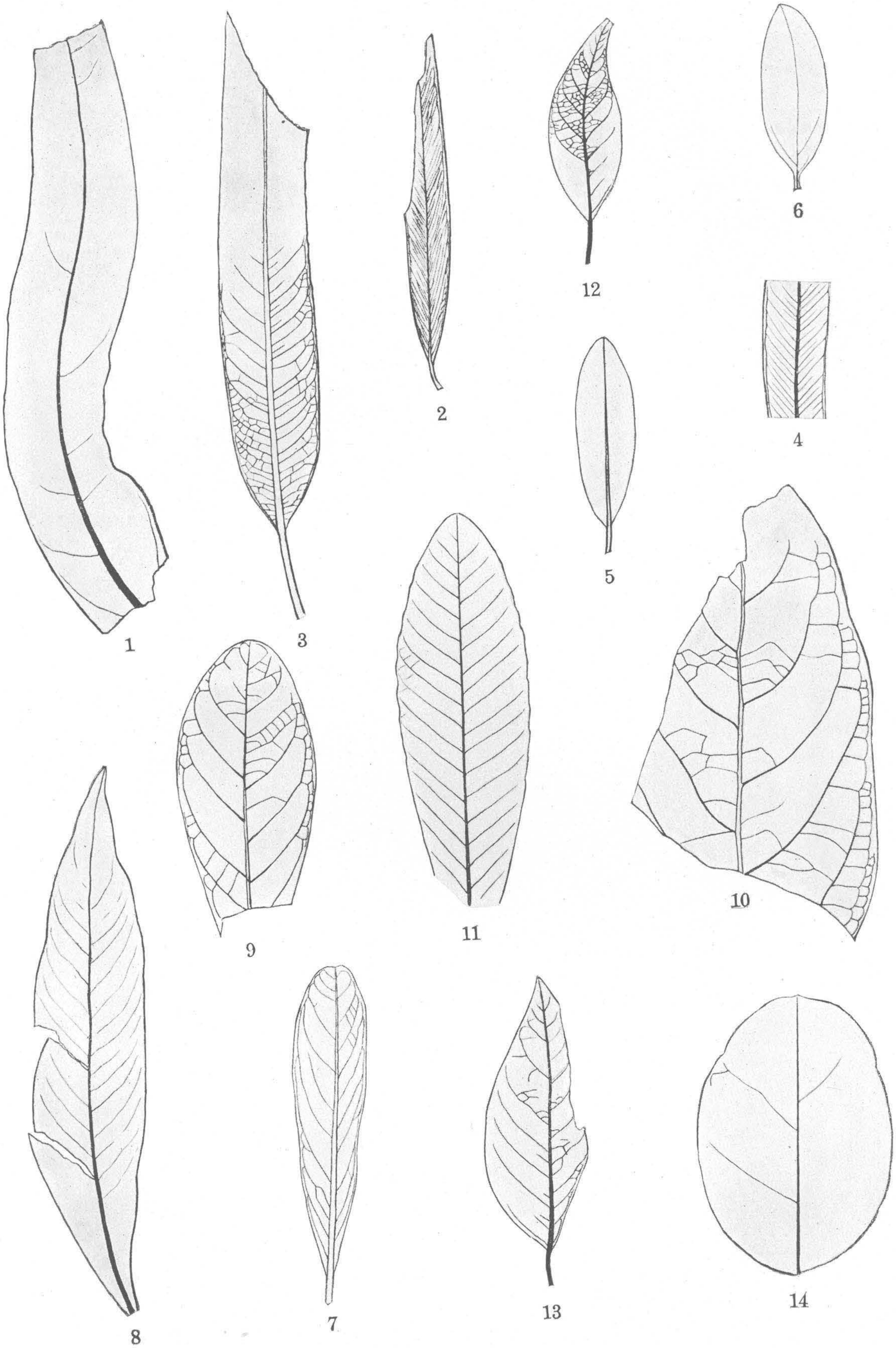


UPPER CRETACEOUS PLANTS FROM SOUTH CAROLINA.

PLATE XIV.

PLATE XIV.

All the specimens except that shown in figure 2 are from the Middendorf arkose member of the Black Creek formation. The specimen shown in figure 2 is from another part of the Black Creek formation.



UPPER CRETACEOUS PLANTS FROM SOUTH CAROLINA.

THE UPPER CRETACEOUS FLORA OF GEORGIA.

INTRODUCTION.

Up to the time of the present study no fossil plants had been specifically recorded from the Coastal Plain of Georgia, although S. W. McCallie mentions several Eocene plant localities and one of Cretaceous age in his report on the underground waters of Georgia,[1] and one of the localities which has furnished materials for the following notes is mentioned by Otto Veatch in his recent report on the clay deposits of Georgia.[2] In 1894 D. W. Langdon recorded leaf fragments in the Cretaceous at Chimney Bluff on Chattahoochee River,[3] and in a recent note on this flora the writer [4] lists a number of the forms found in the Georgia Cretaceous and discusses briefly the botanic and ecologic conditions which they indicate.

Both Lower and Upper Cretaceous rocks are present in Georgia. The Lower Cretaceous sands and clays form a belt of varying width extending across the State along the eastern border of the Piedmont Plateau from Augusta to Columbus and appear to be continuous with the so-called "Hamburg beds" of South Carolina. They are probably to be correlated with the Patuxent ("Cape Fear") formation of North Carolina, which in turn is correlated with the Patuxent formation of Maryland and Virginia, rather than with the younger Tuscaloosa formation of western Alabama, as has been done by Veatch,[2] for L. W. Stephenson has shown that the Tuscaloosa overlies them unconformably in the area of their most western outcrop, a short distance west of Montgomery, Ala.

The Upper Cretaceous formations of Georgia have been recently studied by Mr. Stephenson, who has in preparation a detailed report on the geology, and they will not be considered in detail in the present contribution. A brief statement is, however, necessary, and the writer is under obligations to Mr. Stephenson for furnishing data, especially regarding the plant localities near Buena Vista and Byron. These localities have not been visited by the writer, who is familiar only with the Cretaceous of the Chattahoochee River section and of an area near Columbus, Ga.

GEOLOGY OF THE UPPER CRETACEOUS DEPOSITS OF GEORGIA.

Deposits of Upper Cretaceous age in Georgia are confined to a triangular area lying west of Ocmulgee River and are transgressed east of that point by the Eocene. The relatively narrow base of this triangle is formed by Chattahoochee River, and the apex points somewhat north of east. These Upper Cretaceous deposits represent the Eutaw and Ripley formations, and each formation is subdivided on more or less well-marked lithologic grounds into the following divisions:

- Ripley formation.
    - Providence sand member.
    - Middle division ("Renfroes marl" of Veatch).
    - Cusseta sand member.
- Eutaw formation.
    - Tombigbee sand member.
    - Lower division.

[1] Bull. Georgia Geol. Survey No. 15, 1908, pp. 36, 336, 347.
[2] Bull. Georgia Geol. Survey No. 18, 1909, p. 88.
[3] Langdon, D. W., Report on the geology of the Coastal Plain of Alabama, 1894, p. 440.
[4] Berry, E. W., Bull. Torrey Bot. Club, vol. 37, 1910, pp. 503-511, figs. 1, 2.

RIPLEY FORMATION.

Cusseta sand member.—The Cusseta member is typically developed in southeastern Chattahoochee County, near the town of Cusseta, where it consists of noncalcareous, rather micaceous, mostly unconsolidated quartz sands with local lenses of laminated clays and more extensive lenses of dark, massively bedded clays. It loses its distinctive character to the west along Chattahoochee River, where it is more or less glauconitic and fossiliferous, and to the northeast, where it merges with the underlying and overlying Upper Cretaceous sands. Beds believed to represent this horizon are fossiliferous along the Chattahoochee and contain plant fossils near Buena Vista and near Byron.

Middle division.—The middle part of the Ripley formation consists essentially of massive, micaceous, calcareous, and in many places glauconitic sand with calcareous nodules and dark, argillaceous, pyritiferous, lignitic sands and clays, the sands predominating. These deposits preserve their identity more or less completely from Chattahoochee River eastward across Stewart, Marion, and Schley counties, merging in Macon County with the underlying and overlying Cretaceous sands. They carry an abundant marine fauna, and beds of this age across the border in Alabama have yielded a small flora markedly different in character from that described in the following pages.

Providence sand member.—The Providence sand consists essentially of variegated, more or less cross-bedded sands which pass gradually into the underlying middle division of the Ripley ("Renfroes marl" of Veatch), with the representatives of which they merge toward the east. They are unfossiliferous and hence without interest in the present connection.

EUTAW FORMATION.

Lower division.—The part of the Eutaw formation in the Georgia area which underlies the Tombigbee member consists predominantly of sands, coarse toward the landward margin, and elsewhere in many places calcareous and locally argillaceous and more or less glauconitic. Lenses of dark laminated clay are not uncommon and contain many large teredo-bored logs. Silicified wood is common in the sands. At certain localities molluscan remains are not uncommon, and the clay lenses ordinarily carry vegetable matter. Along Chattahoochee River the sands of the lower division of the Eutaw are in places semilithified by the development of several courses of nodules cemented by carbonate of lime. Eastward the deposits pass into unconsolidated, cross-bedded, ferruginous, and unfossiliferous sands.

The areal extent of these lower deposits is not great. They underlie the northern part of Chattahoochee and Marion counties, a small part of southern Muscogee County, and western Taylor County, beyond which they are not separable from the similar unconsolidated sands which characterize the overlying Upper Cretaceous deposits. They contain a fairly representative flora both in their basal and upper portions.

Tombigbee sand member.—The Georgia representative of the Tombigbee sand member of the Eutaw formation of Mississippi and Alabama is distinctive in character only along Chattahoochee River and for a few miles to the northeast, where it consists of more or less calcareous clays which are locally lignitic and of more or less argillaceous sands with thin layers of calcareous nodules. Eastward it can not be traced beyond Marion County, where it becomes more sandy and is indistinguishable from the adjacent deposits of the Eutaw formation and from the overlying Cusseta sand member of the Ripley formation. It contains marine invertebrates but has failed to yield any recognizable plant remains.

PLANT LOCALITIES.

Determinable fossil plants have been collected in the Upper Cretaceous of Georgia from five different localities, each of which will be briefly described.

McBRIDES FORD.

The locality at McBrides Ford is on the left bank of Upatoi Creek in Chattahoochee County, about 10 miles southeast of Columbus, Ga.

The lower Eutaw deposits, which are above the ford, rest with a marked unconformity on Lower Cretaceous clays. At the base they show fine gravel, grading upward into coarse cross-bedded sands with clay laminæ. At one point about 10 feet above low water a small lens of dark-drab clay, not more than 12 or 15 inches in thickness and pinching out laterally within a few feet, furnished the plant remains listed from this locality. Two large leaves of Manihotites were lying close together and possibly were derived from the same plant. Similar small lenses of clay along the low bank of the creek showed traces of leaves and much comminuted vegetable matter but nothing recognizable.

The species identified from this locality only a few feet above the base of the formation and near its landward margin are:

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

The Sequoia and Androvettia are the most abundant forms. In addition to the plants in the list several species of dicotyledons represented by unidentifiable fragments and a specimen of an undeterminable fern of the Asplenium type were collected.

BROKEN ARROW BEND.

The locality at Broken Arrow Bend includes outcrops on both banks of Chattahoochee River about 13 miles below Columbus. The one farthest up the river, on the Alabama bank, contains marine invertebrates; the other, on the left bank, about 100 yards farther downstream, in Chattahoochee County, Ga., shows a much more extensive section and includes the fossil plants enumerated below. At the base of the bluff in places the much-eroded surface of the Lower Cretaceous rises to a height of about 5 feet. Overlying this are coarse cross-bedded sands of the lower Eutaw with gravel, much lignite, and a few small lenses of dark "shaly" clay about a foot in thickness and 10 to 15 feet in diameter, carrying poor leaf impressions and considerable comminuted vegetable matter.

The identifiable species are:

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

An undeterminable leaf of Ficus was also found here. The Sequoia is characteristic and is the most abundant type. Next in abundance is *Salix eutawensis*, the leaves of which are, however, usually much broken.

CHIMNEY BLUFF.

The locality at Chimney Bluff is on the left bank of Chattahoochee River about 22 miles below Columbus, in Chattahoochee County. (See Pl. XV, *A*.)

At this point the Eutaw shows about 25 feet of irregularly bedded, laminated and cross-bedded, very lignitic, pyritiferous sand and clay, with small lenses of dark-drab clay carrying plant remains, the whole overlain by a lens of fine gray sand about 10 to 15 feet thick, above which, without unconformity, are about 50 feet of yellowish or greenish very argillaceous sands which carry casts of marine invertebrates and which are believed to represent the Tombigbee sand.

The identifiable plants, which are from a layer near the top of the lower division of the Eutaw, are as follows:

Araucaria bladenensis Berry.
Araucaria jeffreyi Berry.
Ficus crassipes Heer.
Ficus krausiana Heer.
Salix flexuosa Newberry.
Salix lesquereuxii Berry.
Sequoia reichenbachi (Geinitz) Heer.

At this locality the Sequoia is rare and the commonest plant is *Araucaria bladenensis*, represented for the most part by macerated twigs and detached leaves, though better preserved twigs of considerable size are not uncommon. The lower part of the exposure is remarkable for its lignite. Large teredo-bored logs, some of them 2 to 3 feet in diameter, are not uncommon, and pellets of fossil resin (amber) are also present. In view of the persistent association of this fossil resin with Araucaria remains from North Carolina southward it seems probable that not all Upper Cretaceous ambers are derived from species of Pinus, though this, as shown by Hollick and Jeffrey, is the source of the amber from Staten Island, N. Y.

Leaf impressions were discovered at this locality in 1888 by the late D. W. Langdon, of the Alabama Geological Survey, who mentioned their occurrence in several publications, but no collections were made until the writer's visit in 1909.

LOCALITY NEAR BUENA VISTA.

The fossil plants from the locality near Buena Vista (see Pl. XV, *B*) were collected by L. W. Stephenson in a gully along the Buena Vista-Tazewell road about 6 miles northeast of Buena Vista, in Marion County, in deposits referred by him to the Cusseta sand member of the Ripley formation. The species identified are the following:

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

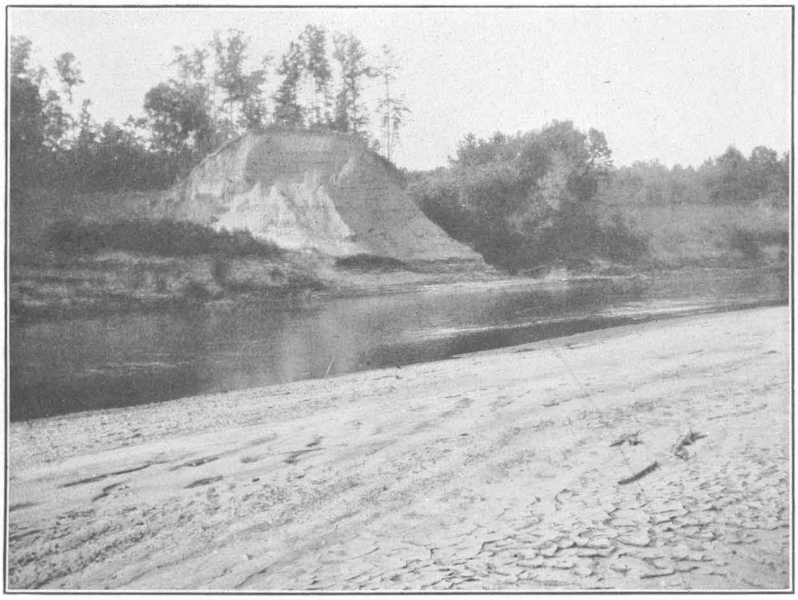
The leaf impressions are scattered and poor, perhaps the most abundant form being the Doryanthites. The Araucaria is represented by detached leaves, and all of the remains show evidence of trituration.

LOCALITY NEAR BYRON.

The locality about 1½ miles northeast of Byron, in Houston County, is in a cut of the Central of Georgia Railway on the north side of the track The plants were collected by L. W. Stephenson and are referred by him to the Cusseta sand member. The materials in this area are predominantly coarse, cross-bedded, rather incoherent arkosic sands with local clay lenses of small extent. The leaf remains from this point are contained in a massive dark-drab clay which carries much comminuted vegetable matter and grades both horizontally and vertically into laminated clay with fine sand partings. The plants are few and poor and include the following recognizable forms:

Araucaria jeffreyi Berry.
Cunninghamites elegans (Corda) Endlicher.
Dryopterites stephensoni Berry.

The Cunninghamites is the commonest form but is very poorly preserved. The collection also contains undeterminable fragments of dicotyledonous leaves.



A. PLANT LOCALITY AT CHIMNEY BLUFF, CHATTAHOOCHEE RIVER, GA.

B. PLANT LOCALITY IN THE CUSSETA SAND MEMBER OF THE RIPLEY FORMATION NEAR BUENA VISTA, GA.

SYSTEMATIC DESCRIPTION OF THE FLORA.

Phylum PTERIDOPHYTA.

Order FILICALES.

Family POLYPODIACEÆ.

Genus DRYOPTERITES Berry.

DRYOPTERITES STEPHENSONI sp. nov.

Plate XVII, figures 1 and 2.

Description.—Fronds bipinnate or possibly tripinnate. Pinnules thick in texture, ovate to lanceolate in outline, ascending, merging toward the apex of the pinnæ. A single vein enters each pinnule, branching from the rachis at an extremely acute angle and immediately breaking up into three branches, the upper as a rule remaining simple and running to the upper margin, the lower generally 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 commonly remain simple and the proximal generally fork once.

This species is based upon the specimen figured and its counterpart. It is quite distinct from any ferns previously known from the American Upper Cretaceous but suggests various forms previously described, for example, the fern remains described by Debey and Ettingshausen from Aachen (Emscherian), on the Prussian border, as *Pteridolemma gymnorachis*.[1] 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.[2]

Still other fern remains described as *Sphenopteris grevillioides* Heer,[3] *Grevillea tenera* Velenovsky,[4] and *Thyrsopteris grevillioides* Hollick,[5] which range from the Kome beds (Barremian) of Greenland to the Upper Cretaceous of Marthas Vineyard (Magothy formation), are suggestive of the Georgia fern in general aspect but are seen to differ both in outline and venation when careful comparisons are instituted. The modern genus Dryopteris of Adanson (Aspidium Swartz) has more than 1,000 species of wide geographic distribution in the existing flora. Fossil species have been described from the Lower Cretaceous upward.[6] The Upper Cretaceous records include *Dryopteris oerstedi* (Heer) Knowlton from the Atane and Patoot beds of Greenland[7] and *Dryopteris kennerleyi* (Newberry) Knowlton from Vancouver Island, neither of which appears to be closely related to the Georgia plant.

Occurrence.—Cusseta sand member of the Ripley formation, cut on Central of Georgia Railway, 1½ miles northeast of Byron, Houston County. (Collected by L. W. Stephenson.)

Collections.—U. S. National Museum.

Phylum SPERMOPHYTA.

Class GYMNOSPERMÆ.

Order CONIFERALES.

Genus ANDROVETTIA Hollick and Jeffrey.

ANDROVETTIA ELEGANS sp. nov.

Plate XVIII, figures 1–10.

Description.—These remains consist of bifacial leafy twigs arranged in a distichous and apparently opposite manner on naked stems, very fernlike in general aspect. These phylloclad-

[1] Denkschr. K. Akad. Wiss. Wien, vol. 17, 1859, p. 234, Pl. VII, figs. 21, 22.
[2] Jahrb. K.-k. geol. Reichsanstalt, vol. 45, 1895, pp. 39 et seq.
[3] Heer, Oswald, Flora fossilis arctica, vol. 3, Abth. 2, 1874, p. 34, Pl. XI, figs. 10 and 11.
[4] Velenovsky, J., Die Flora der böhmischen Kreideformation, pt. 4, 1885, p. 11, Pl. VII, figs. 9, 14, and 16.
[5] Hollick, Arthur, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 31, Pl. I, figs. 10–13.
[6] These were set apart from the modern genus as the genus Dryopterites by the writer in 1911.
[7] The form identified as this species from the Patapsco formation of Virgina is *Cladophlebis browniana*.

like lateral twigs are not simple shoots but reduced branches of a higher order, for they are made up of regularly alternating leaves and reduced leaf-bearing lateral twigs in the axils of these leaves. Phyllotaxy and arrangement of twigs are apparently cyclic throughout, but much masked by reduction, especially of those leaves on the flat surfaces. The lateral leaves are opposite, stout, falcate, pointed, and markedly decurrent, with a single immersed stout leaf trace; proximally they coalesce with their fellows. The leaves on the upper and lower surfaces are apparent on magnification as bluntly rounded scales along the middle of the phylloclad. Between each successive lateral leaf there is a rounded toothed lobe about twice as long as the leaves which represent a vestigial axillary branch. These lobes show vestiges of several leaves, not only by the marginal teeth but also by the lines of adhesion, which can be traced for greater or less distances inward. The vascular system of these reduced lateral twigs can not be made out satisfactorily. Each shows a single once-forked strand, the two forks running to the tips of the reduced basal leaves of the twig. Whether this represents all that is left of the vascular system of these twigs can not be made out. In the more reduced *Androvettia carolinensis* Berry these twigs are usually represented by a single rounded lobe which contains but one once-forked strand like that in the Georgia material.

Distally some specimens show clusters of small terete twigs in the axils of lateral leaves of the main shoots. These twigs are covered with small, ovate, appressed leaves. Similar objects are present in some of the material of *Androvettia statenensis* from Kreischerville, Staten Island, each of which springs from the axil of a normal leaf of the axillary shoot and is doubtfully interpreted as a male ament. This may be the nature of these remarkable objects, although no traces of pollen or pollen sacs can be made out in microscopic preparations of the Georgia fossil. They can hardly represent anything but aments or a most curious type of dimorphic foliage. The illustrations show typical specimens of the normal and dimorphic type, natural size and also enlarged 4 diameters, as well as the apical part of one of the lateral twigs of the normal type enlarged 45 diameters.

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 the describers content themselves with a very good account of this species and refrain from framing a generic diagnosis. This laudable conservatism is abundantly justified by the writer's discovery of two additional species which can not be generically separated from the Staten Island species and which furnish a number of additional characters that serve to isolate this genus.

These remains are all entirely fernlike in superficial appearance, uniformly coriaceous in texture, and by the details of their external characters and internal structure are indubitable gymnosperms of the order Coniferales. Their positive reference to the Araucarineæ by Hollick and Jeffrey will undoubtedly be questioned by many students.

Androvettia carolinensis is not common and is confined to a single locality on Tar River in North Carolina and to a recently discovered locality at about the same horizon near Iuka in northeastern Mississippi. It evidently had a wide range, and its scarcity in the fossil state may possibly be due to its habitat having been remote from the areas of sedimentation. What makes this theory seem plausible is the fact that although the remains are extremely coriaceous they are much broken both in North Carolina and Mississippi, as if they had been in the water a long time, and possibly they were brought down from the upland by streams. The Georgia material is more abundant, but is also confined to a single known locality. The lateral leaves along the edges of phylloclad-like twigs are markedly opposite and well developed and the scale leaves on its flat surfaces are less reduced than in *Androvettia statenensis* or *Androvettia carolinensis*. The lateral twigs are strictly opposite as in the course of the vascular bundles, which consist of a regular alternation of opposite simple bundles and dichotomously forked bundles. As the anatomy of these forms has not yet been studied the reader is referred to

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

Hollick and Jeffrey's memoir cited above, in which the histology of the Staten Island form is discussed.

Androvettia seems clearly distinct from Phyllocladus, and it is probably equally distinct from the various species of Protophyllocladus which have been recorded from the Raritan and later Cretaceous formations of North America. It seems equally distinct from Thinnfeldia but may prove to be related to Moriconia—in fact, the reduced lateral twigs are very suggestive of the similar twigs of *Moriconia americana* Berry, especially the forms of this species collected by the writer from clays in the Middendorf arkose member of the Black Creek formation of South Carolina. The comparison of Androvettia with the Lower Cretaceous species *Ctenopteria insignis, Zamiopsis insignis, Thinnfeldia marylandicum,* and *Plantaginopsis marylandica* by Hollick and Jeffrey is in the writer's opinion singularly unhappy. The last is a monocotyledon and the others either ferns or cycads, not even remotely related to the forms under discussion.

Occurrence.—Lower division of the Eutaw formation, McBrides Ford, Chattahoochee County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Genus **ARAUCARIA** Jussieu.

ARAUCARIA BLADENENSIS Berry.

Plate XIX, figures 1 and 2.

Araucaria bladenensis Berry, Bull. Torrey Bot. Club, vol. 35, 1908, p. 255, Pls. XII; XIII; and XIV, figs. 1–3.

This form is described in the section of this report dealing with the Upper Cretaceous flora of South Carolina (pp. 19–20).

This species, which is so exceedingly common in and characteristic of the Black Creek formation in the North Carolina area, and which is also found in the continuation of these beds in South Carolina, occurs in abundance in the lower part of the Eutaw of western Alabama. In Georgia it is represented at Buena Vista by detached but entirely characteristic leaves which are extremely rare. It is more common at Chimney Bluff, where both the detached leaves and the leafy twigs, often of considerable size, are abundant. The presence at the latter locality of a characteristic cone scale of *Araucaria jeffreyi* suggests the probability of the two being referable to the same species.

Occurrence.—Lower division of the Eutaw formation, Chimney Bluff, Chattahoochee County. (Collected by E. W. Berry.) Cusseta sand member of the Ripley formation, near Buena Vista, Marion County. (Collected by L. W. Stephenson.)

Collections.—U. S. National Museum.

ARAUCARIA JEFFREYI Berry.

Araucaria jeffreyi Berry, Bull. Torrey Bot. Club, vol. 35, 1908, p. 258, Pl. XVI.

This species is described in the section of this report dealing with the Upper Cretaceous flora of South Carolina (pp. 20–21).

The Georgia material is neither abundant nor well preserved, but the identifications are unquestionable. A single scale was collected at Chimney Bluff, on Chattahoochee River, where it was associated with the abundant leafy twigs of *Araucaria bladenensis*, and, as mentioned under the discussion of that species, it renders probable the view that these cone scales and twigs were borne by the same Upper Cretaceous trees. A single specimen, entirely characteristic, was also obtained at the locality near Byron.

Occurrence.—Lower division of the Eutaw formation, Chimney Bluff, Chattahoochee County. (Collected by E. W. Berry.) Cusseta sand member of the Ripley formation, cut on Central of Georgia Railway, 1½ miles northeast of Byron, Houston County. (Collected by L. W. Stephenson.)

Collections.—U. S. National Museum.

Genus BRACHYPHYLLUM Brongniart.

BRACHYPHYLLUM MACROCARPUM FORMOSUM Berry.

Brachyphyllum macrocarpum Berry, Bull. Torrey Bot. Club, vol. 37, 1910, p. 183.
Brachyphyllum macrocarpum Berry, idem, vol. 38, 1911, p. 420 (non Newberry, 1896).
Brachyphyllum macrocarpum formosum Berry, idem, vol. 39, 1912, p. 392, Pl. XXX.

Description.—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* Newberry a very considerable variation within certain fixed limits is at once obvious. This variation is usually one of size, but the more slender specimens are more elongated and smoother. This has been frequently noted by the writer and is commented upon in print by F. H. Knowlton,[1] who in discussing the later 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 a constant difference in size was noticed by the writer. This may reflect a slight difference in climatic conditions, and all of the forms may be interpreted as the variations of a single species. In fact, one of Newberry's figures [2] of a Raritan specimen 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 at a horizon as old as the basal part of the Tuscaloosa formation in Alabama and its presence in the Woodbine sand of Texas. In general, however, it occurs at later and more southern horizons than the type. This might be ascribed to the fact that only the slender and more elongated terminal twigs are preserved at these localities, but such an explanation is regarded as improbable, for the same reasoning should hold good for the areas where only the thicker twigs have been found.

The remains are generally much macerated and broken. The general proportions are decidedly different from the parent type. The leaves are slightly smaller and smoother and somewhat more elongated in their relative proportions and lack the apical papillæ and the convergent striæ. The new variety is much more graceful than the type in appearance and in its general aspect suggests the Lower Cretaceous genus Arthrotaxopsis. The most closely allied form appears to be one from the Albian of Portugal, described by Saporta[3] 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 associated with the type in Maryland; they are abundant throughout the Tuscaloosa of Alabama, ranging upward into the basal part of the Eutaw formation in both Alabama and western Georgia.

Occurrence.—Lower division of the Eutaw formation, McBrides Ford, Chattahoochee County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Genus CUNNINGHAMITES Presl.

CUNNINGHAMITES ELEGANS (Corda) Endlicher.

This species is described in the section of this report dealing with the Upper Cretaceous flora of South Carolina (pp. 24–25).

The Georgia specimens are from the locality near Byron, and though not nearly so large as the exceptional remains of this species from North Carolina, where many of the leaves are 6 centimeters or more in length, they are entirely typical, and with the associated cone scale

[1] Bull. U. S. Geol. Survey No. 163, 1900, p. 29, Pl. IV, figs. 5 and 6.
[2] The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 51, Pl. VII, figs. 1–7. (See fig. 7.)
[3] Saporta, G. de, Flore fossile du Portugal, 1894, p. 176, Pl. XXXI, fig. 14.

of *Araucaria jeffreyi* serve admirably to indicate the probable horizon of the materials found near Byron, which are rather ambiguous lithologically and entirely unfossiliferous except for the three species of plants collected by Stephenson.

Occurrence.—Cusseta sand member of the Ripley formation, cut on Central of Georgia Railway 1½ miles northeast of Byron, Houston County. (Collected by L. W. Stephenson.)

Collections.—U. S. National Museum.

Genus **SEQUOIA** Endlicher.

SEQUOIA REICHENBACHI (Geinitz) Heer.

This species is described in the section of this report dealing with the Upper Cretaceous flora of South Carolina (pp. 23–24).

Twigs of this species are rare at the Chimney Bluff locality but typical and common at McBrides Ford and Broken Arrow Bend. In this connection it is worthy of comment that Sequoia twigs are about the last fragments in floating vegetable débris to disintegrate, and their remains are frequently found in deposits in which the associated vegetation is reduced to an unrecognizable mass, as is so common in typically marine deposits.

Occurrence.—Lower division of the Eutaw formation, Chimney Bluff, McBrides Ford, Broken Arrow Bend, Chattahoochee County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Genus **TUMION** Rafinesque.

TUMION CAROLINIANUM Berry (?).

Tumion carolinianum Berry, Am. Jour. Sci., 4th ser., vol. 35, 1908, p. 383, figs. 1–3.

Description.—The following description is quoted from the work cited above:

> Leaves flat, somewhat rigid, linear-lanceolate, gradually tapering to a slender point from the broad but slightly contracted decurrent base, 25 to 30 millimeters long and up to 3 millimeters in greatest width, averaging somewhat more than 2 millimeters, arranged in a rather close spiral and apparently not distichous in habit. Mid vein absent, but in strong transmitted light a darker, i. e., more opaque, central band gradually dying out and presumably of vascular tissue is seen in the basal third of the leaf; this is not a surficial feature, however, since both the dorsal and ventral surfaces are unmarked centrally. In strong transmitted light the two stomatal bands characteristic of the modern species are fairly well shown after the leaves have been appropriately treated to reduce their opacity. These bands are narrow and their inner margin is just about one-fourth of the distance across the leaf, i. e., they are slightly nearer the margin than the median axis; they are confined to the lower surface and die out apically, becoming well marked proximally, and are made out with difficulty in the upper half of the leaf. The stomata are confined to the surface of these bands and are without orderly arrangement, usually not more than four in a transverse direction. These stomata are of medium size and strictly comparable with those of the existing American tumions with which comparisons have been made; the guard cells are slender and their orientation with respect to the leaf axis is indefinite, with apparently a prevailing tendency in the material examined to a position at right angles instead of one parallel with this axis, as in the case in the living material seen.

The presence of this species in Georgia is based upon three poorly preserved specimens from McBrides Ford that can not be identified with certainty. The leaves seem to be thicker than in the Carolina specimens, and though some of them show traces of the stomatal bands, always difficult to make out in material of this sort, others show suggestions of a midrib. It is believed, however, that this appearance is due to a slight keel developed in the basal part of the leaves, or to the method of preservation, for some of the leaves show longitudinal striations which would be explained in the same manner.

Occurrence.—Lower division of the Eutaw formation, McBrides Ford, Chattahoochee County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Class ANGIOSPERMÆ.

Subclass MONOCOTYLEDONÆ.

Genus DORYANTHITES gen. nov.

DORYANTHITES CRETACEA sp. nov.

Plate XVII, figure 3.

Description.—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 appears 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 at Rockfish Creek, N. C., and were subsequently found 92 miles above Newbern, N. C., on Neuse River, both of which localities are in the Black Creek formation, and it is from the North Carolina specimens that the stomatal characters are described. Recently this same form was discovered in considerable abundance in the lower part of the Eutaw near Havana, Ala., and they are the most abundant fossils at the Georgia locality near Buena Vista.

Referring to the similarly appearing remains previously described it may be noted that Miquel [1] in 1853 described under the heading *Phyllitæ monocotylei* two sorts of parallel-veined leaf fragments from the Upper Cretaceous of Aachen. The first [2] he calls Yuccites? and the second, which suggests the fossils under discussion, he designates "Palma vel Yuccites?"

From the Valanginian of Portugal Heer [3] describes what he calls *Bambusium latifolium*, which is also suggestive of the American material.

Krasser [4] describes remains somewhat similar in appearance from the Cretaceous (Cenomanian) of Moravia as *Typhæloipum 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 Eolirion by Schenk,[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 Georgia material to Yuccites, for though they are similar to the more ancient remains so named, it is entirely improbable that they are congeneric with the Triassic type on which this genus was founded and such an identification would consequently be very misleading. Until the existing tropical Monocotyledonæ 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.

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[1] Verh. Geol. kaart. Nederl., vol. 1, 1853, pp. 33–56, Pls. I–VII.
[2] Idem, Pl. I, fig. 3.
[3] Contributions à la flore fossile du Portugal, 1881, p. 22, Pl. XIX, figs. 1–3.
[4] Beiträge zur Kenntniss der fossilen Kreideflora von Kunstadt: Beitr. Pal. u. Geol. Oester.-Ungarns, vol. 10. 1896, p. 127 (15), Pl. XII (II), fig. 4.
[5] Palæontographica, vol. 19, 1869, p. 20.
[6] Schimper, W. P., and Mougeot, A., Monographie des plantes fossiles du grès bigarré de la chaîne des Vosges, 1844, p. 42.
[7] Velenovsky, J., Die Gymnospermen böhmischen Kreideformation, pt. 4, 1885, p. 1.

Occurrence.—Cusseta sand member of the Ripley formation, near Buena Vista, Marion County. (Collected by L. W. Stephenson.)

Collections.—U. S. National Museum.

Genus **PHRAGMITES** Trinius.

PHRAGMITES PRATTII Berry.

This species is described in the section of this report dealing with the Upper Cretaceous flora of South Carolina (p. 28).

Occurrence.—Lower division of the Eutaw formation, Broken Arrow Bend, Chattahoochee County. (Collected by E. W. Berry.)

Collection.—U. S. National Museum.

Subclass **DICOTYLEDONÆ**.

Order **JUGLANDALES**.

Family **JUGLANDACEÆ**.

Genus **JUGLANS** Linné.

JUGLANS ARCTICA Heer?

This form is described in the section of this report dealing with the Upper Cretaceous flora of South Carolina (p. 30). Its Georgia occurrence, which is the most southerly known, is based on a fragment which, as far as it goes, is characteristic and indicates the remarkable range of this species from 32° to 70° north latitude.

Occurrence.—Lower division of the Eutaw formation, McBrides Ford, Chattahoochee County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Order **SALICALES**.

Family **SALICACEÆ**.

Genus **SALIX** Linné.

SALIX FLEXUOSA Newberry.

This form is described in the section of this report dealing with the Upper Cretaceous flora of South Carolina (pp. 32–33). In Georgia, though not especially abundant, characteristic leaves of this species are found from the base to the top of the Eutaw deposits which underlie the Tombigbee sand member.

Occurrence.—Lower division of the Eutaw formation, McBrides Ford, Chimney Bluff, Broken Arrow Bend, Chattahoochee County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

SALIX LESQUEREUXII Berry.

This species is described in the section of this report dealing with the Upper Cretaceous flora of South Carolina (p. 33). The Georgia remains were obtained near the top of the lower division of the Eutaw formation at Chimney Bluff on Chattahoochee River and are entirely typical.

Occurrence.—Lower division of the Eutaw formation, Chimney Bluff, Chattahoochee County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

SALIX EUTAWENSIS Berry.

Plate XIX, figure 3.

Salix eutawensis Berry, Bull. Torrey Bot. Club, vol. 37, 1910, p. 193, Pl. XXII, figs. 1-11.

Description.—Leaves lanceolate in outline, somewhat falcate in some specimens, variable in size, from 5 to 12 centimeters in length and from 0.5 to 2.3 centimeters in greatest width, which is in the basal half of the leaf. Base lanceolate. Apex gradually narrowed to the attenuate tip. Margin entire for a short distance proximally, above which it is very finely dentate, even in the largest leaves collected. Petiole short and fairly stout. Midrib fairly stout, becoming thin in the apical part of the leaf, inclined to be curved or somewhat flexuous. Secondaries very fine and numerous, branching from the midrib at acute angles and curving upward, becoming in their terminal portions approximately parallel with the margin, sending short curved tertiaries to the marginal teeth and from secondary to secondary.

This species is abundant at the upper Tar River localities but has not been detected at any other localities in the Black Creek formation of North Carolina. It is common in the lower division of the Eutaw formation at Broken Arrow Bend on Chattahoochee River in Georgia, from which place the type material was collected. The Georgia material is more fragmentary than that from North Carolina but withstands drying out much better, the North Carolina material being preserved in a loose carbonaceous sandy clay which furnishes very poor museum specimens.

This typical willow leaf is quite modern in appearance, suggesting the existing *Salix nigra* Marsh, *Salix fluviatilis* Nuttall, or the Mexican *Salix bonplandiana* H. B. K., and is entirely distinct from any Cretaceous willows hitherto described. It approaches *Salix newberryana* Hollick [1] somewhat in general appearance but is much more elongate-lanceolate in outline and ranges to a much smaller size, besides showing other distinctive features. It also resembles certain European Tertiary willows, as, for example, *Salix denticulata, lavateri,* and *varians.* Certain fruits found associated with these leaves in North Carolina are believed to belong to the same species.

Occurrence.—Lower division of the Eutaw formation, Broken Arrow Bend, Chattahoochee County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Order URTICALES.

Family MORACEÆ.

Genus FICUS Linné.

FICUS KRAUSIANA Heer.

Plate XIX, figure 4.

This species is described in the section of this report dealing with the Upper Cretaceous flora of South Carolina (p. 38). The Georgia material is somewhat more slender than the abundant material from South Carolina but agrees well with the type forms.

It is one of the most characteristic post-Raritan and pre-Ripley fossils in the Coastal Plain, the Georgia occurrence carrying it to a point within a few feet of the Tombigbee sand horizon on Chattahoochee River.

Occurrence.—Lower division of the Eutaw formation, Chimney Bluff, Chattahoochee County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

FICUS CRASSIPES (Heer) Heer.

Proteoides crassipes Heer, Flora fossilis arctica, vol. 3, Abth. 2, 1874, p. 110, Pl. XXXI, figs. 6–8a.
Ficus crassipes Heer, idem, vol. 6, Abth. 2, 1882, p. 70, Pls. XVII, fig. 9a, and XXIV, figs. 1, 2.
Ficus crassipes Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 79, Pl. XIII, fig. 3.
Ficus crassipes Berry, Bull. Torrey Bot. Club, vol. 33, 1906, p. 172.

Description.—The following description was written by Heer in 1882:

F. foliis coriaceis, lineari-lanceolatis, basi cuneatim attenuatis, integerrimis, nervo medio crasso, nervis secondariis obsoletis, petiolo longo-valido.

The leaves of this species as they occur in the southern Coastal Plain are narrowly lanceolate with gradually narrowed apex and base, about 15 centimeters in length by 2.5 centimeters in

[1] Hollick, Arthur, in Newberry, J. S., The flora of Amboy clay: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 68, Pl. XIV, figs. 2–7.

greatest width, and resemble *Ficus atavina* Heer in outline but are relatively narrower. The texture is coriaceous and the midrib and petiole are extraordinarily stout in many specimens. The secondary venation when seen is of the usual camptodrome type with relatively long, ascending, curved secondaries.

This species was described originally from the Atane beds of western Greenland, the first rather fragmentary specimens collected having suggested the genus Proteoides. It was subsequently recorded from the Dakota sandstone of Kansas by Lesquereux. In the Atlantic Coastal Plain it is found in the Magothy and Black Creek formations, including the Middendorf member of the latter, and it is especially common in clays of the Tuscaloosa formation of Alabama.

Occurrence.—Lower division of the Eutaw formation, Chimney Bluff, Chattahoochee County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Ficus georgiana sp. nov.

Plate XX, figure 1.

Description.—Leaf ovate-lanceolate in outline, gradually tapering to an acute point. Proximately the leaf is broadly and abruptly rounded to a point within 2 to 3 millimeters of the midrib, thence decurring as a narrow wing 1 millimeter or less in width and preserved for a distance of 1 centimeter. Length, about 17 centimeters. Greatest width, which is near the base of the leaf, 4.5 centimeters. Midrib fairly stout. Margin entire. Secondaries thin, parallel, and numerous, branching from the midrib at angles of about 50° and curving upward distally, camptodrome.

This species suggests *Ficus beckwithii* Lesquereux of the Dakota sandstone and *Ficus krausiana* Heer, which is abundant in the Upper Cretaceous of America from Marthas Vineyard to Alabama and which occurs also in the Dakota sandstone and at the type locality in the Cenomanian of Europe, Moletein, Moravia. The Georgia plant is perfectly distinct from these species, however, the most conspicuous difference being its broadly rounded base.

Occurrence.—Cusseta sand member of the Ripley formation, near Buena Vista, Marion County. (Collected by L. W. Stephenson.)

Collections.—U. S. National Museum.

Ficus ovatifolia Berry.

Plate XIX, figures 5–7.

Ficus ovata Newberry, The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 70, Pl. XXIV, figs. 1–3 (non Don, 1802–3).

Ficus ovatifolia Berry, Bull. Torrey Bot. Club, vol. 36, 1909, p. 253.

Description.—Leaves ovate in outline, extended above into a narrow, usually pointed apex. Length 8 to 12 centimeters. Greatest width, which is in the basal part of the leaf, 4 to 7 centimeters. Base broadly rounded and in many specimens slightly decurrent. Margins entire. Primaries, three from the base, the midrib somewhat stouter than the lateral primaries. Secondaries camptodrome.

This species is closely allied to the Raritan species *Ficus woolsoni* Newberry,[1] differing primarily in its greater elongation and in the tendency of the former to a cordate outline.

The Georgia Cretaceous furnishes three species of pinnately veined lanceolate fig leaves, the present species alone representing that other important section of Ficus with broader leaves and palmate venation. *Ficus ovatifolia* was described originally from the Raritan formation of New Jersey. It is present in the Black Creek formation of North Carolina and very probably in the Tuscaloosa formation of Alabama. The Georgia representatives are not rare at the McBrides Ford locality. One of them (Pl. XIX, fig. 6) shows an unusual variation in the character of the apex, which in this specimen is diagonally retuse.

Occurrence.—Lower division of the Eutaw formation, McBrides Ford, Chattahoochee County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

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[1] Newberry, J. S., The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 70; Pls. XX, fig. 3; XXIII, figs. 1-6.

Order RANALES.

Family MAGNOLIACEÆ.

Genus MAGNOLIA Linné.

MAGNOLIA BOULAYANA Lesquereux.

Plate XX, figure 5.

Magnolia boulayana Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 202, Pl. LX, fig. 2.
Magnolia glaucoides Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 60, Pl. CLXXV, figs. 1 and 7.
Magnolia glaucoides Smith, On the geology of the Coastal Plain of Alabama, 1894, p. 348.
Magnolia glaucoides Newberry, The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 74, Pl. LVII, figs. 1–4.
Magnolia boulayana Knowlton, Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 3, 1901, p. 318.
Magnolia glaucoides Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 67, Pls. XIX, fig. 6; XX, fig. 6.
Magnolia boulayana Berry, Bull. Torrey Bot. Club, vol. 36, 1909, p. 254.
Magnolia boulayana Berry, idem, vol. 37, 1910, p. 23.

Description.—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 width. Apex usually bluntly rounded, in some specimens acute. Base matching the apex. Petiole fairly stout, 3 to 4 centimeters in length. Midrib fairly stout. Secondaries slender, many 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. Subsequently Newberry described the Raritan remains, which are abundant at the Woodridge, N. J., locality, as a new species, *Magnolia glaucoides*, and it has been kept distinct by Hollick, who recognized, however, its practical identity with the form from the Dakota sandstone. There can be no question but that they belong to the same species, and it seems probable that *Magnolia van-ingeni* described by Hollick [1] should be referred to the same species.

In addition to the localities already mentioned this species is found on Marthas Vineyard and Long Island, also in the Tuscaloosa formation of Alabama, and in the Woodbine sand of Texas. The Georgia occurrence is based upon the admirable specimen figured, and forms a link in the chain which serves to connect the eastern and Dakota sandstone floras through the Gulf area.

Occurrence.—Lower division of the Eutaw formation, McBrides Ford, Chattahoochee County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

MAGNOLIA CAPELLINII Heer.

Plate XX, figure 6.

Magnolia capellinii Heer, Phyllites crétacées du Nebraska, 1866, p. 21, Pl. III, figs. 5 and 6.
Magnolia capellinii Heer, Flora fossilis arctica, vol. 3, Abth. 2, 1874, p. 115, Pl. XXXIII, figs. 1–4.
Magnolia capellinii Heer, idem, vol. 6, Abth. 2, 1882, p. 90, Pls. XXIV, figs. 3–5; XXV, figs. 1–3; and XLV, fig. 1.
Magnolia capellinii Velenovsky, Die Flora der böhmischen Kreideformation, pt. 2, 1883, p. 20, Pl. VII, figs. 8 and 9.
Magnolia capellinii Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 203, Pl. LXVI, fig. 1.
Magnolia capellinii Hollick, Trans. New York Acad. Sci., vol. 12, 1893, p. 234, Pl. VI, fig. 6.
Magnolia capellinii Dawson, Trans. Roy. Soc. Canada, 1st ser., vol. 11, sec. 4, 1894, p. 63, Pls. XI, fig. 49, and XIII, fig. 49a.
Magnolia capellinii Hollick, Bull. Geol. Soc. America, vol. 7, 1895, p. 13.
Magnolia capellinii Hollick, Bull. New York Bot. Garden, vol. 3, 1904, p. 413, Pl. LXXVIII, fig. 3.
Magnolia capellinii Berry, Bull. Torrey Bot. Club, vol. 31, 1904, p. 76, Pl. III, fig. 3.
Magnolia capellinii Berry, Ann. Rept. State Geologist New Jersey for 1905, 1906, p. 138.
Magnolia capellinii Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 63, Pl. XVII, figs. 3 and 4.
Magnolia capellinii Berry, Bull. Torrey Bot. Club, vol. 34, 1907, p. 195, Pl. XII, figs. 4 and 5.

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[1] Bull. Torrey Bot. Club, vol. 21, 1894, p. 61, Pl. CLXXV, fig. 6.

Description.—Heer's original description, written in 1866, is as follows:

M. foliis coriaceis, late ovalibus, integerrimis, nervis secundariis angulo acuto egredientibus, curvatis camptodromis.

These leaves vary considerably in size, averaging about 13 centimeters in length by 7 centimeters in width. Outline broadly ovate, the base and apex generally equally pointed, although a few specimens have a somewhat obtuse apex. The texture is 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 very closely approaches the less narrow and apically extended forms of *Magnolia speciosa* Heer. Ordinarily, however, the latter species may be readily detected by its relatively narrower form with produced apex and decurrent base.

This species was described originally from the Dakota sandstone by Heer and has been detected at a large number of localities of homotaxial age in both the Greenland Cretaceous and in that of the Pacific Coast. In the Atlantic Coastal Plain it characterizes the Magothy formation and is present in the Black Creek formation of North Carolina and the Tuscaloosa formation of Alabama. It was doubtfully recorded from the Raritan formation of New Jersey by Lesquereux in 1878, but it has never been detected in the abundant collections of Raritan plants studied either by Newberry or the writer and is not at present admitted to be a member of the Raritan flora. The Georgia occurrence is based on the specimen figured, a broadly ovate leaf, about 13.5 centimeters in length by 6.5 centimeters in width, of coriaceous texture, which is poorly preserved in the sandy clay at McBrides Ford. It approaches some of the forms of *Magnolia speciosa* in appearance, and perhaps it may be more intimately related to the latter species, which is very abundant in the Tuscaloosa formation. In either case the stratigraphic conclusions which may be drawn from the material are identical.

Occurrence.—Lower division of the Eutaw formation, McBrides Ford, Chattahoochee County. (Collected by E. W. Berry).

Collections.—U. S. National Museum.

Genus **MENISPERMITES** Lesquereux.

MENISPERMITES VARIABILIS sp. nov.

Plate XXI, figures 1–4.

Description.—Leaves of medium size, trilobate, but variable in shape. Length about 9 or 10 centimeters. Greatest width, which is from tip to tip of the laterally directed lobes, as much as 16 centimeters in one specimen. Lobes broad and separated by wide shallow sinuses. Margin entire but in some specimens scalloped, the scallops rounded and nearly equilateral, separated by acute sinuses. Base peltate, broadly rounded as in Aspidiophyllum or with a cordate sinus which does not, however, reach the top of the petiole. Primaries stout, three or four in number, palmately divergent from the peltate base, three of them generally equal in caliber. Secondaries slender and numerous, some apparently camptodrome and others craspedodrome.

This peculiar species was apparently inequilateral and variable in outline, but unfortunately no complete specimens were collected, though the remains are not uncommon. They are markedly distinct from any Cretaceous forms hitherto described and add another curious element to the remarkable assemblage found in the lower division of the Eutaw formation of Georgia, which includes the gigantic specimens of Manihotites and the no less curious Androvettia and Doryanthites.

Occurrence.—Lower division of the Eutaw formation, McBrides Ford, Chattahoochee County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Order EUPHORBIALES.

Family EUPHORBIACEÆ.

Genus MANIHOTITES Berry.

MANIHOTITES GEORGIANA Berry.

Plates XXII, XXIII; and XXIV, figures 4 and 5.

Manihotites georgiana Berry, Bull. Torrey Bot. Club, vol. 37, p. 507, figs. 1 and 2, 1910.

Description.—Leaves of extraordinarily large size, 36 to 48 centimeters across, palmately and deeply lobate, the main lobes dichotomously sublobate. Base missing, probably peltate. Margins entire, more or less undulate. Texture coriaceous. Venation coarse. Five or six stout primaries diverge at acute angles from the top of the petiole and fork dichotomously about 5 or 6 centimeters above their base at angles of 30° to 50°. These branches may again fork dichotomously in a distance of 4 to 6 centimeters, or may not give off any branches, or the branches may be clearly subsidiary in size and run to the apex of a subordinate lobe. There are a sparse number of relatively fine secondaries, which diverge at angles of about 45° or more and are apparently camptodrome. In each of the large specimens a straight vein of secondary size runs directly to the base of a single main sinus. It is possible that this vein diverges along the margin in a vein which forms a marginal hem, as in the sinuses of lobed sassafras leaves, but such a vein can not be made out, although at one point there is such a marginal vein connected with the main venation by straight transverse tertiaries. Deep and narrow but rounded sinuses approach within 3 to 5 centimeters of the base and divide the leaf into five or more major lobes; these are subdivided by more or less deep sinuses of a similar character into inequilateral, ovate lanceolate, obtusely pointed subordinate lobes.

It seems probable from the manner in which the extreme base is torn away in the two nearly complete specimens collected that this base was peltate and comparable to those leaves of the modern Manihot, Podophyllum, Jatropha, and similar forms, which are inequilaterally peltate. There was considerable variability in the lobation, as is clearly shown by these two nearly complete leaves, which were found close together in the small leaf-bearing clay lens at McBrides Ford. It seems decidedly probable that these two leaves were from a single plant, for it is very unlikely that two separate leaves of the same degree of preservation would have found their way out in the Cretaceous sea and have come to rest within a few inches of each other in this very restricted clay lens, which was not over a few feet in diameter and some miles from the Cretaceous shore. One leaf has the margins broadly rounded and each main lobe divided into two nearly equal subordinate lobes; in the other leaf these subordinate lobes are subdivided in a like manner and some of these are again sublobate.

Remains of these curious leaves were first encountered at the plant locality near Buena Vista, where they occur in a very fragmentary state, the most complete specimens being the counterparts figured in Plate XXIV, figures 4 and 5. A very small fragment which is identical with or closely related to these forms had been previously collected from the Black Creek formation along Neuse River in North Carolina but had not been recognized. Though these leaves differ in important particulars, notably in having the primaries arranged palmately and the lamina in the forks of the veins less abbreviated, they are similar to and possibly congeneric with *Fontainea grandifolia*, described by Newberry [1] from the Raritan formation in New Jersey. The incomplete nature of the material upon which this species and genus was based makes any detailed comparisons impossible. In the New Jersey species the entire lamina is cut out in the sinuses for a distance of several centimeters.

In discussing the New Jersey plants Newberry [2] compared them with *Haliserites reichii*, [3] reproducing Sternberg's figure. This plant came from the Cretaceous greensand of Niederschoena, Saxony (Cenomanian), and was discovered by Reich, who named it *Fucoides dicho-*

[1] The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 96, Pl. XLV, figs. 1–4.
[2] Op. cit., p. 96, Pl. XLV, fig. 5.
[3] Sternberg, Flora der Vorwelt, vol. 2, 1833, p. 34, Pl. XXIV, fig. 7.

tomus. Sternberg referred it to Haliserites because of its fancied resemblance to a recent alga, *Haliseris polypodoides* Agardh. Though much smaller than the American species of Fontainea, the Saxon plant is hardly a seaweed, and is closely comparable with the American genus.[1]

A similar form, more nearly the size of Fontainea, is figured by Bronn [2] and retained in Haliserites, although Rossmassler and Cotta referred it to Chiropteris. Schimper[3] refers it to Delesseria, comparing it with the modern *Delesseria ruscifolia* Agardh, as well as with Haliseris, and more recently Rothpletz [4] has recognized its angiospermous affinities and renamed it *Phyllites reichi*. Still another similar plant is one described by Velenovsky from the Cenomanian of Bohemia as *Aralia furcata*[5] and compared with the modern genera Jatropha, Vitex, Cussonia, and like forms. It is hardly an Aralia, and is very similar to the forms previously mentioned.

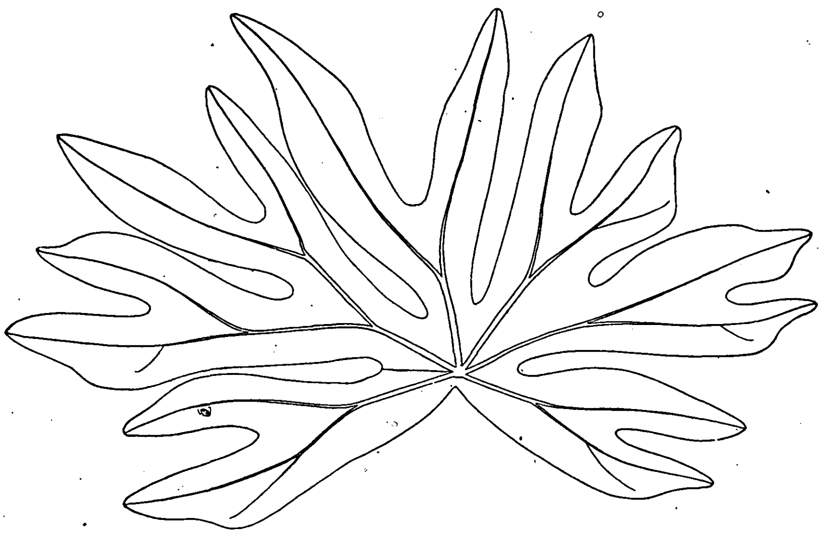

FIGURE 2.—Restoration of the leaf of Manihotites georgiana figured in Plate XXII. (One-eleventh natural size.)

It might be added that Newberry compared his fossils with the leguminous genera Hymenæa and Bauhinia and regarded the genus Sapindopsis from the Lower Cretaceous of Maryland and Virginia as related to the Raritan plant. These are, however, entirely distinct and unrelated.

A number of modern genera have leaves more or less suggestive of this Upper Cretaceous species, for example, Podophyllum, Jatropha, Cecropia, and various tropical Araliaceæ. The fossils have been carefully compared with these and with a number of other modern genera. They are closest, however, to certain modern species of Manihot, and it is believed that the remarkably variable leaves of the latter furnish a satisfactory clue to the relationship of this Cretaceous form, for no other comparable modern genus shows similar wavy margins and inequilateral rounded lobes. The venation is also very similar. Figures 2 and 3 show reduced restorations of the fossil leaves figured on Plates XXII and XXIII.

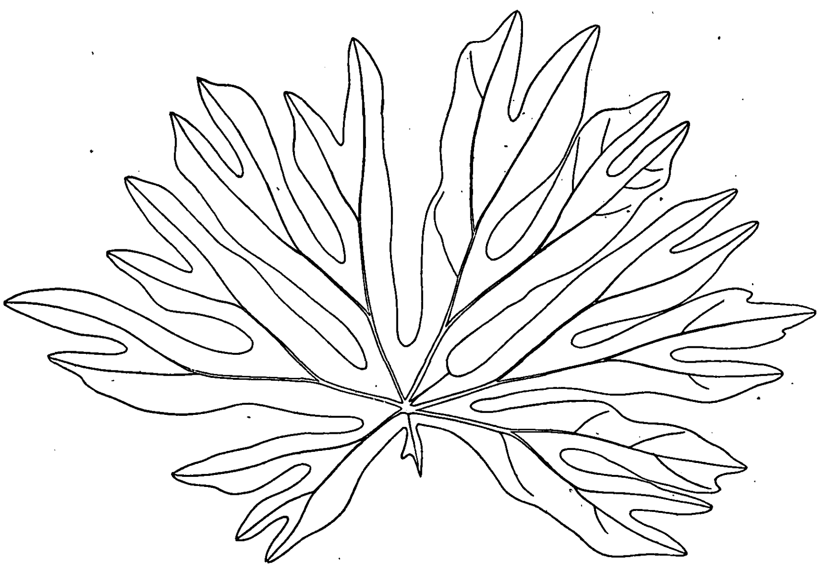

FIGURE 3.—Restoration of the leaf of Manihotites georgiana figured in Plate XXIII. (One-fifteenth natural size.)

[1] Rothpletz in 1896 recognized the dicotyledonous nature of this species and renamed it *Phyllites reichi*. (Zeitschr. Deutsch. geol. Gesell., vol. 48, p. 904.)
[2] Lethæa geognostica, Pl. XXVIII, fig. 1.
[3] Paléontologie végétale, vol. 1, 1869, p. 178.
[4] Zeitschr. Deutsch. geol. Gesell., vol. 48, 1896, p. 904.
[5] Die Flora der böhmischen Kreideformation, pt. 3, 1884, p. 13, Pl. IV, fig. 1 (*Aralia elegans*).

The modern species of Manihot Adanson number between 80 and 100 and are nearly all endemic in tropical South America, the great majority occurring in Brazil, which has more than 70 species. There are one or two species in Argentina, and the remaining species occur in Peru and Guiana and northward through Central America into Mexico. According to Tracy [1] the various cultivated varieties of Manihot (cassava), though natives of the Tropics, can be grown where the growing season lasts 10 or 11 months, as in parts of the Gulf States. Light frost, however, and even continued cool weather entirely stop growth. Even in the Tropics the best growth is made in coastal regions, so that if the present fossil species is assumed to have required a similar habitat it would serve to corroborate the ecologic evidence furnished by the other members of the Georgia Upper Cretaceous flora.

Occurrence.—Lower division of the Eutaw formation, McBrides Ford, Chattahoochee County. (Collected by E. W. Berry.)

Collection.—U. S. National Museum.

Order RHAMNALES.

Family RHAMNACEÆ.

Genus PALIURUS Linné.

PALIURUS UPATOIENSIS sp. nov.

Plate XXI, figures 5 and 6.

Description.—Leaves small, obovate, 3 to 4 centimeters in length by 1.3 to 1.6 centimeters in greatest width, which is about halfway between the apex and the base. Apex broadly and evenly rounded. Base narrowly decurrent. Margin entire. Primaries three in number from the extreme base, about equal in caliber, acrodrome. Secondaries not made out. Texture rather coriaceous.

This species is clearly distinct from any previously described Cretaceous forms, although it resembles somewhat *Paliurus obovatus* Lesquereux, of the Dakota sandstone of the West and *Paliurus populifolius* Berry of the Magothy formation of New Jersey. In outline these leaves are not unlike some of the less orbicular leaves of Pistia found in the Black Creek formation of North Carolina, but the venation is of a different character and the broad sheathing base found in Pistia is wanting.

Occurrence.—Lower division of the Eutaw formation, McBrides Ford, Chattahoochee County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Genus ZIZYPHUS Linné.

ZIZYPHUS LAURIFOLIUS sp. nov.

Plate XXI, figure 7.

Description.—Leaves lanceolate, 9 to 10 centimeters in length by about 2 centimeters in greatest width, about equally pointed at the apex and the base. Margin entire. Primaries three in number from the extreme base, the midrib being the stoutest. Secondaries for the most part not seen, though a few, acutely branching and camptodrome, from the outside of the lateral primaries can be made out.

This species is entirely distinct from any heretofore described from the Cretaceous, although it resembles somewhat *Zizyphus cliffwoodensis* Berry from the Magothy formation of New Jersey.

Occurrence.—Lower division of the Eutaw formation, McBrides Ford, Chattahoochee County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

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[1] Tracy, F. M., Farmers' Bull. No. 167, U. S. Dept. Agr., 1903.

Order THYMELEALES.

Family LAURACEÆ.

Genus CINNAMOMUM Blume.

CINNAMOMUM NEWBERRYI nom. nov.

Plate XXI, figures 9–11.

Cinnamomum sezannense Heer, Flora fossilis arctica, vol. 6, Abth. 2, 1882, p. 77, Pls. XIX, fig. 8, and XXXIII, figs. 11 and 12 (non Watelet).
Cinnamomum sezannense Heer, idem, vol. 7, 1883, p. 30, Pl. LXI, fig. 1a (non Watelet).
Cinnamomum sezannense Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 107, Pl. XII, fig. 7 (non fig. 6, which is a leaf of *Cinnamomum membranaceum* (Lesquereux) Hollick).
Cinnamomum sezannense Dawson, Trans. Roy. Soc. Canada, 1st ser., vol. 11, sec. 4, 1894, p. 64, Pl. XIII, fig. 58 (non Watelet).
Cinnamomum sezannense Hollick, Bull. Torrey Bot. Club, vol. 21, 1894, p. 53, Pl. CLXXX, figs. 5 and 7 (non Watelet).
Cinnamomum intermedium Smith, On the geology of the Coastal Plain of Alabama, 1894, p. 348 (nomen nudum).
Cinnamomum intermedium Newberry, The flora of the Amboy clays: Mon. U. S. Geol. Survey, vol. 26, 1896, p. 89, Pl. XXIX, figs. 1–8 and 10 (non Ettingshausen).
Cinnamomum sezannense Penhallow, Trans. Roy. Soc. Canada, 2d ser., vol. 8, sec. 4, 1902, p. 46 (non Watelet).
Cinnamomum sezannense Hollick, Fifty-fifth Ann. Rept. N. Y. State Mus. for 1901, 1903, p. r50.
Cinnamomum intermedium Berry, Rept. State Geologist, New Jersey, for 1905, 1906, p. 139, Pl. XX, figs. 2–6 (non Ettingshausen).
Cinnamomum intermedium Berry, Bull. Torrey Bot. Club, vol. 33, 1906, p. 179, Pl. VII, figs. 3 and 4 (non Ettingshausen).
Cinnamomum intermedium Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 74, Pls. XXIX, fig. 7, and XXX, figs. 1 and 2 (non Ettingshausen).
Cinnamomum intermedium Berry, Bull. Torrey Bot. Club, vol. 37, 1910, p. 27 (non Ettingshausen).

Description.—The name of this important American Cretaceous species is unfortunately preoccupied, as it was used in 1887, nine years before Newberry's work appeared, by the late Baron Ettingshausen [1] for an early Tertiary species from New Zealand. A new name is therefore necessary, and the writer feels that none can be more appropriate than one which honors the memory of one of America's pioneer paleobotanists.

Leaves subcoriaceous, lanceolate to ovate-lanceolate in outline, varying 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 Georgia material is not uncommon, but is for the most part extremely fragmentary. The single complete leaf is of the short type like that shown in Newberry's figure 10,[1] or like the leaves from the Arctic and from the Dakota sandstone which have usually been referred to *Cinnamomum sezannense* Watelet. That they are not in the slightest degree related to this European basal Eocene type may be readily seen by a comparison of the American Cretaceous material with the figures of the true *Cinnamomum sezannense* as given by Watelet, Saporta, and others.[2]

The present species, as here revised according to the foregoing citations, has a remarkable range in the earlier half of the Upper Cretaceous. The Raritan formation of New Jersey 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 member of the Black Creek of South Carolina, in the Tuscaloosa formation of Alabama, where it is especially abundant at certain localities, 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 [3] from the Woodbine sand in

[1] Denkschr. K. Akad. Wiss. Wien, Math.-nat. Kl., vol. 53, 1887, p. 166, Pl. IV, figs. 20–22.
[2] Watelet, A., Description des plantes fossiles bassin de Paris, 1866, Pl. L, fig. 2. Saporta, G. de, Flore fossile de Sézanne, 1865, Pl. VIII, fig. 5; Végétation à l'époque des marnes heersiennes de Gelinden, 1873, Pl. VI, figs. 5, 6; Revision de la flore heersienne de Gelinden, 1878, Pl. IX, figs. 2–6. Friedrich, P. A., Beiträge zur Kenntniss der Tertiärflora der Provinz Sachsen, 1883, Pl. I, fig. 5.
[3] Hill, R. T., Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 7, 1901, p. 317.

Cooke County, Tex. Although not known from Europe the forms from the Cenomanian of Bohemia which Velenovsky describes as *Aralia daphnophyllum* [1] are very similar to this American species.

Occurrence.—Lower division of the Eutaw formation, McBrides Ford, Chattahoochee County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Cinnamomum heerii Lesquereux?

Plate XXI, figure 8.

Cinnamomum heerii Lesquereux, Am. Jour. Sci., 2d ser., vol. 27, 1859, p. 361.
Cinnamomum heerii Lesquereux, Trans. Am. Philos. Soc., vol. 13, 1869, p. 431, Pl. XXIII, fig. 12.
Cinnamomum heerii Lesquereux, The Cretaceous flora, 1874, p. 84, Pl. XXVIII, fig. 11.
Daphnogene heerii Lesquereux, Ann. Rept. U. S. Geol. and Geog. Survey Terr. for 1874, 1876, p. 343.
Cinnamomum heerii Lesquereux, The Cretaceous and Tertiary floras, 1883, p. 54.
Cinnamomum heerii Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 105, Pl. XV, fig. 1.
Cinnamomum heerii Newberry, The later extinct floras of North America: Mon. U. S. Geol. Survey, vol. 35, 1898, p. 100, Pl. XVII, figs. 1–3.
Cinnamomum heerii Knowlton, in Hill, Twenty-first Ann. Rept. U. S. Geol. Survey, pt. 7, 1901, p. 318, Pl. XXXIX, fig. 5.
Cinnamomum heerii Kurtz, Revista Mus. La Plata, vol. 10, 1902, p. 52.
Cinnamomum heerii Berry, Ann. Rept. State Geologist New Jersey for 1905, 1906, p. 139.
Cinnamomum heerii Berry, Bull. Torrey Bot. Club, vol. 33, 1906, p. 179.
Cinnamomum heerii Berry, idem, vol. 34, 1907, p. 200, Pl. XIII, figs. 2 and 3.
Cinnamomum heerii Hollick, The Cretaceous flora of southern New York and New England: Mon. U. S. Geol. Survey, vol. 50, 1907, p. 75, Pl. XXX, figs. 5 and 6.

Description.—Leaves coriaceous, entire, ovate in outline, more or less attenuated apically. Base broadly rounded. Primaries three, stout, suprabasilar. Secondaries camptodrome.

The exact status of this species is made out with difficulty. In typical specimens it is clearly distinct from *Cinnamomum Newberryi* Berry in its more regular outline and venation, broader form, more rounded base, and stouter suprabasilar primaries. Other remains have been referred to *Cinnamomum heerii* which are not typical in some of these distinctive characters, and the well-known variation of the leaves of Cinnamomum renders a satisfactory solution of the problem difficult. This species was doubtfully recorded from the Raritan formation by Lesquereux in 1878, but it has not been detected at this horizon either by Newberry or by the writer and is not admitted as a member of the Raritan flora. It does, however, characterize the somewhat younger beds represented in the west by the Dakota sandstone and the Woodbine sand and in the Coastal Plain by the Magothy formation of the north and the Black Creek and Tuscaloosa formations of the south. In the Georgia area it is represented by fragments showing the coriaceous texture, broad base, and suprabasilar primaries of the species. It occurs at McBrides Ford.

Occurrence.—Lower division of the Eutaw formation, McBrides Ford, Chattahoochee County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Genus MALAPOENNA Adanson.

Malapoenna horrellensis Berry.

Malapeonna horrellensis Berry, Bull. Torrey Bot. Club, vol. 37, 1910, p. 198, Pl. XXIV, figs. 1–9.

Description.—The following description is given in the work cited above:

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, as 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 four to six 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

[1] Velenovsky, J., Die Flora der böhmischen Kreideformation, pt. 1, 1882, p. 23, Pls. V, figs. 5–8, 10; VI, figs. 1–5.

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 fairly 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 may possibly be confused with *Cinnamomum heerii* when only the basal part of the leaf is found, but the general proportions and characters of the whole leaf are perfectly distinct.

It is common at several localities in the upper beds of the Black Creek formation in North Carolina and is represented in the collections from the Eutaw formation of Alabama by several forms as yet unstudied. The Georgia occurrence is based on fragmentary material from Broken Arrow Bend on Chattahoochee River.

The genus Malapoenna has more than one hundred existing species, chiefly of the Oriental tropics, and is well represented in the fossil state from the Dakota and Magothy formations upward. It is especially well represented in the Paleocene of Europe and in the Shoshone group of America. Of the two species in the Dakota sandstone of the West, one occurs in the Tuscaloosa formation at Cottondale, Ala., and the other in the Magothy formation of New Jersey.

Occurrence.—Lower division of the Eutaw formation, Broken Arrow Bend, Chattahoochee County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Order **UMBELLALES.**

Family **ARALIACEÆ.**

Genus **ARALIA** Linné.

ARALIA EUTAWENSIS sp. nov.

Plate XX, figure 7.

Description.—Leaves relatively small in size, palmately quinquelobate. Length about 8 centimeters. Greatest width 8 to 9 centimeters across the basal lobes, which are directed laterally; the other three lobes are directed upward. Margin entire. Lobes obtusely pointed, inclined to be parallel sided, divided not quite halfway to the base, the upper two sinuses narrow, the lateral sinuses more open and obtusely rounded. Base slightly decurrent. Primaries five in number, diverging from the base or just above it, equal in caliber, and slightly flexuous in their course. Secondaries not made out.

This species greatly resembles the leaves from the Magothy formation of New Jersey and from the Black Creek formation of North Carolina, which have been identified with *Aralia newberryi* Berry of the Raritan formation. In fact, a careful study of a considerable series of these forms will probably result in uniting these Magothy and Black Creek forms with the present species as distinct from the Raritan species.

Occurrence.—Lower division of the Eutaw formation, McBrides Ford, Chattahoochee County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

Order **MYRTALES.**

Family **MYRTACEÆ.**

Genus **EUCALYPTUS** L'Héritier.

EUCALYPTUS ANGUSTA Velenovsky.

Plate XX, figures 2–4.

This species is described in the section of the report dealing with the Upper Cretaceous flora of South Carolina (pp. 55–56). The Georgia occurrences include well-marked remains from

Buena Vista, which are here figured, and more fragmentary but entirely typical material from McBrides Ford.

Occurrence.—Lower division of the Eutaw formation, McBrides Ford, Chattahoochee County. (Collected by E. W. Berry.) Cusseta sand member of the Ripley formation, Buena Vista, Marion County. (Collected by L. W. Stephenson.)

Collections.—U. S. National Museum.

Order **ERICALES**.

Family **ERICACEÆ**.

Genus **ANDROMEDA** Linné.

ANDROMEDA NOVÆCÆSAREÆ Hollick.

Plate XXIV, figure 1.

This species is described in the section of this report dealing with the Upper Cretaceous flora of South Carolina (pp. 58–59). It was one of the few species whose leaves successfully resisted maceration in the shallow shoreward deposits known as the Cusseta sand member of the Ripley formation of Georgia. It occurs at Buena Vista in association with *Araucaria bladenensis*.

Occurrence.—Cusseta sand member of the Ripley formation, Buena Vista, Marion County. (Collected by L. W. Stephenson.)

Collections.—U. S. National Museum.

ANDROMEDA CRETACEA Lesquereux?

Plate XXIV, figure 2.

Andromeda cretacea Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 117, Pls. XVII, figs. 17 and 18, and XXIV, fig. 5.

Description.—Leaf small, thin, lanceolate, acuminate, with a thin midrib. Length about 3.5 centimeters. Greatest width about 7.5 millimeters, about halfway between the apex and the base. Secondaries not seen in the Georgia material. In the type material from Kansas they are parallel, nearly equidistant, much curved near the margins, camptodrome.

This species was based upon rather fragmentary material from the Dakota sandstone of Ellsworth County, Kans., and the Georgia material, which is referred with some hesitation to this species, is about as poor as the type material. It has not heretofore been collected outside the type locality, although similar forms which are probably of this species are present in the writer's collections from the Tuscaloosa formation of western Alabama.

Occurrence.—Lower division of the Eutaw formation, McBrides Ford, Chattahoochee County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

ANDROMEDA WARDIANA Lesquereux.

Plate XXIV, figure 3.

Andromeda wardiana Lesquereux, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 119, Pl. LXIV, fig. 17.

Description.—Leaf elliptical in outline, entire. Apex and base equally narrowed but the apex bluntly rounded. Length 5.3 centimeters. Greatest width, which is halfway between the apex and the base, 2.3 centimeters. Midrib thin. Secondaries not made out. In the type they are thin, diverging at an angle of about 40° and camptodrome.

The type material came from the Dakota sandstone of Ellsworth County, Kans. The Georgia material shows a leaf which is a trifle larger but which in its general proportions and outline is identical with the western form, and there can be no doubt of their identity.

It is quite possible, in fact probable, that this species is not distinct from *Andromeda tenuinervis* Lesquereux,[1] which, if the form referred to it by Hollick[2] is correctly identified, approaches it closely in size. The two differ somewhat in texture and in the degree of acuteness of the apex, but whether these features are of specific value or not is an open question.

Occurrence.—Lower division of the Eutaw formation, McBrides Ford, Chattahoochee County. (Collected by E. W. Berry.)

Collections.—U. S. National Museum.

BOTANIC CHARACTER OF THE FLORA.

The Cretaceous flora of Georgia as disclosed by the collections studied is relatively small, embracing only 32 determinable species. That it presents but a meager picture of the actual plant covering of the adjacent land is obvious in many ways. It need only be contrasted with the abundant floras of near-by more or less homotaxial deposits, such as the Tuscaloosa formation of northwestern Alabama or the Middendorf arkose member of the Black Creek formation to the northeast in South Carolina, to emphasize the disparity in the number of specific forms. This is believed to be due not to any relative paucity in the contemporaneous vegetation of the Cretaceous Piedmont area of Georgia, but to the character of the sediments and the opportunities they afforded for preservation of leaf remains. All the Upper Cretaceous deposits of Georgia are marine in character, and though some, like the Cusseta and Providence sand members of the Ripley formation, were evidently deposited in shallow water near shore, current or wave action seems to have been comparatively violent. Thus the vegetable débris which was floated into the Cretaceous sea was much triturated before entombment or thoroughly oxidized in the loose matrix afterwards. That such débris was present in the water is evident wherever local lenses of clay were laid down in quieter waters. It is from such relatively insignificant lenses that all the flora now available is derived, and the character of these remains, both as to their condition of preservation and with regard to the forms represented, fully substantiates the preceding statements. The areas in which these deposits merged into their estuarine or fluviatile phases, and in which plant fossils were probably better preserved, have been entirely destroyed by subsequent erosion, as might be expected, or else the Cretaceous shore line was an almost continuous sand beach without any of the considerable reentrants which usually play so prominent a part in preserving the records of ancient floras. The most prolific Cretaceous plant locality in Georgia is that at McBrides Ford, near the landward margin of the Eutaw formation, and here the total number of recognizable forms is only 19. (See p. 101.)

Though these are not all forms whose existing representatives belong to the strand flora or to that which flourished in immediate proximity to the coast, it is noticeable that nearly all are forms with coriaceous foliage, like the conifers, of which there are four species, and like the species of Andromeda, Ficus, Eucalyptus, and Magnolia. Furthermore the types represented which may be regarded as inland forms are species that probably inhabited stream bottoms. These are not abundant in individuals and are usually much macerated and broken.

The next locality in point of abundance of forms is that at Chimney Bluff, where small lenses of clay at the top of the Eutaw formation, comparable in size with those at the preceding locality near the base of the formation, have yielded seven species, three of which are conifers, two willows, and two coriaceous fig leaves. The six species recorded from near Buena Vista, the five species from Broken Arrow Bend, and the three species from the locality near Byron are also of these types. This kind of a flora, which might perhaps be termed unrepresentative, renders exact correlations difficult and makes satisfactory comparisons possible only with such floras as those preserved in the typically marine beds of the Black Creek formation of the Carolinas or with the upper Tuscaloosa and Eutaw floras of Alabama. In the absence of later records in this area it is impossible to surmise, for example, how many of the elements found in the lower Tuscaloosa of Alabama survived as late as the Cusseta sand member of the Ripley

[1] Lesquereux, Leo, Mon. U. S. Geol. Survey, vol. 17, 1892, p. 116, Pl. XXXVIII, fig. 7.
[2] Hollick, Arthur, Mon. U. S. Geol. Survey, vol. 50, 1906, p. 102, Pl. XXXIX, fig. 7.

formation and how many had become extinct. The uniformity of the Eastern Cretaceous floras from the Magothy of New Jersey to the Tuscaloosa of Alabama, over a distance of 900 miles or more in a northeast-southwest direction, indicates strongly that many of these types were present in the Georgia flora, for the small representation of plants found in the overlying middle division of the Ripley formation is entirely different in character. This condition is similar to that exhibited by the differences of certain western interior floras, such as those of the Colorado and Montana groups.

As previously mentioned, the Georgia Cretaceous flora numbers 32 species, distributed among 16 families in 14 orders. A single fern, a species of Dryopterites of the family Polypodiaceæ, is recorded from one locality. Its modern representatives are so varied, numerous, and widespread that it furnishes no satisfactory data for climatic or other physical speculations. The conifers are represented by 7 species, the majority apparently belonging to the subfamily Araucarieæ, although the relatively primitive Taxaceæ are represented by a species of Tumion. The Monocotyledonæ are represented by two forms of little significance, although one appears to be most closely allied with certain modern tropical forms. The Dicotyledonæ number 22, and include in addition to the remarkable genus Manihotites a scattering of forms. There are four species of Ficus, three of which have coriaceous lanceolate leaves, and three species of willow, probably, like the modern willows, mesophytic river-bank types. There are three species of Andromeda which doubtless owe their preservation to their small coriaceous leaves, and two species each of Magnolia and Cinnamomum. The genera Juglans, Menispermites, Paliurus, Zizyphus, Malapoenna, Aralia, and Eucalyptus are each represented by a single species, those species belonging to Menispermites, Paliurus, and Zizyphus being new to science.

As the botanical facies shown by this flora is due largely to the resistant character of the foliage preserved, combined with what are usually termed the accidents of preservation, little is to be gained by any comment on the relative abundance of some types or the absence of others.

PHYSICAL CONDITIONS INDICATED BY THE FLORA.

The physical conditions that bore upon the Upper Cretaceous flora of Georgia were probably substantially the same as those already described as existing in South Carolina. (See pp. 67–68.)

The climate was probably mild and without frost, the humidity was high, and the rainfall was abundant and probably distributed somewhat uniformly throughout the year.

RANGE OF THE MESOZOIC FLORA.

To illustrate some of the features of Mesozoic plant distribution and the relative and apparently progressive restriction in range which has taken place in comparatively recent times, the writer has introduced the accompanying sketch maps (figs. 4–8), which show in a generalized way the range in the existing flora of the genera Cinnamomum, Eucalyptus, Araucaria, and Tumion. When the known occurrences of these genera during the Cretaceous are plotted on maps of the world several very important and interesting features are brought out, and additional data derived from other forms, such as the Magnoliaceæ, Proteaceæ, and Actinostrobeæ are entirely in accord with the conclusions reached in this way.

In a general way there has been a restriction of a number of these Mesozoic types or their descendants to the Southern Hemisphere, where they have become isolated in one or in both of the continental land masses which project southward from the almost circumpolar land mass of the Northern Hemisphere. That this restriction is more in the nature of a segregation by the extinction of intermediate links in the chain of distribution rather than an actual migration away from hostile or toward optimum conditions for growth and reproduction is well shown by the cosmopolitanism of most fossil floras, particularly those of the Mesozoic. The present distribution of Tumion, Taxodium, Sequoia, Sassafras, and Liriodendron is corroborative of this generalization, for the isolation, by extinction, of these genera and of many others that might be mentioned, has left their modern representatives in favorable areas, not in the

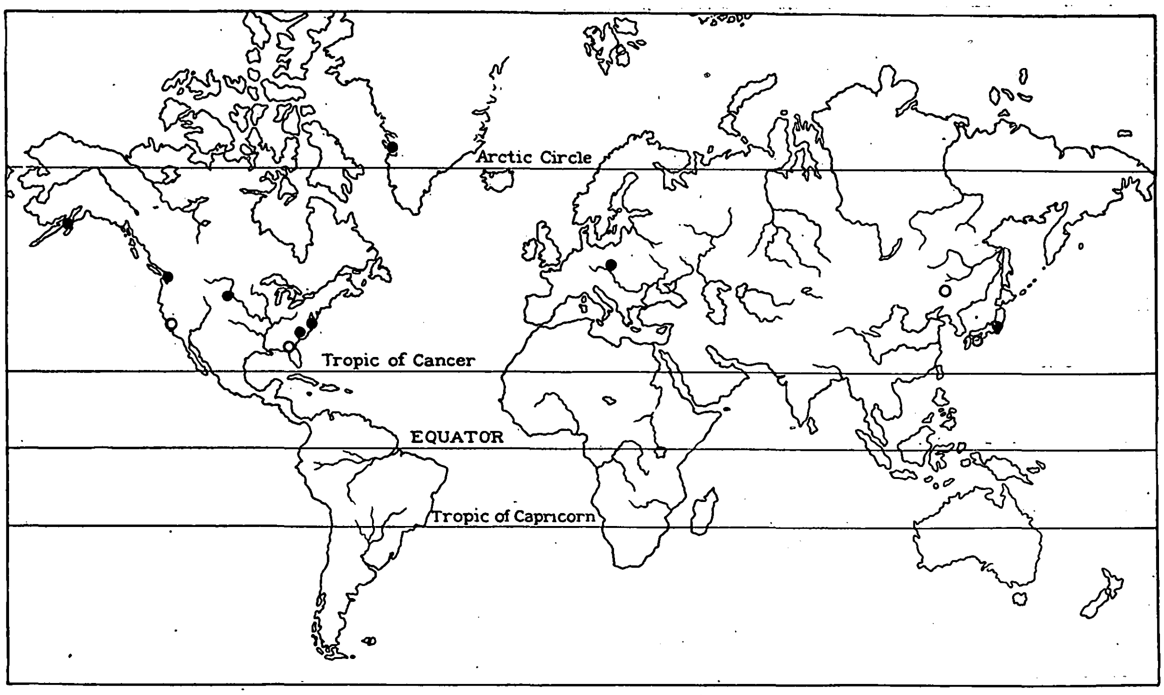

FIGURE 4.—Sketch map showing the Cretaceous (●) and Recent (O) distribution of Tumion.

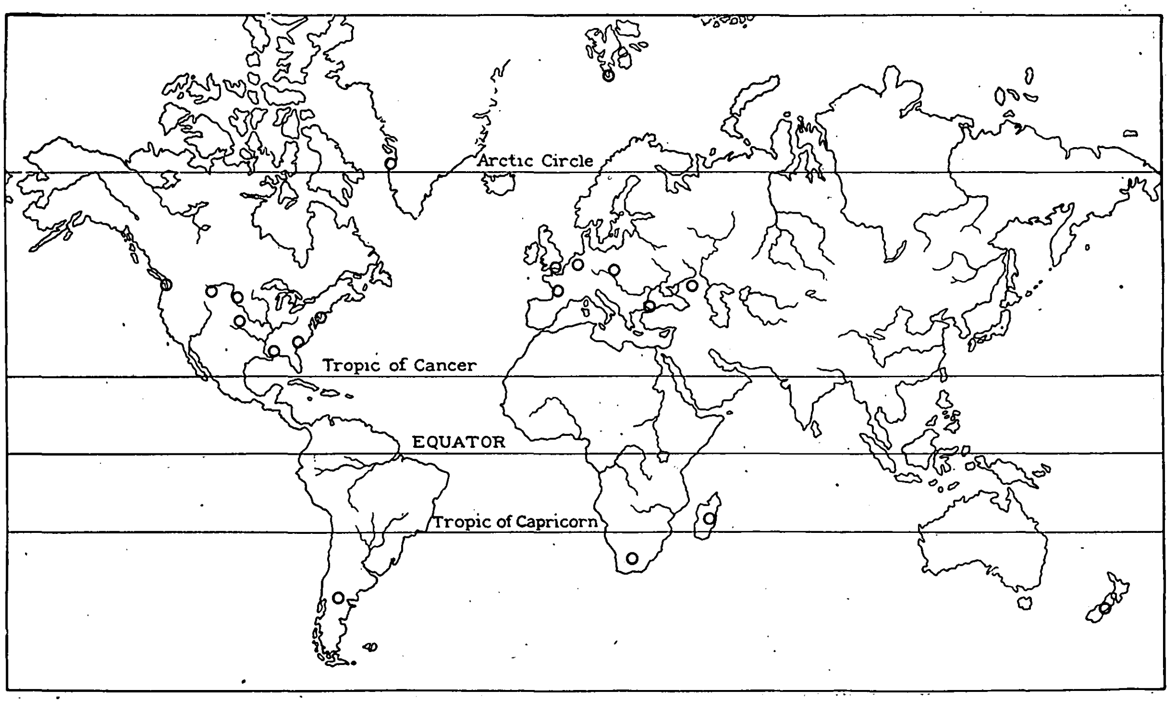

FIGURE 5.—Sketch map showing the Cretaceous occurrences of the Araucarieæ.

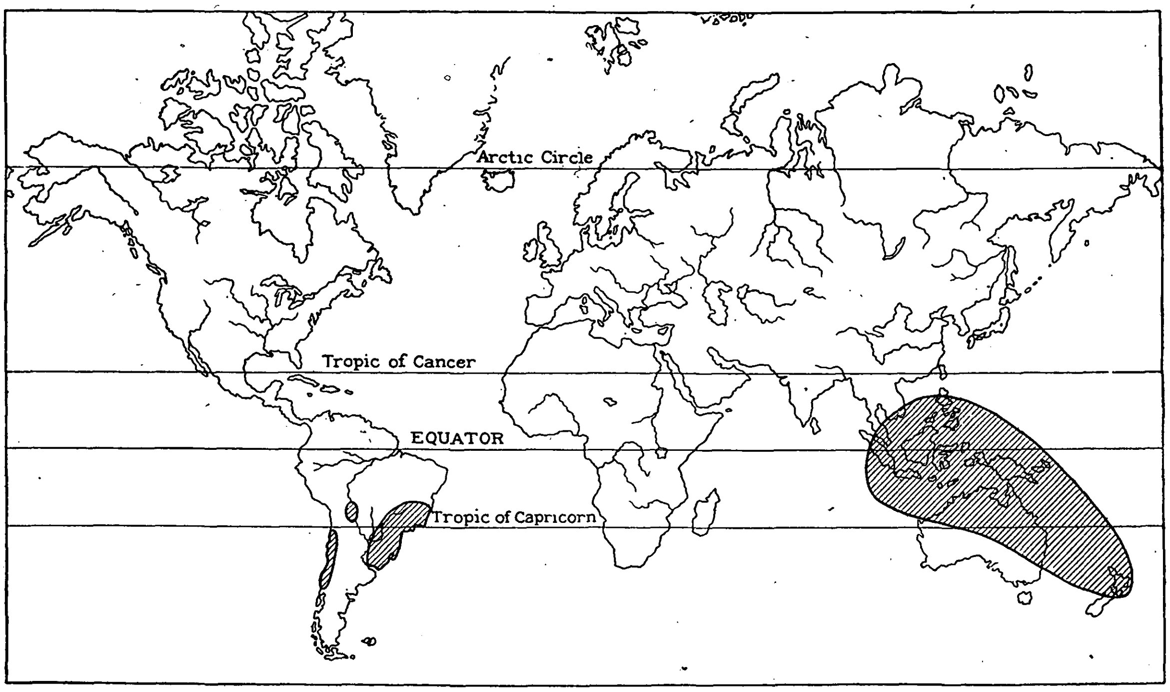

FIGURE 6.—Sketch map showing the existing distribution of the Araucarieæ.

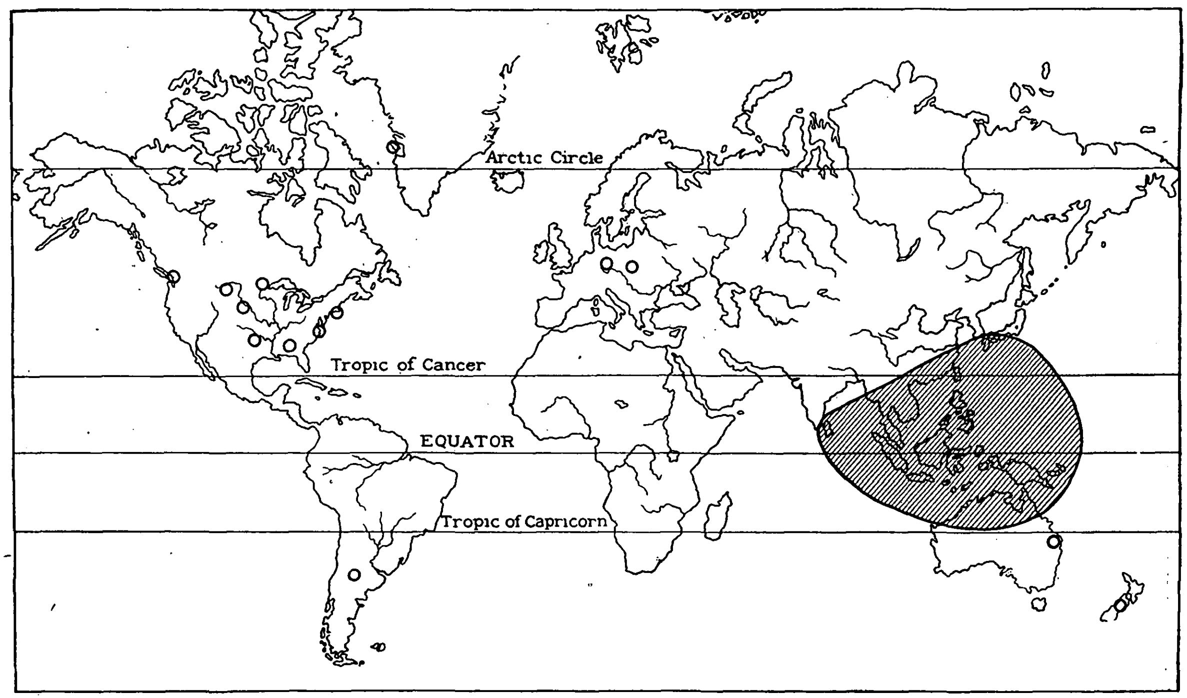

FIGURE 7.—Sketch map showing the Cretaceous (O) and Recent (shaded) distribution of Cinnamomum. The Recent limits should have been extended to include India.

southern continents, but north of the equator. Tumion, for example, has one species at a single locality in Florida, another in California, and two or three others in China and Japan. The once cosmopolitan Taxodium has a single eastern American species at the present day and a climatically stranded form in Mexico. Sequoia, once of world-wide distribution has the two well-known species of the Pacific Coast States. Sassafras is now reduced to a single eastern American species, and Liriodendron to a single American species and another in eastern Asia, though both these genera as well as Taxodium continued to be prominent elements of the cosmopolitan flora as late at the Pliocene.

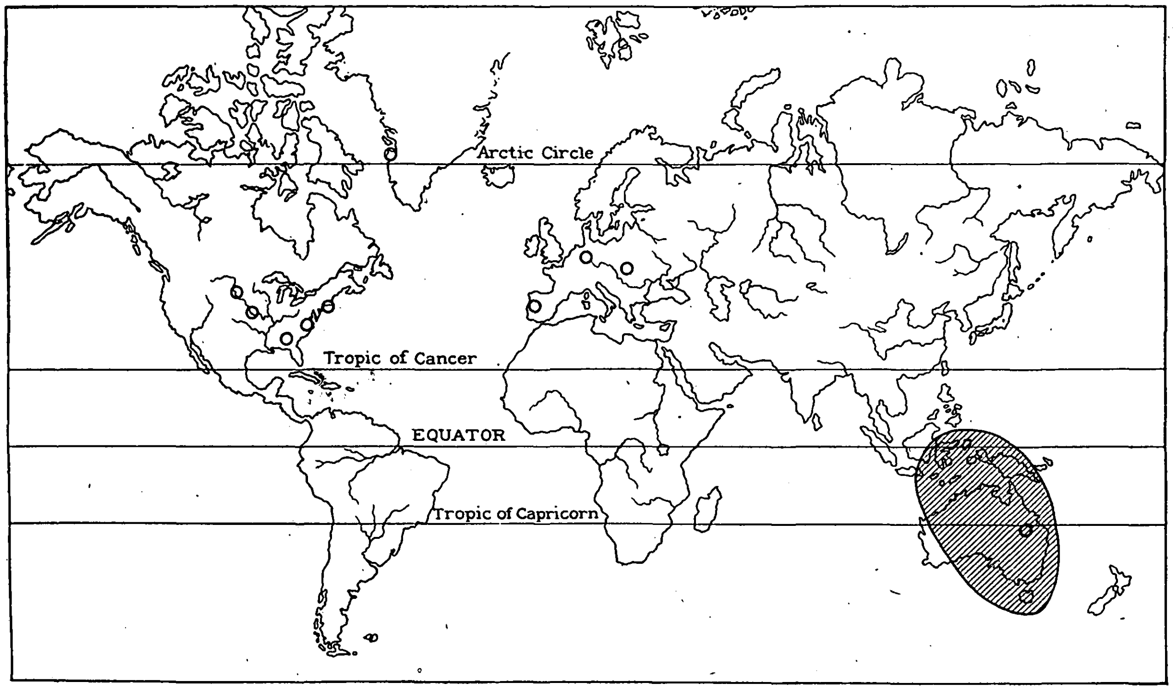

FIGURE 8.—Sketch map showing the Cretaceous (O) and Recent (shaded) distribution of Eucalyptus.

CORRELATION OF THE FLORA.

LOWER DIVISION OF THE EUTAW FORMATION.

The fossil plants from the lower division of the Eutaw formation represent the following 27 species:

Andromeda cretacea Lesquereux ?
Andromeda wardiana Lesquereux.
Androvettia elegans Berry.
Aralia eutawensis Berry.
Araucaria bladenensis Berry.
Araucaria jeffreyi Berry.
Brachyphyllum macrocarpum formosum Berry.
Cinnamomum heerii Lesquereux ?
Cinnamomum newberryi Berry.
Eucalyptus angusta Velenovsky.
Ficus crassipes Heer.
Ficus krausiana Heer.
Ficus ovatifolia Berry.
Juglans arctica Heer ?
Magnolia boulayana Lesquereux.
Magnolia capellinii Heer.
Malapoenna horrellensis Berry.
Manihotites georgiana Berry.
Menispermites variabilis Berry.
Paliurus upatoiensis Berry.
Phragmites pratti Berry.
Salix eutawensis Berry.
Salix flexuosa Newberry.
Salix lesquereuxi Berry.
Sequoia reichenbachi (Geinitz) Heer.
Tumion carolinianum Berry ?
Zizyphus laurifolius Berry.

These species are very unequally represented at the three localities within the Eutaw formation where fossil plants have been found, 19 coming from McBrides Ford, near the base of the formation, though only 5 were collected from Broken Arrow Bend, also near the base of the formation, and 7 from Chimney Bluff, near the top of the formation. The only species present at more than one locality are *Salix flexuosa* and *Sequoia reichenbachi*, which are present at all three. It is believed, however, that these features are due almost entirely to accidents of preservation, as 20 of the 27 species occur at earlier horizons either in Alabama or along the Atlantic Coastal Plain and 8 occur at later horizons in Georgia or elsewhere. Of these 27 species the new species of Aralia, Menispermites, Paliurus, and Zizyphus are confined to the Eutaw of Georgia and hence are of little value in correlation. Nevertheless they furnish some evidence of value, for the Aralia is closely allied to a species of the Magothy formation, and although Menispermites is represented by a single species, and Paliurus and Zizyphus are not present in any of the floras of the Montana group, all three are common in earlier floras, both in the Coastal Plain and in the Dakota sandstone of the West. Nine species occur in strata as old as the Raritan, 14 are found in the Magothy formation of the northern Coastal Plain, 7 occur in the Middendorf member of the Black Creek formation of South Carolina, 19 are found in the typical Black Creek deposits of North and South Carolina, and 11 have been recognized in the Tuscaloosa formation of Alabama.

Comparisons with floras more remote geographically indicate that 14 of the Georgia species are found in the flora of the Dakota sandstone, whereas only 2 occur in the flora of the Montana group, one of these two species being *Sequoia reichenbachi*, a form which possesses little or no stratigraphic value because it occurs from the base to the summit of the Cretaceous. Five species are common to the Atane beds of Greenland and three to the Patoot beds of the same area, one of these three also being *Sequoia reichenbachi*. Five species are common to the Cenomanian and three to the Turonian of Europe, but the only ones common to the Senonian of Europe are *Cunninghamites elegans* and *Sequoia reichenbachi*.

The preceding statements render any extended discussion superfluous. It is clear that the flora of the Eutaw formation of Georgia is of approximately the same age as the Magothy-Matawan flora of the northern Coastal Plain and the Black Creek flora of the Carolinas. It has much in common with the more extensive Tuscaloosa flora of western Alabama, but is probably younger than the bulk of the Tuscaloosa flora or that found in the Middendorf arkose member of the Black Creek formation.

RIPLEY FORMATION.

CUSSETA SAND MEMBER.

The Cusseta sand has furnished fossil plants at only two localities—one near Buena Vista, in Marion County, and the other near Byron, in Houston County. These plants are few in number and are poorly preserved.

The following species, six in all, have been recognized from the locality near Buena Vista:

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

Three of the foregoing species occur in the underlying Eutaw formation, and all but the Ficus, which is new, are found in the Black Creek formation of North and South Carolina. The Andromeda is a characteristic species of the Black Creek formation and is one of the type fossils of the Magothy formation of the northern Coastal Plain, although it makes its earliest appearance in the Raritan formation, as does also the Eucalyptus. None of the six genera except Ficus are represented in the flora of the Montana group, and the latter is represented by very different species. It seems clear, then, that the Cusseta sand is pre-Montana in age and that it falls within the same general paleobotanic limits that include the Magothy-Matawan, typical Black Creek, Middendorf, and upper Tuscaloosa floras of the East and the flora of a part of the Dakota sandstone of the West.

The deposits near Byron seem to lack for the most part any physical or faunal data for accurate correlation; in fact, these extensive interbedded sands and clays constitute landward Cretaceous deposits which may represent the whole of the Upper Cretaceous section along Chattahoochee River or in western Alabama, so that the following comments must be understood to apply only to the horizon yielding the fossil plants, which, according to Stephenson, is referred to the Cusseta member. These plants number but three species—*Dryopterites stephensoni* Berry, *Cunninghamites elegans* (Corda) Endlicher, and *Araucaria jeffreyi* Berry, the first-named form being new to science.

As Dryopterites occurs in the Lower Cretaceous, Dryopteris-like forms are found in post-Cretaceous floras down to the present time, and Dryopteris (Aspidium) is to-day a widespread and dominant genus of ferns, the Georgia species, which is unlike any of the described forms, is of no value in correlation. Of the other two forms, *Cunninghamites elegans* has a rather wide geographic range, occurring both in this country and abroad, and its geologic range is also considerable. In Europe it ranges from the Cenomanian to the Senonian, inclusive, and in this country it has a parallel range, from the Magothy flora of the East to the Montana flora of the West. It has been recorded from Lower Cretaceous horizons in Europe, but these determinations are believed to be erroneous. The nearest geographic occurrence to that in Georgia is that of the upper part of the Black Creek formation of North Carolina; hence the conclusion that the exposures near Byron are not older than those of the Black Creek and not younger than those of the Montana group appears to be firmly established.

The remaining species, *Araucaria jeffreyi*, is not a widespread form, and its intimate association with *Araucaria bladenensis* in the Eutaw formation at Chimney Bluff, Ga., and in the Black Creek formation of North Carolina indicates that it may represent cone scales of the latter species. Taken alone, *Araucaria jeffreyi* points to the same conclusion regarding the age of the deposits near Byron as does the distribution of *Araucaria bladenensis*, but the latter furnishes more definite data.

Araucaria bladenensis is one of the most abundant and typical forms of the Black Creek formation in North and South Carolina, ranging from its base to its summit. It has also been found in the Cusseta sand member of the Ripley formation near Buena Vista, in the Eutaw formation just below the Tombigbee sand member at Chimney Bluff, and in the base of the Eutaw formation in western Alabama. A closely allied or identical form occurs in the Magothy of Maryland and New Jersey, and a similarly allied form has been described from the Turonian of France and Bohemia. Though the lower limit of the species is settled, therefore, with some degree of certainty, its upper limit remains vague. It is not found above the horizon represented by the plant beds near Buena Vista, which are placed in the Cusseta sand. This fact is not so important, however, as it would at first appear, for the floras from the later Cretaceous in the eastern United States are extremely meager. However, as nothing in any way allied to it has been discovered in the abundant floras of Montana or later Cretaceous age in the West, the evidence points to its pre-Montana age.

Nothing has been said in the foregoing pages of the probable European equivalents of these floras—a most fascinating as well as a most difficult problem. It is well not to be dogmatic until the associated faunas are critically studied, and even then a close parallelism between areas as remote as the opposite shores of the Atlantic is hardly to be expected. Nevertheless, the sequence of events in both the Lower and the Upper Cretaceous furnishes certain broad similarities, and some correlations, though they are necessarily approximate, appear to be justified.

In the European Upper Cretaceous section Cenomanian floras appear in Portugal, France, Germany, Bohemia, Dalmatia, and elsewhere. The Turonian has few fossil plants, the largest floras being those of Bohemia and southern France, which have perhaps a score of species. The Emscherian furnishes a more representative flora, principally from Germany, Bohemia, the Tyrol, and other scattered localities in Austria. As regards the classic American Upper Cretaceous section of Meek and Hayden, it has been customary to correlate the Dakota sandstone with the Cenomanian, the Colorado group with the Turonian, and the Montana group with the Senonian. In a study of the northern Coastal Plain the writer has found good grounds for considering the Raritan formation to represent part of the Cenomanian.[1] The Magothy has also been referred at various times to this epoch, the Matawan to the Turonian, and the Mon-

[1] Berry, E. W., Jour. Geology, vol. 18, 1910, pp. 252-258.

mouth to the Senonian. More recently Weller has suggested that the Magothy and the Matawan are also to be correlated with the Senonian. The writer does not purpose to discuss the faunal evidence in this connection, for others are better qualified to do that work. It becomes, however, a paleobotanic question, for in the Black Creek formation of North Carolina the Matawan fauna is found associated with the Magothy flora, as indeed it is to a considerable extent in the Magothy formation in the New Jersey area. In a recent discussion of the correlation of the Black Creek formation of North Carolina, Clark[1] has correlated it with the combined Magothy and Matawan formations of New Jersey and has suggested that it may represent the European Turonian, the lower limit of the Senonian equivalents in the eastern United States being marked by the introduction of the *Belemnitella americana* fauna.

The floral evidence is entirely favorable to this interpretation, which would involve consideration of the Dakota sandstone and the overlying Benton as of Turonian age. There can be no question in the mind of anyone competent to judge the evidence that these eastern floras from Georgia northward are closely allied to the Dakota flora and markedly distinct from any described floras of the Montana group. The accompanying table of distribution shows the occurrences of fossil plants in Georgia and their range elsewhere, and furnishes a graphic summary of the preceding discussion.

Distribution of Upper Cretaceous plants in Georgia and their range elsewhere.

	Georgia localities.					Raritan formation, New Jersey to Maryland.	Magothy formation, New Jersey to Maryland.	Black Creek formation, North and South Carolina.	Tuscaloosa formation, Alabama.	Woodbine sand, Texas.	Dakota sandstone, western interior.	Montana group, western interior.	Atane beds, Greenland.	Patoot beds, Greenland.	Cenomanian, Europe.	Turonian, Europe.	Senonian, Europe.
	McBrides Ford.	Broken Arrow Bend.	Chimney Bluff.	Near Buena Vista.	Near Byron.												
Dryopterites stephensoni					×												
Androvettia elegans	×																
Araucaria bladenensis			×	×			×	×								?	
Araucaria jeffreyi			×		×			×								?	
Brachyphyllum macrocarpum formosum	×						×		×	×		×					
Cunninghamites elegans					×		×	×				×		×	×	×	×
Sequoia reichenbachi	×	×	×			×	×	×	×		×	×	×	×	×	×	×
Tumion carolinianum (?)	×							×									
Phragmites pratti		×						×									
Doryanthites cretacea				×			×	×									
Juglans arctica (?)	×					×	×	×			×		×				
Salix flexuosa	×	×	×			×	×	×	×		×						
Salix lesquereuxii			×			×	×	×			×						
Salix eutawensis		×						×									
Ficus krausiana			×				×	×	×		×				×	×	
Ficus crassipes			×				×	×	×		×		×				
Ficus georgiana				×													
Ficus ovatifolia	×					×	×	×	×								
Magnolia boulayana	×					×	×		×	×	×						
Magnolia capellinii	×						×	×	×		×		×		×		
Menispermites variabilis	×																
Manihotites georgiana	×			×				×									
Paliurus upatoiensis	×																
Zizyphus laurifolius	×																
Cinnamomum newberryi	×					×	×	×	×	×	×		×	×	?		
Cinnamomum heerii (?)	×						×	×	×	×	×						
Malapoenna horrellensis		×						×									
Aralia eutawensis	×																
Eucalyptus angusta	×			×		×		×							×		
Andromeda novæcæsareæ				×		×	×	×	×	×							
Andromeda cretacea (?)	×										×						
Andromeda wardiana	×								×		×						

[1] Clark, W. B., Bull. Geol. Soc. America, vol. 20 (1908), 1910, pp. 653, 654.

THE MIDDLE EOCENE FLORA OF GEORGIA.

INTRODUCTION.

This paper gives a preliminary account of a small flora collected from the middle Eocene of Georgia. This flora, though containing only a few species, is of exceptional interest in the biologic problems which it suggests and is likely to prove of considerable geologic value in the study of the Gulf Eocene, the fossil plants of which are to a large extent unknown to science. No fossil plants have previously been described from any of the formations of the Coastal Plain in the State of Georgia, although plant remains are present in both the Cretaceous and the Tertiary rocks. The only published records of Tertiary plants from this area known to the writer refer to two of the localities described in the following pages.

From the Fiske property McCallie,[1] on the authority of F. H. Knowlton, recently enumerated: "A palm near to the living *Sabal adansoni*, Castanea resembling *Castanea dentata*, Quercus sp ?, Ficus sp. ?"

From the locality south of Macon on the Macon-Marion public road, the same author[2] mentions "several species of fossil leaves." None of these collections, however, has previously received critical study, and in fact no definite floral remains have ever been recorded from deposits of Claiborne age anywhere throughout the territory in which it outcrops. Fossil plants are said to occur in the Claiborne of Alabama at two localities, but so far as the writer can ascertain no collections have ever been made from either of these. At the classic type locality at Claiborne Landing on Alabama River, near the top of the celebrated "Claiborne sands," there is, according to Smith and Langdon,[3] a lens of laminated gray clay with leaf impressions, and bands of lignite are said also to occur in these same beds. Langdon[4] also records lignitic sandy clays full of fossil leaves on Conecuh River, in southern Alabama.

The upper formation (Yegua or "Cockfield") of the Claiborne group in the southern Arkansas and northern Louisiana area is said by both Harris and Veatch to contain numerous plant-bearing and lignitic beds. It seems certain that when the Claiborne deposits of the Mississippi embayment are studied in greater detail a considerable flora will be discovered.

GEOLOGY OF THE MIDDLE EOCENE.

The Claiborne group of Georgia reaches its greatest exposed development in a belt extending from Savannah River on the northeast to Ocmulgee River on the southwest. Beyond the Ocmulgee it is deeply buried by the transgression of the Vicksburg and Jackson formations and is exposed only along Chattahoochee River south of Fort Gaines[5] and along Flint River, where Veatch and Stephenson have discovered Claiborne fossils at Penny Bluff, west of Americus. This northeastern belt is 10 to 30 miles in width, and is the only area of interest in the present connection, because it contains the only known Eocene plants in the State. The materials consist of heavy beds of sand, in many places indurated and pebble-bearing, extensive lenses of porous laminated clays with some local limestones and marls, and in some places lignitic deposits. In general the clays represent deposition in the early part of Georgia Claiborne time.[6] They are light in color but are in many places iron-stained. They are laminated or thinly bedded with films of fine light sand, and commonly contain impure calcareous nodules and thin layers of soft limestone of small areal extent. These clays are more or less continuous from Augusta southwestward to Twiggs and Bibb counties. Immediately above the clays, and replacing

[1] McCallie, S. W., Underground waters of Georgia: Bull. Geol. Survey Georgia No. 15, 1908, p. 336.
[2] Idem, p. 347.
[3] Report on the geology of the Coastal Plain of Alabama, 1894, pp. 126, 129.
[4] Idem, p. 387.
[5] McCallie, S. W., op. cit., p. 33.
[6] The Georgia Claiborne, in the light of later studies of the fossil plants collected in Alabama, Mississippi, and Louisiana, appears to represent the upper Claiborne of the complete Gulf section.

them in some areas, are heavy beds of iron-stained sands, which are in many places salicified and fossiliferous, and which show very commonly toward their upper limits phases of sandy fossiliferous marl, as at Shell Bluff, in Burke County.

The thickness of the Claiborne group in Georgia is placed between 300 and 500 feet, divided into Barnewell sand above and the McBean formation below. The fossil plants come from the basal part (Congaree clay member) of the McBean formation.

The Claiborne in Georgia generally rests with marked unconformity upon the Cretaceous, locally transgressing those rocks and resting on the eroded surface of the crystalline rocks of the piedmont. It is overlain by the Vicksburg and Jackson formations or by the surficial deposits of the Lafayette? and later formations. Most of the fossil plants enumerated in the following pages were collected in the vicinity of Grovetown, in Columbia County, 15 miles west of Augusta on the Georgia Railroad. The Claiborne deposits in this region occupy a pre-Claiborne estuary deeply eroded in the underlying Cretaceous surface, outcropping as a narrow tongue only 2 or 3 miles in width and extending to the northwest from the main body of the Claiborne deposits in Richmond County a distance of about 18 miles.

The stratigraphic relations are well illustrated by the diagrammatic section (fig. 9) of the plant-bearing horizon in Phinizy Gully. This gully extends in an approximately east-west direction about 1 mile east of the Grovetown railroad station and was formerly used by the Augusta-Wrightsboro wagon road, long since abandoned. The east-west line in the figure marks the bed of the gully. The Eocene clay is laminated with fine sand partings and local layers of comminuted lignite, and contains scattered leaf impressions and casts of Modiolus and small Pelecypoda. Most of the leaf impressions, which are nowhere abundant, carry only sufficient carbonaceous matter to form a very light tan impression, which furnishes beautiful specimens of good lasting qualities, their preservation being endangered only by the usually great shrinkage of the clay in drying.

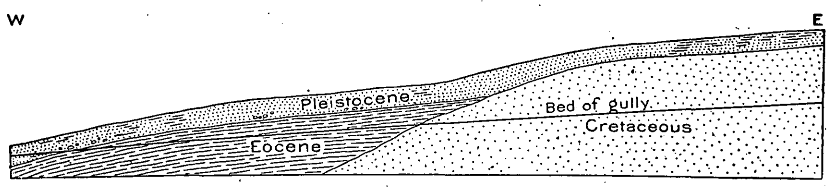

FIGURE 9.—Diagrammatic geologic section of Phinizy Gully.

Eastward up the gully, some 50 or 60 feet beyond the plant locality, appear abruptly the light-colored coarse gravelly arkosic sands of the Lower Cretaceous. These become argillaceous in their upper part and rise 10 to 15 feet above the Eocene surface, and deposits of both ages are overlain in the sides of the gully by a thin covering of Pleistocene and Recent deposits, the whole furnishing an exceptionally fine example in small compass of an erosional unconformity.

The plant locality known as the Fiske property contains several small pits, the principal opening being just east of the Grovetown railroad station along the Georgia Railroad. It was formerly worked and the product marketed as a fuller's earth, but it has been idle for some time. At the time of the writer's visit the sides had slumped a great deal and the pit was full of water. The laminated clay appears again along the railroad in a low cut a short distance north of the station, where it contains unidentifiable fragments of leaves. About 1¼ miles southwest of Grovetown station and one-half mile west of the railroad track recent erosion exposes the laminated clays. At this locality indistinct invertebrate impressions and fragments of Acrostichum, too poor to be worth collecting, were observed. That remains of the vegetation of the Claiborne are not everywhere uncommon is shown at a locality 3½ miles south of Grovetown, known as the Chapman lignite mine. At this locality about 10 feet of black, compact, earthy lignite, filled with trunks and limbs of trees, is exposed beneath pinkish clays and coarse Eocene sands. The base of the lignite is not exposed and its thickness or horizontal extent is unknown. It is by far the largest known lignitic deposit in the State, reminding the observer of the Upper Cretaceous and Eocene lignite beds of the far West or those of the Wilcox group in the Mississippi embayment. Specimens of wood from these deposits were found, when prepared for microscopic examination, to have undergone too much decay before entombment to permit of identification except to the extent that they were dicotyledonous—a fact worthy of comment, for in the recent coal work in the western lignitic areas it has been found that the recognizable lignites are nearly all of coniferous origin, although the enormous number of dicotyledonous leaf impressions in the surrounding clays effectually testify to the abundance of this class of plants during the formation of the lignite beds.

Two other plant localities remain to be mentioned. One is represented by a single specimen obtained in digging a well near Poplar Church, 13½ miles west of Sandersville, in Washington County. The second is on the Macon-Marion public road, 10 miles south of Macon, in Twiggs County, at the old Thorpe place. Here there is an exposure of nearly 100 feet of the "fuller's earth," overlain by 50 feet of red argillaceous sand. The clay is less thinly bedded at this locality, but the thin seams of comminuted leaves are exactly like those seen at Phinizy Gully, and the identifiable leaf remains are scattered irregularly in the same way but are less common.

The Claiborne deposits near Hephzibah, in Richmond County, contain fragments of leaves and numerous impressions of twigs and small stems, but the writer was unable to identify anything at this locality. It was also impossible to identify any of the poorly preserved leaf impressions of a small collection made recently by Otto Veatch, of the Geological Survey of Georgia, on the Fort Gaines-Edison public road, 2½ miles east of Fort Gaines, in Clay County.

The species identified from all the known plant-bearing Claiborne outcrops in Georgia are brought together in the following table:

Distribution of the Claiborne flora in Georgia.

	Fiske property, Grovetown.	Phinizy Gully, near Grovetown.	10 miles south of Macon.	Poplar Church.
Acrostichum georgianum		×		
Arundo pseudogoepperti		×	×	
Castanea clairbornensis	×			
Conocarpus eocenica	×	×	(?)	
Dodonæa viscosoides	×	×	×	
Ficus claibornensis	×		×	
Malapoenna sp			×	
Mimosites georgianus	×	×	×	
Momisia americana		×		
Pisonia claibornensis		×	(?)	
Pistia claibornensis	×			
Potamogeton megaphyllus		×		
Rhizophora eocenica		×	×	×
Sapindus georgiana		×		
Sphærites claibornensis	×		×	
Terminalia phæocarpoides	×			
Thrinax eocenica	×	×		

A considerable fauna is listed from the various outcrops by McCallie,[1] the determinations being by Vaughan and Dall. Invertebrates have been found closely associated with the plant remains at several points. The smaller figured specimen of Thrinax contains several impressions of Modiolus and small pelecypod shells, and one of the best specimens of Acrostichum is partly hidden by a Modiolus valve. The collections from the Fiske property include the following invertebrates:[2]

Turbinella (Psilocochlis) mccalliei Dall.
Calyptrea aperta Solander.
Nucula magnifica Conrad.
Nucula ovula Lea.
Leda, 2 sp.
Ostrea sp.
Modiolus texanus Gabb.
Modiolus alabamiensis Aldrich?
Cytherea ovata var. greggi Harris.
Balanus sp.

From the plant locality on the Macon-Marion public road the following invertebrates are recorded:[3]

Nucula ovula Lea.
Crassatellites protexta Conrad.
Diplodonta sp.

[1] McCallie, S. W., op. cit., pp. 336-348. [2] Idem, p. 336 (identified by Vaughan). [3] Idem, p. 347 (identified by Vaughan).

From the well near Poplar Church which furnished a leaf of *Rhizophora eocenica* the following invertebrates are recorded: [1]

Nucula ovula Lea.
Glycymeris trigonella Conrad.
Ostrea alabamiensis Lea.
Modiolus aff. texanus Gabb.

As already stated, the Claiborne has a very considerable areal extent outside the region considered in this report; in fact it is one of the most extensively developed groups of marine beds in the Coastal Plain and is certainly the most extensive post-Cretaceous group, for it has a known extension from the Rio Grande on the south to the Carolinas and probably to Maryland on the north. Its extremely fossiliferous character early attracted attention, and a study of collections of invertebrate remains from a local development of beds of this age at Claiborne Landing on Alabama River enabled Conrad in 1835 to prove the presence of Eocene beds in the Gulf Coastal Plain. The name Claiborne as at present understood is applied to a larger unit as a group term. Plant remains are present in some of the more argillaceous members at the type locality on Alabama River, but these have never been collected. The comparison of this flora with that of the Georgia Eocene would prove a most interesting and valuable study.

The shore line was not stationary during Claiborne time, for considerable oscillation is indicated in the change from marine to estuarine sedimentation in the Mississippi embayment region. The Eocene Gulf Stream was no doubt a large factor in the northward extension of the southern flora which occurs at Grovetown. With the recession of the sea as Eocene time progressed and the emergence of the Florida area in the Miocene, this warm current would be deflected somewhat to the east. Considerable evidence has been set forth by Dall, and more recently by Vaughan, for the existence of a cooler inshore current in the middle Miocene.

With regard to the existence of land to the southward little is known. The vertebrate paleontologists, notably Osborn, insist on a late Cretaceous or early Eocene land connection with South America to account for the mammalian fauna of the Notostylops beds of Patagonia and the presence of Edentata-Dasypoda in the North American middle Eocene. Corroborative evidence is furnished by the appearance of the flora of the Dakota sandstone in Argentina, although this land connection is vigorously denied by other students.

In any event, the Georgia Eocene flora need not be supposed to have migrated from equatorial South America. It undoubtedly flourished during the whole of the Tertiary all along the then-existing coast from the Mexico-Central America region to the Georgia occurrence.

SYSTEMATIC DESCRIPTION OF THE FLORA.

Phylum THALLOPHYTA.

Order PYRENOMYCETES.

Genus SPHÆRITES Unger.

SPHÆRITES CLAIBORNENSIS sp. nov.

Plate XXIV, figure 6.

Description.—Perithecia small and numerous, arranged in elevated rings 1 to 1.5 millimeters in diameter on the upper surface of the leaves of Ficus.

Large numbers of fungi of this sort have been described by European paleobotanists, chiefly from Tertiary horizons, and referred to the genera *Sphæria* Haller or *Sphærites* Unger. They possess little biologic interest except in so far as they indicate the presence of this class of plants in various bygone floras, and American paleobotanists have usually ignored them entirely.

The present species is similar to *Sphærites myricæ* (Lesquereux) Meschinelli,[2] from the Green River formation of Wyoming, a form which occurs on leaves of a species of Myrica, and

[1] McCallie, S. W., op. cit., p. 343 (identified by Vaughan).

[2] Lesquereux, Leo, The Tertiary flora, 1878, p. 34, Pl. I, fig. 4.

to *Sphærites nervisequus* Fritel,[1] from the Sparnacian of the Paris Basin, a type, somewhat smaller than the Georgia form, which occurs on the leaves of a species of Lauraceæ.

Occurrence.—Congaree clay member of McBean formation (of Claiborne group), Fiske property, Grovetown, Columbia County, 10 miles south of Macon, Twiggs County. (Collected by E. W. Berry.)

Collection.—U. S. National Museum.

Phylum PTERIDOPHYTA.

Order FILICALES.

Family POLYPODIACEÆ.

Genus ACROSTICHUM Linné.

ACROSTICHUM GEORGIANUM sp. nov.

Plate XXVII, figure 1.

Description.—Frond large, pinnate (?). Pinnæ thin but coriaceous, oblong-lanceolate, inequilateral, with an entire undulating margin, an obtusely rounded apex, and a narrowed (?) base, about 2.5 centimeters in width and of unknown length, presumably about 10 to 12 centimeters. The pinnæ may have been considerably larger than is here indicated, for all the collected material is fragmentary and in some of the fragments the thin stiff edges are folded over, indicating a possible greater width. Midveins stout. Lateral veins numerous, 1 millimeter or less apart, very fine intricately anastomosing, branching from the midvein at acute angles, the angle dependent on their situation in the basal or apical part of the pinna. The basal veins subtend angles of about 60°; those in the apex approach a position almost parallel with the midvein; and the intermediate ones branch at a very acute angle and immediately diverge outward, their general direction being about 50° from that of the midvein. Areolation of slightly elongated, 5 or 6 sided meshes.

What appear to be fragments of the fertile pinnæ of this species occur at the locality 10 miles south of Macon, but they are too uncertain to be even tentatively identified as such and are not included among the occurrences of this species listed herewith. Nevertheless the fragments are so suggestive of this species that, if sterile pinnæ had been found at the same locality, the writer would not hesitate to class them as fragments of fertile pinnæ.

This handsome species is unfortunately based on fragments, the largest being that figured. There are eight such specimens from the Phinizy Gully locality, one partly concealed by a valve of Modiolus. Still smaller fragments showing the characteristic areolation were noticed at other outcrops in the vicinity of Grovetown.

The species is closely related to *Acrostichum hesperium* Newberry,[2] of the Green River formation of Wyoming, differing from it in being somewhat more slender in habit and in having straighter midveins and less elongate, finer areolation. There is no evidence of the coalescence of the terminal pinnæ, a feature which serves to distinguish Newberry's species from all other described fossil species of Acrostichum.

A similar form is the European *Acrostichum* (*Chrysodium*) *lanzæanum* Gardner and Ettingshausen,[3] described at length by Gardner and common in the Lutetian and Bartonian of southern England. What appear to be identical remains are reported from the Ligurian of Dalmatia and southern Franch, from the Tongrian of France and Italy, and more doubtfully from the Ypresian of France. Another species is reported by Saporta from the Aquitanian of southern France, and Squinabol reports two additional species from the Tongrian of Liguria, Italy.

Another American species of Upper Cretaceous or lower Eocene age was described in 1902 by Hollick [4] from Colorado. In this connection mention should also be made of a fern from

[1] Fritel, P. H., Mém. Soc. géol. France, vol. 40, 1910, p. 13, Pl. I, fig. 14.
[2] Newberry, J. S., The later extinct floras of North America: Mon. U. S. Geol. Survey, vol. 35, 1898, p. 6, Pl. LXI, figs. 2-5.
[3] British Eocene flora, pt. 1, 1879, p. 26, Pls. I and II, figs. 1-4.
[4] Torreya, vol. 2, 1902, p. 146, Pl. IV, figs. 3-6.

Sand Creek, Colo., described by Lesquereux [1] as *Gymnogramma gardneri*, which both Gardner and Saporta are inclined to consider an Acrostichum. This fern is of Upper Cretaceous or basal Eocene age.

The modern species of Acrostichum are swamp forms. They are few in number and include, in addition to several unimportant species of the Lesser Antilles and West Indies, the widespread tropical fern, *Acrostichum* (*Chrysodium*) *aureum* Linné, a common coastal species of mangrove and nipa swamps and similar situations, more particularly on the dryer and less saline soils, which ranges in America from Bermuda and peninsular Florida to Brazil, in Africa from Guinea to Natal and the Mascarene and Seychelles islands, and in the Orient from southern China and Polynesia to northern Australia. It is remarkable that this cosmopolitan modern genus should appear about the same time in America and Europe and display a number of closely allied forms at widespread localities in both the Eocene and Oligocene, and yet not be detected at any of the numerous outcrops of later Miocene or Pliocene plant-bearing deposits. Undoubtedly this southward retreat from latitude 51° north is to be explained by changing physical conditions, chief among which were lessening humidity and lowering temperature.

Occurrence.—Congaree clay member of McBean formation (of Claiborne group), Phinizy Gully, Columbia County. (Collected by E. W. Berry.)

Collection.—U. S. National Museum.

Phylum **SPERMATOPHYTA.**

Class **ANGIOSPERMÆ.**

Subclass **MONOCOTYLEDONÆ.**

Order **POALES.**

Family **POACEÆ.**

Genus **ARUNDO** Linné.

ARUNDO PSEUDOGOEPPERTI sp. nov.

Plate XXIV, figure 7.

Arundo goepperti? Münster, in Lesquereux, Ann. Rept. U. S. Geol. and Geog. Survey, Terr., 1871, suppl., p. 5.
Arundo goepperti? Münster, in Lesquereux, The Tertiary flora, 1878, p. 86, Pl. VIII, figs. 3–5.

Description.—Lesquereux in 1871 and again in 1878 referred several fragments of leaves and striated stems of grasslike form found in the Green River formation to the well-known European species *Arundo goepperti*. These fragments agree fairly well with the European material, but when it is considered that remains of this kind have little to distinguish them specifically, and that these American forms are so far removed geographically from the type forms and occur at a horizon invariably of considerably greater age, the propriety of considering them distinct is obvious.

A number of fragments from Phinizy Gully are referred to this species, one of the best, although not the largest, being figured. The most that can be said of their botanic relationship is that they represent large marsh grasses analogous, if not intimately related, to the modern genus Arundo, to which they are referred as a matter of convenience and long standing usage rather than because of any very definite proof of this relationship.

In his elaboration of the Green River flora Lesquereux has described an additional but similar species, *Arundo reperta*,[2] and other remains which he refers to Phragmites. It is quite possible that some of these remains, especially those named *Arundo reperta*, are referable to the present species.

The modern species of Arundo, which number about six, are distributed throughout the warmer countries of the world. This species and the original *Arundo goepperti* are usually compared with the modern *Arundo donax* Linné, which is indigenous to the Mediterranean region and which grows in wet places.

[1] The Tertiary flora, 1878, p. 58, Pl. IV, fig. 2.
[2] The Tertiary flora, 1878, p. 87, Pl. VIII, figs. 6–8.

Occurrence.—Congaree clay member of McBean formation (of Claiborne group), Phinizy Gully, Columbia County, 10 miles south of Macon, Twiggs County. (Collected by E. W. Berry.)

Collection.—U. S. National Museum.

Order NAIADALES.

Family NAIADACEÆ.

Genus POTAMOGETON Linné.

POTAMOGETON MEGAPHYLLUS sp. nov.

Plate XXVII, figure 2.

Description.—Leaf ovate-lanceolate in outline, 8 or 9 centimeters in length by 3.6 centimeters in greatest width, which is in the basal half of the leaf. Apex not seen, but the margins converge abruptly apically, so that it was rather obtusely or acutely pointed. Base rounded. Veins numerous, about 1 millimeter apart, unbranched, acrodrome. Midrib not differentiated. Transverse veinlets not visible. Texture apparently thin and firm.

The present species resembles a number of fossil forms of undetermined botanic affinity such as *Smilacina rackiana* Pilar,[1] of the later Tertiary of Europe. It comes closest, however, to the leaves from Trocadéro in the Eocene of the Paris basin (Lutetian), referred by Saporta [2] to the genus Ottelia Pers (Hydrocharitaceæ), but described originally as a species of Potamogeton by both Brongniart [3] and Watelet [4] and referred by Bureau to the genus Monochoria of the Pontederiaceæ.

Between 30 and 40 fossil species have been referred to this genus, none of which appear to be identical with the Georgia form. They range in age from the Arctic Senonian through the Eocene, Oligocene, Miocene, and Pliocene to the Pleistocene, several still existing species being recorded from the latter, both in this country and abroad.

The modern species number more than 60 and occur both in the tropics and in the temperate zone, with a larger representation in the latter. The species generally have a wide, many a cosmopolitan range, a single species commonly extending over a great many degrees of latitude; for example, *Potamogeton perfoliatus* Linné extends over more than 20 degrees of latitude in America, from Newfoundland and British Columbia to Florida and California, and also occurs in Europe and Asia. It is an interesting fact that all the wide-ranging species extend into both comparatively high and low latitudes, whereas species of more restricted range, such as *Potamogeton floridanus* Small and *Potamogeton curtissii* Morong, of Florida, are commonly confined to warmer regions.

This condition may be taken to indicate either that species confined to low latitudes in the existing flora, or their immediate ancestors in more ancient floras, had originally a much wider range than now, or that the modern wide-ranging species have greatly extended their range in recent times. The writer inclines to accept the latter supposition, although it is well known that the majority of aquatics, both animal and plant, are little influenced even by rather wide differences in latitude.

A fossil species of about the same size as the Claiborne species but with a more open venation has been described by Heer from the Tertiary of Spitzenbergen as *Potamogeton nordenskioldi*.[5] Both this form and the Georgia species probably represent floating, not emerged or submerged, leaves.

Occurrence.—Congaree clay member of McBean formation (of Claiborne group), Phinizy Gully, Columbia County. (Collected by E. W. Berry.)

Collection.—U. S. National Museum.

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[1] Pilar, A. G., Flora fossilis susedana, 1883, p. 13, Pl. III, fig. 8.
[2] Le monde des plantes, 1879, p. 227, f. 45.
[3] Tableau, 1849, p. 115.
[4] Description des plantes fossiles du bassin de Paris, 1866, p. 86, Pl. XXIII, fig. 1.
[5] Flora fossilis arctica, vol. 1, 1868, p. 157, Pl. XXX, figs. 1b, 5c, 5d, and 6–8.

Order ARECALES.

Family ARECACEÆ (PALMÆ).

Genus THRINAX Linné.

THRINAX EOCENICA sp. nov.

Plates XXV and XXVI, figure 3.

Description.—Leaves orbicular in outline, of relatively small or medium size, indicating in the collected material a diameter ranging from 36 to 60 centimeters or more. Many-cleft,

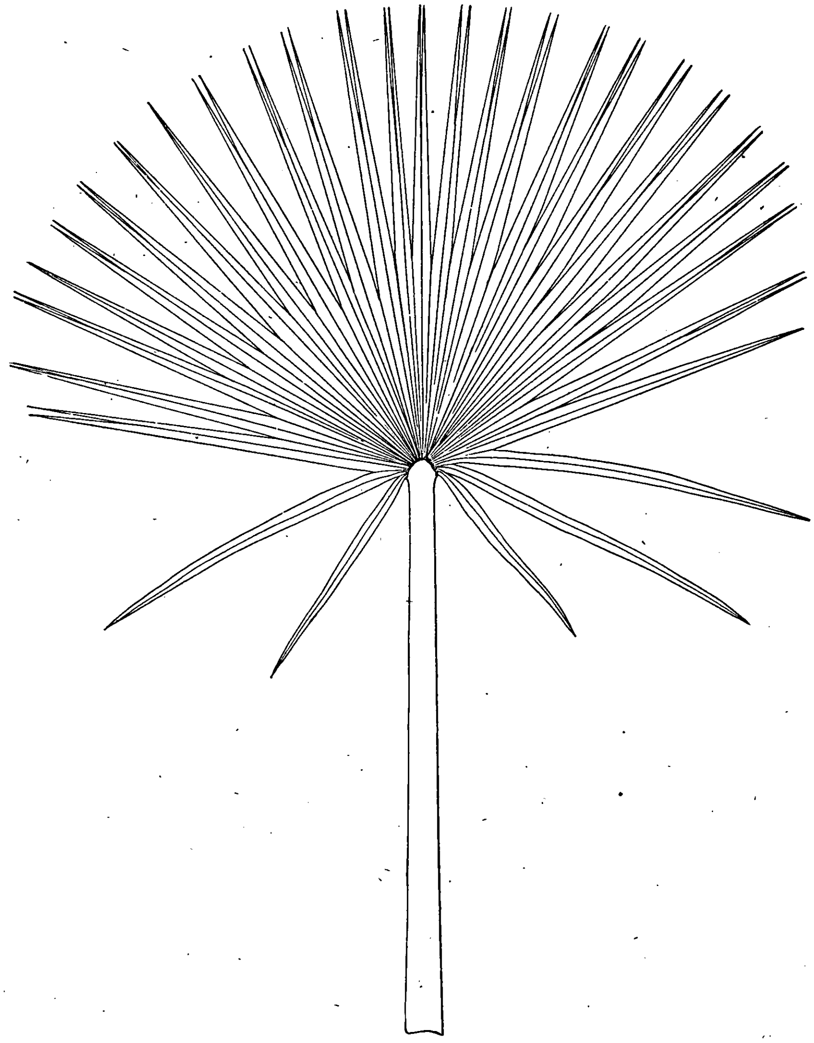

FIGURE 10.—Restoration of *Thrinax eocenica* Berry. (About one-sixteenth natural size.)

the numerous rays carinate, much crowded at the obtusely rounded end of the rachis, two cleft distad. Rachis considerably flattened, smooth, entirely unarmed, 1 centimeter wide in the single preserved specimen of one of the smaller leaves. Ligule free, erect, concave, inconspicuous. Segments 25 in number on a small complete specimen; larger fragments showing about two-thirds of a leaf contain 31 rays, indicating that the complete leaf was made up of about 45 segments. The basal rays on each side are somewhat reduced in size and entirely free, and all the rays become separated about two-thirds of the distance from their base. Primary veins prominent. Intermediate veins very fine, five on each side, something less than a millimeter apart, with very fine veinlets between them. (See fig. 10.)

Fossil palm leaves present few characters for successful comparison with existing genera; hence the numerous fossil species of such genera as Flabellaria, Sabalites, and Geonomites. The Georgia material is for the most part fragmentary; the greater the size of leaves that floated into the Claiborne sea the more fragmentary the preserved material. These fragments are very common at the Phinizy Gully locality. The two figured specimens, by far the best obtained, are from the Fiske property at Grovetown. The larger is an impression; the smaller, a most beautiful specimen, has the leaf substance preserved and shows the upper surface of the frond. This locality was flooded at the time of the writer's visit and the workings abandoned, but laborers reported that palm leaves were frequently encountered and that some of them reached a diameter of 3 or 4 feet. The present collections, though they leave much to be desired, are in the sum of their characters clearly referable to the genus Thrinax, a determination which the writer made after a careful comparison of the fossil leaves with those of various existing palms in the National Herbarium and in the New York Botanical Garden, and which was immediately suggested by Dr. N. L. Britton when the photographs of these specimens were submitted to him.

The present species is clearly distinct from all the palms described by Lesquereux or Newberry from the West, and little is to be gained by more detailed comparison. It is equally distinct from the homotaxial European palm material, the only material which suggests any relationship being the leaves from the Ligurian of Dalmatia referred by Ettingshausen [1] to *Flabellaria raphifolia* (Sternberg) Ettingshausen. It differs, according to the illustrations given by this author of the same species in his Häring flora, in having a long acumen.

In the modern flora Thrinax has nine or ten species in the West Indies and Antilles, three of the species being found on the Florida Keys.

Occurrence.—Congaree clay member of McBean formation (of Claiborne group), Fiske property, Grovetown, Columbia County (collected by S. W. McCallie); Phinizy Gully (collected by E. W. Berry).

Collection.—U. S. National Museum.

Order ARALES.

Family ARACEÆ.

Genus PISTIA Linné.

PISTIA CLAIBORNENSIS sp. nov.

Plate XXVI, figures 1 and 2.

Description.—Leaves broadly obovate with a retuse apex giving them an obcordate outline; 2.5 centimeters in length by 2.5 centimeters in greatest breadth. Base broadly cuneate, descending to the wide petiole. Apex with a shallow, broadly rounded sinus. Venation indistinct, fasciculate, forming irregular polygonal meshes by repeated cross branching. There are indications in the fossil of intumescence and inflation in the basal half of the leaf exactly comparable to conditions found in the existing species.

This species is the first to be discovered in the Tertiary, and only three Cretaceous species are known. It is clearly distinct from any previously described fossils, but resembles somewhat certain leaves of *Pistia corrugata* Lesquereux from the Montana group, differing from this species in the degree of apical retuseness. It differs in the same respect from the leaves of the existing species seen by the writer, although the older leaves of the latter tend to a truncate form and are often slightly retuse.

In size, outline, and venation this Eocene species is not very different from the modern *Pistia stratiotes* Linné, in which species Engler (Die natürlichen Pflanzenfamilien) has united all the living representatives of the genus. The result of Engler's classification makes this a somewhat variable and widely distributed species, in general confined to the tropical and subtropical zones. In this country it is found from Florida to Texas. It occurs in the West

[1] Denkschr. K. Akad. Wiss. Wien, Math.-nat. Kl., vol. 8, 1855, p. 12, Pls. III, fig. 4; XIV, fig. 1.

Indies, and southward through Mexico and Central America to Paraguay and Argentina. In Africa it occurs from Natal to Senegambia and Nubia, and also in Madagascar and the Mascarene Islands. In Asia it appears throughout the East Indies and northward to the Philippines.

Few fossil forms have been referred to this genus. Hosius and Von der Marck [1] described in 1880 a form which they called *Pistites loriformis* from the Lower Senonian of Westphalia, but this is probably cycadean, as Schimper suggested.[2] Lesquereux [3] in 1876 named a remarkably well-preserved form from Point of Rocks, Wyo., *Pistia corrugata*, and later fully described and illustrated it,[4] his specimens including leaves of various sizes and rootlets. This fossil comes from beds belonging to the Montana group (Senonian), which are of about the same age as the French beds from which the only other species, *Pistia mazelii*, was known. This specie was mentioned and figured from the lignites of Fuveau (Provence), France, by Saporta and Marion,[5] but has never been adequately described.

Recently the writer showed[6] Heer's *Chondrophyllum nordenskioldi*, described from the Atane beds of Greenland, to be a true Pistia and to be exceedingly abundant in the Black Creek formation of North Carolina, which is of Colorado (Turonian) age.

It is significant as showing the real imperfection of the geologic record, even of the European Tertiary, that this widespread modern type ranged over at least two continents during the Upper Cretaceous and presumably had a still wider range in Cenozoic times, and yet not a single specimen has ever before come to light at any of the thousands of localities where plant beds of the latter age have been exploited.

Occurrence.—Congaree clay member of McBean formation (of Claiborne group), Fiske property, Grovetown, Columbia County.

Collections.—U. S. National Museum.

Subclass DICOTYLEDONÆ.

Order FAGALES.

Family FAGACEÆ.

Genus CASTANEA Adanson.

CASTANEA CLAIBORNENSIS sp. nov.

Plate XXVIII, figures 1 and 2.

Description.—Leaves oblong-lanceolate in outline, of a thin, firm texture, about 18 or 19 centimeters in length by 4.5 centimeters in greatest width, which is about halfway between the apex and the base. Apex acuminate (?). Base cuneate, acute. Margin coarsely serrate, with sharp ascending teeth becoming less marked proximad, the margin finally entire toward the base of the leaf. Petiole and midrib stout. Secondaries of medium size, numerous, regular, parallel, and alternate, craspedodrome; they branch from the midrib at angles of about 40° and curve slightly upward, terminating in the marginal teeth. The tertiary venation, which consists of numerous close-set and nearly straight transverse veins, constitutes about the only feature in which these leaves differ from those of our modern American chestnut *Castanea dentata* (Marsh) Borkhausen.

The genus Castanea is represented by a fairly large number of fossil species, one doubtful form occurring as early as the Senonian of Europe. In addition the genus Dryophyllum Debey, often considered as in part ancestral to Castanea and forming a link between the latter genus and Quercus, has a number of species in the Upper Cretaceous and "Paleocene."

Species of Castanea are found in the Eocene deposits in Montana, Oregon, Canada, Alaska, Greenland, France, Italy, and England. There are a number of species in the

[1] Palæontographica, vol. 26, 1880, p. 182, Pl. XXXVIII, figs. 151, 152.
[2] Zittel's Handbuch, 1890, p. 378.
[3] Ann. Rept. U. S. Geol. and Geog. Survey Terr., 1874, p. 299.
[4] Tertiary flora, 1883, p. 103, Pl. LXI, figs, 1, 3-7, and 9-11.
[5] L'évolution du règne végétale, Phanérogames, vol. 2, 1885, p. 37, figs. 114c and 114d.
[6] Berry, E. W., Bull. Torrey Bot. Club, vol. 37, 1910, p. 189, Pl. XXI, figs. 1-15.

European Oligocene and in the Miocene of Japan, Europe, and America, the latter including some from New Jersey on the east coast and from Oregon on the west coast. No less than eight species have been described from the European Pliocene. These are all very similar and are variously combined and segregated by different authors. They at least indicate the abundance of the chestnut in southern Eurasia during preglacial times.

The common modern chestnut of Europe (*Castanea vulgaris*) is recorded from interglacial beds in northern Italy and France and the modern chinquapin (*Castanea pumila*) is recorded from the American Pleistocene in Kentucky and West Virginia.

Starkie Gardner comments on the incongruity of Castanea being a member of the warm temperate or subtropical Eocene flora and expresses the belief that these supposed chestnuts are really referable to the tropical genus Godoya Ruiz and Pavon (Ochnaceæ). After a careful comparison of the various fossil species with the foliage of this modern genus the writer is strongly of the opinion that Gardner's comparison has no actual basis. A review of the possible evidence bearing on the supposed incongruity of Castanea associated with various tropical and subtropical genera indicates that the modern species of chestnut number five, including *Castanea vulgaris* Lamarck of southern Europe, another species in eastern Asia, and three species in America. Of the latter, *Castanea nana* Muhlenberg is found in the sand hills and barrens of Georgia and Florida to Louisiana. *Castanea dentata* (Marsh) Borkhausen is found on rich, noncalcareous soils from Maine and Ontario to Michigan, Tennessee, Georgia, and Alabama. In the latter State it occurs as far south as Tuscaloosa County, where the mean annual temperature is about 63° F., as against 42° for Maine and about the same for Ontario, Canada. The limits are 21° apart, and indicate a very wide actual range of temperature.

We find that the allied genus Castanopsis Spach, which Prantl[1] makes a section of Castanea, although it appears to be a little nearer Quercus than Castanea, has something like 25 species, mostly of southeastern Asia and tropical India, with one western American species which ranges from southwestern Washington to southern California. The closely allied genus Quercus, though primarily a temperate type, has many strictly tropical species. These various considerations effectually dispose of any criticism of the presence of Castanea associated with Thrinax, Acrostichum, Pisonia, and similar forms in the Eocene of Georgia.

Occurrence.—Congaree clay member of McBean formation (of Claiborne group), Fiske property, Grovetown, Columbia County. (Collected by S. W. McCallie.)

Collection.—U. S. National Museum.

Order URTICALES.

Family ULMACEÆ.

Genus MOMISIA F. G. Dietrich.

MOMISIA AMERICANA sp. nov.

Plate XXVII, figure 13.

Description.—Leaf ovate in outline, 6 to 7 centimeters in length by 2.6 centimeters in greatest width, which is in the lower half of the leaf. Apex not preserved, presumably acute. Base obtusely pointed. Margin entire as far as seen; there is a possibility, however, that it was sparsely toothed apically. Primaries, three from the top of the petiole, the midrib the stoutest, all slender.

This species is unfortunately based on the single incomplete specimen figured. It is much like the leaves ordinarily referred to the genus Cinnamomum, of which three or four European species have been recognized at innumerable horizons from the Eocene to the Pliocene and at a large number of localities both in this country and abroad. Some of these are indisputable cinnamomums, as is attested by well-preserved fruiting specimens; others find their only relation to that genus in the palmately triveined character. The present species, though it may represent a Cinnamomum, has seemed to the writer to be more closely related to the

[1] Engler, A., and Prantl, K., Die natürlichen Pflanzenfamilien, pt. 3, 1894.

Ulmaceæ, resembling certain South American species of Celtis, such as *Celtis iguanens* (Jacquin) Sargent of Bolivia. It more closely resembles, however, *Momisia aculeata* (Swartz) Klotsch, a widespread species of tropical America and the West Indies which reaches its northern limits in the valley of the Rio Grande and on the Florida keys.

The genus Momisia has not previously been recorded in a fossil state. In the living flora it has upward of a score of species confined to tropical America. Engler[1] reduces it to a subgenus of Celtis, but there is little doubt that it should be accorded generic rank.

Occurrence.—Congaree clay member of McBean formation (of Claiborne group). Phinizy Gully, Columbia County. (Collected by E. W. Berry.)

Collection.—U. S. National Museum.

Family MORACEÆ or ARTOCARPACEÆ.

Genus FICUS Linné.

Ficus claibornensis sp. nov.

Plates XXIV, figure 6, and XXVII, figures 3 and 4.

Description.—Leaves oblong-lanceolate in outline, about 12 centimeters in length by 3.5 centimeters in greatest width, which is about halfway between the apex and the base. Apex acute. Base equally acute and somewhat decurrent on the extremely stout petiole, which is about 3 centimeters in length and fully 3 millimeters in diameter; the petiole is notably curved in one specimen. Midrib apparently equally stout below, becoming thinner above; not well seen because all the collected material shows only the upper surface of the leaves. The texture was evidently coriaceous, much like that in the leaves of the commonly cultivated rubber plant, and the venation is made out with difficulty. The secondaries are numerous, thin, and parallel, as in lanceolate fig leaves of the *Ficus elastica* type. The younger leaves are much less elongated, being ovate-lanceolate in outline as shown in Plate XXIV, figure 6. This specimen is 8 centimeters in length by 3 centimeters in maximum width, and the surface is dotted with the leaf spots caused by a species of Sphærites. This fig is the most abundantly represented fossil at the locality 10 miles south of Macon.

Among the 600 or more described living species of Ficus which range over the warmer regions of the whole world, and among 300, more or less, fossil species known, which range from the Cretaceous to the Pleistocene, it would be possible to mention many whose foliage greatly resembles that of the present species, but it is hardly worth while to do more than point out that a number of modern tropical American species have foliage very close to this Eocene form. Various modern species of Ficus have been shown to owe their distribution to fruit-eating birds, and this may well have been the means by which the present species migrated along the Claiborne coast.

Occurrence.—Congaree clay member of McBean formation (of Claiborne group), Fiske property, Grovetown, Columbia County (collected by S. W. McCallie); 10 miles south of Macon, Twiggs County (collected by E. W. Berry).

Collection.—U. S. National Museum.

Order CHENOPODIALES.

Family NYCTAGINACEÆ.

Genus PISONIA Linné.

Pisonia claibornensis sp. nov.

Plate XXVIII, figure 3.

Description.—Leaf ovate, 1.5 centimeters in length by 0.8 centimeter in greatest width, which is a little more than halfway between the base and the apex. Apex obtusely pointed. Base cuneate, slightly more produced and more pointed than the apex. Margin entire. Petiole

[1] Die natürlichen Pflanzenfamilien, pt. 3, 1894.

missing. Midrib rather stout in a leaf so small. Secondaries few, branching from the midrib at an acute angle, 45° or slightly less, and curving upward, camptodrome. Leaf substance thin but apparently coriaceous.

This species, except for its smaller size, is very similar to *Pisonia eocenica*, described by Ettingshausen from the Eocene or lower Oligocene of the Tyrol.[1] Among living species it resembles *Pisonia floridana* Britton of the Florida keys, which is, however, somewhat more rounded apically, giving its leaves a more obovate outline. The fossil is identical in every particular with the smaller leaves of the modern Central American species *Pisonia macranthocarpa* Donnell Smith. Inasmuch as the fossil species is based upon the single specimen figured it is impossible to tell whether the specimen collected is below the average size for the species or not. Presumably the leaves did not grow more than 50 per cent larger than the one figured. In *Pisonia macranthocarpa* the leaves vary considerably in size, some being larger than the fossil and others only one-third its size. Many are almost identical in size.

Several modern species are probably dispersed through the agency of ocean currents, and the same means of distribution may have been adopted by *Pisonia claibornensis*, for many of its associates seem to have been similarly adapted for sea voyages.

Members of the genus are not rare in the fossil state. The oldest recorded species is based on leaves described by Velenovsky from the Chlomeker sandstone near Leipa, Bohemia, as *Pisonia atavia*.[2] These are of Upper Cretaceous and probably Senonian age, and if collected at a homotaxial horizon in this country would be referred to the genus Persoonia Swartz.[3] No other Cretaceous leaves have been referred to Pisonia,[4] although Lesquereux referred the only American species ever described, *Pisonia racemosa*,[5] to the Laramie. The material came from the "Black Buttes beds" of Wyoming, whose exact age has never been settled, although it may be basal Eocene. This species, which was based both on leaves and on fruiting specimens, had somewhat larger, more rounded leaves, and more ascending secondaries than the Georgia fossil. Five species recorded from the European Tertiary have the following distribution:

Pisonia lancifolia Heer, Flora Tertiaria Helvetiæ, vol. 2, 1856, p. 75, Pl. LXXXVIII, fig. 4; Tortonian of Switzerland.

Pisonia ovata Ludwig, Palæontographica, vol. 8, 1859, p. 107, Pl. XLIV, figs. 1 and 2; Oligocene of Hesse.

Pisonia bilinica Ettingshausen, Die fossile Flora des Tertiär-Beckens von Bilin, pt. 1, 1867, p. 89, Pl. XXIX, figs. 2 and 4; Miocene of Bohemia.

Pisonia radobojana Ettingshausen, Beiträge zur Kenntniss der fossile Flora von Radoboj, 1870, p. 877; Sarmatian of Croatia (leaves and fruit).

Pisonia eocenica Ettingshausen, previously mentioned; leaves and fruit in the lignites of Häring in the Tyrol. These beds are referred to the Ligurian by Gumbel and Friedrich, to the Stampian by De Lapparent, and to the Sannoisian by Douxami and Marty. The same species has been identified in the Oligocene of Saxony, Styria, Dalmatia, and Switzerland, and in the Miocene of Styria and Carniola. Massalongo records it from the Messinian of Italy.

The modern species of Pisonia are numerous and occur in the tropics of both hemispheres. They are largely developed in Central and tropical South America and several species appear in the West Indies and Antilles. Heimerl[6] divides the genus into six sections, some of which should undoubtedly be given generic rank; in fact, Britton[7] proposes to form from the West Indian, Bahaman, and Antillean species the genus Torrubia Velloso (Fl. Flum., 1825, p. 139), restricting Pisonia to vines to correspond with the type species *Pisonia aculeata* Linné.

Foreign usage and geologic considerations, which are even more important, make it inadvisable to follow too closely the innovations of systematists dealing only with existing flora; and especially where use of one or another name for closely related genera is in question, it is believed that a somewhat conservative course is the more desirable. The present species is therefore referred to Pisonia.

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[1] Die tertiäre Flora von Häring in Tirol: Abhandl. K.-k. geol. Reichsanstalt, vol. 2, Abth. 3, 1853, p. 43, Pl. XI, figs. 1-22.

[2] Die Flora böhmischen Kreideformation, pt. 4, 1885, p. 6, Pl.VIII, figs. 13 and 14.

[3] Cf. *Persoonia lesquereuxii* Knowlton, The flora of the Dakota group: Mon. U. S. Geol. Survey, vol. 17, 1892, p. 89, Pl. XX, figs. 10-12.

[4] The writer has recently described (Bull. Torrey Bot. Club, vol. 37, 1910, p. 191) a well-characterized Cretaceous species of Pisonia from the Black Creek formation of North Carolina, and the genus has also been found to be represented at various Tertiary horizons in the Mississippi embayment area.

[5] The Tertiary flora, 1878, p. 209, Pl. XXXV, fig. 4.

[6] Engler, A., and Prantl, K., Naturlichen Pflanzenfamilien, vol. 3, Abth. 1, 1889.

[7] Bull. Torrey Bot. Club, vol. 31, 1904, pp. 611-615.

Occurrence.—Congaree clay member of McBean formation (of Claiborne group), Phinizy Gully, Columbia County; 10 miles south of Macon, Twiggs County. (Collected by E. W. Berry.)

Collection.—U. S. National Museum.

Order ROSALES.

Family MIMOSACEÆ.

Genus MIMOSITES.

MIMOSITES GEORGIANUS sp. nov.

Plate XXVII, figures 5–9.

Description.—Leaflets of small size, ovate-lanceolate in outline, somewhat inequilateral, sessile, ranging from 2 to 3.8 centimeters in length and from 0.5 to 0.8 centimeter in maximum width, which may be in the apical or basal portion of the leaf or halfway between. Apex rounded or obtusely pointed. Base somewhat rounded or cuneate and pointed. Some of the leaves are perfectly symmetrical, others are somewhat extended apically, and still others have the base slightly extended. Margins entire. Midrib fairly stout below, thin above. Venation not seen.

These small leaflets are common at the Phinizy Gully locality but rare at the other Claiborne outcrops. They are almost identical with the leaflets of various modern Mimosaceæ. The fossil species of Mimosites are numerous and many species are contained in undescribed collections from the Wilcox group in the Mississippi embayment area.

Occurrence.—Congaree clay member of McBean formation (of Claiborne group). Phinizy Gully, Columbia County, Ga. (collected by E. W. Berry); Grovetown (collected by T. W. Vaughan); 10 miles south of Macon, Twiggs County (collected by E. W. Berry).

Collection.—U. S. National Museum.

Order SAPINDALES.

Family DODONÆACEÆ.

Genus DODONÆA Linné.

DODONÆA VISCOSOIDES sp. nov.

Plate XXVIII, figures 4–8.

Description.—Leaves somewhat variable in shape, obovate in general outline, ranging from 4 to 7.5 centimeters in length by 1 to 2 centimeters in greatest width, which is usually above the center of the leaf. Sessile or nearly so. Apex rounded, in many specimens broadly; base extended, more or less narrowly cuneate with straight sides. Texture coriaceous. Midrib medium, becoming attenuated apically. Secondaries slender, commonly obscure, particularly in impressions of the upper surface of the leaves; 6 to 10 pairs, indifferently opposite, subopposite, and alternate, camptodrome; they branch from the midrib at angles which may be as small as 12° or as large as 70°, the basal ones becoming very ascending in specimens in which the base is much produced; the normal angle of divergence is about 45°. The basal secondaries branch near the base of the leaf and take a nearly straight ascending course parallel with the leaf margin and 1 to 2 millimeters from it, connecting almost a third of the length of the leaf from the base with a short outwardly and downwardly directed branch from the secondary next above. The other secondaries are placed at regular intervals and are more or less straight halfway to the margin, at which point they curve upward in a wide arch to joint an outwardly directed branch from the next succeeding secondary; beyond this they form a series of very small arches parallel with the margin and of a caliber which might well be termed tertiary. Tertiaries straight, lateral, or transverse in direction. Areolation fine, four or five sided.

This species is one of the commonest forms found in the Georgia Eocene, and apparently will prove a useful type fossil for this horizon, as it occurs at all the localities where fossil plants have been observed in the Claiborne of Georgia. The collection contains 10 specimens from the locality south of Macon, a large number from Phinizy Gully, and several on the reverse of one of the figured specimens of Thrinax from the Fiske property at Grovetown. Fragments of these leaves were also observed at other localities in the vicinity of Grovetown, where they were too poorly preserved to warrant being collected.

About 15 fossil species of Dodonæa have been described, and all are European but one, which is based on a rather doubtful fruit from Florissant, Colo., that is probably an Ulmus.[1] Seven of these 15 species are Oligocene, embracing both leaves and characteristic fruits and recorded from Styria, Prussia, France, Tyrol, and Switzerland. Seven are Miocene, including both leaves and fruit and coming from Baden, Croatia, Switzerland, Prussia, and Bohemia. Of these European forms *Dodonæa vetusta* Heer,[2] from the Aquitanian of Switzerland, and *Dodonæa prisca* Weber,[3] from the Aquitanian of Rhenish Prussia, are quite similar to the Georgia species and clearly represent the same type of leaf, although they show marked specific differences. It seems probable that some of the leaves from the American Eocene and the European Gypse (Ligurian) commonly referred to the willow oaks, represent Dodonæa. For example, Saporta describes two species of Dodonæa fruits from St. Zacharie, France, but no leaves, although the late Eocene and early Oligocene have furnished a number of suggestive leaves of this genus which have been usually referred to Quercus.

In the modern flora there are about 50 species of Dodonæa, more than 40 of these being Australian. A single species is found in the Hawaiian Islands and another in Madagascar. The Claiborne form closely resembles the mdoern *Dodonæa viscosa* Linné, which is found in peninsular Florida and on the keys, as well as in the oriental and occidental tropics, and which ranges as far north as Bermuda (latitude 32°), where it frequents the inner edges of the sand dunes. It is a small sapindaceous tree of the "beach jungle" and is one of the prominent forms in the tropical plant association named by Schimper the Barringtonia formation. It is protected from the strong isolation by varnished leaves with a thick epidermis and reduced stomata. Like many other strand plants, it is distributed largely through the agency of ocean currents.

As is true of numerous other late Cretaceous and Tertiary dicotyledonous genera, the former world-wide range of Dodonæa has given place to modern massing of its species in a single region in the southern hemisphere with only a few outlying and scattered species in other regions, to witness its former cosmopolitanism.

Occurrence.—Congaree clay member of McBean formation (of Claiborne group). Phinizy Gully, Columbia County (collected by E. W. Berry); Grovetown, Columbia County (collected by S. W. McCallie and T. W. Vaughan); 10 miles south of Macon on Macon-Marion public road, Twiggs County (collected by S. W. McCallie and E. W. Berry).

Collection.—U. S. National Museum.

Family SAPINDACEÆ.

Genus SAPINDUS Linné.

SAPINDUS GEORGIANA sp. nov.

Plate XXVII, figures 11 and 12.

Description.—Leaflets small, lanceolate, falcate, 4 to 5.5 centimeters in length by 0.5 to 0.9 centimeters in greatest width, which is in the central part of the leaf. Apex and base both acuminate. Margin entire. Midrib stout below, becoming thin above. Secondaries, six to eight alternate pairs, branching from the midrib at an acute angle and curving upward, camptodrome, very fine and made out with difficulty.

There are more than 50 fossil species of Sapindus, ranging from the Cenomanian of America, Europe, and Greenland through the various Tertiary horizons to the Pleistocene. Among these species are three which approach the Georgia species—*Sapindus affinis* Newberry, *Sapindus angustifolius* Lesquereux, and *Sapindus stellariæfolia* Lesquereux. *Sapindus affinis* Newberry,[4]

[1] Lesquereux, Leo, The Cretaceous and Tertiary floras, 1883, p. 182, Pl. XXXVI, fig. 5.
[2] Flora Tertiaria Helvetiæ, vol. 3, 1859, p. 64, Pl. CXXI, figs. 13, 14.
[3] Weber, C. O., Palæontographica, vol. 2, 1852, p. 85, Pl. V, fig. 8.
[4] Newberry, J. S., The later extinct floras of North America: Mon. U. S. Geol. Survey, vol. 35, 1898, p. 116, Pls. XXX, fig. 1, and XL, fig. 2.

though perfectly distinct, in its smaller leaflets somewhat resembles the broader forms from Georgia. *Sapindus angustifolius* Lesquereux,[1] a Florissant, Colo., species which has been identified (probably erroneously) in the "Eolignitic" of Kentucky and Louisiana by Lesquereux and Hollick, respectively, is also very similar to the broader Georgia leaves. Finally, *Sapindus stellariæfolius* Lesquereux,[2] from Florissant, very closely approaches the Georgia species. It is, however, somewhat smaller, although it preserves the same general outlines, and according to Cockerell is not of Green River age, as suggested by Lesquereux, but of late Miocene, which serves to emphasize its specific distinctness.

The modern species of Sapindus number about 10; they inhabit warm temperate and tropical Asia and America. At least four species are found within the limits of the United States, and it would not be difficult to select leaflets from the common *Sapindus marginatus* Willdenow from the same area as the fossil species which would approach it very closely. The fossil is, however, more nearly related in all probability to *Sapindus saponaria* Linné, a common West Indian and South American tree which reaches the Florida keys and which has become a widespread member of the littoral flora through the agency of ocean currents. Hemsley records an instance of seeds of this species which were washed ashore on the south coast of Bermuda, germinating after their ocean voyage of about 900 miles (?).

A number of additional comparisons may be suggested, as, for example, with the leaves, so common in the Oligocene of Europe, which are referred to the Australian myrtaceous genus Callistemon R. Brown and to Callistemophyllum Ettingshausen. Among existing species the leaves of *Sapindus georgiana* may also be compared with those of *Gomphia linearis* of the South American Ochnaceæ and *Rhus lanceolatea* A. Gray, a Texas species of Anacardiaceæ.

Occurrence.—Congaree clay member of McBean formation (of Claiborne group). Phinizy Gully, Columbia County, Ga. (Collected by E. W. Berry.)

Collection.—U. S. National Museum.

Order THYMELEALES.

Family LAURACEÆ.

Genus MALAPOENNA Adanson.

MALAPOENNA sp.

Plate XXVII, figure 10.

Description.—A single poorly preserved lauraceous fruit was obtained from the locality south of Macon. It is too poor for adequate description, and is referred with hesitation to the genus Malapoenna.

Occurrence.—Congaree clay member of McBean formation (of Claiborne group), 10 miles south of Macon, Twiggs County, Ga. (Collected by E. W. Berry.)

Collection.—U. S. National Museum.

Order MYRTALES.

Family RHIZOPHORACEÆ.

Genus RHIZOPHORA Linné.

RHIZOPHORA EOCENICA sp. nov.

Plate XXIX, figures 1 and 2.

Description.—Leaves of small size (presumably young) and of medium size, elliptical in outline, rounded or obtusely pointed at the apex, a few somewhat emarginate smaller-sized variants from the normal form. The base slightly narrowed and broadly cuneate. Margins entire. Length about 7 to 8 centimeters; greatest width about 3.3 centimeters. Texture coriaceous, especially in the leaf shown in figure 1, Plate XXIX, in which the margins were

[1] Lesquereux, Leo, The Tertiary flora, 1878, p. 265, Pl. XLIX, figs. 2–7.

[2] Idem, p. 264, Pl. XLIX, fig. 1.

apparently somewhat revolute. Midrib and petiole extremely stout. Secondary venation immersed and not seen.

Leaves of this species are not common in the collections, probably because the collections are small and far from representative. The species is, however, of peculiar interest in that it sheds much light on the environment of the Claiborne flora of Georgia. Because of this great care has been taken to compare the present fossils with the leaves of all living or extinct forms which might be expected to occur in the latitude of Georgia at this stage of the Eocene. The species is obviously new to science, and it shows so many points of contact with the modern forms of Rhizophora, especially with *Rhizophora mangle* Linné of the American tropics, that its reference to this genus seems clearly warranted. With the exception of a single specimen of Rhizophora described by Massalongo[1] from the later Tertiary (Messinian) of the east coast of Italy, and a form referred to this genus by Ettingshausen, this is the only known fossil representative of this widespread modern genus. The form determined by Ettingshausen came from the Ligurian-Aquitanian of Austria, and was compared by him with the existing *Rhizophora parvifolia* Roxburg, of the East Indies.[2] The similarity of this form to various members of the Myrtaceæ and Leguminosæ, however, caused Schenk[3] to express doubt of Ettingshausen's identification.

It is possible that in the past leaves of this genus may not have been recognized when collected; the leaves from the "Eolignitic" which Lesquereux[4] identified with *Quercus chlorophylla* Unger are almost certainly not that species and are very similar to Rhizophora leaves. Not having seen the specimens, the writer is not justified in doing more than to call attention to this possible relation.

There are three existing species of Rhizophora. *Rhizophora mangle* Linné of the American tropics is found as far north as Mosquito Inlet and Cedar Key in peninsular Florida and at the mouth of the Mississippi; it also extends from the Mexican coast for some distance along the coast of Texas. It occurs throughout the Bahamas and West Indies and very generally throughout Central America and northern South America, having in comparatively recent times extended its range northward through the Bahamas to Bermuda. On the west coast it is found northward to Lower California and southward to the Galapagos Islands. *Rhizophora mucronata* Lamarck ranges from southern Japan to northern Australia and westward to east Africa; *Rhizophora conjugata* Linné is confined to tropical Asia. Doubtless modern systematists will differentiate additional specific forms, but judging by the rather uniform habits of these plants such differentiation will be based on minor characters. The mangrove plants possess the singular ability to flourish in sea water, and their manner of life and development have become well adapted both structurally and physiologically to their mode of existence, so that they have become widely disseminated and individually abundant; in fact, they are the most remarkably specialized plants for this habitant known, and their specialization was in a measure reached in the Eocene. They do much work as makers of land, as has often been described, and they are especially well developed on low shores around the heads of tropical or subtropical bays and estuaries. (See Pl. XVI, p. 160.) It is believed that the Grovetown locality was well toward the northern limit of the range of mangrove swamps in Claiborne time and that they were not so prominent an ecologic feature there as they evidently were farther south. Presumably there were some such swamps in the Grovetown estuary and elsewhere along the Claiborne coast from which the present leaves were derived, and possibly the lignite deposits a few miles southwest of Grovetown may represent such a swamp in place. The shores of this estuary were for considerable distances sandy, made up of the reworked sands of the Lower Cretaceous, as is shown by the fossil plants collected, for plants characteristic of the beach jungle predominate over those characteristic of mangrove swamps.

[1] Studii sulla flora fossile e geologia stratigraphica del Semigalliese, 1859, p. 407.
[2] Die Tertiäre Flora von Häring in Tirol, 1853, p. 82, Pl. XXVII, figs. 28 and 29.
[3] Zittel's Handbuch, Abth. 2, 1890, p. 632.
[4] Proc. Am. Philos. Soc., new ser., vol. 13, 1869, p. 416, Pl. XVII, figs. 5-7.

Occurrence.—Congaree clay member of McBean formation (of Claiborne group), Phinizy Gully, Columbia County, Ga. (collected by E. W. Berry); a well 13½ miles west of Sandersville, Washington County, Ga. (collected by S. W. McCallie); a locality 10 miles south of Macon, Twiggs County, Ga. (collected by E. W. Berry).

Collection.—U. S. National Museum.

Family COMBRETACEÆ R. Brown (TERMINALIACEÆ J. St. Hilaire)

Genus TERMINALIA Linné.

TERMINALIA PHÆOCARPOIDES sp. nov.

Plate XXIX, figure 3.

Description.—Leaves of medium and large size, broadly obovate in general outline with a rounded or pointed apex and a cuneate base. Margins entire. Length about 15 or 16 centimeters, and greatest width, which is above the middle, about 7 or 8 centimeters. Midrib stout. Secondaries about 8 pairs, subopposite or alternate, branching from the midrib at angles of about 50° and curving upward, approximately parallel, camptodrome. Tertiary venation not seen. As the remains of this species are merely impressions the texture can not be determined.

In a more northern flora this species would doubtless be compared with a Magnolia, and possibly some fossil species of Magnolia may be profitably compared with Terminalia. Otherwise the abundance of Terminalia in the European Tertiary, where it furnishes both leaves and characteristic fruits, and its absence from America is difficult to understand.

The present species is very similar to the modern widespread *Terminalia catappa* Linné if the apical portion, which is unfortunately missing, is broad and rounded like the outside dotted line in the figure; and is very similar to the modern *Terminalia phæocarpa* Eichler of northern South America if the outline corresponds to the inner dotted line in the figure.

The modern species of Terminalia are all tropical and number more than 100 forms, distributed among the various continents in the following proportions according to Engler and Prantl: America, 24; Asia, 27; Madagascar, 16; Africa, 17; Australia, 19. One indigenous species, *Terminalia buceras*, reaches the United States; it is common along the shores of the Caribbean Sea, extending northward through the West Indies to Elliotts Key, Fla., and growing generally on coral soil.

The present species is the only known American fossil member of this genus. About a dozen species are described from Europe, the oldest, not positively identified, coming from the Upper Cretaceous of Bohemia. One species is described from the lower Oligocene of Aix (Provence, France) and the others range in age from the Oligocene to the Pliocene and are represented by both leaves and fruit. They are especially common along the extended late Tertiary seacoast of south-central Europe, the Messinian showing four species, the Sarmatian three, and the Astian two. The European fossil form nearest the Georgia form, though the resemblance is not especially close, is *Terminalia radobojensis* Unger, which has a recorded range from the Tongrian to the Astian.

Terminalia catappa is one of the prominent elements in the oriental littoral forest or beach jungle of the Tropics (Barringtonia formation of Schimper), its buoyant fruits having enabled it to become widespread within its limits of range through the agency of ocean currents. In this connection attention should be called to the two species *Magnolia hilgardiana* [1] and *Magnolia laurifolia* [2] described by Lesquereux from the "Eolignitic" of the Mississippi embayment. Either of these species may find its nearest modern affinity among the various species of Terminalia rather than Magnolia, and it is perhaps significant that Lesquereux compared the second of these to the European Tertiary species *Terminalia radobojensis* Unger.

Occurrence.—Congaree clay member of McBean formation (of Claiborne group). Fiske property, Grovetown, Columbia County. (Collected by S. W. McCallie.)

Collection.—U. S. National Museum.

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[1] Lesquereux, Leo, Proc. Am. Philos. Soc., new ser., vol. 13, 1869, p. 421, Pl. XX, fig. 1.

[2] Idem, p. 421, Pl. XX, figs. 2 and 3.

Genus CONOCARPUS Linné.

CONOCARPUS EOCENICA sp. nov.

Plate XXIX, figures 4–7.

Description.—Leaves of medium and small size, lanceolate and usually inequilateral in outline, with an obtusely pointed apex and a similarly pointed base, margins entire. Length 6 to 10 centimeters; greatest width, which is about midway between the apex and the base, 1.5 to 2.6 centimeters. Midrib stout. Secondaries remote, about six pairs, opposite or subopposite, branching from the midrib at angles of about 50°, extending outward and then sweeping upward in a broadly rounded curve, parallel with the margin and approximately parallel with their fellows, ultimately camptodrome. Tertiaries fine forming a polygonal areolation.

This species is represented by several specimens from both localities near Grovetown and is obviously related to Conocarpus both in outline and in venation, as well as probably in habitat.

Conocarpus is a monotypic genus in the existing flora, the single species, *Conocarpus erectus* Linné, being 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 found in the Galapagos Islands and extends northward from the West Indies to the Florida Keys and to Bermuda, where it is found on the sand dunes. Its distribution has been effected through the agency of ocean currents. The fossil form appears to be closest to the modern variety *arboreus* Grisebach of Central America. The modern species is not only a typical member of the mangrove association of Africa and America, but much more widespread than the mangroves, for it is equally a plant of strand and dunes. The texture and anatomy of its leaves differ somewhat according to their degree of exposure to the rays of the sun.

No other fossil species of Conocarpus are known, but this species may be compared with certain European Tertiary forms referred to the allied genus Eugenia, of which several have been described, more especially from the Oligocene. Both *Eugenia aizoon* Unger and *Eugenia haeringiana* Unger are somewhat similar to the Georgia leaf.

Occurrence.—Congaree clay member of McBean formation (of Claiborne group). Phinizy Gully, Columbia County, Ga. (collected by E. W. Berry); Fiske property, Columbia County, Ga. (collected by S. W. McCallie); 10 miles south of Macon, Twiggs County, Ga. (collected by E. W. Berry).

Collection.—U. S. National Museum.

EOCENE FLORAS OF EUROPE AND NORTH AMERICA.

A large number of species of plants have been described from various Eocene localities in Europe, but the data for an accurate comparison of these floras with that of the Claiborne are most incomplete. This lack of data is due in a measure to the fact that the bulk of the European Eocene deposits are marine, and the usual difficulties in correlation present themselves when the attempt is made to compare isolated fluviatile and lacustrine plant-bearing beds with their marine equivalents where the standards and nomenclature are largely those of invertebrate paleontology. This is particularly true of the Eocene, because the most complete paleobotanic section of this age, which is checked by paleozoology, has remained to a large extent undescribed. The splendid series of plant-bearing horizons of the south of England have, with the exception of sporadic descriptions of certain local florules by De la Harpe, Heer, Ettingshausen, and others, and the work of J. Starkie Gardner on the ferns and conifers, remained unknown down to the present. It seems remarkable that only two Englishmen, Bowerbank and Gardner, have devoted any considerable attention to these floras, and the latter failed to complete his work, so that in many ways the most interesting part of the British Eocene flora, certainly the most useful for purposes of correlation, remains unknown to science except for various antiquated and scattered references.

A brief sketch will be given of the present state of knowledge of European Eocene floras, commencing with the earliest and giving special attention to the floras more nearly homotaxial with the American Claiborne.

The basal Eocene beds, Montian and Thanetian stages (Paleocene of Schimper and Saporta and lower Landenian of the last edition of De Lapparent) furnish a fairly representative flora described from the plastic clay of Trieu de Leval (Hainaut) Belgium by Marty,[1] from the travertines of Sézanne, France, by Saporta,[2] and from the marnes heersiennes of Gelinden, Belgium, by Saporta and Marion.[3] In addition to these two florules a few scattered algæ and fragments of land plants are preserved in the marine deposits of these stages.

The lower Eocene beds, Sparnacian and Ypresian[4] stages, include in earlier deposits the flora found in the Oldhaven, Woolwich, and Reading beds of England, largely unstudied, and the small flora recently described by Fritel[5] from the Paris basin. In their later deposits (Cuisian of Dollfuss, 1909, in part the Londinian of Mayer-Eymar, 1857) they include the flora of the grès de Belleu in France[6] and those of Alum Bay and the London clay in England. The London clay fossils are largely lignitized and pyritized fruits and seeds from the Isle of Sheppey and leaf impressions from the pipe clay of Alum Bay. These have never been figured or carefully studied, but the following old list will give some idea of the Alum Bay flora:

Alum Bay flora as determined by Ettingshausen.[7]

Acacia brittanica Ettingshausen and Gardner.
sotzkiana Unger.
Acer eocenicum Ettingshausen and Gardner.
præ-decipiens Ettingshausen and Gardner.
Adenopeltis alumensis Ettingshausen and Gardner.
Alyxia europæa Ettingshausen and Gardner.
Amygdalus pereger Unger.
præ-œningensis Ettingshausen and Gardner.
tenue-striata Ettingshausen and Gardner.
Andromeda protogæa Unger.
Anemia subcretacea Saporta.
Anona cyclosperma Ettingshausen and Gardner.
elongata Ettingshausen and Gardner.
Apocynophyllum grande Ettingshausen and Gardner.
haeringianum Ettingshausen.
præ-amsonia Ettingshausen and Gardner.
titaniæ Ettingshausen and Gardner.
Aralia primigenia De la Harpe.
Aristolochia alumensis Ettingshausen and Gardner.
Aronium eocenicum Ettingshausen and Gardner.
Artocarpidium grandifolium Ettingshausen and Gardner.
integrifolium Unger.
Arundo goepperti (Muenster).
Banksia dillenioides Ettingshausen.
ungeri Ettingshausen.
Bombax menjæ Ettingshausen and Gardner.
sagorianum Ettingshausen.
tenuinerve Ettingshausen and Gardner.
Bumelia dryadum Ettingshausen and Gardner.
oreadum Unger.
Cæsalpinia æmula Heer.
haidingeri Ettingshausen.
Callicoma fornacis Ettingshausen and Gardner.
Callistemophyllum diosmoides Ettingshausen.
Callistemophyllum elegans Ettingshausen and Gardner.
melaleucæforme Ettingshausen.
obtusum Ettingshausen and Gardner.
Callitris curta Bowerbank.
Carpolithes alumensis Ettingshausen and Gardner.
crassipes Ettingshausen and Gardner.
elliptico-valvatus Ettingshausen and Gardner.
napærum Ettingshausen and Gardner.
præboveyanus Ettingshausen and Gardner.
tricoccinus Ettingshausen and Gardner.
Cassia berenices Unger.
fischeri Heer.
feroniæ Ettingshausen.
hyperborea Unger.
memnonia Unger.
phaseolites.
præ-lignitum Ettingshausen and Gardner.
præ-memnonia Ettingshausen and Gardner.
præ-phaseolites Ettingshausen and Gardner.
præ-sagorina Ettingshausen and Gardner.
præ-stenophylla Ettingshausen and Gardner.
pseudo-glandulosa Ettingshausen.
sagoriana Ettingshausen.
ungeri De la Harpe.
zephyri Ettingshausen.
Cecropia eocenica Ettingshausen and Gardner.
Cedrela primigenia Ettingshausen and Gardner.
Celastrophyllum undulatium Ettingshausen and Gardner.
Celastrus elænus Unger.
fengæ Ettingshausen and Gardner.
myricinus Ettingshausen and Gardner.
præ-europæus Ettingshausen and Gardner.
salidæ Ettingshausen and Gardner.
tafnis Ettingshausen and Gardner.

[1] Études sur les végétations fossiles du Trieu de Leval (Hainaut): Mém. Musée d'hist. nat. Belgique, vol. 5, 1907. This is an older flora than that of Gelinden or Sézanne and is said to show affinities with tropical American flora.

[2] Prodrome d'une flore fossile des travertins anciens de Sézanne: Mém. Soc. géol. France, 2d ser., vol. 8, 1868, pp. 289–436, Pls. XXII–XXXVI.

[3] Saporta, G. de, and Marion, A. F., Essai sur l'état de la végétation à l'époque des marnes heersiennes de Gelinden: Mém. cour. et des Sav. étrang. Acad. roy. Belgique, vol 37, 1873, No. 6, pp. 1–94, Pls. I–XII. Revision de la flore heersienne de Gelinden, etc.: Idem, vol. 41, 1878, No. 3, pp. 1–112, Pls. I–XIV.

[4] These and other Eocene floras of the Paris basin are at present being admirably revised by Prof. P. H. Fritel, of the Museum of Natural History, Paris.

[5] Fritel, P. H., Étude sur les végétaux fossiles de l'étage Sparnacien du bassin de Paris: Mém. Soc. géol. France, vol. 16, 1910, No. 40.

[6] Watelet, A., Description des plantes fossiles du bassin de Paris, 1866.

[7] Proc. Roy. Soc. London, vol. 30, 1880, pp. 228–236.

Celtis woodwardi Ettingshausen and Gardner.
Ceratopetalum crassipes Ettingshausen and Gardner.
haeringianum Ettingshausen.
manni Ettingshausen and Gardner.
Chrysodium lanzeanum (Visiani).
Cinchonidium lanceolatum Ettingshausen and Gardner.
præ-bilinicum Ettingshausen and Gardner.
præ-latifolium Ettingshausen and Gardner.
Cinnamomum eocenicum Ettingshausen.
polymorphum Al. Braun.
rossmæssleri Heer.
Cissus auroræ Ettingshausen and Gardner.
celastrifolia Ettingshausen and Gardner.
Clerodendron europæum Ettingshausen and Gardner.
Comptonia acutiloba (Sternberg).
Copaifera harpei Ettingshausen and Gardner.
prisca Ettingshausen and Gardner.
veledæ Ettingshausen and Gardner.
Cornus atlantica Ettingshausen and Gardner.
Cupania corrugata Bowerbank.
depressa Bowerbank.
grandis Bowerbank.
lobata Bowerbank.
subangulata Bowerbank.
tumida Bowerbank.
Cupressinites globosus Bowerbank.
Cyperites eocenicus Ettingshausen and Gardner.
Dalbergia cyclophylla Ettingshausen and Gardner.
eocenica Unger.
haeringiana Ettingshausen.
longifolia Ettingshausen and Gardner.
primæva Unger.
ungeri Ettingshausen.
Daphne aquiranica Ettingshausen.
Daphnogene anglica Heer.
veronensis Massalongo.
Diospyros eocenica Ettingshausen and Gardner.
Dodonea præ-salicites Ettingshausen and Gardner.
subglobosa Ettingshausen and Gardner.
Elæodendron dubium Ettingshausen.
Eucalyptus haeringiana Ettingshausen.
oceanica Unger.
Eugenis apollinis Unger.
Fagus intermedia Ettingshausen and Gardner.
Ficus arenacea Lesquereux.
bowerbankii De la Harpe.
bumeliæfolia Ettingshausen.
cisæ Ettingshausen and Gardner.
deleta Ettingshausen and Gardner.
falconeri Heer.
granadilla Massalongo.
hydrarchos Unger.
inguionis Ettingshausen and Gardner.
jynx Unger.
lanceolata Heer.
morrisii De la Harpe.
nerthi Ettingshausen and Gardner.
planicostata Lesquereux.
præ-arcinervis Ettingshausen and Gardner.
præ-lanceolata Ettingshausen and Gardner.
reussii Ettingshausen.
rhamnoides Ettingshausen and Gardner.
wudgæ Ettingshausen and Gardner.
Flabellaris sp.
Fraxinus jovis Ettingshausen and Gardner.
præ-savinensis Ettingshausen and Gardner.
Glycyrrhiza deperdita Unger.
Glyptostrobus europæus Brongniart.
Grevillea hermionis Ettingshausen and Gardner.
Grewiopsis integerrima Ettingshausen and Gardner.
Hightea elliptica Bowerbank.
turbinata Bowerbank.
Hiraea intermedia Ettingshausen and Gardner.
Ilex atlantica Ettingshausen and Gardner.
Juglandites cernuus Saporta.
Juglans præ-parschlugiana Ettingshausen and Gardner.
sharpei De la Harpe.
Lauris agathophyllum Unger.
haidingeri Ettingshausen.
jovis De la Harpe.
lalages Unger.
ocoteides Lesquereux.
primigenia Unger.
salteri De la Harpe.
socialis Lesquereux.
swoszowiciana Unger.
vetusta Saporta.
Leguminosites callisemæfolium Ettingshausen and Gardner.
pachyphyllus Ettingshausen and Gardner.
Lomatia brittanica Ettingshausen and Gardner.
Magnolia stygia Ettingshausen and Gardner.
Malpighiastrum banisterinum Ettingshausen and Gardner.
grandifolium Ettingshausen and Gardner.
præ-venosum Ettingshausen and Gardner.
Marattia hookeri Ettingshausen and Gardner.
Mimosites præ-cassiæformis Ettingshausen and Gardner.
Myrica acuminata Unger.
haeringiana Unger.
lignitum Unger.
sagoriana Ettingshausen.
salicina Unger.
Myrsine erdæ Ettingshausen and Gardner.
Myrtus eocenica Ettingshausen and Gradner.
Nelumbium buchii Ettingshausen.
Notelæa primigenia Ettingshausen and Gardner.
Nymphæa doris Heer.
Nyssa alumensis Ettingshausen and Gardner.
europæa Unger.
præ-striolata Ettingshausen and Gardner.
Olea brittanica Ettingshausen and Gardner.
Palæolobium haeringianum Unger.
heterophyllum Unger.
præ-radobojense Ettingshausen and Gardner.
sotzkianum Unger.
Persoonia eocenica Ettingshausen.
Phaseolites eriosemæfolius Unger.
Phyllites apocynoides Ettingshausen and Gardner.
arbutoides Ettingshausen and Gardner.
cecropioides Ettingshausen and Gardner.
crassipies Ettingshausen and Gardner.
densinervis Ettingshausen and Gardner.
elæocarpoides Ettingshausen and Gardner.
euphorbioides Ettingshausen and Gardner.
ficoides Ettingshausen and Gardner.
franguloides Ettingshausen and Gardner.

Phyllites freæ Ettingshausen and Gardner.
gargantuæ Ettingshausen and Gardner.
hederaceus Ettingshausen and Gardner.
hilticis Ettingshausen and Gardner.
hymenæoides Ettingshausen and Gardner.
lantanoides Ettingshausen and Gardner.
myrtaceus Ettingshausen and Gardner.
nimrodis Ettingshausen and Gardner.
nerthi Ettingshausen and Gardner.
sapindoides Ettingshausen and Gardner.
simaruboides Ettingshausen and Gardner.
syringæformis Ettingshausen and Gardner.
veledæ Ettingshausen and Gardner.
Physolobium antiquum Unger.
orbiculare Unger.
Pisonia eocenica Ettingshausen.
Pistacia brittanica Ettingshausen and Gardner.
Pittosporum eocenicum Ettingshausen and Gardner.
Planera ungeri Ettingshausen.
Podocarpus eocenica Unger.
Podogonium obtussissimum Ettingshasen and Gardner.
sheppyense Ettingshausen and Gardner.
Populus eocenica Ettingshausen and Gardner.
Porana œningenesis Al. Braun.
Proteoides crassipes Ettingshausen and Gardner.
Prunus druidum Ettingshausen and Gardner.
pygmæorum Ettingshausen and Gardner.
Pterospermites dentatus Ettingshausen and Gardner.
Pterospermum eocenicum Ettingshausen and Gardner.
Quercus bournensis Ettingshausen and Gardner.
drymeja Unger.
lonchitis Unger.
lyellii Heer.
præ-lonchitis Ettingshausen and Gardner.
præ-mediterranea Ettingshausen and Gardner.
viburnifolia Lesquereux.
Rhamnus acutangula Ettingshausen and Gardner.
præ-pomaderris Ettingshausen and Gardner.
præ-rectinervis Ettingshausen and Gardner.
Rhus atlantidis Ettingshausen and Gardner.
Rhus cyclophylla Ettingshausen and Gardner.
prisca Ettingshausen.
Rhytisma eucalypti Ettingshausen and Gardner.
priscum Ettingshausen and Gardner.
Sabal major Unger.
Salix præ-integra Ettingshausen and Gardner.
rhedæ Ettingshausen and Gardner.
tenuifolia Ettingshausen and Gardner.
Salmalia borealis Ettingshausen and Gardner.
Santalum acheronticum Ettingshausen.
microphyllum Ettingshausen.
osyrinum Ettingshausen.
salicinum Ettingshausen.
Sapindus angustifolius Lesquereux.
crassinervis Ettingshausen and Gardner.
eocenicus Ettingshausen and Gardner.
falcifolius Al. Braun.
Sapotacites emarginatus Heer.
eocenicus Ettingshausen and Gardner.
sideroxyloides Ettingshausen.
Saurauja robusta Saporta.
Sclerotium antiquum Ettingshausen and Gardner.
Sequoia couttsiæ Heer.
langsdorfii Brongniart.
Smilax lancifolia Ettingshausen and Gardner.
Sophora europæa Unger.
Sterculia labrusca Unger.
sigfridi Ettingshausen and Gardner.
Symplocos brittanica Ettingshausen and Gardner.
Ternstrœmia bilinica Ettingshausen.
eocenica Ettingshausen and Gardner.
Ulmus antiquissima Saporta.
plurinervia Unger.
Vaccinium acheronticum Unger.
eocenicum Ettingshausen and Gardner.
Vitis præ-tentonica Ettingshausen and Gardner.
Zizyphus integrifolius Heer.
pachyneuris Ettingshausen and Gardner.
ungeri Heer.
vetustus Heer.

Isle of Sheppey flora as determined by Ettingshausen.[1]

Acer sp.
Agave eocenica Ettingshausen and Gardner.
Amomum sheppyensis Ettingshausen and Gardner.
stenocarpum Ettingshausen and Gardner.
Amygdalus eocenica Ettingshausen and Gardner.
sporadum Ettingshausen and Gardner.
Apeiobopsis variabilis (Bowerbank).
Apocynophyllum sheppyensis Ettingshausen and Gardner.
Areca prisca Ettingshausen and Gardner.
recentior Ettingshausen and Gardner.
Aronium eocenicum Ettingshausen and Gardner.
Asterocaryum europæum Ettingshausen and Gardner.
Bactris prisca Ettingshausen and Gardner.
Bauhinia primigenia Ettingshausen and Gardner.
Callitris comptoni (Bowerbank).
curta (Bowerbank).
Carpolithes affinis Ettingshausen and Gardner.
amygdaloides Ettingshausen and Gardner.
atlantidis Ettingshausen and Gardner.
Carpolithes biococculatus Ettingshausen and Gardner.
bispermus Ettingshausen and Gardner.
breviangulatus Ettingshausen and Gardner.
brevicristatus Ettingshausen and Gardner.
bruceoides Ettingshausen and Gardner.
caryopsiformis Ettingshausen and Gardner.
caryotoides Ettingshausen and Gardner.
circumscriptus Ettingshausen and Gardner.
colletioides Ettingshausen and Gardner.
costatus Ettingshausen and Gardner.
cruciferinus Ettingshausen and Gardner.
disciformis Ettingshausen and Gardner.
folliculiformis Ettingshausen and Gardner.
franguloides Ettingshausen and Gardner.
hydrophylloides Ettingshausen and Gardner.
lineatus Ettingshausen and Gardner.
metrosideroides Ettingshausen and Gardner.
morrisii Ettingshausen and Gardner.
musæformus Etingshausen and Gardner.

[1] Proc. Roy. Soc. London, vol. 29, 1879, pp. 388–396.

Carpolithes napæarum Ettingshausen and Gardner.
nimrodis Ettingshausen and Gardner.
nyssæformis Ettingshausen and Gardner.
populoides Ettingshausen and Gardner.
pluriocculatus Ettingshausen and Gardner.
punctatostriatus Ettingshausen and Gardner.
radiotopunctatus Ettingshausen and Gardner.
reticulatorugosus Ettingshausen and Gardner.
subalatus Ettingshausen and Gardner.
sulcatus Ettingshausen and Gardner.
tenuepunctatus Ettingshausen and Gardner.
verrucosus Ettingshausen and Gardner.
websterioides Ettingshausen and Gardner.
zizyphoides Ettingshausen and Gardner.
zoroastri Ettingshausen and Gardner.
Caulinites sheppyensis Ettingshausen and Gardner.
Chamærops borealis Ettingshausen and Gardner.
Cinchonidium priscum Ettingshausen and Gardner.
Corchorites quadricostatus Ettingshausen and Gardner.
quinquecostatus Ettingshausen and Gardner.
Corylus primigenia Ettingshausen and Gardner.
Cotoneaster sheppyensis Ettingshausen and Gardner.
Cucumites sheppyensis Ettingshausen and Gardner.
Cupania corrugata (Bowerbank).
depressa (Bowerbank).
grandis (Bowerbank).
inflata (Bowerbank).
lobata (Bowerbank).
pygmæa (Bowerbank).
subangulata (Bowerbank).
tumida (Bowerbank).
Cupressinites elongatus Bowerbank.
globosus Bowerbank.
recurvatis Bowerbank.
subfusiformis Bowerbank.
Cyperites eocenicus Ettingshausen and Gardner.
Diospyros eocenica Ettingshausen and Gardner.
pleadum Ettingshausen and Gardner.
Elæis eocenica Ettingshausen and Gardner.
Eucalyptus oceanica Unger.
Eugenia eocenica Ettingshausen and Gardner.
Euphorbiophyllum eocenicum Ettingshausen and Gardner.
Faboidea acuta Bowerbank.
angustissima Bowerbank.
bifalcis Bowerbank.
complanata Bowerbank.
crassa Bowerbank.
crassicutis Bowerbank.
doliformis Bowerbank.
larga Bowerbank.
longiuscula Bowerbank.
marginata Bowerbank.
oblonga Bowerbank.
ovata Bowerbank.
pinguis Bowerbank.
plana Bowerbank.
planidorsa Bowerbank.
planimeta Bowerbank.
quadrapes Bowerbank.
robusta Bowerbank.
rostrata Bowerbank.
semicurvilinearis Bowerbank.
subdisca Bowerbank.
Faboidea subrobusta Bowerbank.
subtenuis Bowerbank.
symmetrica Bowerbank.
tenuis Bowerbank.
ventricosa Bowerbank.
Hightea elegans Bowerbank.
elliptica Bowerbank.
inflata Bowerbank.
minima Bowerbank.
orbicularis Bowerbank.
oviformis Bowerbank.
turbinata Bowerbank.
turgida Bowerbank.
Hybothya crassa (Bowerbank).
Illicium apollinis Ettingshausen and Gardner.
Iriartea punctata Ettingshausen and Gardner.
striata Ettingshausen and Gardner.
Juglans eocenica Ettingshausen and Gardner.
Laurus lalages Unger.
Lawsonia europæa Ettingshausen and Gardner.
Leguminosites æquilateralis Bowerbank.
cordatus Bowerbank.
crassus Bowerbank.
curtus Bowerbank.
dimidiatus Bowerbank.
elegans Bowerbank.
enormis Bowerbank.
gracilis Bowerbank.
inconstans Bowerbank.
lentiformis Bowerbank.
lobatus Bowerbank.
longissimus Bowerbank.
planus Bowerbank.
reniformis Bowerbank.
rotundatus Bowerbank.
subquadrangularis Bowerbank.
subovatus Bowerbank.
trapeziformis Bowerbank.
Liquidambar eocenicum Ettingshausen and Gardner.
Livistona eocenica Ettingshausen and Gardner.
Magnolia eocenica Ettingshausen and Gardner.
Menispermatacites abutoides Ettingshausen.
Metrosideros microcarpa Ettingshausen and Gardner.
Mimosites brownianus Bowerbank.
Musa eocenica Ettingshausen and Gardner.
Nelumbium buchii Ettingshausen.
microcarpum Ettingshausen and Gardner.
Nipa burtini (Brongniart).
elliptica (Bowerbank).
lanceolata (Bowerbank).
parkinsonis (Brongniart).
semiteres (Bowerbank).
Nyssa eocenica Ettingshausen and Gardner.
Œnocarpus sheppyensis Ettingshausen and Gardner.
Petrophiloides conoideus Bowerbank.
imbricatus Bowerbank.
oviformis Bowerbank.
Pinus sheppyensis Ettingshausen and Gardner.
Podogonium sheppyenses Ettingshausen and Gardner.
Proteoides bisulcatus Ettingshausen and Gardner.
Prunus druidum Ettingshausen and Gardner.
prisca Ettingshausen and Gardner.
Quercus drymeja Unger.

Quercus, eocenica Ettingshausen and Gardner.
lonchitis Unger.
Sabal dianæ Ettingshausen and Gardner.
dryadum Ettingshausen and Gardner.
major Unger.
oreadum Ettingshausen and Gardner.
Salisburia eocenica Ettingshausen and Gardner.
Sapindus eocenicus Ettingshausen and Gardner.
Sapotacites chrysophylloides Ettingshausen and Gardner.
mimusops Ettingshausen.
Sequoia bowerbankii Ettingshausen and Gardner.
Smilax pristina Ettingshausen and Gardner.
Solanites elegans Ettingshausen and Gardner.
Solenostrobus corrugatus (Bowerbank).
semiplotus (Bowerbank).
subangulatus (Bowerbank).
sulcatus (Bowerbank).
Sphæria flabellariæ Ettingshausen and Gardner.
Strychnos urani Ettingshausen and Gardner.
Symplocos radobojana Unger.
Theobroma nimrodis Ettingshausen and Gardner.
zoroastri Ettingshausen and Gardner.
Thlaspidium ovatum Ettingshausen and Gardner.
Tricarpellites aciculatus Bowerbank.
communis Bowerbank.
crassus Bowerbank.
curtus Bowerbank.
gracilis Bowerbank.
patens Bowerbank.
rugosus Bowerbank.
Thrinax bowerbankii Ettingshausen and Gardner.
var. elliptica.
var. globosa.
Victoria najadum Ettingshausen and Gardner.
sheppyensis Ettingshausen and Gardner.
Wetherellia variabilis Bowerbank.
Xulinosprionites latus Bowerbank.
zingiberiformis Bowerbank.

This list, though it leaves much to be desired, shows that the flora of this horizon indicates a considerably warmer climate than the floras which preceded it, though it is doubtful that it was as tropical in character as Gardner represented it to be.

The middle Eocene, with which the Claiborne is more directly comparable, is divided by De Lapparent into the Lutetian and Bartonian stages. The Lutetian, the lower part of the Parisian of D'Orbigny, is marked by an advance of the sea, both in Europe and America. In France the sea advanced southward beyond the old Suessonian shore line around Paris, to the west, and north into Belgium. A similar arm of the sea extended across the present site of the Pyrenees. Practically all Italy and a large part of Austria-Hungary were submerged and a great Mediterranean or Nummulitic sea extended from the Atlantic eastward to the Indian Ocean, over southeastern Europe, northern Africa, and southwestern Asia, and with possibly a narrow northern outlet to the Arctic Ocean across the Russian Empire. The calcaire grossier beds of the Paris basin are typically marine below, becoming lacustrine or fluviatile above (calcaire grossier supérieur). Bureau [1] has described a few plants from these beds, the number including species of Nitophyllum, Pandanus, Flabellaria, Sabal, Palmacites, Yucca, and Nuphar. In the upper beds at Trocadéro, near Paris (argile verte lignitifère), an estuary flora, largely undescribed, occurs. Species identified from this locality include Dryandra, *Euphorbiophyllum vetus*, *Nerium parisiensis*, *Ottelia. parisiensis* (which is comparable with the Potamogeton described in this report), *Pandanus lutetianus*, and *Zizyphus pseudoungeri*. The characteristic large floating seeds of *Nipadites burtini*, also found at this place, suggest an environment like that of Grovetown. The Monte Bolca plant beds of Italy, with their numerous and large palms, are in general of character similar to these other localities. The plant beds of the Bagshot sands and Bournemouth clays of southern England, and possibly those of Antrim and Mull described by J. Starkie Gardner, also belong at about the same level. The south coast flora, of which the angiosperms have never been described or figured, includes the following forms:

FILICALES:
Acrostichum lanzæanum (Visani).
Adiantum apalophyllum Saporta.
Anemia subcretacea (Saporta) Ettingshausen and Gardner.
Asplenites præ-allosuroides Ettingshausen and Gardner.
Gleichenia hantonensis (Wanklyn) Ettingshausen and Gardner.
Glossochlamys transmutans Ettingshausen and Gardner.

FILICALES—Continued.
Goniopteris stiriaca (Unger) Ettingshausen and Gardner.
Hewardia regia Ettingshausen and Gardner.
Lygodum kaulfussi Heer.
Meniphyllum elegans Ettingshausen and Gardner.
Osmunda lignitum (Giebel) Heer.
Phegopteris bunburii (Heer) Ettingshausen and Gardner.
Phegopteris præ-cuspidata Ettingshausen and Gardner.

[1] Études sur la flore fossile du calcaire grossier parisien, Mém. Soc. Philom., 1888, pp. 235-264, Pls. XXII and XXIII.

FILICALES—Continued.
- Phymatodes affine Ettingshausen and Gardner.
- Phymatodes polypodioides Ettingshausen and Gardner.
- Pteris bournensis Ettingshausen and Gardner.
- Pteris eocenica Ettingshausen and Gardner.
- Woodwardia? venosa Ettingshausen and Gardner.

CONIFERALES:
- Araucaria gœpperti Sternberg.
- Cupressus taxiformis Unger.
- Glyptostrobus (Gardner).
- Glyptostrobus eocenum (Gardner).
- Pinus bowerbankii Carruthers.
- Pinus dixoni Bowerbank.
- Podocarpus eocenica Unger.

CONIFERALES—Continued.
- Podocarpus? incerta Gardner.
- Sequoia couttsiæ Heer (considered an Arthrotaxopsis by Gardner).
- Sequoia tournalii (Brongnart) Saporta.

MONOCOTYLEDONÆ:
- Numerous specimens of both fan and feather palms (Iriartæa, Phœnix, Calamus, and Nipa).

DICOTYLEDONÆ:
- Castanea-like leaf (=Godoya? according to Gardner).
- Ficus.
- Myrica.
- Cinnamomum.
- Dioscorea.

The flora of the pottery clays and lignites of Bovey Tracey in Devonshire was fully described by Heer [1] in 1863, who referred it to the Aquitanian. This determination was questioned by J. Starkie Gardner,[2] who considered the Bovey Tracey flora to be of the same age as that from Bournemouth, or Lutetian. Notwithstanding the inadequacy of the evidence in support of Gardner's opinion, it was generally accepted, especially in Great Britain. Recently Clement and Eleanor M. Reid [3] have reexamined both the geology and the flora of Bovey Tracey and have corroborated Heer's conclusion that these thick deposits (160 meters) are a unit of upper Oligocene age. They are considered homotaxial with the Wetterau lignites of Germany (Aquitanian or lower Miocene of the fifth edition of De Lapparent).

The Bartonian or upper Parisian takes its name from the Barton clays of England (100 meters thick), with an undescribed flora, and there are scattered florules of this age from various localities in France and Italy. Such a florule from Brives in Velay has been partially described by Saporta.[4] It includes the following genera: Acacia?, Andromeda, Comptonia, Dryandra, Laurus, Leguminosites, Magnolia, Myrica, Myrsine, Phœnix, Populus, Quercus, Sabalites, Sapotacites, Sapindus, Sophora?, and Zanthoxylon?.

From Main, Anjou, and Vendée, in western France, Crié in various contributions [5] has described a flora of this age in more than 50 species, referred to the following genera: Anacardites, Anemia, Andromeda, Apeiobopsis, Apocynophyllum, Bambusa, Bumelia, Celastrus, Diospyros, Echitonium, Ficus, Flabellaria, Laurus, Lygodium, Morinda, Myrica, Myrsine, Nerium, Palmacites, Podocarpus, Quercus, Sabalites, and others.

The upper Eocene—Ludian, Priabonian, and Ligurian (if the last is made to include the "gypse," which by many students is placed in the lower Oligocene)—has a rich flora, that described by Saporta [6] from Aix in Provence, France, being the most complete and remarkable. It is much later in character than the Claiborne flora and need not be considered in detail. The floras from the lignites of Häring [7] in the Tyrol and from Monte Promina [8] and other localities in Dalmatia [9] belong at about this level or slightly higher.

In North America, on the border between the Cretaceous and the Eocene in the Rocky Mountain province, a large number of local floras appear. These floras are found in the Arapahoe and Denver formations of Colorado, the Livingston formation and the Lance formation ("Hell Creek beds") of Montana, the "Ceratops beds" (Lance formation) of Wyoming, and in various

[1] Heer, Oswald, On the fossil flora of Bovey Tracey: Philos. Trans. Roy. Soc. London, vol. 152B, 1862, pp. 1039-1086, Pls. LV-LXXI.

[2] On the correlation of the Bournemouth marine series with the Bracklesham beds, the upper and middle Bagshot beds of the London basin and the Bovey Tracey beds: Geol. Mag., 1879, pp. 148-154.

[3] The lignite of Bovey Tracey: Philos. Trans. Roy. Soc. London, vol. 201B, 1910, pp. 161-178, Pls. XV-XVI.

[4] Essai descriptif sur les plantes fossiles des arkoses de Brives près le Puy-en-Velay, 1878.

[5] Annales sci. géol., vol. 9, 1877, pp. 1-72, Pls. VIII-XXII; Bull. Soc. Linn. Normandie (III), vol. 1, 1877, pp. 121-123; vol. 2, 1878, pp. 46-50; Compt. rend., vol. 92, 1881, p. 759; vol. 100, 1885, p. 870; vol. 103, 1886, pp. 487, 699, 894, 1143.

[6] Études sur la végétation du sud-est de la France à l'époque tertiaire: Ann. sci. nat., botanique, sér. 5, vol. 9, 1868, suppl. 1, Révision de la flore fossile des gypses d'Aix; sér. 7, vol. 7, 1888, Dernières adjonctions à la flore fossile d'Aix-en-Provence.

[7] Ettingshausen, Constantin, Abhandl. K.-k. geol. Reichsanstalt Wien, vol. 2, Abth. 3, 1853, pp. 1-118, Pls. I-XXXI.

[8] Ettingshausen, Constantin, Denkschr. K. Akad. Wiss. Wien, Math.-nat. Kl., vol. 8, 1854, pp. 17-44, Pls. I-XIV; Sitzungsber. K. Akad. Wiss. Wien, Math.-nat. Kl., vol. 12, 1854, pp. 180-182.

[9] Kerner, Fritz v., Tertiärpflanzen vom Ostrande des Sinjsko Polje in Dalmatien: Verhandl. K.-k. geol. Reichsanstalt, 1902, pp. 342-344.

other areas. The deposits in which they occur consist of lacustrine, fluviatile, and terrestrial deposits derived from the rising land area of the Rocky Mountain province. Some are embraced in what Cross has termed the Shoshone group,[1] and the others are referred by Knowlton [2] to what he calls the lower member of the Fort Union formation. They may profitably be compared with the Paleocene of Europe. All were apparently laid down subsequent to the epeirogenic uplift which marks the close of the conformable Cretaceous deposits in this general region, or, in other words, are post-Laramie. Their floras are, according to F. H. Knowlton, markedly distinct from that of the true Laramie and are, on the other hand, essentially identical in character with the flora of the true Fort Union. These floral relations correspond to the conformable sequence by which the deposits pass into those of the typical Fort Union in some of the areas.

Most known American Eocene floras, however, come from the basal Eocene or Fort Union formation, between 500 and 600 species having been collected from the beds of this age (Thanetian?). This flora is apparently of northern origin and is very different in character from the Georgia Eocene flora. It is characterized by species of Aralia, Celastrus, Cocculus, Corylus, Elæodendron, Ficus, Ginkgo, Glyptostrobus, Grewiopsis, Hicoria, Juglans, Onoclea, Populus, Platanus, Pterospermites, Sapindus, Sequoia, Taxodium, Viburnum, and other genera, and presents everywhere an unmistakable botanical facies. Its marked contrast with the Claiborne flora of Georgia is to be explained in part by the fact that the one is a seacoast flora of tropical affinities, whereas the other is an inland flora, in the main of temperate affinities, although it contains palms, figs, camphor trees, and other warm-temperate types, indicating a climate moderately warm and humid, marked by mild winters but far from tropical. The Fort Union flora is, of course, a much older Eocene flora than that of the Claiborne of Georgia, which is more nearly the age of that of the Green River formation of Wyoming. Present knowledge of the flora of the Green River formation, with which the flora of the Florissant lake beds of Colorado was confused by Lesquereux, is due to the labors of Lesquereux [3] and Newberry.[4] As described by these authors, excluding that of the much younger Florissant lake beds, the Green River flora embraces the following number of species in the genera enumerated:

Acrostichum, 1.	Cissus, 1.	Leguminosites, 1.	Quercus, 2.
Alnus, 1.	Cyperus, 1.	Lygodium, 1.	Rhus, 1.
Ampelopsis, 1.	Equisetum, 1.	Manicaria, 1.	Sabal, 1.
Aralia, 1.	Eucalyptus?, 1.	Musophyllum, 1.	Salix, 2.
Arundo, 2.	Ficus, 4.	Myrica, 1.	Sapindus, 1.
Brasenia?, 1.	Ilex, 2.	Phragmites, 1.	Sphæria, 1.
Cheilanthes, 1.	Juglans, 3.	Planera, 2.	Zizyphus, 2.

This flora indicates a considerably warmer climate than that of the Fort Union, for it includes such types as Acrostichum, Manicaria, and Musophyllum. It furnishes points of contact with the Georgia Eocene flora in the species of Acrostichum, which is very close to the Georgia species, in an identical species of Arundo, and in the common generic representation of Ficus and Sapindus. It differs in the presence of genera like Ilex, Juglans, Myrica, Planera, Quercus, Rhus, Salix, and Zizyphus, which are for the most part temperate types.

The inland flora of the Georgia area contemporaneous with the Claiborne strand flora, if known, would undoubtedly furnish additional forms similar to those of the Green River formation, which show a commingling of warm temperate and tropical types such as are found in modern times in the subtropical and temperate rain forests with a mean annual temperature of about 14° C., uniform humidity, and a rainfall exceeding 200 centimeters per annum.

The Green River formation, on the evidence of its vertebrate remains, is correlated by Osborn [5] with the upper Ypresian of France, a correlation not very different from that indicated by the accompanying plant remains, which suggest a comparison with the more recent Lutetian

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[1] Cross, Whitman, Proc. Washington Acad. Sci., vol. 11, 1909, pp. 27–45.
[2] Knowlton, F. H., idem, pp. 179–238.
[3] Lesquereux, Leo, Cretaceous and Tertiary floras, 1883.
[4] Newberry, J. S., The later extinct floras of North America: Mon. U. S. Geol. Survey, vol. 35, 1898.
[5] Osborn, H. F., Age of mammals, 1910, p. 42.

stage of the Paris basin. The Green River is the only described middle Eocene flora known on this continent. Other Eocene floras deserving of mention in this connection are those of the Clarno formation in the John Day basin, Oreg., and the so-called "Eolignitic" flora (Wilcox and Midway groups) of the Mississippi embayment. The lower Clarno flora (Cherry Creek, Oreg.), is lower Eocene in age and includes the number of species indicated of the following genera: [1]

Aralia, 2.	Diospyros, 1.	Juglans, 2.	Pteris, 1.
Asplenium, 1.	Equisetum, 1.	Lastrea, 1.	Quercus, 2.
Cinnamomum, 1.	Ficus, 1.	Lygodium, 1.	Rhamnus, 1.
Cornus, 1.	Hicoria, 1.	Magnolia, 2.	Salix, 1.

It has been compared by Knowlton with the upper Fort Union flora. The upper Clarno flora (Bridge Creek, etc., Oreg.) is of upper Eocene age and has been compared by Knowlton with the Green River flora. It includes the number of species indicated of the following genera: [2]

Acer, 2.	Cassia, 1.	Grewia, 2.	Quercus, 7.
Alnus, 5.	Corylus, 1.	Hicoria, 1.	Rhamnus, 1.
Ailanthus, 1.	Cratægus, 1.	Juglans, 4.	Sapindus, 1.
Betula, 4.	Cinnamomum, 1.	Liquidambar, 1.	Sequoia, 2.
Berberis, 1.	Ficus, 1.	Myrica, 1.	Ulmus, 2.
Carpinus, 1.	Fraxinus, 2.	Platanus, 2.	

Neither of these John Day Eocene floras offers any points of resemblance to that of Georgia.

The "Eolignitic" flora of the Mississippi embayment for the most part has yet to be described. Many years ago Lesquereux [3] described various collections made in this area by Professor Hilgard, and Hollick [4] has described a small collection from Louisiana. There is a very large field for future work in this area, as Tertiary plants in a most excellent state of preservation are common at a considerable number of localities in Alabama, Mississippi, Arkansas, Tennessee, Kentucky, and Louisiana. All these described lower Eocene plants appear to be older than the Claiborne and merit a few comments. In Lesquereux's report such familiar genera as Populus, Salix, Quercus, Juglans, and Magnolia are discussed, but not all the identifications appear to be well founded. In the writer's judgment the Salisburia is a fern of the genus Lygodium, *Populus monodon* is not a Populus but a Ficus, and it is doubtful if *Salix worthenii* and *Salix tabellaris* are willows. *Quercus moorii* and the forms identified as *Quercus lyellii* Heer and *Quercus chlorophylla* Unger, the writer believes, are hardly oaks, and the latter of the three is suggestive of Rhizophora. The Banksia described by Lesquereux is not, in the writer's opinion, referable to that genus; and *Magnolia hilgardiana* and *Magnolia laurifolia* are both suggestive of Terminalia. Doubtless modern methods of collecting and study would result in a very different intrepretation of this flora and would furnish much data regarding physical conditions.

The writer spent parts of the field seasons of 1910–1913 in collecting in the embayment area. Very extensive collections were made, especially from the Wilcox group, and these collections are being elaborated at the present time. They fully confirm the above statements. These floras are subtropical in character and show many features similar to those of the early Tertiary floras of the south of England as elaborated by Ettingshausen.

The flora described by Hollick from Louisiana has nothing in common with that of Georgia, and the fossils might well have been compared with the existing arborescent flora of the American tropics rather than with fossil plants listed in previously published works. It is apparently a more tropical flora than that described by Lesquereux, for it contains, among other interesting things, at least two species of breadfruit (Artocarpus).

[1] Knowlton, F. H., Bull. U. S. Geol. Survey No. 204, 1902.
[2] Knowlton, F. H., loc. cit.
[3] Lesquereux, Leo, Am. Jour. Sci., 2d ser., vol. 27, 1859, pp. 363-366; Proc. Am. Philos. Soc., new ser., vol. 13, 1869, pp. 411-430, Pls. XIV-XXII.
[4] Hollick, Arthur, in Harris, G. D., and Veatch, Otto, A preliminary report on the geology of Louisiana, 1900, pp. 276-288, Pls. XXXII-XLVIII.

Knowlton[1] has described a few fossil woods from Arkansas and has identified a small collection of leaf remains of Eocene age from Texas.[2] Penhallow[3] has also described some fossil woods from the Texas Eocene.

Other American Eocene floras deserving of mention are those of the Kenai formation of the north Pacific coast region.[4] They have nothing in common with the Claiborne flora and are said to be of upper Eocene age. A full historical sketch, with references to the older works and lists of the forms collected, is given in various papers by Knowlton.[5] Their chief interest rests on the fact that they are apparently of the same age as the widespread so-called "Arctic Miocene" of Heer. Another flora of upper Eocene age correlated with the upper Clarno flora of the John Day basin in Oregon is the meager one described by Knowlton from The Dalles, Oreg.,[6] and that of the Payette formation collected along Snake River in western Idaho.[7] These are all so far removed from the Georgia area and are also so much younger that they are of slight interest in the present connection.

In central Washington several Eocene formations have been described as containing fossil plants.[8] The oldest of these is the Swauk formation, outcropping just east of the Cascade Mountains. The flora, as yet undescribed, is said to be a representative one and is remarkable for its large and abundant palms and for the Central American and tropical South American types which it contains.

Separated from the Swauk formation by several hundred or thousand feet of basaltic lava flows and interbedded tuffs is the Roslyn formation bearing an Eocene flora of a more temperate type, apparently lacking palms and other tropical plants. A still younger Eocene formation is the Manastash formation, which contains a temperate flora as yet undescribed. There is also an extensive but undescribed Eocene flora in the Puget group of Washington west of the Cascade Mountains.[9]

ECOLOGIC CONDITIONS INDICATED BY THE BOTANIC CHARACTER OF THE FLORA.

The Georgia Claiborne flora is not extensive, as it embraces only 17 well-defined species, and these forms are not representative of the Claiborne flora as a whole but are for the most part representative of a single or at most two plant associations—one the strand flora, confined to the beach and extending inland where the edaphic factors were favorable, and the other the coastal swamp flora, more or less confined to muddy or possibly sandy shores between low and high tide.

These 17 species are distributed in fifteen families and include one fungus, one fern, and four Monocotyledonæ—a reed, a Potamogeton, a Pistia, and a palm. There are 11 Dicotyledonæ, representing the families Ulmaceæ, Fagaceæ, Moraceæ, Nyctaginaceæ, Mimosaceæ, Lauraceæ, Terminaliaceæ, Rhizophoraceæ, Dodonæaceæ, and Sapindaceæ. No gymnosperms, which are usually represented in European Lutetian floras, at least by the genus Podocarpus, have been discovered.[10] The following table of described species, all of which are new to science, gives in one column the described fossil species with which the Georgia plants are compared and in another the geologic occurrence or range of these species. A third column shows the existing species with which these Claiborne plants are most closely allied and a fourth column the geographic distribution and the character of the habitat of these species.

[1] Knowlton, F. H., Ann. Rept. Geol. Survey Arkansas for 1889, 1890, vol. 2, pp. 249-267, Pls. IX-XI.
[2] Knowlton, F. H., in Vaughan, T. W., Am. Geologist, vol. 16, 1895, pp. 308, 309.
[3] Penhallow, D. P., Trans. Roy. Soc. Canada, 3d ser., vol. 1, sec. 4, 1908, pp. 93-113.
[4] This flora is being studied by Dr. Hollick.
[5] Knowlton, F. H., Harriman Alaska Expedition, vol. 4, 1904, pp. 149-162, Pls. XXII and XXIII; Bull. Geol. Soc. America, vol. 5, 1893, pp. 573-590; Proc. U. S. Nat. Mus., vol. 17, 1894, pp. 207-240, Pl. IX.
[6] Knowlton, F. H., Bull. U. S. Geol. Survey No. 204, 1902, p. 112.
[7] Knowlton, F. H., Eighteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1898, pp. 721-744, Pls. XCIX-CII.
[8] Knowlton in Smith, G. O., Mount Stuart folio (No. 106), Geol. Atlas U. S., U. S. Geol. Survey, 1904, pp. 5 and 7.
[9] Knowlton, F. H., in Willis, Bailey, and Smith, G. O., Tacoma folio (No. 54), Geol. Atlas U. S., U. S. Geol. Survey, 1899, p. 3.
[10] The writer has recently found the genus Arthrotaxis, a coastal type, in the Eocene deposits of the Mississippi embayment.

Existing and fossil species comparable to the Claiborne flora of Georgia.

Georgia species.	Fossil species for comparison.	Range.	Living species for comparison.	Habitat and range.
Acrostichum georgianum	Acrostichum hesperium Newberry.	Green River	Acrostichum aureum Linné.	Swamps, Florida to Brazil, Africa, Asia, Polynesia, and Australia.
Arundo pseudogoepperti	Arundo goepperti (Münster) Heer.	Oligocene to Pliocene.	Arundo donax Linné	Wet places, Mediterranean region.
Castanea clalbornensis			Castanea dentata (Marsh) Borkhausen.	Uplands, Maine to Alabama.
Conocarpus eocenica	Eugenia aizoon Unger; Eugenia hæringiana Unger.	Oligocene	Conocarpus erectus Linné	Muddy or sandy shores, Florida to Galapagos Islands, west tropical Africa.
Dodonæa viscosoides	Dodonæa species of Europe.	Upper Eocene and Oligocene.	Dodonæa viscosa Linné	Florida keys and tropical shores of both hemispheres.
Ficus claibornensis	Ficus species	Eocene	Ficus sp	Beach jungle of tropical America.
Malapoenna sp			Malapœnna geniculata (Walt.) Coulter.	Shallow ponds, Georgia to Louisiana.
Momisia americana	Cinnamomum species	Eocene	Momisia aculeata (Swartz) Klatsch.	Florida keys and throughout tropical America.
Pisonia claibornensis	Pisonia eocenica Ettingshausen.	Ligurian	Pisonia macranthocarpa Donnell Smith.	Shore zone, Central America.
Pistia claibornensis			Pistia stratiotes Linné	Aquatic floating plant, tropics and subtropics of Old and New Worlds.
Potamogeton megaphyllus	Ottelia parisiensis Saporta	Lutetian		
Rhizophora eocenica			Rhizophora mangle Linné	Tidal flats, American tropics and subtropics.
Sapindus georgiana	Sapindus affinis Newberry; Sapindus angustifolius Lesquereux.	Mouth of Yellowstone; Lower Eocene of Gulf.	Sapindus saponaria Linné	Strand, Bermuda and Florida keys to South America.
Sphærites claibornensis	Sphærites myricæ (Lesq.) Mesch.	Green River	Various Pyrenomycetes	
Terminalia phæocarpoides	Terminalia radobojensis Unger.	Tongrian to Astian	Terminalia phæocarpa Eichler.	Strand, northern South America.
Thrinax eocenica	Flabellaria raphifolia (Sternberg) Ettingshausen.	Ligurian of Dalmatia.[a]	Thrinax sp	Florida keys and West Indies.

[a] Not the other recorded occurrences.

Before considering the facts which may be legitimately deduced from this fossil flora it might be valuable to point out frankly to what extent the writer feels certain of his identifications. It is believed that all the identifications have been made with unusual care and that a considerably larger amount of comparative living material has been passed in review than is generally customary. The National Herbarium and the collection of the New York Botanical Garden have been carefully searched for modern analogúes of these fossil leaves; the latter institution is especially rich in comparative material because it has been so active of late years in West Indian exploration. It is believed that the following genera are positively recognized: Acrostichum, Castanea, Dodonæa, Ficus, Conocarpus, Rhizophora, Pistia, Sapindus, Sphærites, and Thrinax. With regard to the genus Rhizophora, other tropical genera have somewhat similar coriaceous leaves, but the associated species in the Claiborne and the contemporary physical conditions serve firmly to corroborate this identification. Both Terminalia and Momisia are less certainly identified. They are types of leaves that might belong to other and unrelated genera; this is especially true of the Momisia, though both fossils agree remarkably well in their characters with the leaves of the recent species with which they have been compared and fossil leaves similar to those which have been here referred to Terminalia are elsewhere accompanied by characteristic fruits. The Pisonia agrees perfectly with the leaves of the existing species with which it has been compared, and is generically identical with other fossil leaves so identified. The reference of the Arundo to the grasses is positive, but in so far as its generic affinity is concerned the writer has simply conformed to paleobotanic usage. The form classed as Potamogeton may not be a Potamogeton, although it resembles that genus very closely and is most certainly a monocotyledon of aquatic or semiaquatic habit.

In examining these Claiborne forms and the ecology of the modern types with which they have been compared, it will be observed that only three species, the Castanea, the Pistia, and the Potamogeton, are not coastal forms, and that the two last-named forms are aquatics whose presence associated with coastal swamp or strand plants is not difficult to explain. The Castanea, then, apparently represents the only upland type preserved in this flora, and, as it is not common, the presumption is strong that it was brought down to the basin of sedimentation by some Eocene river, most likely by the river which it seems certain emptied into this Claiborne estuary.

It is interesting to note that the remaining 12 species are all plants of a coastal habitat, their modern representatives flourishing in tidal nipa swamps of the Orient, in mangrove swamps of the Orient and Occident, on the strand in beach jungle, or on the landward side of coastal sand dunes. Nearly all are represented by forms found in the existing flora on the Florida keys or along the shores of peninsular Florida, some, like the Conocarpus, flourishing equally well on either muddy or sandy shores. Every species has representatives in the American tropics, and four of the compared forms, *Conocarpus erectus, Dodonæa viscosa, Rhizophora mangle,* and *Sapindus saponaria,* range northward to Bermuda. In Schimper's classical work on the Indo-Malayan strand flora the following representation of species in genera which occur in the Claiborne flora may be noted:

Acrostichum (Chrysodium), 1 sp.
Dodonæa (viscosa), 1 sp.
Eugenia, 2 sp. (represented in West Africa and in America by the allied genus Conocarpus).
Ficus, 1 sp.
Malapoenna (Litsæa), 1 sp.
Pisonia, 4 sp.
Rhizophora, 2 sp.
Sapindus, 1 sp.
Terminalia, 1 sp. (catappa).

Of these the Sapindus, Terminalia, Dodonæa, Ficus, Malapoenna, and Pisonia are more particularly elements in the littoral forest (beach jungle of Kurz, Barringtonia formation of Schimper); the others are integral members of or rather intimately associated with the Rhizophora or Nipa associations. It is really remarkable to what an extent the identified elements in the Claiborne flora of Georgia agree in indicating the character of their habitats, which were tidal Rhizophora swamps at certain points in the Grovetown estuary where the conditions were favorable, and elsewhere the sand beaches or the rain forests, which, if they did not come down to the water's edge, were developed behind the dunes that possibly in places formed the highest inner margin of the beach.

The Claiborne species of Conocarpus, Dodonæa, Ficus, Pisonia, Rhizophora, Sapindus, and Terminalia all have more or less coriaceous leaves, due to a combination of factors of which the following may be enumerated. Those which grew below the level of high tide had to withstand the salinity of the estuary waters and those which grew above high tide in more or less exposed situations had to withstand the drying effect of windblown salt spray, which must have been considerable and which undoubtedly was an important factor, just as it is in similarly situated plant associations in the existing flora. Another factor was the strong light of low latitudes, to which was added reflection from the water in the mangrove swamps and from the sand in the beach jungles.

Certain deductions regarding the climate and rainfall of the latitude of Grovetown in Claiborne time can be drawn from the distribution of the modern allies of these fossil forms. Since they are all rather uniform in their distribution, the accompanying sketch map (fig. 11) showing the geographic range of the modern species of Rhizophora will serve in a measure for all the genera.

The present winter isotherm in the latitude of Grovetown is approximately 48° F. None of the closely allied modern plants flourish north of the winter isotherm of 52° F. and most of them do not occur north of the winter isotherm of 60° F. None of the fossil forms except possibly the Potamogeton, the modern species of which range over a great many degrees of latitude, or the Castanea, which likewise has a wide range, would be expected to occur outside the latitudes where what Schimper calls the subtropical or warm temperate rain forests are found. We would expect the Claiborne climate, at least at low elevations along the coast and in proximity to the warm Eocene ocean current or currents, to have been uniformly humid, with an annual rainfall somewhere between 150 and 200 centimeters. The actual rainfall could become a more or less negligible factor provided the water table approached close to the surface and the humidity was high and constant. The temperature would have to be uniform rather than hot, judging by modern standards, for any degree of winter cold would have been fatal. This climate need not have been tropical, nor would it be surprising if the Claiborne marine fauna failed to show tropical forms or reef corals, for the main factors which would limit the spread of a flora like the one described would be uniform humidity, ample rainfall, and the absence of severe cold. In the existing flora these favorable factors permit the existence of an almost tropical plant growth in New Zealand uplands, in latitude 40° south, and a quasi-tropical vegetation might flourish much more readily in latitude 33° north in Eocene time, particularly along a coast. Minimum temperatures mark the limits of distribution; other factors, such as soil, humidity, and rainfall, furnish optimum conditions for development within these wider limits.[1]

Such considerations are in a large measure corroborated by the results of investigations of the conditions in Europe at this time. It is well known that the middle Eocene floras of Europe show many tropical characters absent in the lower Eocene. These characters first become marked in the fruits from the London clays and the leaves from Alum Bay and in homotaxial deposits on the Continent, and though it was formerly the common practice to correlate these floras with Australian or African types, they show closer affinities with the modern floras of Malaysia and tropical America, as was long ago suggested by Gardner. The

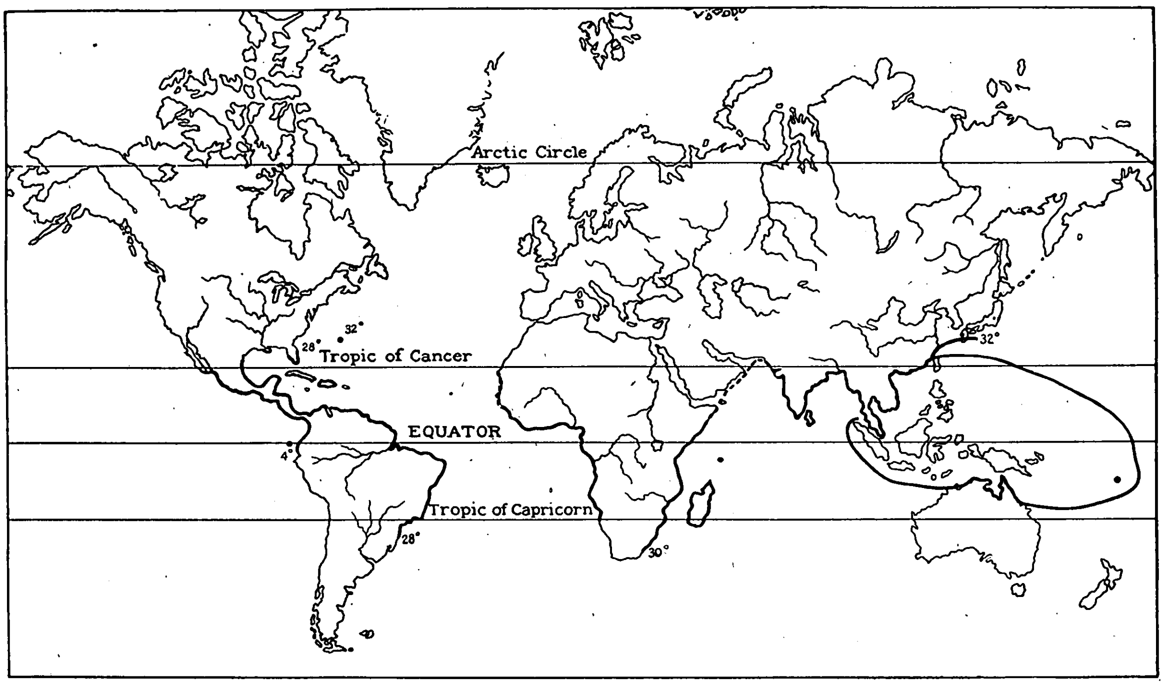

FIGURE 11.—Sketch map showing the distribution of existing species of Rhizophora.

sketch map forming figure 12 (p. 160) will bring this out very well. It shows the distribution of the modern genus Nipa and of the Eocene genus Nipadites, which is indistinguishable from the modern Nipa. Nipa has only one existing species, which inhabits the tidal waters of the Indian Ocean and ranges from India through the Malay Archipelago to the Philippines, vying with the mangroves for possession of the tidal flats. It produces clusters of large floating fruits, and similar fruits form the basis for the genus Nipadites. As shown by the map, these tropical or subtropical floras ranged northward in Europe at this time to southern England or, on this continent, to about the latitude of Newfoundland. These Eocene Nipa swamps furnished a congenial habitat for a species of Acrostichum closely allied to the one described from the Georgia Claiborne, and other comparable forms are not wanting. A species of Pandanus is associated with Nipadites in the Paris basin just as the two are found associated at the present time in the Oriental tropics, and many similar occurrences could be mentioned.

The Lutetian abroad and the Claiborne in this country are both characterized by a considerable transgression of the sea.

[1] The real factor recognized in the foregoing statement is not so much killing cold as length of growing season.

As the Claiborne flora of Georgia indicates more tropical conditions than the known earlier Eocene floras, it seems probable that its direction of advance was from the tropics northward. The Claiborne strand flora was so largely dependent upon warm ocean currents for its dispersal and survival that an Eocene representative of the Gulf Stream can be safely assumed. Even if the course of this current was offshore, the coastal area was under its direct influence by reason of accessory or counter currents of similar character. Tidal currents more or less transverse to the shore line and minor wind-blown currents assisted in carrying the oceanic drift into the shallows and through the inlets into the estuaries, or over the sand bars into the lagoons. Judging from modern conditions in comparable areas the general direction of the prevailing winds was either parallel with or transverse to the coast line, and though considerable minor variations probably existed, their general direction was probably from the southeast during the greater part of the year.

In studying the present flora the writer became much interested in the means of dissemination of its modern allies. It has been shown that certain species of Eugenia, Terminalia,

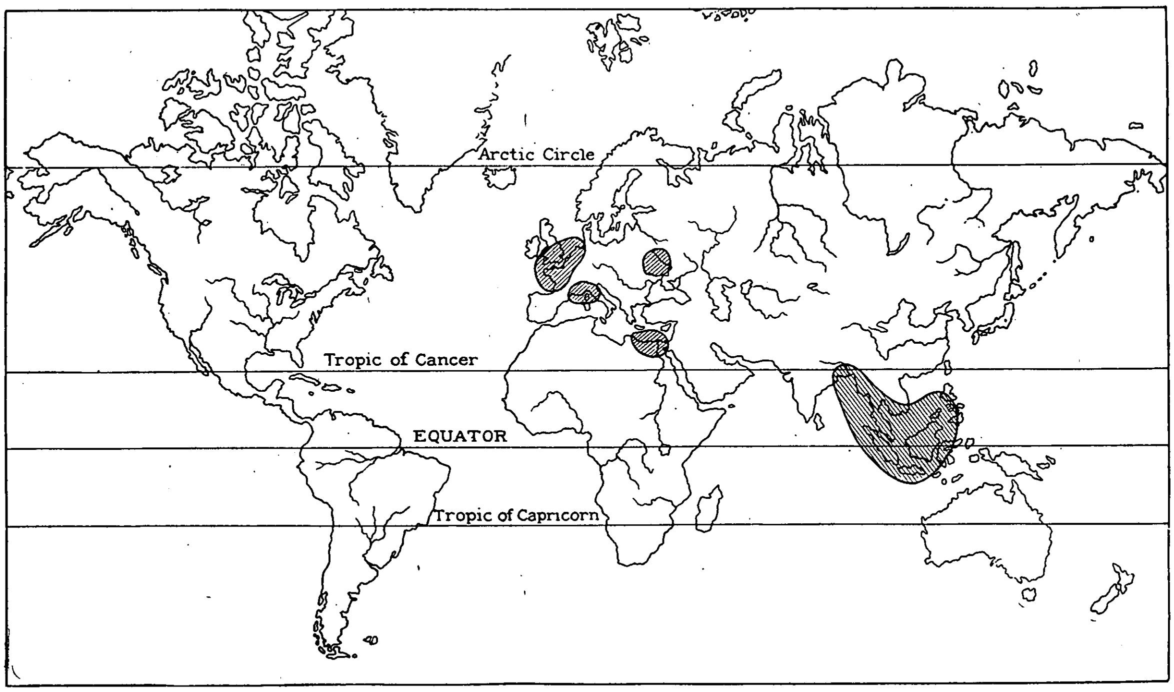

FIGURE 12.—Sketch map showing the distribution of Nipa (northwest-southeast ruling) and Nipadites (northeast-southwest ruling).

Rhizophora, Pisonia, and Sapindus have become adapted for dispersal through the agency of ocean currents by specialization of their fruits or seeds, which have developed air chambers or woody husks for buoyancy and practically impervious coverings to exclude sea water from their vital parts. Best known, perhaps, is the extreme specialization of the mangrove, which sends its germinating plantlets out into the world fully prepared to anchor themselves in water of the required depth. The somewhat similar specialization of the other members of this flora, though less in degree, is almost as effective, judging by the geographic distribution of these genera in the existing flora, so that the part played by ocean currents is considerable, despite the contrary opinion of De Candolle. Hemsley has even recorded seeds of such a plant as *Sapindus saponaria* washing ashore on the south coast of Bermuda and actually germinating; in fact, this author gives a large amount of interesting data upon the dispersal of plants by ocean currents in his discussion of insular floras in the *Challenger* report devoted to such floras. Other species of the Georgia Claiborne flora, particularly species of Ficus, may be supposed to have been distributed by fruit-eating birds; in fact, the seeds of a number of modern species of Ficus have been recorded from the crops of birds. The same means of distribution may

A. MANGROVE SWAMP ALONG MIAMI RIVER, NEAR MIAMI, FLA.

B. HABIT OF GROWTH OF MANGROVES ALONG MIAMI RIVER.

have been also applied to the Malapoenna, but no data concerning methods of distribution are available for the small remainder of the Claiborne forms.

It can be readily shown that the existing flora of peninsular Florida, the Bahamas, and Bermuda contains a large element which has been derived in comparatively recent geologic times from the south. Almost the entire flora of the Bahamas and Bermuda has had such an origin. If, however, geographic distribution is studied in the light of historical geology, the main elements in these modern floras will be found to have been already in existence in the middle Eocene, if not earlier. Such study shows that nearly all the modern plant families, except possibly the most specialized forms, as the orchids among the Monocotyledonæ or the Compositæ and their allies among the Dicotyledonæ, were at some period more widely distributed than they are at the present time, and that the details of modern distribution represent not so much the interchange of different types between continents as the greater or less degree of segregation of descendants of forms once spread over much wider areas. This generalization is made even more emphatic when the comparisons embrace the floras of the Upper Cretaceous, although the certainty of identification based upon foliar characters for many genera varies more or less directly with the length of time that they have been preserved.

From a study of the Claiborne flora it is evident that the main elements of the modern flora of tropical America reached at least as far north as latitude 33° and probably several degrees farther in the middle Eocene, and that in post-Eocene time, probably not until toward the close of the Tertiary, they retreated southward to the West Indies, Central America, and northern South America as the result of lowering temperatures or diminished rainfall or both. Therefore, though the strictly modern movement of the subtropical flora along the course of the Gulf Stream has been from the south toward the north as the various coral islands of the Bahamas formed, this dispersion was preceded by similar migrations on a much more extended scale during the early Tertiary. From a study of the marine faunas of Florida Dall [1] places this change of climate at the close of the Oligocene and predicates [2] a southwardly flowing cold ocean current to account for it.

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[1] Dall, W. H., Trans. Wagner Inst., vol. 3, pt. 6, 1903, pp. 1549, 1550.

[2] Vaughan, T. W., A contribution to the geologic history of the Floridian Plateau: Publication Carnegie Inst., Washington No. 133, 1910.

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PLATE XVII.

PLATE XVII.

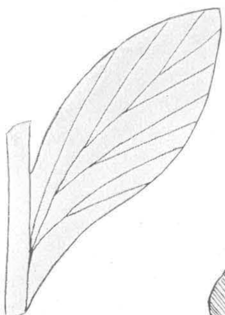
Page.

FIGURES 1, 2. *Dryopterites stephensoni* Berry 103

1. Type found near Byron.
2. Pinnule of same, × 6.

FIGURE 3. *Doryanthites cretacea* Berry (type, found near Buena Vista) 108

All the specimens are from the Eutaw formation.



2

3

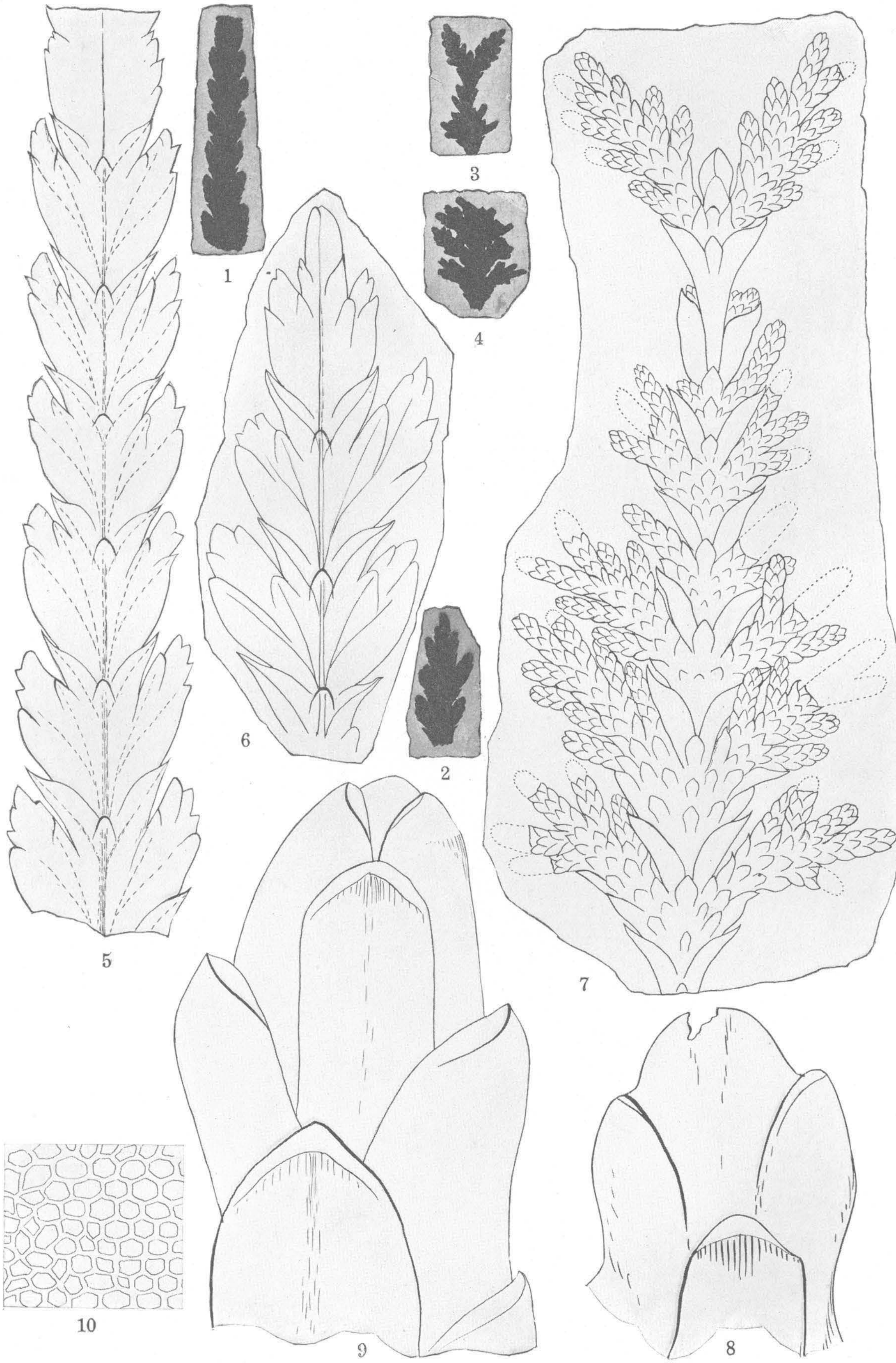
UPPER CRETACEOUS PLANTS FROM GEORGIA.

PLATE XVIII.

PLATE XVIII.

1–4. Specimens, natural size, from McBrides Ford.
5–7. Same, × 4.
8, 9. Apical part of two lateral twigs, × 45.
10. Epidermis, × 205.

All the specimens are from the Eutaw formation.

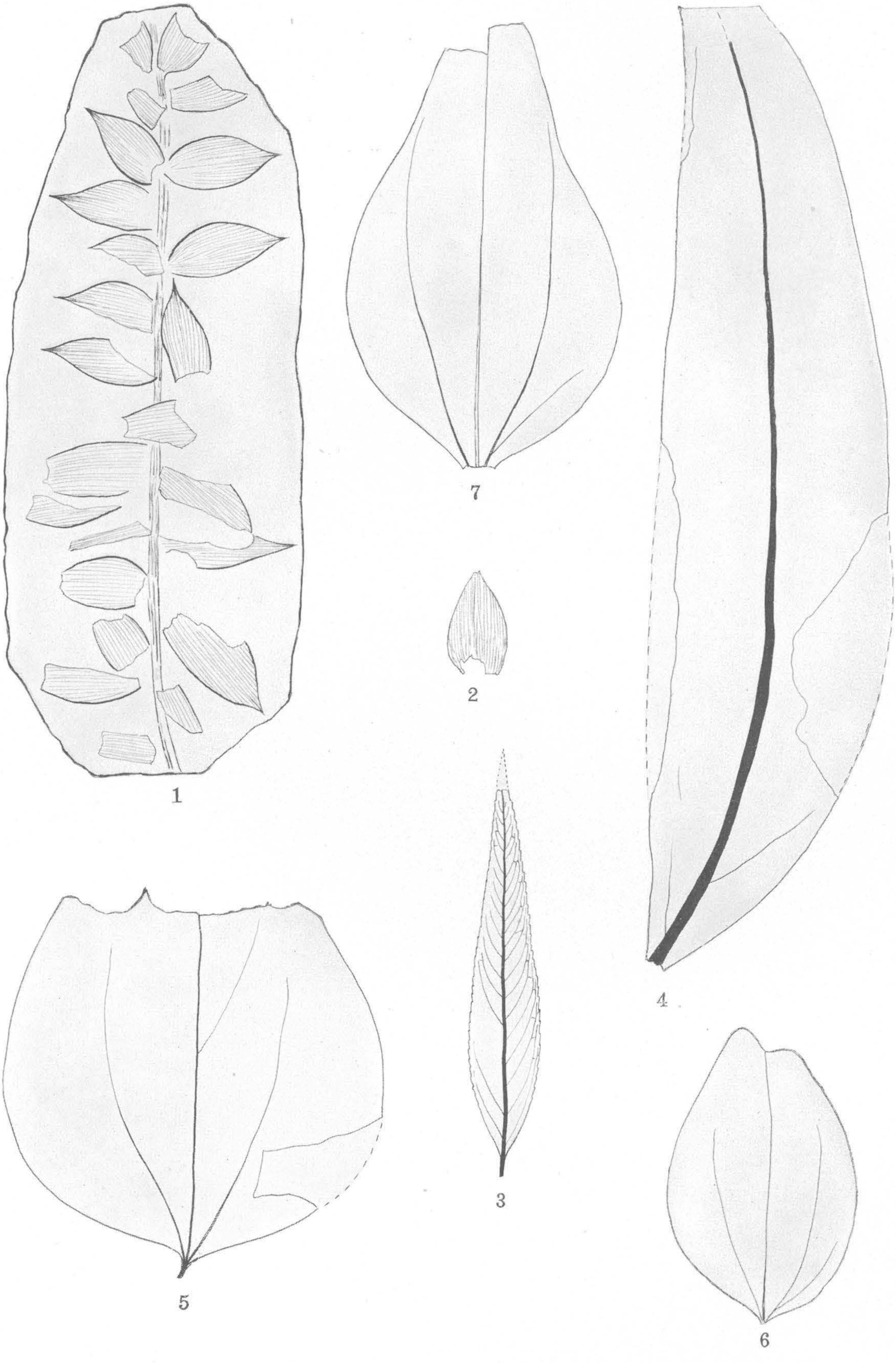


UPPER CRETACEOUS PLANTS FROM GEORGIA.

PLATE XIX.

PLATE XIX.

All the specimens are from the Eutaw formation.

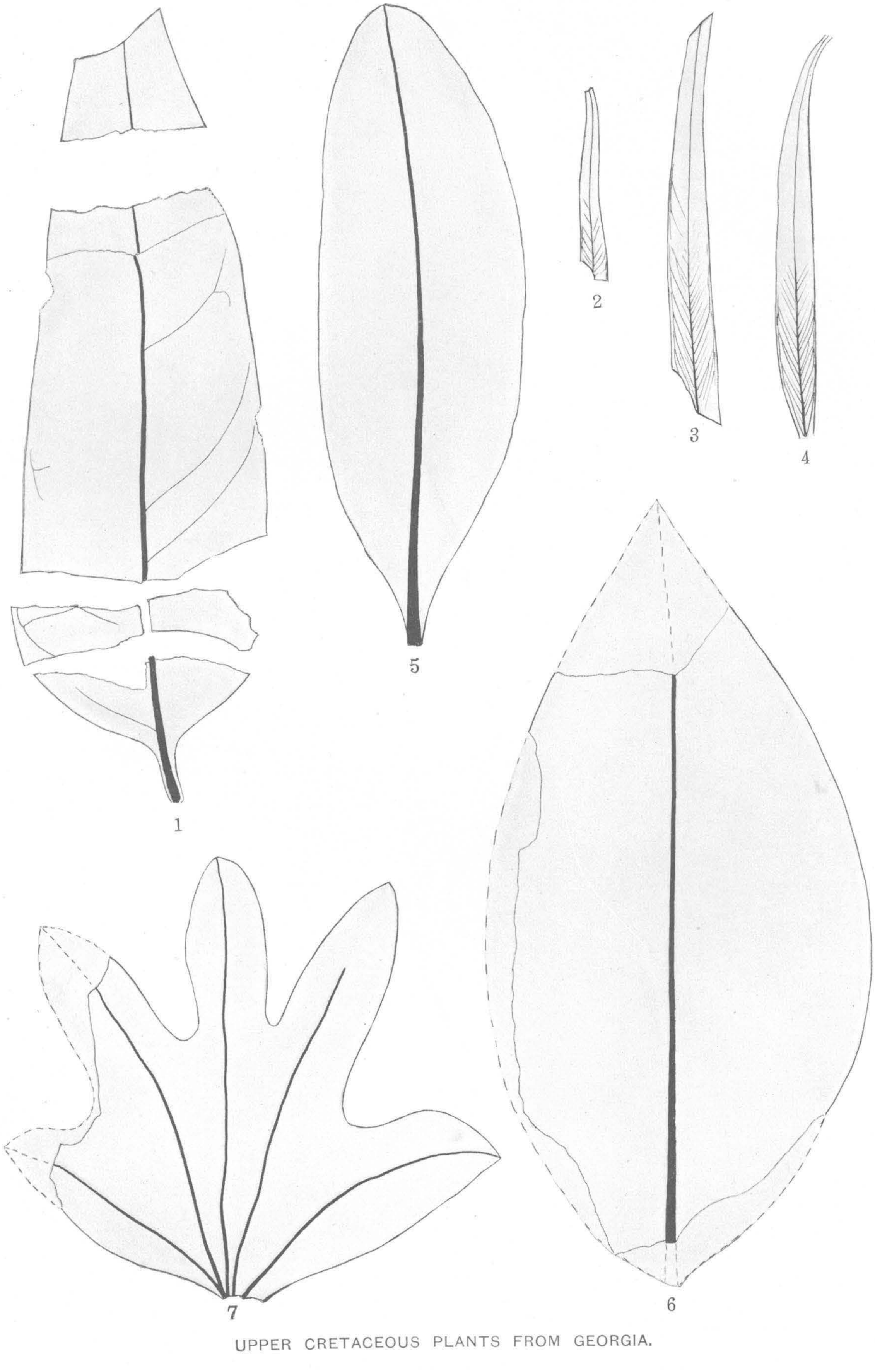


UPPER CRETACEOUS PLANTS FROM GEORGIA.

PLATE XX.

PLATE XX.

All the specimens are from the Eutaw formation.

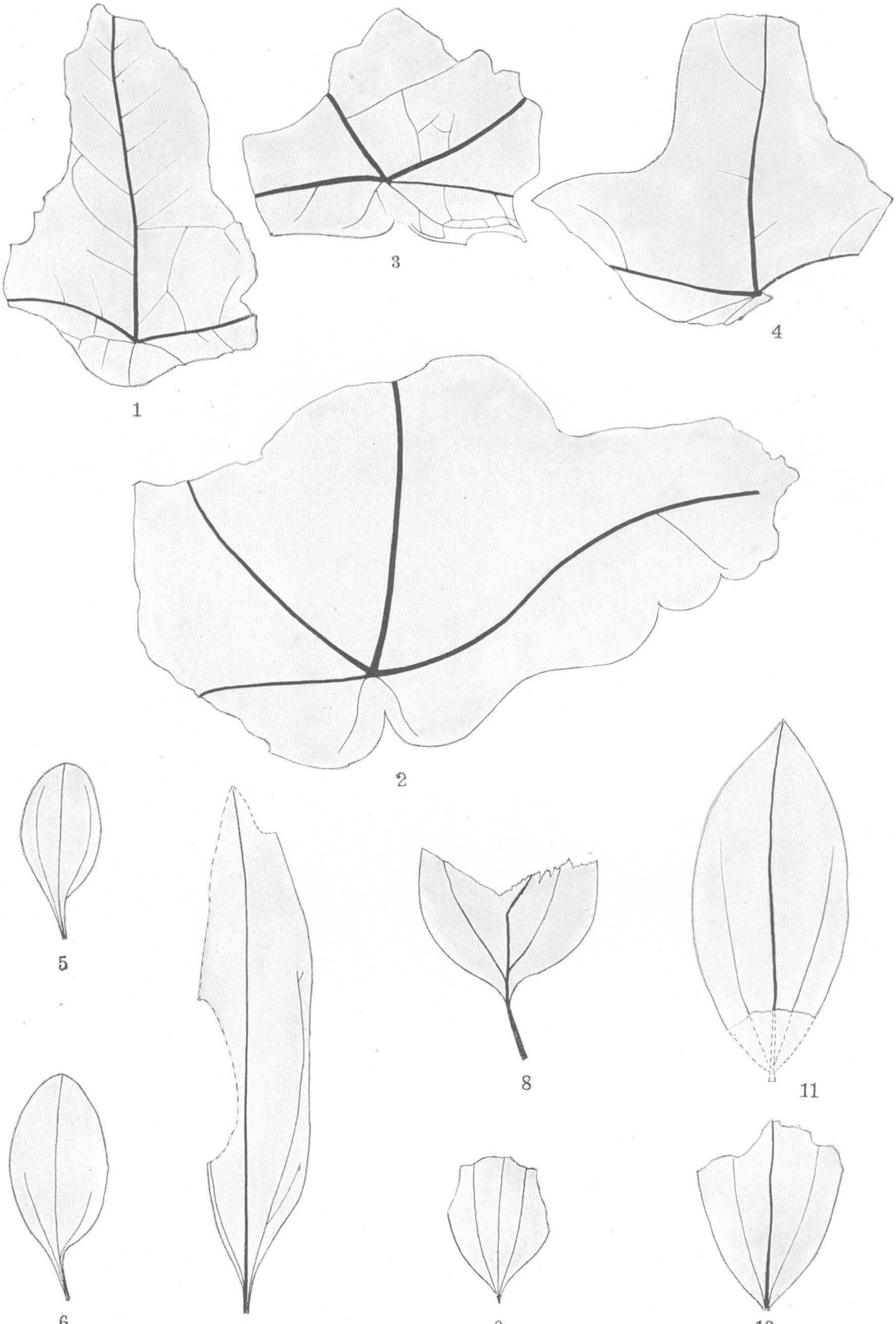


UPPER CRETACEOUS PLANTS FROM GEORGIA.

PLATE XXI.

PLATE XXI.

All the specimens are from the Eutaw formation.



UPPER CRETACEOUS PLANTS FROM GEORGIA.

PLATE XXII.

PLATE XXII.

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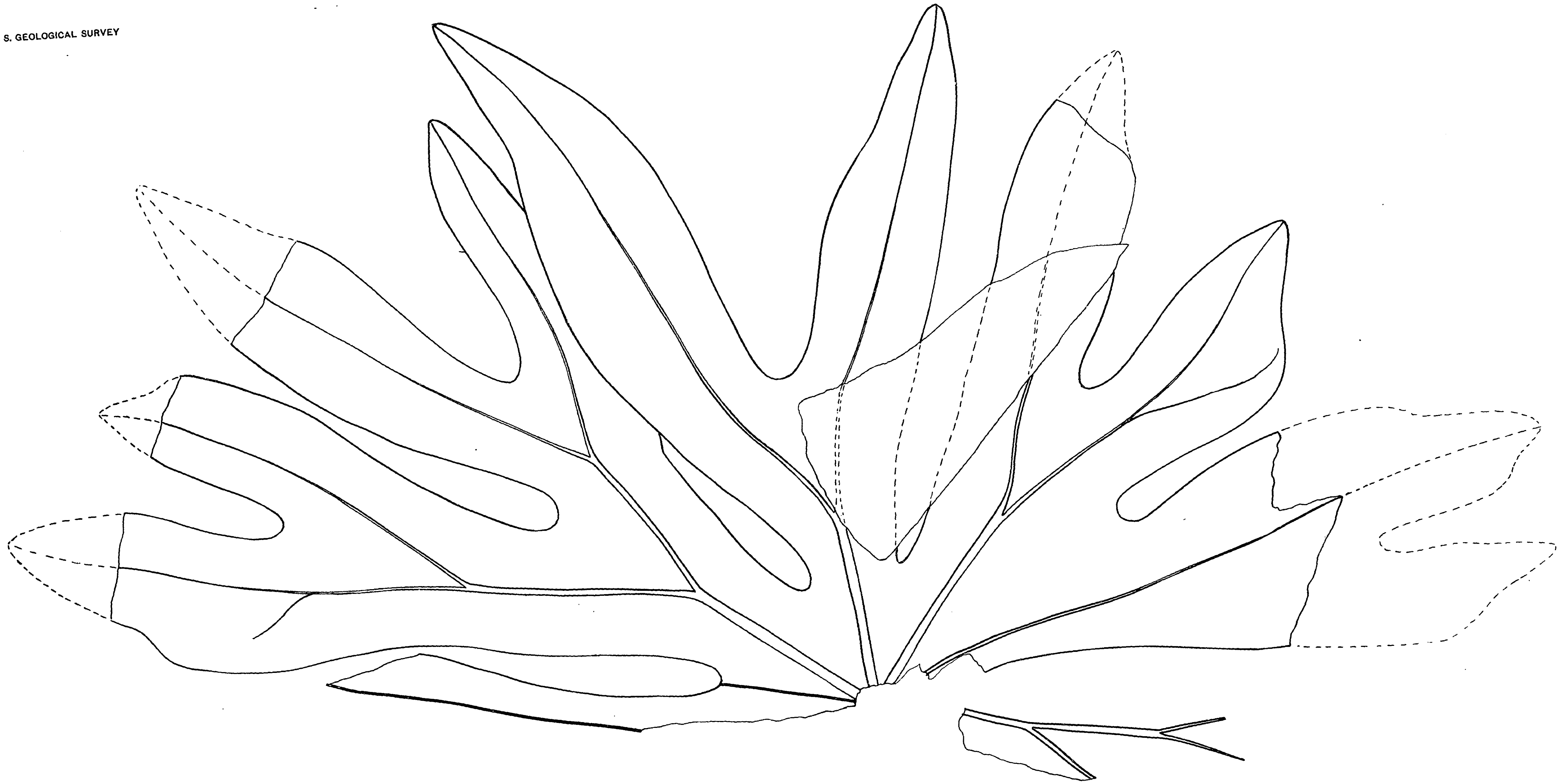
Manihotites georgiana Berry, type specimen from Eutaw formation at McBrides Ford 114



UPPER CRETACEOUS PLANT FROM GEORGIA.

PLATE XXIII.

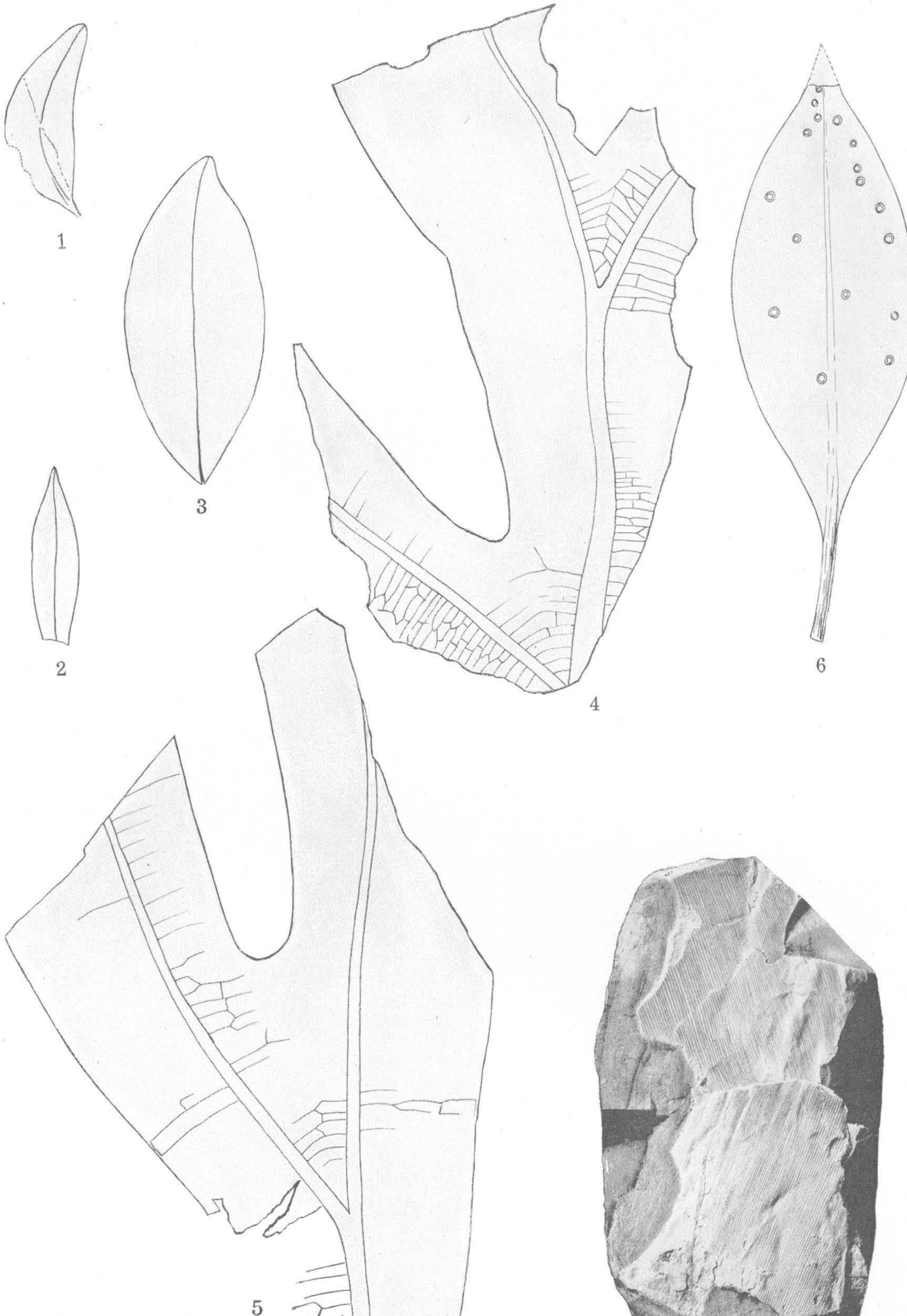
PLATE XXIII.

UPPER CRETACEOUS PLANT FROM GEORGIA.

PLATE XXIV.

PLATE XXIV.

All the specimens except those shown in figures 6 and 7 are from the Eutaw formation. The specimens shown in figures 6 and 7 are from the Congaree clay member of the McBean formation.



UPPER CRETACEOUS AND EOCENE PLANTS FROM GEORGIA.

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PLATE XXV.

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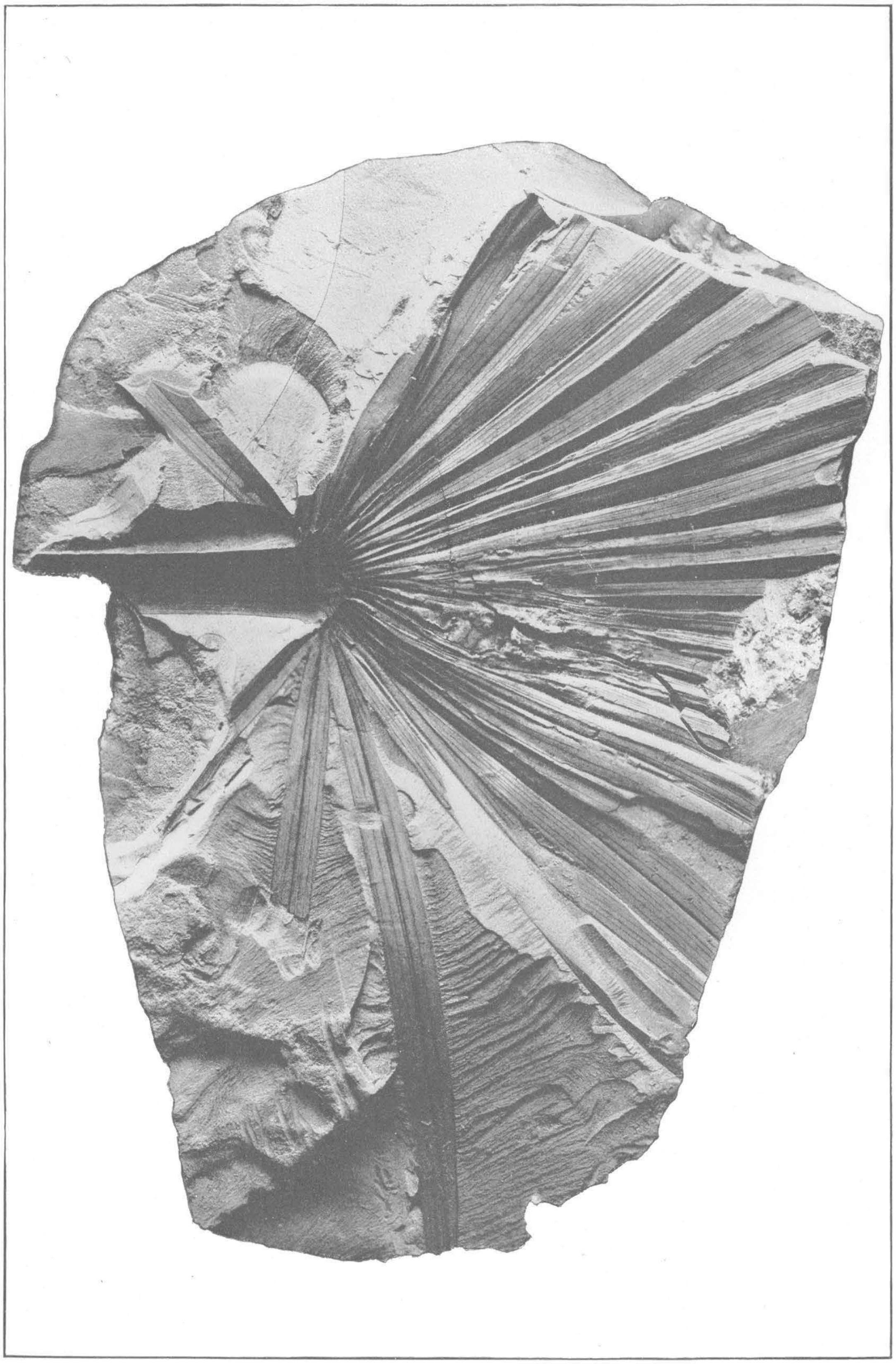
Thrinax eocenica Berry, type from Congaree clay member of the McBean formation at Fiske property, Grovetown	136



EOCENE PLANT FROM GEORGIA.

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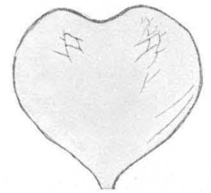
All the specimens are from the Congaree clay member of the McBean formation.

1



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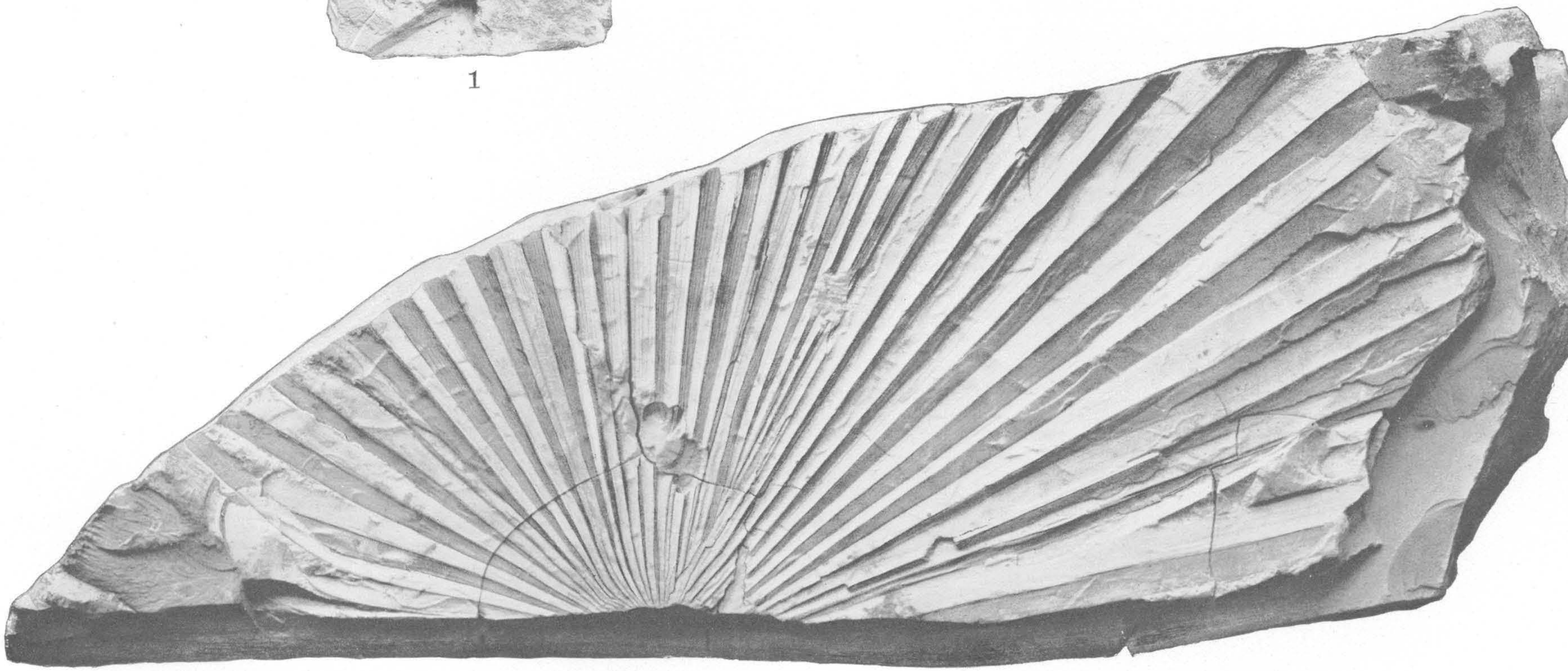

3

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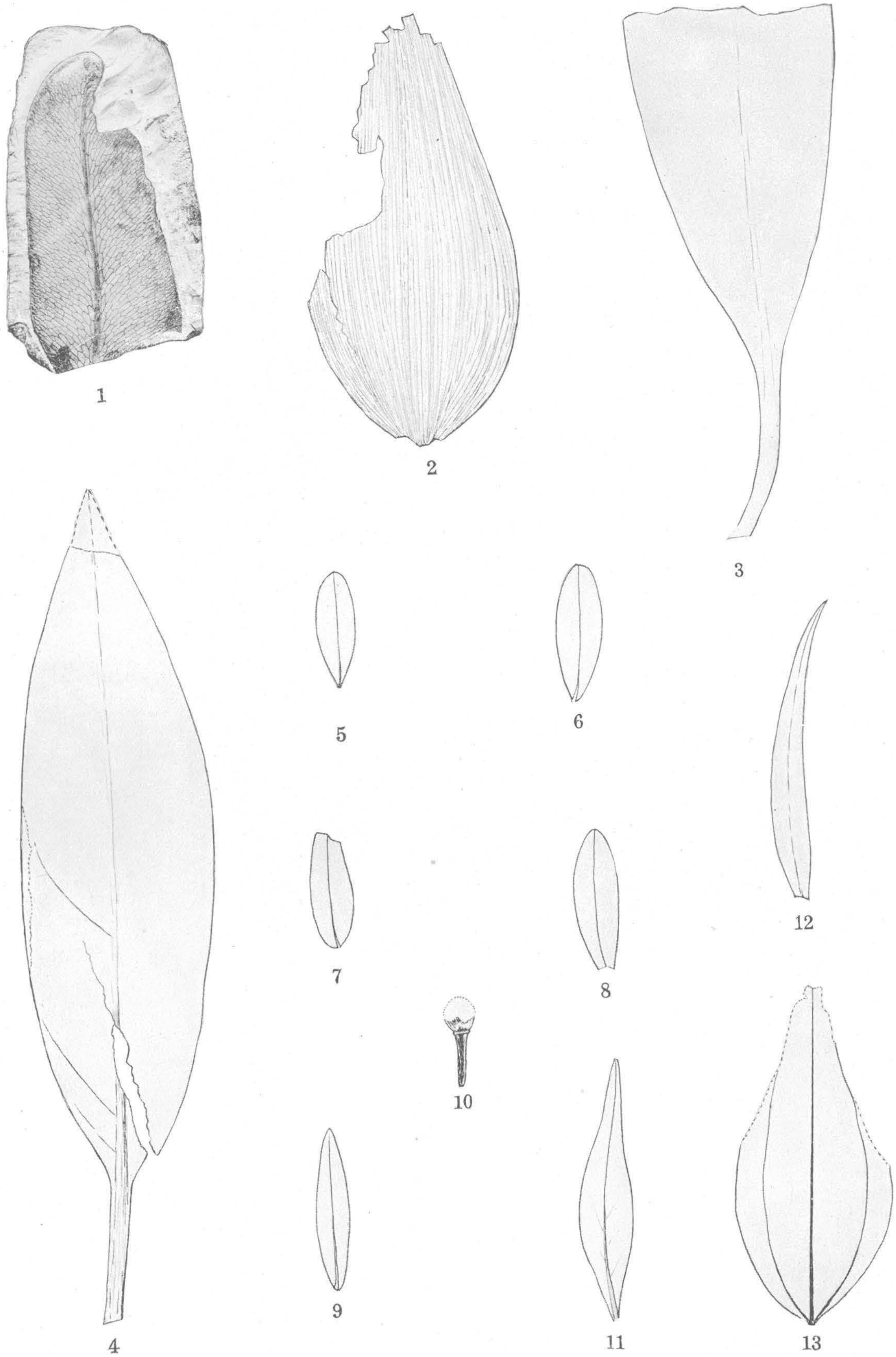
All the specimens are from the Congaree clay member of the McBean formation.

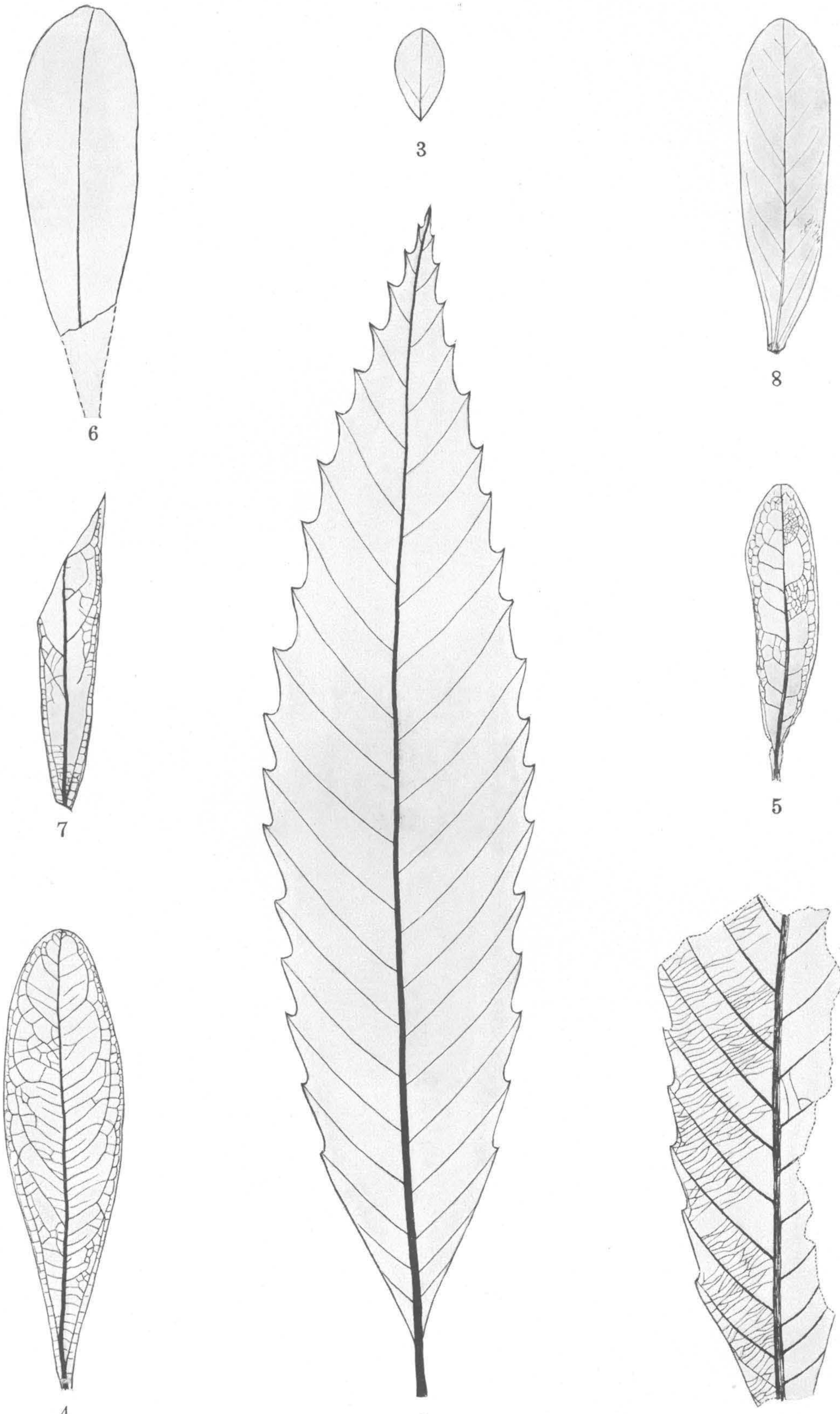


EOCENE PLANTS FROM GEORGIA.

PLATE XXVIII.

PLATE XXVIII.

All the specimens are from the Congaree clay member of the McBean formation.

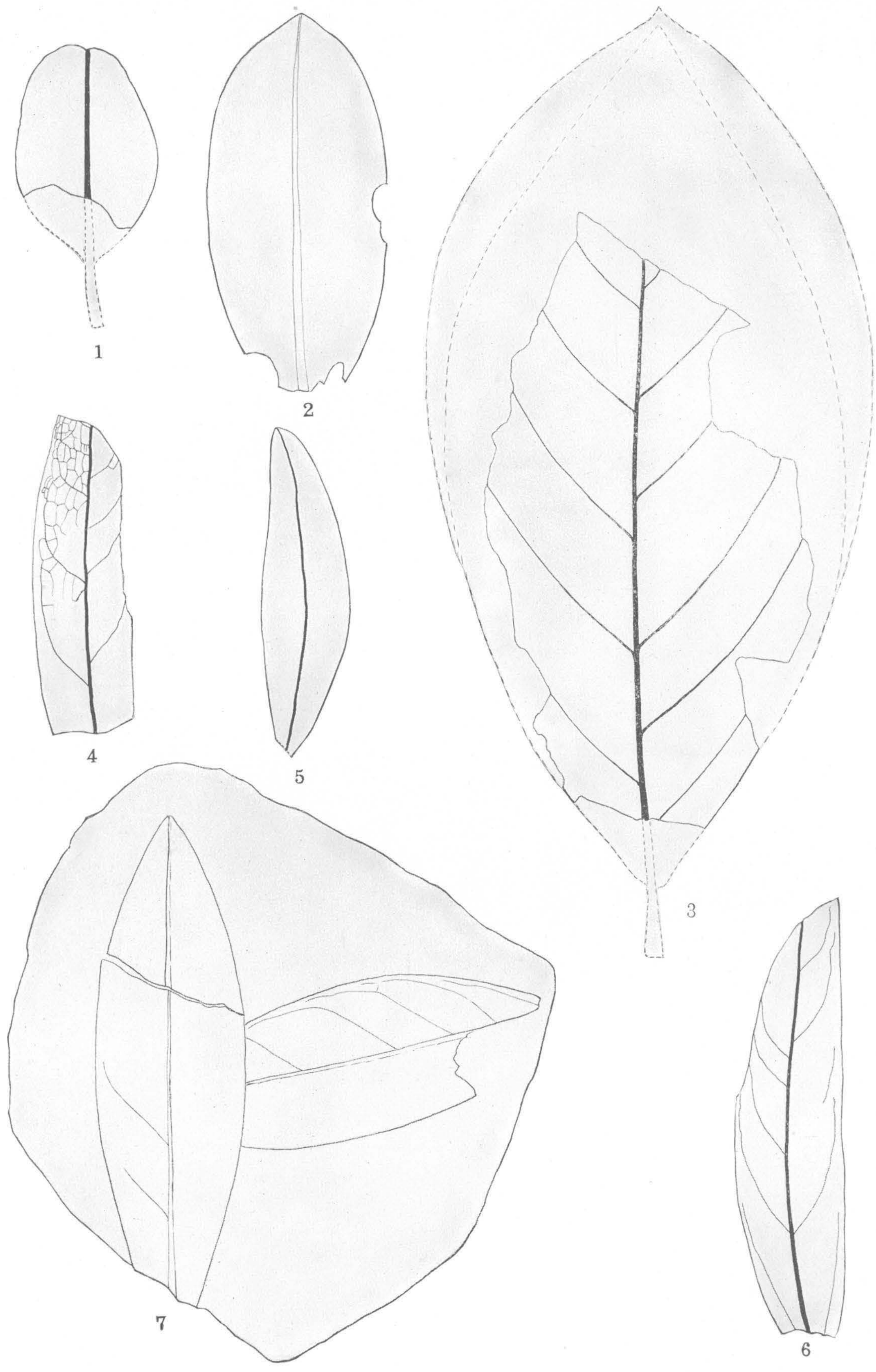


EOCENE PLANTS FROM GEORGIA.

PLATE XXIX.

PLATE XXIX.

All the specimens are from the Congaree clay member of the McBean formation.



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INDEX.

Names in *italic* are synonyms; figures in **black face** are descriptions; figures in *italic* are illustrations.

D.