THE PHYSICAL CONDITIONS INDICATED BY THE FLORA OF THE CALVERT FORMATION.

By EDWARD WILBER BERRY.

INTRODUCTION.

The object of the present paper is to give a summary of the small flora preserved in the Miocene diatomaceous beds of the Calvert formation in the District of Columbia and Virginia, and more especially to discuss its bearing on the physical conditions of the Calvert epoch. Subsequent to the middle Eocene the next abundant marine fauna preserved along the middle Atlantic coast is that of the Calvert formation of the Chesapeake group. Although Miocene faunas so low in the stratigraphic column are known south of Virginia only in the vicinity of Porters Landing, Savannah River, Ga., closely related but younger Miocene faunas extend southward at least as far as Florida, where the containing formation rests unconformably on beds in which occur the warmer-water faunas of the Apalachicola group.

The change from the Apalachicola faunas to those of the Miocene constitutes one of the most striking faunal changes of the later Tertiary in southeastern North America, and its emphasis by Dall and others has led to what I believe to be a misconception of the real climatic conditions of Calvert time. Likewise from the fact that the conspicuous deposits of diatomaceous ooze in existing marine waters are in the polar oceans it has been unscientifically assumed that the diatomaceous beds so characteristic of the Calvert formation must have been formed by species which had a more or less comparable environment.

CHARACTER AND EXTENT OF THE CALVERT FORMATION.

The Calvert formation, named by Shattuck [1] in 1902 from the Calvert Cliffs, in Calvert County, Md., consists of 200 to 400 feet of diatomaceous earth, sandy clays, and marls. It is typically developed in Maryland, where the basal member (Fairhaven) comprises about 65 feet of diatomaceous earth, locally argillaceous and showing occasional influxes of sands. The Calvert has been recognized in southern New Jersey and Delaware. It is also well represented in Virginia but disappears in the southern part of that State by the transgression of the St. Marys formation, which completely buries it in North Carolina, overlapping on the crystalline rocks of the Piedmont Plateau in some areas.

Fossil land plants have been found in the Calvert at Richmond, Va., in the District of Columbia along the Benning road near the District line, and at Good Hope Hill. The formation crops out on the Good Hope road at a point near the top of the hill, where a few feet of light-colored clay (Calvert) rests unconformably on the fossiliferous beds of the Magothy formation (Upper Cretaceous). The Calvert is overlain by gravels of late Tertiary or early Pleistocene age. This locality is one of the most northwesterly points at which the Calvert can be recognized with certainty, and it must also have been near the landward margin of the Calvert sea. No invertebrates are associated with the plants at this outcrop.

At the Richmond locality the Calvert consists of very clayey diatomaceous earth 40 to 50 feet in thickness, which rests unconformably upon remnants of the Eocene or upon the underlying Lower Cretaceous or crystalline rocks and is overlain by Pleistocene deposits. That this locality also was near the shore line of the Calvert sea, as it is near the landward limit of the existing Calvert deposits, is indicated not only by the more clayey nature of the materials compared with similar diatomaceous deposits elsewhere in the Calvert formation but

[1] Shattuck, G. B., The Miocene formation of Maryland: Science, new ser., vol. 15, p. 906, 1902.

by the contained plant fossils, as well as by considerable comminuted lignite, that in places forms layers 5 to 12 millimeters thick. The Calvert contains marine invertebrates in the immediate vicinity of this outcrop, and associated with the plants are *Nassa peraltoides* Martin and *Discinisca lugubris* (Conrad), the latter a species which occurs in shallow water free from sand.

FAUNA OF THE CALVERT FORMATION.

The fauna of the Calvert formation is extensive, particularly in the marls that overlie the diatomaceous beds. In addition to the remains of marine vertebrates, which are in general wide-ranging and of little significance in ecology, there is a considerable molluscan fauna. From the Calvert of Maryland 235 species of Mollusca have been described. About 100 species have been recorded from the Virginia extension of these beds, but this number will be considerably increased when the studies of Dr. J. A. Gardner are published. Twenty-three of the Calvert species have been identified in the Florida Miocene (Jacksonville and Choctawhatchee formations), where 40 per cent of the fauna is common to the Chesapeake group, resembling more specifically the faunas of the Miocene formations younger than the Calvert. From an analyses of these Maryland faunas Dall,[1] a few years ago, concluded that they indicated shallow marine waters and temperatures somewhat warmer than those of the present time in the latitude of Maryland. Of the species that persist in the existing fauna, the bulk are found south of Cape Hatteras. I see no reason for doubting Dall's conclusions, which obviously preclude the "cold" or even the "cool temperate" conditions that have commonly been considered as characteristic of the Chesapeake group.

The United States hydrographic charts give the mean temperature of the surface water of the Atlantic in the latitude of Maryland from December to May as 55°, and from June to November as 71.5°. The figures for Massachusetts Bay are 45° and 63.5°, respectively. The figures for the vicinity of Beaufort, N. C., which is immediately south of Cape Hatteras and which would appear to afford conditions corresponding to Dall's qualitative estimate, are 65+° for December to May and 76° for June to November. If Dall's estimate is reasonably correct it would indicate that the mean annual temperature of the water in which the Calvert molluscan fauna lived was close to 70°. The mean for the year at the surface off the Maryland coast is 63°, and at Beaufort it is 70°, and although the bottom temperatures are slightly less than the surface temperatures they are more uniform and for shallow seas like the Calvert would not be appreciably lower.

[1] Dall, W. H., Maryland Geol. Survey, Miocene, pp. cxxix–clv, 1904.

FLORA OF THE CALVERT FORMATION.

COMPOSITION AND ENVIRONMENT.

The most abundant plant remains in the Calvert are the siliceous tests of diatoms. These have been much studied by diatomists, who have identified a very large number of species. I am indebted to Dr. Albert Mann for the statement that the Calvert diatom flora indicates a comparatively shallow, strictly marine habitat with relatively warm or subtropical temperature.

The remains of land plants preserved in the strictly marine beds of the Calvert are few both in number of species and in number of individuals. As a result of the present study I am able to enumerate 26 species—16 from Virginia and 17 from the District of Columbia, with 7 forms common to the two areas. The flora includes 1 pteridophyte (Salvinia), 2 conifers (Taxodium and Pinus), and 23 dicotyledons. Leguminous forms and oaks predominate, although the cypress (Taxodium) is by far the most common form at Richmond, where cone scales and seeds as well as an abundance of the deciduous twigs are preserved.

Although this flora is so small it fortunately comprises forms whose characters indicate very clearly the physical conditions along the shore of the Calvert sea. The accompanying table indicates the most similar fossil and existing species:

Comparison of Calvert flora with most similar fossil and existing forms.

Calvert flora.	District of Columbia.	Richmond.	Most similar fossil form.		Most similar existing form.	
			Name.	Horizon.[a]	Name.	Habitat and range.
Salvinia formosa Heer?		×	Salvinia formosa Heer	Tortonian of Baden	Salvinia natans (Linné) Hoffmann.	Aquatic; widely distributed in Eurasia.
Pinus sp	×				Pinus tæda Linné	Wet, coastal; Delaware to Texas.
Taxodium dubium (Sternberg) Heer.	×	×	Taxodium dubium (Sternberg) Heer.	Eocene to Pliocene	Taxodium distichum (Linné) L. C. Richard.	River swamps; Delaware to east Texas.
Salix ræana Heer		×	Salix ræana Heer	Tertiary of Greenland; Mascall formation of Oregon.		
Quercus calvertonensis Berry	×	×			Quercus alba Linné	Canada to Florida and Texas.
Quercus lehmanni Hollick	×				Quercus emoryi Torrey	Arid uplands; western Texas, southern Arizona, and New Mexico.
Quercus chapmanifolia Berry	×		Some of forms referred by Heer to Quercus myrtilloides Unger.	Miocene of Switzerland.	Quercus chapmani Sargent	Sandy, coastal Georgia and Florida.
Carpinus grandis Unger		×	Carpinus grandis Unger	Tortonian of Europe; Mascall formation of Oregon; Tertiary of Greenland	Carpinus caroliniana Walter	Bottoms and swamps; southern Canada to Florida.
Ulmus basicordata Hollick	×	×	Ulmus minuta Goeppert	Tortonian of Europe	Ulmus alata Michaux	Uplands and swamps; Virginia to Texas.
Planera ungeri Ettingshausen		×	Planera ungeri Ettingshausen.	Tortonian of Europe; Tertiary of Greenland	Planera aquatica Gmelin	Swamps; North Carolina to Florida and Texas.
Ficus richmondensis Berry		×	Ficus tiliæfolia (Alex. Braun) Heer.	Tortonian of Europe		
Platanus aceroides Goeppert		×	Platanus aceroides Goeppert.	Tortonian of Baden; Tertiary of Greenland	Platanus occidentalis Linné	Bottom lands; New England to Florida and Texas.
Phyllites cercocarpifolia Berry	×				Cercocarpus breviflorus Gray	Dry ridges; western Texas, southern Arizona, New Mexico, and Mexico.
Cæsalpinia ovalifolia Hollick	×		Cæsalpinia townshendi Heer.	Tortonian of Baden	Cæsalpinia species	American Tropics and subtropics.
Cassia toraformis Berry	×		Cassia lignitum Unger	Tortonian of Europe	Cassia tora Linné	Sandy; Virginia to Florida and tropical America.
Podogonium virginianum Berry	×	×	Podogonium obtusifolium Heer. Leguminosites deperditus Heer.	Tortonian of Baden		
Dalbergia calvertensis Berry	×	×	Cæsalpinia micromera Heer	do		
Leguminosites calvertensis Berry		×	Pods referred by Heer to Acacia.	do	Leucæna greggi Watson	Ravines and banks; western Texas and Mexico.

[a] Many of these forms are wide-ranging and have been identified from various horizons. Only the most similar materials are cited.

Comparison of Calvert flora with most similar fossil and existing forms—Continued.

Calvert flora.	District of Columbia.	Richmond.	Most similar fossil form.		Most similar existing form.	
			Name.	Horizon.[a]	Name.	Habitat and range.
Rhus milleri Hollick	×	×	Rhus pyrrhæ Unger	Tortonian of Baden		
Celastrus bruckmanni Alex. Braun.		×	Celastrus bruckmanni Alex. Braun.	Tortonian of Europe; Tertiary of Greenland		
Ilex calvertensis Berry	×				Ilex vomitoria Aiton	Coastal; south Atlantic and Gulf States.
Berchemia priscaformis Berry	×		Berchemia prisca Saporta; Berchemia multinervis (Alex. Braun) Heer.	Aquitanian of France; Tortonian of Baden	Berchemia scandens (Hill) Trelease.	Low woods; Virginia to Texas.
Nyssa gracilis Berry		×	Nyssa arctica Heer	Tertiary of Greenland	Nyssa biflora Walter	Swamps and pond borders; Maryland to Louisiana near coast.
Vaccinium cf. V. textum Heer	×		Vaccinium textum Heer	Tortonian of Baden		
Pieris scrobiculata Hollick	×				Pieris nitida (Bartram) Bentham.	Wet woods; Virginia to Cuba.
Fraxinus richmondensis Berry		×			Fraxinus americana Linné; Fraxinus pennsylvanica Marshall.	Canada to Texas.
Phyllites sp. Hollick	×					

[a] Many of these forms are wide-ranging and have been identified from various horizons. Only the most similar materials are cited.

Among the recent species with which the Calvert forms are compared three range as far north as southern Canada and one other ranges into New England. On the other hand, all the forms, including the four just mentioned, range southward to Florida or Texas and five of these extend into the American Tropics. It is obvious that these wide-ranging forms are of slight value in an endeavor to estimate the climatic conditions along the coast in Calvert time. More significance attaches to the northern limits of the other existing forms with which those of the Calvert are compared. Three of these have their northern limits in southern Arizona and New Mexico, two in Georgia, two in North Carolina, four in Virginia, one in Maryland, and two in Delaware. Some of the comparisons with recent forms are closer or more significant than others. Among these may be cited those with *Taxodium distichum*, *Quercus chapmani*, *Planera aquatica*, *Berchemia scandens*, and *Pieris nitida*. Of these, the bald cypress (*Taxodium distichum*) reaches its northern limit in southern Delaware; *Quercus chapmani* is confined to the coast of Georgia and the Gulf of Mexico; Planera reaches northward to the Coastal Plain of North Carolina; and Berchemia and Pieris extend to the Coastal Plain of Virginia. It is obvious that if these comparisons are legitimate the Calvert flora would find its most favorable conditions for existence along the present south Atlantic and Gulf coasts.

Another method of approach is furnished by comparing the Calvert flora with the contemporaneous floras of Europe. Of the 26 Calvert species, 7 are identical with and 10 are extremely close to forms of the Tortonian of Europe. The Tortonian has a very extensive flora, and as a result of the elaborate analysis by Heer it was considered to indicate a mean annual temperature of 65°.

Regarding the specific environment of the different Calvert species, I consider the following as denizens of river or estuary swamps:

Salvinia formosa.	Fraxinus richmondensis.
Taxodium dubium.	Pinus sp.
Nyssa gracilis.	

The following may be considered as dwellers on river bars or behind coastal sand dunes:

Salix ræana.	Platanus aceroides.
Ulmus basicordata.	Berchemia priscaformis.
Cassia toraformis.	Carpinus grandis.
Pieris scrobiculata.	

Those which probably flourished in low bottoms, on the lower flood plains of streams, are

Carpinus grandis.	Podogonium virginianum.
Planera ungeri.	Leguminosites calvertensis.
Platanus aceroides.	Ficus richmondensis.
Berchemia priscaformis.	Pieris scrobiculata.

Most of these could readily live also in river or estuary swamps.

The species which may legitimately be considered to have been inhabitants of the strand or of coastal dunes are

Quercus calvertonensis.	Dalbergia calvertensis.
Quercus lehmanni.	Rhus milleri.
Quercus chapmanifolia.	Ilex calvertensis.
Phyllites cercocarpifolia.	Vaccinium cf. V. textum.
Cæsalpinia ovalifolia.	Celastrus bruckmanni.
Cassia toraformis.	Pinus sp.

All but Salvinia and Cassia were probably arborescent, and Cassia may have been. All the dicotyledons except Fraxinus, Carpinus, Platanus, Ficus, and *Quercus calvertonensis* show marked reduction of the leaf laminæ, clearly indicating a sandy habitat or a swamp habitat, the latter being physiologically dry and in its effects much like the former.

The leaves of the oaks, Berchemia, Podogonium, *Phyllites cercocarpifolia*, Dalbergia, Rhus, Ilex, Vaccinium, and Celastrus are coriaceous or subcoriaceous, and those of the Pieris are tomentose, both features tending to prevent transpiration and indicating a physiologically dry habitat as well as exposure to abundant sunshine.

In comparing the two localities, that at Richmond clearly indicates a low coast which was lined with cypress swamps and in which the very inconsiderable run-off carried only the finest muds. That in the District of Columbia, in its small-leafed oaks, Ilex, Vaccinium, Pieris, and abundance of Leguminosæ, as clearly indicates a region of dunes comparable with the present Santa Rosa Peninsula, between Pensacola Bay and the Gulf of Mexico.

Physical conditions may produce decided differences in the flora of the continental margin and the marine life of the sea which washes it, as for example in the English Pliocene, where the only avenue of immigration for terrestrial plants and fresh-water mullusks was from the south, while the only avenue of immigration for the marine fauna lay in the cool currents that entered the North Sea from the north. However, the Calvert fossils do not represent a northward extension of the south Atlantic and

Gulf flora along the Coastal Plain and a southward migration of a marine shallow-water fauna in the opposite direction along the coast, but both floral and faunal evidence are in accord.

In this connection it is of interest to call attention to the fact that five of the Calvert plants occur in the late Eocene or Oligocene of western Greenland, in latitude 70° N. This Arctic flora I believe to be contemporaneous with those more southern floras of the late Eocene (Jackson) or early Oligocene (Catahoula and Vicksburg) which are most tropical in their facies. It seems also to be established that with the gradual lowering of temperatures during later Tertiary time this circumpolar flora spread southward over North America and Eurasia.

PROBABLE AGE.

Seven of the Calvert plants, or 26.9 per cent, are common to the Tortonian of Europe, and ten others, or 38 per cent, are represented in the Tortonian by very similar forms. In view of the fact that these floras spread into both regions from a common and equally accessible source, as I have just stated, the evidence that the Calvert flora indicates a Tortonian age is as conclusive as intercontinental correlations can ever be. Compared with other American floras of Miocene age, that of the Calvert has little in common with the described Miocene floras from Colorado, Idaho, Oregon, or California, which are all lake or river valley floras of moist upland forest types.

CONCLUSIONS.

The Calvert flora was a coastal flora of strikingly warm-temperate affinities, comparable with the existing coastal floras of South Carolina and Georgia along the south Atlantic coast or with those along the coast of the Gulf of Mexico from western Florida to eastern Texas. The general climatic features it indicates are in accord with those which may be legitimately deduced from the evidence of the marine faunas. The climate of the Chesapeake Miocene epoch, cooler undoubtedly than that of the Apalachicola or preceding epochs, was neither cold nor cool temperate.

The age indicated by the Calvert flora is middle Miocene, or in terms of European geology Tortonian.

NEW SPECIES OF PLANTS.

Class GYMNOSPERMÆ.

Order CONIFERALES.

Family PINACEÆ.

Genus PINUS Linné.

Pinus sp.

Plate XII, figure 1.

A somewhat macerated seed of Pinus of the *Pinus tæda* type occurs at Good Hope Hill. The material is insufficient for characterization.

Pinus tæda Linné ranges from Delaware southward along the coast to Texas and extends up the Mississippi Valley to Tennessee and Arkansas.

Class ANGIOSPERMÆ.

Order FAGALES.

Family FAGACEÆ.

Genus QUERCUS Linné.

Quercus chapmanifolia Berry, n. sp.

Plate XI, figures 1, 2.

Leaves small, oblong-obovate in general outline, with a rounded apex and a wide or narrowly cuneate, ultimately slightly rounded base. Length from 27 to 45 millimeters; maximum width, at or above the middle, from 14 to 30 millimeters. Margins entire, slightly undulate. The lateral margins ascend to or above the middle, where they curve to form irregular and unequally developed rounded lobes subtending usually shallow and open rounded sinuses. A second short and broadly rounded lobe may be developed, usually on only one side, in the apical region. Petiole short and stout enlarged proximad, 2 to 3 millimeters in length. Midrib stout, usually curved or flexuous, prominent on the lower surface of the leaf. Secondaries of varying caliber dependent on the extent to which lobes are developed; in the prominently lobed specimen shown in figure 2 a subopposite pair are stout and prominent on the lower surface of the leaf, where the lobation is feeble, as in figure 4. The secondaries are thin. There are as many craspedodrome secondaries as there are lobes—two or three to a leaf; the rest of the secondaries are camptodrome; all are somewhat irregularly spaced and rather straight in their courses,

their angles of divergence depending on the relative width of the leaves. Texture coriaceous.

This significant new species is rather clearly marked off among previously described fossil forms. Among existing forms its size and general outline as well as its limits of variation are almost exactly those of *Quercus chapmani* Sargent. This may be readily seen without extended discussion by the ink prints of the leaves of the latter species introduced for comparison and shown in figures 3 to 8 of Plate XI.

This similarity is, I believe, an indication of relationship, and in its light the habitat of the existing species becomes of special interest. *Quercus chapmani* is a small tree, or more commonly a shrub, inhabiting sandy barrens near the coast, of rare occurrence from South Carolina to Florida along the Atlantic coast, reaching its maximum of abundance and development along the Gulf coast of western Florida from the shores of Tampa Bay to Pensacola. The leaves figured come from the Santa Rosa Peninsula, where it is typically developed and where the environment is comparable with that of Miocene time along the shores of the shallow Calvert sea.

Occurrence: Good Hope road, Anacostia Heights, D. C.

Quercus lehmanni Hollick.

Plate XI, figures 9–11.

Quercus lehmanni. Hollick, Miocene, p. 483, figs. 1a, 1b, Maryland Geol. Survey, 1904.

This species was briefly described by Hollick in 1904. Recent material collected from the type locality enables me to give the following somewhat fuller characterization:

Leaves small and narrow, oblong in general outline. Length from 21 to 38 millimeters; maximum width, across the median marginal lobes, from 14 to 17 millimeters. Apex conically pointed. Base broadly rounded, generally somewhat inequilateral. Margins with one to three irregularly spaced reduced lobes on each side; these lobes are more or less developed, short, and conical and are little more than coarse teeth; they subtend usually open sinuses, although in some specimens the lobes are directed upward instead of outward and the sinuses are correspondingly narrow. Petiole short and stout. Midrib stout, straight, or curved, prominent on the lower surface of the leaf. Secondaries thin, two to four pairs; they diverge from the midrib at angles of about 45° and ascend in straight or somewhat flexuous courses; a craspedodrome secondary runs to the tip of each lobe, and a basal one on each side arches along the lower lateral margin. Tertiaries obsolete. Texture coriaceous. The lobes are irregularly spaced; if there is but one on one side there are usually two on the other, and if there are two on one side there are usually three on the other; they may all be above the middle of the leaf, as in figure 9, but often there is a small oblique one lower down, as in figures 10 and 11. Midway between the apex and the base, where the leaf is consequently widest, they are subopposite, as are the corresponding secondaries.

These characteristic leaves are not uncommon, but like most of the plant material in the Calvert formation they are usually much broken. Their size, form, and texture are indicative of barren soil, bright sunshine, and sparse rainfall. Compared with existing species they are found to resemble the toothed leaves sometimes developed on *Quercus virginiana* Miller, a coastal species of southeastern North America, which is also abundant in the Pleistocene and which in the form of *Quercus previrginiana* Berry is exceedingly abundant in the Pliocene of the Gulf coast. Most of the leaves of *Quercus virginiana* are oblong, elliptical, or obovate with merely undulate margins, and the significance of the occasional toothed leaves is unknown. A modern species with which *Quercus lehmanni* may be more legitimately compared is *Quercus emoryi* Torrey. The latter has the small narrow leaves with rounded bases and irregular teeth. They differ somewhat from the fossil leaves in their proportions, having generally a broader base, but many leaves can be selected that exactly match the fossil. *Quercus emoryi* is a stout tree of the uplands of western Texas and southern New Mexico and Arizona, and although it is not necessarily directly affiliated with this Miocene form of the Atlantic coast, it is not improbable that the two forms have a common ancestor which once flourished in an intermediate area.

Occurrence: Good Hope road, Anacostia Heights, D. C.

Order URTICALES.

Family ULMACEÆ.

Genus ULMUS Linné.

Ulmus basicordata Hollick.

Plate XII, figure 2.

Ulmus basicordata. Hollick, Miocene, p. 484, fig. 1f, Maryland Geol. Survey, 1904.

This characteristically small Ulmus was compared by Hollick with the cosmopolitan *Planera ungeri* Ettingshausen, especially with the type material [1] from the late Miocene of Austria. This protean and probably composite species has a recorded range from the Eocene to the Pleistocene and a geographic distribution from Japan and Manchuria throughout Europe to North America, Iceland, and Greenland. It has been recorded by me from the Calvert formation at Richmond, Va., and that material is certainly quite distinct from *Ulmus basicordata,* whatever may be thought of some of the European records of *Planera ungeri.*

In my judgment *Ulmus basicordata* finds its closest European relative in *Ulmus minuta* Goeppert.[2] This little species has been recorded from a large number of European localities, ranging in age from the middle Miocene to the Pliocene. The American *Ulmus basicordata* may be compared more particularly with the material of *Ulmus minuta,* from the Tortonian of Baden, on the Swiss border, described by Heer.[3]

Occurrence: Richmond, Va., and Good Hope Hill, D. C.

Order ROSALES.

Family ROSACEÆ.

Genus PHYLLITES of authors.

Phyllites cercocarpifolia Berry, n. sp.

Plate XII, figures 3, 4.

Leaves small, obovate, with a broadly rounded tip and a cuneate base. Length about 6 millimeters; maximum width, slightly above the middle, about 3.5 millimeters. Margins entire, possibly slightly revolute. Texture distinctly coriaceous. Petiole short and stout, less than 1 millimeter in length. Midrib relatively stout and prominent. Secondaries thin but prominent, numerous, equally spaced and subparallel; about seven or eight subopposite pairs diverge from the midrib at acute angles and pursue a nearly straight ascending course to the margins, where they are abruptly camptodrome. Tertiaries obsolete.

This tiny leaf suggests a relationship with the genus Cercocarpus, of the Rosaceæ, and the resemblance is so great that I feel justified in referring the fossil to that family. Cercocarpus is a small genus of about five species of trees and shrubs confined to the dry interior and mountainous regions of the United States and Mexico. The fossil greatly resembles the entire leaves of *Cercocarpus breviflorus* Gray, a small tree of the pine and oak forests of the dry elevated ridges of southern Arizona, New Mexico, western Texas, and northern Mexico. Although I do not feel justified in referring the fossil to Cercocarpus without more conclusive evidence I believe that the resemblance noted indicates such a relationship.

Occurrence: Benning road, D. C., near District line.

Family CÆSALPINIACEÆ.

Genus CASSIA Linné.

Cassia toraformis Berry, n. sp.

Plate XII, figures 6, 7.

Leaflets small, sessile, inequilateral. Apex broad, inequilateral, slightly emarginate. Base broad, slightly pointed, inequilateral. Margins entire. Leaf substance thin. Length about 15 millimeters; maximum width, slightly below the middle, 7.5 millimeters. Midrib of medium size, nearly straight. Secondaries thin, about seven pairs, diverging from the midrib at acute angles, those in one-half of the lamina more acute, sweeping upward in ascending subparallel curves, parallel with the lower lateral margins, camptodrome. Tertiaries thin, of the Cassia type.

This species appears to be a new species of Cassia, although it may represent an allied genus of the Cæsalpiniaceæ. Among the hundreds of existing species there are a number very similar to the fossil, which I have named from its resemblance to the existing *Cassia tora* Linné, an annual of sandy soils ranging

[1] Ettingshausen, Constantin, Fossile Flora von Wien, p. 14, pl. 2, figs. 5–18, 1851.

[2] Goeppert, H. R., Tertiäre Flora von Schossnitz in Schlesien, p. 31, pl. 14, figs. 12–14, 1855.

[3] Heer, Oswald, Flora tertiaria Helvetiæ, vol 2, p. 59, pl. 79, figs. 9–13, 1856; vol. 3, p. 181, pl. 151, fig. 30, 1859.

from Virginia southward to Florida, Cuba, and tropical America.

The fossil species are numerous and range from the Upper Cretaceous to the present. Among previously described fossil forms *Cassia toraformis* is identical with some of the leaves from the Tortonian of Oeningen, Baden, which Heer [1] refers to *Cassia lignitum* Unger. It is also very similar to *Cæsalpinia escheri* Heer,[2] from Oeningen.

Occurrence: Good Hope Hill, D. C.

Order SAPINDALES.

Family ILICACEÆ.

Genus ILEX Linné.

Ilex calvertensis Berry, n. sp.

Plate XII, figure 8.

Leaves small, ovate in general outline, with a bluntly pointed apex and base, the latter slightly inequilateral. Length about 16.5 millimeters; maximum width, midway between the apex and base, about 7 millimeters. Margins entire for most of their length, apically with slight and remote denticulations. Texture subcoriaceous. Petiole short and stout, about 1.75 millimeters in length. Midrib stout and prominent proximad, attenuated distad, curved. Secondaries thin; five subopposite pairs diverge from the midrib at wide angles and are conspicuously camptodrome in the marginal region. Tertiary venation obsolete.

Ilex is a large genus with over 100 described fossil species and over 200 existing species. It ranges from the Upper Cretaceous to the present, and existing forms are found in all tropical and temperate regions except western North America, Australia, New Zealand, and New Guinea. The largest number occur in Brazil and Guiana.

Ilex calvertensis may be compared with the existing *Ilex vomitoria* Aiton, a small tree of the coastal region of the South Atlantic and Gulf States. It also resembles *Ilex vomitoriafolia* Berry, a coastal form of the lower Eocene (Wilcox group) of the Mississippi embayment, with which it may be affiliated.

Occurrence: Good Hope Hill, D. C.

[1] Heer, Oswald, Flora tertiaria Helvetiæ, vol. 3, p. 121, pl. 138, figs. 23–28, 1859.

[2] Idem, p. 111, pl. 155, fig. 21.

Order RHAMNALES.

Family RHAMNACEÆ.

Genus BERCHEMIA Necker.

Berchemia priscaformis Berry, n. sp.

Plate XII, figures 11, 12.

Leaves small, lanceolate, with equally acuminate apex and base. Length about 13 millimeters; maximum width between apex and the base, about 5.5 millimeters. Margins entire, slightly undulate corresponding with the camptodrome endings of the secondaries. Texture subcoriaceous. Petiole relatively long and slender, about 2 millimeters in length. Midrib relatively stout, somewhat curved, prominent on the lower surface of the leaf. Secondaries thin but prominent, numerous; seven or eight pairs diverge from midrib at regular intervals and acute angles, curving slightly and subparallel, camptodrome close to the margins. Tertiaries mostly obsolete, a few percurrent ones seen.

This characteristic little species is scarcely distinguishable from the smaller and more lanceolate leaves of *Berchemia scandens* (Hill) Trelease, a high-climbing shrub frequenting low woods from Virginia to Florida and from Missouri to Texas. The genus contains about 10 existing species, the others being natives of Asia and tropical Africa. About half a dozen fossil species have been described. These include a rare form in the Aquitanian of France, another in the Burdigalian of Bohemia, species in the Pliocene of France and Holland, and the widespread *Berchemia multinervis* (Alex. Braun) Heer. *B. multinervis* has a recorded range from the Tongrian to the Astian throughout central and southern Europe. It has been identified in the lower Eocene (Raton, Denver, and Fort Union formations) of the Rocky Mountain province and in the Miocene of Oregon.

The American material referred to *B. multinervis* is larger and wider than the Calvert species and has a more pronounced tertiary venation. Some of the smaller leaves of *B. multinervis* from European localities are much like *B. priscaformis*, as for example a leaf figured by Heer [3] from the Tortonian of Oeningen, Baden, which is but slightly larger or wider.

[3] Idem, pl. 123, fig. 17.

The Calvert species is named from its resemblance to *Berchemia prisca* Saporta,[1] from the Aquitanian of Peyriac, France, a very similar but slightly more oblong leaf.

Occurrence: Good Hope Hill, D. C.

Order ERICALES.

Family VACCINIACEÆ.

Genus VACCINIUM Linné.

Vaccinium cf. V. textum Heer.

Plate XII, figures 14, 15.

Several specimens of a small oval subcoriaceous leaf are indistinguishable from *Vaccinium textum* Heer,[2] from the Tortonian of Oeningen, Baden. Heer's description is as follows:

V. folius subcoriaceis, ovalibus, integerrimis, apice obtusiusculis, basi rotundatis; nervis secundariis camptodromis, areis reticulatis.

The Calvert form agrees with its European contemporary in size, general outline, and texture, as well as in secondary and tertiary venation characters. The only difference is the more acute base of the American form. The latter feature and the wide geographic separation of the two occurrences have prevented the direct reference of the American form to Heer's species.

[1] Saporta, G. de, Études sur la végétation du sudest de la France à l'époque tertiaire, vol. 2, p. 338, pl. 11, fig. 1, 1866.

[2] Heer, Oswald, op. cit., p. 190, pl. 153, figs. 40–42.

The genus contains about 125 existing species of wide geographic distribution, especially in the temperate and boreal regions of the Northern Hemisphere. It occurs, however, at high elevations in the Tropics, both north and south of the Equator, and evidently grew in intermediate areas at some past times.

The fossil species are numerous and ranged from the Eocene onward, with their maximum display during the Miocene, when they were especially abundant in southern Europe along the shores of the Mediterranean Sea of that epoch.

Occurrence: Good Hope Hill, D. C.

Family ERICACEÆ.

Genus PIERIS Don.

Pieris scrobiculata Hollick.

Plate XII, figure 13.

Pieris scrobiculata. Hollick, Miocene, p. 486, tf. 1g, Maryland Geol. Survey, 1904.

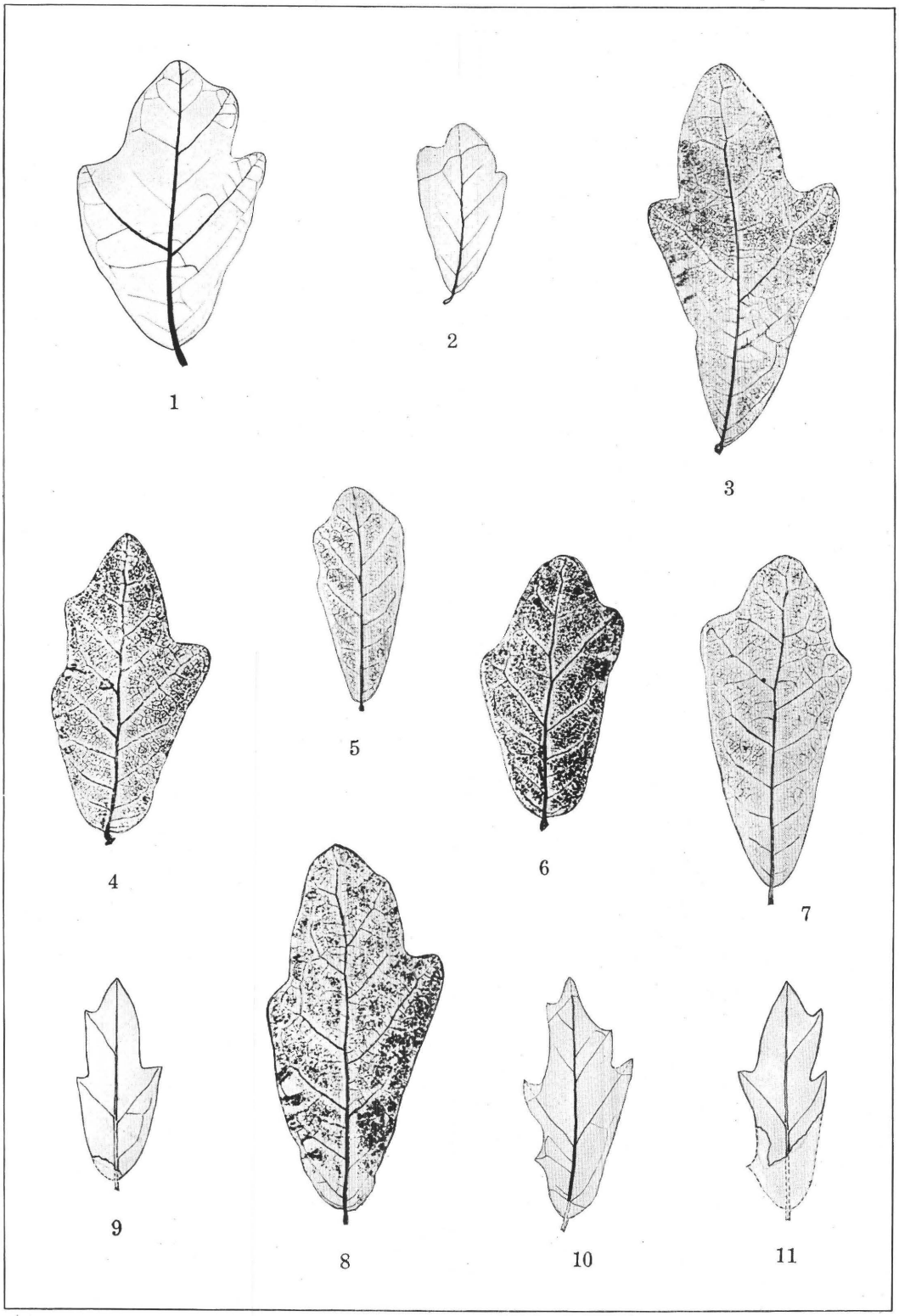
This species was described by Hollick from material obtained at the Good Hope Hill locality. He compared it with the existing *Pieris nitida* (Bartram) Bentham and Hooker, a shrub of wet woods which ranges from southeastern Virginia to Florida near the coast and is said to occur also in Cuba. Additional material from the type locality agrees with the type in outline and texture, but is only 11 millimeters in length and 5 millimeters in maximum width.

Occurrence: Good Hope Hill, D. C.

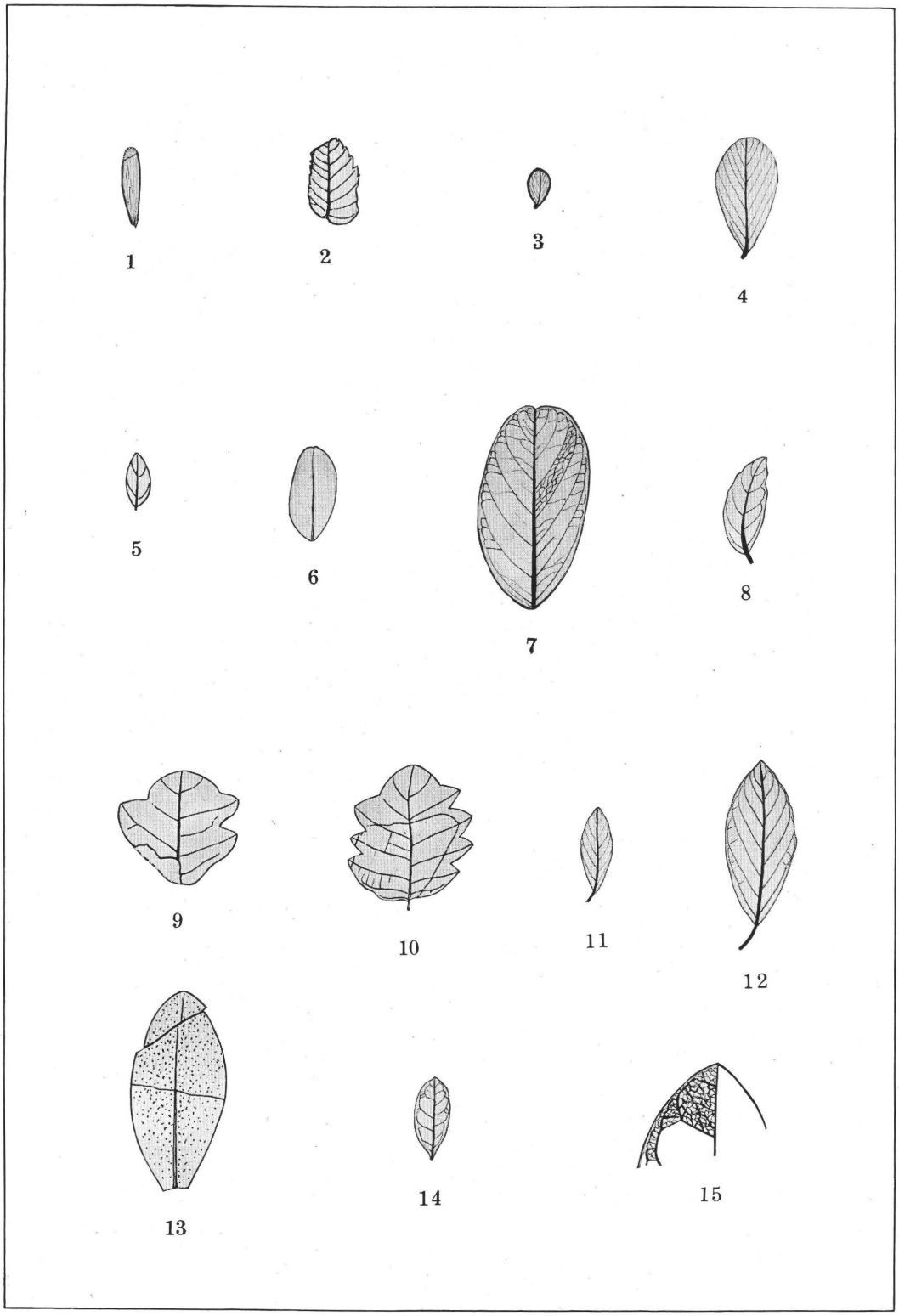
PLATES XI-XII.

PLATE XI.

FIGURES 1, 2. *Quercus chapmanifolis* Berry. Good Hope Hill, D. C.
FIGURES 3–8. *Quercus chapmani* Sargent. A modern form from Santa Rosa Peninsula, Fla.
FIGURES 9–11. *Quercus lehmanni* Hollick. Good Hope Hill, D. C. (Figs. 9 and 11 after Hollick.)



FOSSIL PLANTS FROM THE CALVERT FORMATION.



FOSSIL PLANTS FROM THE CALVERT FORMATION.

PLATE XII.

FIGURE 1. Pinus sp.
FIGURE 2. *Ulmus basicordata* Hollick. (After Hollick.)
FIGURE 3. *Phyllites cercocarpifolia* Berry.
FIGURE 4. Same, × 3.
FIGURE 5. *Cæsalpinia ovalifolia* Hollick. (After Hollick.)
FIGURE 6. *Cassia toraformis* Berry.
FIGURE 7. Same, × 3.
FIGURE 8. *Ilex calvertensis* Berry.
FIGURE 9. *Rhus milleri* Hollick.
FIGURE 10. Same, a more lobate form from Richmond, Va.
FIGURE 11. *Berchemia priscaformis* Berry.
FIGURE 12. Same, × 2.
FIGURE 13. *Pieris scrobiculata* Hollick. (After Hollick.)
FIGURE 14. Vaccinium cf. *V. textum* Heer.
FIGURE 15. Tip of same to show venation.

All but figure 10 from Good Hope Hill, D. C.