

PLEISTOCENE PLANTS FROM NORTH CAROLINA

By EDWARD WILBER BERRY

INTRODUCTION

The field work upon which this report is based was done in 1906 and 1907 as a part of the cooperative study of the Atlantic Coastal Plain, under the direction of the late William Bullock Clark. Associated with the writer in this work were L. W. Stephenson, B. L. Miller, jr., and J. E. Pogue. Preliminary accounts of the plants collected were published in 1907¹ and 1909.²

As has been frequently emphasized, the study of the Pleistocene floras in this country is in an exceedingly backward state as measured by the volume and precision of our knowledge of Pleistocene floras in Europe. Researches in Pleistocene geology in North America have been confined almost entirely to glaciology, and the problem of the correlation of the glacial deposits with those outside the glaciated area has not been solved, nor is there any general agreement regarding the genesis of the Pleistocene deposits south of the terminal moraines. The present account of what is known of the Pleistocene flora of North Carolina and the conclusions that may be legitimately derived from it is offered in the hope that it may stimulate an interest in a neglected field of research and form a small part of the evidence upon which to base future more comprehensive conclusions and generalizations.

A word of explanation regarding the illustrations is required. Nearly all of them have been made from leaves preserved as carbonaceous films in the peaty clays. These specimens were carefully washed out, and blue prints were made directly from them. Outlines and as much of the venation as could be seen were inked on the blue prints, which were then bleached. This procedure made it possible to handle a much larger amount of material and prevented any possible damage to the exceedingly fragile specimens, which were mounted on cards or between glass. The accompanying drawings were made from tracings of the original nature prints.

¹ Berry, E. W., Contributions to the Pleistocene flora of North Carolina: Jour. Geology, vol. 15, pp. 338-349, 1907.

² Berry, E. W., Additions to the Pleistocene flora of North Carolina: Torreya, vol. 9, pp. 71-73, 1909.

GEOLOGY OF THE PLEISTOCENE IN NORTH CAROLINA

The Pleistocene formations of North Carolina were discussed in detail by Stephenson³ in 1912. Five formations, mapped largely by their topographic form and constituting five terrace plains with seaward-facing scarps and reentrants up the stream valleys, were recognized. These are, from youngest to oldest; the Pamlico, Chowan, Wicomico, Sunderland, and Coharie. Among these formations identifiable fossil plants have been found only at a single locality in the Wicomico, at two localities in the Chowan, and at two localities in the Pamlico.

The Wicomico locality is 1¼ miles east of Weldon, in Northampton County, where the following section is exposed, according to Stephenson:

Section 1¼ miles east of Weldon, N. C.

	Feet
Yellow more or less sandy clay, largely concealed by vegetation.....	35
Yellow pebbly argillaceous sand.....	2
Lenses of yellow clay with leaves.....	½
Yellow very coarse pebbly arkosic sand.....	2½

The principal Chowan locality is along the right bank of Neuse River 79⅔ miles above New Bern and 4½ miles above Seven Springs, in Wayne County, where the following section is exposed:

Section on Neuse River above Seven Springs, N. C.

	Feet
Clay loam grading down into sandy loam.....	4
Coarse white and yellow sand with gravel layers and boulders in lower portion.....	7
Tough blue clay interstratified with lignitic and leaf layers 2 to 3 inches thick.....	3

Published accounts of the fossil plants from this section have alluded to it as station 850.

The second Chowan locality is at Dupree Landing, on the right bank of Tar River about 14 miles above Greenville, in Pitt County, where the following section is exposed in a depression in the Patuxent formation:

Section at Dupree Landing, N. C.

	Feet
Sandy loam and argillaceous sand with pebbles along base.....	6
Lignite.....	0-3

³ Stephenson, L. W., The Coastal Plain of North Carolina: North Carolina Geol. and Econ. Survey, vol. 3, pp. 266-290, 1912.

The Pamlico formation, whose surface constitutes the lowest terrace plain of eastern North Carolina, contains fossil plants at Old Mill Landing, on the left bank of Roanoke River 8 miles above Williamston, in Bertie County, where the following section is exposed:

Section at Old Mill Landing, N. C.

	Ft.	in.
Surface loam grading down into buff sand with small pebbles interstratified with argillaceous layers	10	
Fine gravel		8-10
Concealed	3	6
Gravel	1	
Cross-bedded sand	1	
Gravel		6
Yellow sandy clay	5	
Dark micaceous clay with plants	0-1	

nately named. The Wicomico formation in North Carolina is a direct southward continuation of the Wicomico formation of Maryland and Virginia. The Chowan and Pamlico together correspond to what has been called the Talbot formation in Maryland and Virginia, the Chowan corresponding to the older and the Pamlico to the younger part of the Talbot, and it is probable that detailed work would show a corresponding division of the Talbot in Virginia and on the Eastern Shore of Maryland. (See fig. 5.)

CHARACTER OF THE FLORA

The flora here described contains more or less certainly determined remains of 48 species, representing

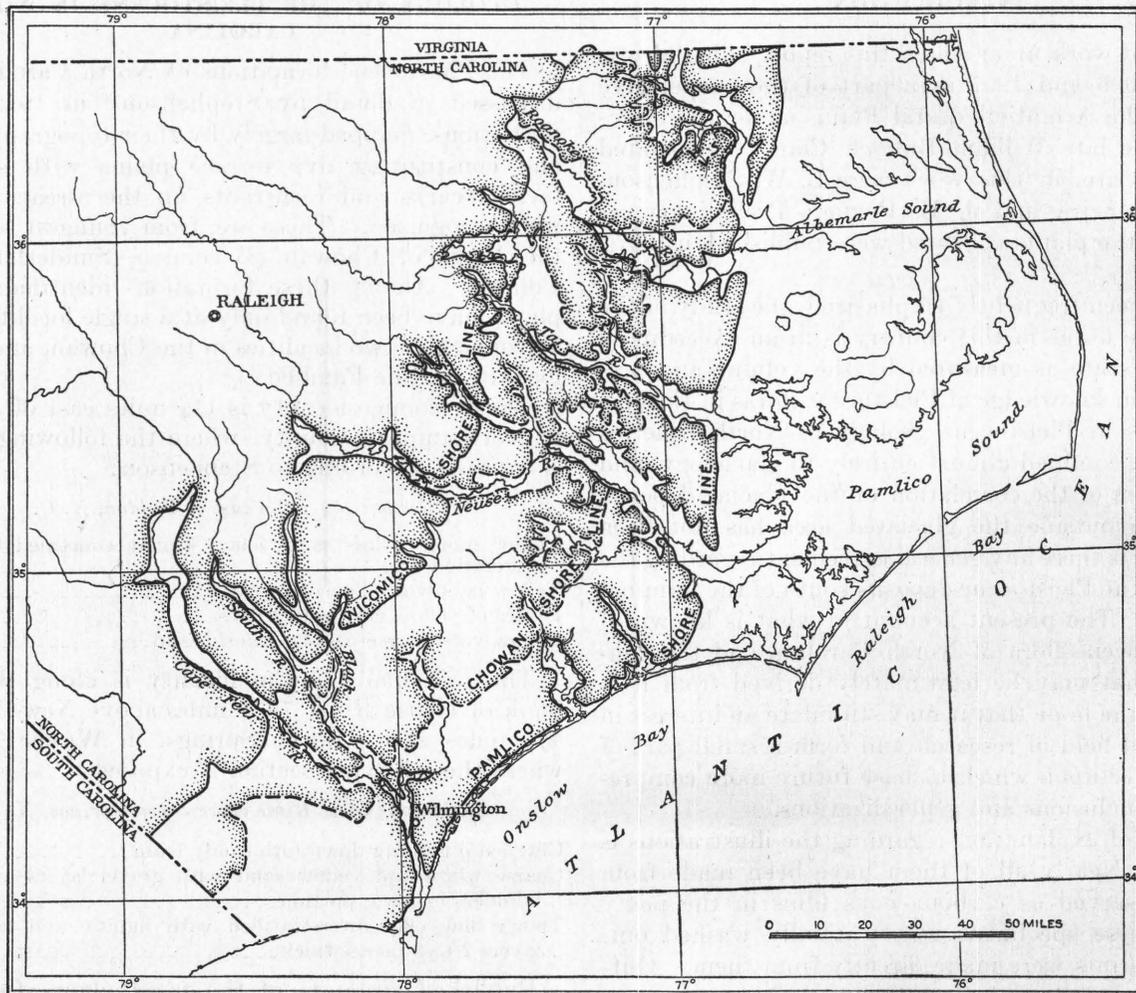


FIGURE 5.—Map showing the Pamlico, Chowan, and Wicomico coasts of North Carolina

The second Pamlico locality is a low exposure on the right bank of Neuse River 10 or 12 miles below New Bern, in Craven County, from which only the remains of the bald cypress and pine have been recorded.

As regards the correlation of these formations with the Pleistocene formations of the adjacent States it may be stated that all can be traced for long distances in the Coastal Plain, both north and south of North Carolina. In South Carolina these formations and their corresponding terrace plains have not been defi-

30 genera in 23 families and 17 orders. All but two conifers, representing the genera *Pinus* and *Taxodium*, are angiosperms or flowering plants, and of these all belong to the class Dicotyledonae except fruits representing a grass and a pond weed.

None of the recorded species are forms that appear at all out of place in a North Carolina flora, although several no longer exist at or near the localities where the fossils were found. Two species of willows, one of birch, two of oaks, two of crab apple, two of hawthorn,

one of *Dendrium*, and one of *Vaccinium* are described as new and consequently extinct species. These new forms constitute nearly 23 per cent of the whole flora, a proportion that is somewhat misleading, for the following reasons: One of the oaks is obviously an abnormality or hybrid and not a true botanical species; the two species of *Malus* and the birch are not very precisely differentiated; and the two species of *Crataegus* belong to a genus that appears to have undergone rapid mutation in recent times and to be of uncertain value. This leaves an extinct species of *Quercus* and one of *Dendrium* that I regard as satisfactory and a species of *Vaccinium* that may be authentic or may possibly represent an abnormality.

Both the oak and the *Dendrium* represent Pleistocene forms, each regarded as ancestral to two existing species of different environmental requirements. Thus the true percentage of extinct species may really be about 4 instead of nearly 23.

Nearly all the species represented are trees or shrubs. The only herbaceous forms are *Sparganium*, *Chaetochloa*, and *Polygonum*, represented by fruits and not by leaves. Thus in Pleistocene time, as to-day in the backwaters of rivers and estuaries of the Coastal Plain of North Carolina, the bulk of the leaves that were preserved in the sediments were the leaves of trees.

The most abundantly represented forms in this Pleistocene flora are the bald cypress, the river birch, the beech, various oaks, and the button ball. The oaks are remarkable for both their individual abundance and variety, ten species being recorded, representing both dry and wet soil forms. The most abundant of these are the wet-soil forms *Quercus nigra*, *Q. phellos*, and *Q. michauxii*, although *Quercus predigtata* is about equally abundant.

All of North America north of the terminal moraine, with the exception of a few nunataks or small ice-free areas that projected above the continental ice sheet and a few ice-free regions, the largest known of which were in central and northern Alaska, have been colonized by vegetation since the end of the Wisconsin glaciation, which is considered to have been from 10,000 to 20,000 years ago.

A great deal of misconception has existed regarding the severity of glacial climates and their effect on the Tertiary vegetation of North America. There is little doubt that the present major floristic regions were well marked toward the end of the Tertiary period, particularly as regards the separation of the eastern mesophytic region from that of the Pacific region by the intervening area, consisting mainly of prairie or grass land, but including at the south desert or semidesert.

During the maximum extent of the ice there must have been considerable crowding and competition between the native flora and that which formerly existed in the glaciated region. That there was an actual

zonal arrangement of climatic belts south of the ice front seems very doubtful. Even in the immediate vicinity of the ice front there was probably no continuous barren ground or tundra zone inhabited by arctic vegetation. None of the evidence as yet disclosed in the Pleistocene floras of North America, although admittedly very incomplete, shows an appreciable lowering of temperature at any great distance away from the ice front. This may, of course, be due to the fact that the bulk of the Pleistocene plants so far discovered have come from relatively low altitudes and mostly from the Coastal Plain.

The plant localities in the Pleistocene area of North Carolina are about 425 miles south of the terminal moraine on the Atlantic coast, about 400 miles south of its position in southern Ohio, about 475 miles southeast of it in Indiana, and slightly over 600 miles east-southeast of its southernmost limit in southern Illinois.

Unless there were a secular lowering of temperature amounting to a cataclysmal change, which is highly improbable, the effect of the ice sheet on the vegetation of low-lying coastal lands several hundred miles away would not be detectable. The coastal region of North Carolina during the Pleistocene epoch appears to have been densely forested and to have received an abundant rainfall, both factors that would tend to stabilize the climate and prevent extremes. By comparison with areas that have been critically studied, like the Dismal Swamp, it may be concluded that the climate along the Pleistocene coast of North Carolina, except where the normal climate was disturbed by violent and long-continued winds, was highly favorable for a vigorous and dense forest cover, with slight daily variations of temperature, a long growing season, heavy and well-distributed rainfall, a uniformly high humidity, and freedom from violent frosts.

The cypress swamps along the Pleistocene coast clearly indicate that it was fringed by barrier beaches similar to those existing at the present time along the northern Carolina coast, and that in the inclosed sounds behind these beaches the salinity of the water was kept down by the volume of river water entering them; otherwise salt marshes would have gradually replaced the swamp forests.

The plant remains discovered in the North Carolina Pleistocene show no elements that can be definitely interpreted as northern forms, and although the horizons at which they occur can not be precisely correlated with glacial chronology, three horizons are represented—namely, the Wicomico, Chowan, and Pamlico—and it is not likely that all the periods of coastal subsidence and the deposition of coastal terraces should have coincided with interglacial stages, particularly as most of these terrace deposits, both here and elsewhere along the Atlantic coast, contain what appear to be ice-borne boulders, including some of considerable size.

These boulders at certain localities have been explained as indicating material dropped by icebergs from the north. This might be true for the erratics found in the "banks" of eastern North Carolina, though such an explanation of the presence of such erratics seems improbable. It is certainly not an adequate explanation of their presence at many places in the Pleistocene deposits, as, for example, in the drainage basin of Potomac River. I believe that these are to be explained as borne by river ice, although the smaller ones may have been carried in the roots of drifted trees. If this explanation is sound it indicates a considerable severity of climate, with the formation of much ice, in the uplands along the Alleghany Mountains, which in fact seems to be necessary to explain the present stranded floras and faunas on the higher peaks even as far south as western North Carolina. In regions where boulders are common in the subsoil, as is in a measure true of the Piedmont district of North Carolina, trees encompass many of the boulders in their root systems, and if such trees are overturned by windstorms within reach of rivers in flood periods such stones may be carried long distances. I collected a cobble in 1909 from the root of an Upper Cretaceous tree lignified in the Tuscaloosa formation of Alabama, which is an objective demonstration of this process in the past.

After the storm of August, 1924, which uprooted many large trees in southeastern Connecticut, nearly every tree had one or more boulders tightly clasped by the roots, and these boulders already once glaciated would, if stream transportation had been available, have been carried out and eventually come to rest in fine marine muds. The largest boulder seen was in the roots of a tall pine 18 inches in diameter and had dimensions of 55 by 19 by 20 inches.

The following 27 Pleistocene species out of a total of 48, or considerably more than half, are forms that in the existing flora range long distances north and south of North Carolina:

Sparganium sp.	Polygonum sp.
Hicoria ovata.	Liriodendron tulipifera.
Hicoria glabra.	Liquidambar styraciflua.
Populus cf. P. heterophylla.	Rubus sp.
Carpinus caroliniana.	Malus pseudoangustifolia.
Betula nigra.	Malus coronariafolia.
Fagus americana.	Cercis canadensis.
Quercus velutina.	Ilex opaca.
Quercus prinus.	Vitis sp.
Quercus palustris.	Xolisma ligustrina.
Quercus alba.	Vaccinium corymbosum.
Quercus lyrata.	Viburnum molle.
Celtis occidentalis.	Viburnum nudum.
Platanus occidentalis.	

Many of these species have extended their range northward into New England, southern Canada, and the States north of Ohio River since the retreat of the Wisconsin ice sheet, but at its maximum extent

they appear to have approached it rather closely, at least in the Coastal Plain, where some of them are recorded as far north as New Jersey, and several were growing in southern Maine at a time when the rivers were still encumbered with valley ice. It is exceedingly difficult to evaluate the Pleistocene fossil plants of the Middle Atlantic States, because most of the species range long distances to the north and south, and considerable extensions or contractions of their range might have taken place without being registered in this middle region.

None of the North Carolina plants are definitely northern types or forms that in the existing flora are approaching their southern limit of range in the Carolina region. Quite the reverse is true. Of a total of 48 recorded species the following 14 are at or near their northern limit of range as judged by the existing flora:

Pinus serotina.	Ulmus alata.
Taxodium distichum.	Planera aquatica.
Hicoria aquatica.	Crataegus spathulatoides.
Quercus nigra.	Persea pubescens.
Quercus michauxii.	Nyssa biflora.
Quercus phellos.	Dendrium pleistocenium.
Quercus predigitata.	Vaccinium arboreum.

This is nearly 30 per cent of the known Pleistocene flora of North Carolina and, if it means anything, indicates a milder climate than prevails in that area at the present time.

It is true that there is considerable evidence that certain species, such as *Taxodium distichum* and *Planera aquatica*, are becoming more restricted in the Coastal Plain at the present time, but this restriction appears to have followed a late Pleistocene or post-glacial extension northward, and certainly, for the Coastal Plain flora as a whole, the main movement has been one of a marked expansion northward on the heels of the retreating ice sheet.

More than half of the fossil plants from North Carolina are forms that in the modern flora require wet habitats. These forms are indicated in the accompanying table. Some of them, such as *Pinus serotina*, *Taxodium distichum*, *Sparganium*, *Hicoria aquatica*, *Quercus nigra*, *Quercus phellos*, *Quercus palustris*, *Planera aquatica*, and *Nyssa biflora*, prefer in modern times partly or permanently inundated bottoms. Others, like *Salix*, *Betula nigra*, *Liquidambar styraciflua*, *Quercus michauxii*, and *Ilex opaca*, get along with a less constantly flooded substratum. Others not enumerated among the 25 wet species, like *Fagus americana*, *Quercus lyrata*, *Quercus alba*, *Liriodendron tulipifera*, and *Cercis canadensis*, are woodland forms of deep, moist soils.

The dry-soil species are fewer in number and include *Hicoria glabra*, *Quercus velutina*, *Quercus prinus*, *Celtis occidentalis*, and *Vaccinium arboreum*. There are

several forms that may be considered as occurring on both wet and dry soils. In this category are *Quercus predigitata*, *Ulmus alata*, *Rubus*, *Vitis*, *Xolisma ligustrina*, and *Dendrium pleistocenicum*.

The Pleistocene flora of North Carolina fulfills the requirements that might have been expected from the areal distribution of the deposits in which it has been found. Each deposit consists of sediments laid down in an estuary, and most of the fossil plants are those that might be expected to occur in the bottoms of the lower courses of estuary streams. The few dry-ground forms represented as fossils either grew near at hand on high and dry river bluffs or were brought from the more remote upper courses of these streams into the basin of sedimentation occasionally, as through the agency of floods.

The map showing the shore lines of the seas in which the formations were laid down (fig. 5) brings out with notable clearness the estuary character of the fossiliferous localities, especially in Bertie, Pitt, and Wayne counties.

Plant geographers have always been interested in the representatives of the eastern North American deciduous-forest region which are found in the uplands of southern Mexico, Guatemala, and Costa Rica, and which obviously indicate a once continuous area of distribution, since broken by the conditions that produced the wide belt of arid country now found in the southwestern United States and northern Mexico.

There is as yet little evidence for dating this southward extension of the mesophytic temperate flora of North America into the Tropics. Without predicating climatic changes for which there is no warrant in the available evidence we must conclude that it could not have occurred before the elevation of these Central American regions above the tierra caliente, or tropical and subtropical altitudinal zones. This event is believed to have occurred in late Tertiary time, although the distribution of marine faunas shows clearly numerous earlier changes of level

Among these upland genera occurring in Central America might be enumerated *Abies*, *Pinus*, *Taxodium*, *Liquidambar*, *Quercus*, *Juniperus*, *Alnus*, *Salix*, *Populus*, *Celtis*, *Tilia*, *Arbutus*, *Morus*, *Vitis*, *Hicoria*, *Fraxinus*, *Rhus*, *Juglans*, *Ulmus*, *Prunus*, *Cornus*, *Cercis*, *Staphylea*, *Platanus*, *Arctostaphylos*, *Carpinus*, and perhaps others. There is good reason for believing that certain of these genera accomplished this southward radiation early in the Tertiary period, if not in the Upper Cretaceous, and probably some, such as the Ulmaceae, invaded North America from the south.

Celtis occurs in the Eocene and *Alnus* and *Rhus* in the Pliocene of South America; *Liquidambar* is found in the Miocene of southern Mexico; and there is every reason to believe that of the genera enumerated above *Pinus*, *Liquidambar*, *Alnus*, *Celtis*, *Rhus*, and *Juglans* represent an old element in this southern region. Others that appear to be somewhat more recent are *Taxodium*, *Quercus*, *Abies*, *Juniperus*, *Salix*, *Populus*, *Vitis*, and possibly *Ulmus*. It is difficult to imagine physical conditions different enough from the present to permit Pleistocene dispersal, and on the other hand it is difficult to imagine species like those of *Carpinus*, *Platanus*, and *Taxodium* existing practically unchanged for a long time in two segregated regions of rather different environments.

An attempt to portray the possible floristic regions at the period of maximum extent of the continental ice is shown on the accompanying sketch map (fig. 6). It is of course much generalized, being based upon very inadequate knowledge, and it synthesizes a too long and too constantly changing period of time. It differs from previous maps of this nature in restricting the possible belt of northern coniferous and arctic plants to certain unspecified situations in the immediate vicinity of the ice front, and, except for a restriction of the central prairie region, in regarding the eastern and western North American mesophytic regions as having been much as they are at the present time, and with much the same association of species.

Habitat and range of Pleistocene plants from North Carolina

	Habitat				Range	
	Wet	Dry	Both wet and dry	Woods	Long distance both north and south	Near northern limit of range
Coniferophyta:						
Pinales:						
Pinaceae:						
Pinus serotina Michaux	×					^a ×
Cupressinaceae:						
Taxodium distichum (Linné) L. C. Richard	×				×	×
Angiospermophyta:						
Monocotyledonae:						
Pandanales:						
Sparganiaceae:						
Sparganium sp.	×					
Graminales:						
Poaceae:						
Chaetochloa sp.						
Dicotyledonae:						
Juglandales:						
Juglandaceae:						
Hicoria ovata (Miller) Britton	×				×	
Hicoria glabra (Miller) Britton		×			×	
Hicoria aquatica (Michaux son) Britton	×					×
Salicales:						
Salicaceae:						
Populus cf. P. heterophylla Linné	×				×	
Salix viminalifolia Berry	×					
Salix bebbianaformis Berry	×					
Fagales:						
Betulaceae:						
Carpinus caroliniana Walter	×				×	
Betula nigra Linné	×				×	
Betula pseudofontinalis Berry						
Fagaceae:						
Fagus americana Sweet				×	×	
Quercus nigra Linné	×					×
velutina Lamarck		×			×	
abnormalis Berry						
prinus Linné		×			×	
michauxii Nuttall	×					×
palustris DuRoi	×				×	
alba Linné				×	×	
lyrata Walter	×				×	
phellos Linné	×					×
predigitata Berry			×			×
Urticales:						
Ulmaceae:						
Ulmus alata Michaux			×			×
Celtis occidentalis Linné		×			×	
Planera aquatica (Walter) Gmelin (?)	×					×
Platanales:						
Platanaceae:						
Platanus occidentalis Linné	×				×	
Polygonales:						
Polygonaceae:						
Polygonum	×				×	
Ranales:						
Magnoliaceae:						
Liriodendron tulipifera Linné				×	×	
Rosales:						
Hamamelidaceae:						
Liquidambar styraciflua Linné	×				×	
Rosaceae:						
Rubus sp.			×		×	
Pomaceae:						
Malus pseudo-angustifolia Berry					×	
Malus coronariafolia Berry					×	
Crataegus spathulatoidea Berry	×					×
Crataegus coccineaefolia Berry						
Caesalpiniaceae:						
Cercis canadensis Linné				×	×	
Sapindales:						
Ileceae:						
Ilex opaca Aiton	×				×	
Rhamnales:						
Vitaceae:						
Vitis sp.			×		×	

• At northern limit

Habitat and range of Pleistocene plants from North Carolina—Continued

	Habitat				Range	
	Wet	Dry	Both wet and dry	Woods	Long distance both north and south	Near northern limit of range
Angiospermophyta—Continued.						
Dicotyledonae—Continued.						
Thymeleales:						
Lauraceae:						
Persea pubescens (Pursh) Sargent	×	-----	-----	-----	-----	×
Umbellales:						
Cornaceae:						
Nyssa biflora Walter	×	-----	-----	-----	-----	×
Ericales:						
Ericaceae:						
Xolisma ligustrina (Linné) Britton	-----	-----	×	-----	×	-----
Dendrium pleistocenicum Berry	-----	-----	×	-----	-----	×
Vacciniaceae:						
Vaccinium corymbosum Linné	×	-----	-----	-----	×	-----
spatulata Berry	-----	-----	-----	-----	-----	-----
arboreum Marshall	-----	×	-----	-----	-----	×
Rubiales:						
Caprifoliaceae:						
Viburnum molle Michaux (?)	-----	-----	-----	×	×	-----
Viburnum nudum Linné (?)	×	-----	-----	-----	×	-----



FIGURE 6.—Map of North America showing the glaciated region, the floral geography, and source of the postglacial directions of dispersal (shown by arrows).

SYSTEMATIC DESCRIPTIONS

CONIFEROPHYTA

Order PINALES

Family PINACEAE

Genus PINUS Linné

Pinus serotina Michaux

Plate XLV, Figure 9

Pinus rigida Berry (not Miller), Jour. Geology, vol. 15, p. 339, 1907.

Leaves in threes, sometimes with sheaths preserved. These leaves were referred by me to *Pinus rigida* in 1907, as they seemed to be shorter than those of *Pinus serotina*. Subsequently cones were collected which in their smaller size, thinner scales, and slender, easily abraded prickles ally the leaves with *P. serotina* instead of *P. rigida*, which is more at home in the plant association recorded from the Coastal Plain of North Carolina.

Needles from the locality on Neuse River in Wayne County; needles and numerous cones from the locality on Tar River in Pitt County.

According to Pinchot and Ashe *Pinus serotina* in the existing flora does not extend up Tar River beyond Washington. It has not previously been found fossil.

Pinus rigida Miller in North Carolina is confined to the western Piedmont Plateau region and the mountain counties south of French Broad River, growing on dry, commonly sandy or gravelly ridges.

Pinus serotina Michaux, the pond, swamp, loblolly, or pocosin pine, is found on low peaty or wet sandy soils from North Carolina to Florida near the coast. In North Carolina it is practically confined to the Coastal Plain south of Albemarle Sound and reaches west to the fall line only in the valleys of Neuse and Cape Fear rivers.

Occurrence: Chowan formation, right bank of Neuse River, 4½ miles above Seven Springs, Wayne County; Dupree Landing, Tar River, Pitt County. Pamlico formation, below New Bern, Neuse River, Craven County.

Family CUPRESSINACEAE

Genus TAXODIUM Richard

Taxodium distichum (Linné) L. C. Richard

Plate XLV, Figures 1-8

Taxodium distichum Holmes, Elisha Mitchell Soc. Jour., vol. 2, p. 92, 1885.

Hollick, Maryland Geol. Survey, Pleistocene, pp. 218, 237, pl. 68, 1906.

Berry, Torrey, vol. 6, p. 89, 1906; Jour. Geology, vol. 15, p. 339, 1907; Am. Naturalist, vol. 43, pp. 432-434, figs. 1, 2, 1909; Am. Jour. Sci., 4th ser., vol. 29, p. 391, 1910; Torrey, vol. 10, p. 263, 1910; Plant World, vol. 16, pp. 39-45, figs. 1, 2, 1911; Am. Jour. Sci., 4th ser., vol. 34, p.

219, figs. 1, 2, 1912; Torrey, vol. 14, pp. 160, 162, 1914; U. S. Nat. Mus. Proc., vol. 48, p. 296, 1915; Torrey, vol. 15, p. 206, 1915; U. S. Geol. Survey Prof. Paper 98, p. 195, pl. 45, figs. 1-6, 1916; Jour. Geology, vol. 25, p. 662, 1917; Florida Geol. Survey Ninth Ann. Rept., p. 21, 1917; Washington Acad. Sci. Jour., vol. 14, p. 15, pl. 1, figs. 37-42; pl. 3, 1924.

It is probably not always possible to differentiate fossil specimens of the common bald cypress from the pond cypress, *Taxodium imbricarium* (for example, from cones or seeds alone); nevertheless it appears significant that among the very numerous Pleistocene occurrences of *Taxodium* that have been recorded, wherever the stumps or twigs are preserved, these represent *Taxodium distichum* and not *Taxodium imbricarium*. The numerous twigs and stumps found in the North Carolina Pleistocene belong to *Taxodium distichum*. It may be legitimately inferred from this circumstance that *Taxodium imbricarium* had not yet been differentiated at that time. If we assume that the pond cypress was already in existence, its absence from the fossil record at so many localities along the Atlantic coast is a strong argument for the method of genesis of the Pleistocene terraces advocated in the present report—namely, by marine control due to changes in relative level. If these terraces were purely the result of stream control and continental deposition, as is advocated in some quarters, it is almost impossible to conceive that somewhere the pond cypress would not have been preserved.

The bald cypress has a most interesting geologic history, and its immediate and scarcely distinguishable Tertiary ancestor attained a holarctic distribution in the later Tertiary.

The oldest beds in which the existing species has been definitely recognized are the Pliocene deposits along the Gulf coast of Alabama (Citronelle formation). It was exceedingly common at numerous widespread localities in southeastern North America during the Pleistocene epoch. Unfortunately it is not possible to correlate the outcrops at these localities with the chronology of the glaciated region to the north. Several of these Pleistocene localities are farther north or farther inland than the existing limits of range of the species, which is from southern Delaware and southern Maryland to extreme southern Florida and Texas. In North Carolina it is restricted to the Coastal Plain region. The leafy twigs and many seeds are present at the Neuse River locality in Wayne County; stumps, knees, and burls at the locality in Craven County; and leafy twigs, cone scales, and a staminate ament at the locality in Bertie County.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County. Pamlico formation, Old Mill Landing, Roanoke River, Bertie County, and below New Bern, Neuse River, Craven County.

ANGIOSPERMOPHYTA

Class MONOCOTYLEDONAE

Order PANDANALES

Family SPARGANIACEAE

Genus SPARGANIUM Linné

Sparganium sp.

Sparganium sp. Berry, Torrey, vol. 14, p. 160, 1914.

A nutlike fruit of some species of *Sparganium* is present at the locality on Neuse River in Wayne County. The determination was made for me by W. L. McAtee. It probably represents the existing *Sparganium androcladum* (Engelmann) Morong.

The genus *Sparganium* goes back to the Eocene and possibly earlier. It is common in the European Pleistocene and was presumably common in that of North America, although the records are few, including only this one and *Sparganium eurycarpum* Engelmann, recorded from the Wicomico formation at Washington, D. C.⁴

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Order GRAMINALES

Family POACEAE

Genus CHAETOCLOA Scribner

Chaetochloa sp. Berry

Chaetochloa sp. Berry, Torrey, vol. 14, p. 160, 1914.

A caryopsis of some grass, identified by W. L. McAtee as a species of *Chaetochloa*, is contained in the collection from the Neuse River locality in Wayne County.

The genus *Chaetochloa*⁵ includes *Setaria* Beauvois, *Ixophorus* Nash, and various species referred to *Panicum*, of which there are many species in our existing Coastal Plain flora.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Class DICOTYLEDONAE

Order JUGLANDALES

Family JUGLANDACEAE

Genus HICORIA

Hicoria glabra (Miller) Britton

Plate XLVI, Figures 1-4

Carya porcina Nuttall. Mercer, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 11, pp. 277, 281, figs. 8⁴, 5, 12, 16, 1899.

Hicoria pseudoglabra Hollick, Maryland Geol. Survey, Pleistocene, p. 221, pl. 72, figs. 1, 16, 17, 1906.

⁴ Berry, E. W., Washington Acad. Sci. Jour., vol. 14, p. 16, pl. 1, fig. 36, 1924.

⁵ Scribner, F. L., U. S. Dept. Agr. Div. Agrostology Bull. 4, p. 38, 1897.

Hicoria glabra Berry, Torrey, vol. 6, p. 89, 1906; Jour. Geology, vol. 15, p. 340, 1907; Torrey, vol. 9, p. 97, figs. 1-5, 1909; vol. 10, p. 264, fig. 1, 1910.

Fragmentary leaflets of this species are not uncommon at the locality on Neuse River in Wayne County, and several of these are figured. They are associated with several husks of nuts and one flattened nut and undoubtedly represent *Hicoria glabra*. Nuts of this species are not uncommon in the Pleistocene deposits of the Atlantic Coastal Plain and have been recorded from the Talbot formation of New Jersey and Maryland, from the Sunderland formation of Maryland, and from the Port Kennedy cave in Pennsylvania.

In the recent flora this species ranges from Maine to Minnesota and southward to Florida and Texas. In North Carolina, although found throughout the State on dry soils of ridges, it occurs chiefly in the Piedmont Plateau region, being uncommon in the mountains and rare in the Coastal Plain.

Hicoria is not uncommon in the Pleistocene. In addition to the two other species recorded from North Carolina, *Hicoria alba* occurs in Pennsylvania and Canada, *Hicoria villosa* occurs in Alabama, *Hicoria minima* occurs in Massachusetts, and several specifically undetermined nuts and leaflets have been recorded from Maryland and Alabama.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Hicoria ovata (Miller) Britton

Plate XLVI, Figures 6, 7

Carya ovata Miller. Mercer, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 11, p. 279, fig. 8⁶, 1899.

Hicoria ovata Britton. Berry, Jour. Geology, vol. 15, p. 340, 1907.

Characteristic terminal leaflets of this species are present at the Neuse River locality in Wayne County. No nuts were collected, but nuts of this species found in the Port Kennedy cave in Pennsylvania were described by Mercer.

In the existing flora this species ranges from Quebec to Minnesota and southward to Florida and Texas. It is found on rich, deep, moderately moist soil near streams and swamps. In North Carolina it is nowhere common, occurring chiefly west of the fall line but in part across the Coastal Plain in the valleys of Roanoke and Cape Fear rivers.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Hicoria aquatica (Michaux son) Britton

Plate XLVI, Figure 5

Salix sp. Berry, Jour. Geology, vol. 15, p. 340, 1907.

Hicoria sp. cf. *H. microcarpa* (Nuttall) Britton. Berry, Idem. *Hicoria aquatica* Berry, Torrey, vol. 9, p. 71, 1909; vol. 14, pp. 161, 162, 1914.

This species is represented by a single small but characteristic lateral leaflet and several nuts from

the locality on Neuse River in Wayne County. As the vernacular name water hickory indicates, this is a species that inhabits frequently inundated river swamps. Its range at the present time extends from southeastern Virginia to Florida and Texas, extending up the Mississippi Valley to the mouth of the Ohio but there as well as elsewhere being confined to the Coastal Plain. In North Carolina it occurs chiefly on the peninsula between Albemarle and Pamlico sounds and in Pender and Brunswick counties in the valleys of Northeast Cape Fear and lower Cape Fear rivers.

It indicates what the areal distribution of the Chowan formation along Neuse River shows—namely, that at that stage of the Pleistocene a drowned river valley like that of the present-day lower Cape Fear extended across Lenoir County and halfway across Wayne County.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Family SALICACEAE

Genus POPULUS Linné

Populus? cf. *P. heterophylla* Linné

Bud scales similar to those of *Populus* but possibly referable to *Fagus*, leaves of which are so common, occur in the collections from the locality on Neuse River in Wayne County. They are exactly like those of *Populus heterophylla* Linné, which at the present time is found in river swamps from Connecticut to Georgia and Louisiana and is not uncommon in such situations in the Coastal Plain region of North Carolina. Because of the absence of leaves of *Populus* in the deposit and the great abundance of leaves of *Fagus* and *Betula*, which have rather similar resinous bud scales, I have queried the generic reference. In examining the recent river deposits of the Coastal Plain rivers of North Carolina I have frequently noticed bud scales of *Fagus* but have not observed those of *Populus*. *Populus* leaves are, however, recorded from the Pleistocene of Maryland and Alabama.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Genus SALIX Linné

Salix bebbianaformis Berry, n. sp.

Plate XLVI, Figure 8

Leaves of rare occurrence, ovate-lanceolate, with pointed apex and base, entire margins, thin texture. Midvein medium in size. Secondaries thin, ascending, about five regularly spaced, camptodrome pairs.

This species appears to be a Pleistocene willow. Its relation to existing species is entirely problematic, and the name given to it indicates merely a resem-

blance in leaf form without implying any close botanic relationship.

Salix bebbiana Sargent is a moist-soil species, chiefly of stream and swamp margins, of the northern United States and Canada, and if the fossil could be more precisely correlated with this species, it would afford an interesting problem of distribution.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Salix viminalifolia Berry

Plate XLVII, Figures 1-4

Salix viminalifolia Berry, U. S. Nat. Mus. Proc., vol. 48, p. 297, 1915.

This species was named from its resemblance to the osier willow, *Salix viminalis* Linné, a native of Eurasia, not rare in European Pleistocene deposits, commonly cultivated in our Eastern and Middle States, and here and there escaped in wet places. The name can not be taken as indicative of relationship between the living and fossil species, for the position of the latter is uncertain.

The fossil species may be described as follows: Leaves elongated, linear-lanceolate, abruptly acute at the apex and base. Margins usually somewhat undulate, entire in all the specimens seen. Petiole stout, curved, expanded proximad, 6 to 10 millimeters long. Length about 15 centimeters. Maximum width about 1.5 to 2.25 centimeters. Midvein stout, somewhat flexuous. Secondaries thin, numerous, camptodrome.

Occurrence: Chowan formation, right bank of Neuse River, 4½ miles above Seven Springs, Wayne County (common).

Order FAGALES

Family BETULACEAE

Genus BETULA Linné

Betula nigra Linné

Plate XLVII, Figures 8-19

Betula nigra Knowlton, Am. Geologist, vol. 18, p. 371, 1896.

Berry, Jour. Geology, vol. 15, p. 341, 1907; Am. Naturalist, vol. 41, p. 692, pl. 2, figs. 2-4, 1907; vol. 43, p. 435, 1909; Am. Jour. Sci., 4th ser., vol. 29, p. 393, 1910; Torrey, vol. 14, p. 162, 1914.

Characteristic leaves of the black or river birch, of all sizes, are common in the North Carolina Pleistocene. Their permutations in size and outline are shown in the accompanying figures. The species inhabits swamps and river bottoms and, in the existing flora, ranges from Massachusetts to Minnesota and Kansas and southward to Florida and Texas. In North Carolina it is found along streams and swamp borders throughout the Coastal Plain and Piedmont regions.

The genus goes back to Upper Cretaceous time and became much diversified in the early Tertiary. Several existing species made their appearance in the Pleistocene of this country and Eurasia.

Betula nigra has been reported from the Pleistocene of West Virginia, Virginia, Georgia, Alabama, and Mississippi and was evidently a common and widespread type in the country bordering the coast of the Pleistocene sea in southeastern North America.

Occurrence: Chowan formation, right bank of Neuse River, 4½ miles above Seven Springs, Wayne County (abundant leaves and bark fragments); Pamlico formation, Old Mill Landing, Roanoke River, Pitt County (leaves).

***Betula pseudofontinalis* Berry**

Plate XLVIII, Figures 1, 2

Betula pseudofontinalis Berry, Jour. Geology, vol. 15, p. 341, 1907.

Leaves broadly ovate, with a rounded or bluntly pointed apex and a broadly truncated, rounded, entire base. Margins somewhat irregularly serrate or dentate above. Texture subcoriaceous. Petiole long. Midvein stout. Secondaries stout, rather openly and somewhat irregularly spaced, craspedodrome.

This is a somewhat poorly defined form, named from its resemblance to the leaves of the existing western *Betula fontinalis* Sargent, but the name is not intended to imply a direct botanic relationship with that species.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Genus CARPINUS Linné

***Carpinus caroliniana* Walter**

Plate XLVII, Figures 5-7

Carpinus caroliniana Walter. Berry, Jour. Geology, vol. 15, p. 340, 1907; Am. Naturalist, vol. 41, p. 692, vol. 41, p. 692, pl. 1, figs. 8, 9, 1907; Am. Jour. Sci., 4th ser., vol. 29, p. 395, 1910.

Carpinus pseudocaroliniana Hollick, Maryland Geol. Survey, Pleistocene, p. 225, pl. 71, fig. 10, 1906.

The hornbeam, or blue beech, was apparently a common member of the Pleistocene forest flora of southeastern North America and has been recorded from the early Pleistocene (Sunderland) of Maryland and from later Pleistocene deposits in North Carolina, Georgia, and Alabama. In North Carolina it is represented by a small number of characteristic leaves.

In the existing flora it grows in moist woods in the vicinity of streams and swamps and ranges from Nova Scotia westward to Georgian Bay and Minnesota and southward to Florida and Texas, reappearing in the uplands of southern Mexico and Central America. In North Carolina it occurs along streams and in wet situations throughout the State.

There are about a dozen living species in central and southern Europe, Asia, and eastern North America. The genus appears in the Eocene and is exceedingly common in the holarctic Tertiary floras.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Family FAGACEAE

Genus FAGUS Linné

***Fagus americana* Sweet**

Plate XLVIII, Figures 3-13

Fagus ferruginea Aiton. Knowlton, Am. Geologist, vol. 18, p. 371, 1896.

Mercer, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 11, pp. 277, 281, figs. 8-15, 1899.

Emerson, U. S. Geol. Survey Bull. 597, p. 148, 1917.

Fagus americana Sweet. Berry, Torrey, vol. 6, p. 88, 1906.

Hollick, Maryland Geol. Survey, Pleistocene, p. 226, 1906.

Berry, Jour. Geology, vol. 15, p. 341, 1907; Am. Naturalist,

vol. 41, p. 692, pl. 2, fig. 7, 1907; vol. 43, p. 435, 1909;

Am. Jour. Sci., 4th ser., vol. 29, p. 393, 1910; Torrey,

vol. 14, p. 162, 1914; vol. 15, p. 206, 1915.

The American beech, sometimes named *Fagus grandifolia* Ehrhart, on the ground of priority, is one of the commonest members of the Pleistocene flora in southeastern North America.

Leaves, nuts, or husks have been recorded from rather numerous localities in Massachusetts, Pennsylvania, Maryland, Virginia, Alabama, and Mississippi. In the North Carolina Pleistocene both leaves and husks are common. The leaves show considerable variation in size and outline, as shown by the accompanying illustrations. In general they appear to have been smaller than the average size of the modern leaves of this species.

In the existing flora the beech occurs chiefly in deep, damp woods, ranging from Nova Scotia to Lake Huron and southward to Florida and Texas. In North Carolina it occurs throughout the State and is said by Pinchot and Ashe to be smaller and less abundant in the Coastal Plain than in the Piedmont and mountain regions.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Genus QUERCUS Linné

***Quercus alba* Linné**

Plate L, Figures 1-5

Quercus alba Linné. Penhallow, Roy. Soc. Canada Trans., vol. 10, sec. 4, p. 74, 1904; Am. Naturalist, vol. 41, p. 448, 1907.

Mercer, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 11, p. 281, 1899.

Berry, Jour. Geology, vol. 15, p. 342, 1907; Am. Jour. Sci., 4th ser., vol. 34, p. 221, 1912.

Quercus pseudoalba Hollick, Maryland Geol. Survey, Pleistocene, p. 227, pl. 70, fig. 2; pl. 71, figs. 1-6, 1906.

The white oak is not uncommon in the Pleistocene, having been recorded from the old Pleistocene (Sunderland) of Maryland, from the interglacial beds of the Don Valley in Ontario, from the Great Valley of Virginia, and from postglacial deposits in Massachusetts. Its leaves, both young and old forms, are common in the Pleistocene of North Carolina.

In the existing flora the white oak is found in woods from Maine to Ontario, westward to Minnesota and Nebraska, and southward to Florida and Texas. In North Carolina it occurs throughout the State but is most abundant on the Piedmont Plateau, being rarely found in the Coastal Plain south of Neuse River or on the latest Pleistocene Pamlico terrace soils of the eastern part of the State.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

***Quercus abnormalis* Berry**

Plate LI, Figure 24

Quercus abnormalis Berry, Jour. Geology, vol. 15, p. 342, 1907.

This identification is based upon the single abnormal oak leaf figured. This specimen is incomplete but indicates a linear-lanceolate leaf divided near the middle into two linear-lanceolate lobes that diverge at an angle of about 50°. The margins are entire so far as seen, and the base and tips were probably acute. The midvein is stout and prominent, and numerous stout secondaries diverge from it at wide angles and are camptodrome. The texture is coriaceous, and all the observed features stamp it as a form of *Quercus*, possibly a hybrid or more probably an abnormality. Estimated length about 12 centimeters. Width about 1.5 centimeters.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

***Quercus predigitata* Berry**

Plate LIII, Figures 1-6

Quercus falcata Michaux. Knowlton, Am. Geologist, vol. 18, p. 371, 1896.

Quercus predigitata Berry, Jour. Geology, vol. 15, p. 342, 1907; Am. Jour. Sci., 4th ser., vol. 34, p. 22, figs. 4, 5, 1912; Torrey, vol. 14, p. 162, 1914; vol. 19, p. 9, 1919.

This oak is considered to be the ancestral type from which the Spanish oak and the water Spanish oak were differentiated in dry and wet environments. At any rate the fossil leaves show gradations intermediate between the leaves of these modern species, and their precise differentiation in the fossil state is impossible.

The species has a considerable range in the Pleistocene of southeastern North America, being recorded from West Virginia, the Great Valley of Virginia, western Tennessee, and Mississippi. In North Carolina its leaves are common and variable in the deposits of the Chowan formation on Neuse River and are also

present in the earlier Wicomico formation near Weldon, both localities near the heads of drowned Pleistocene streams.

The existing *Quercus digitata* Sudworth is a tree of dry soils, ranging from southern New Jersey to central Florida and westward to Texas. In North Carolina it is not uncommon throughout the State except in the western mountains and in the eastern part, which is underlain by the Pamlico formation.

Quercus pagodaefolia Ashe, on the other hand, is a species of rich wet bottom lands and ranges from Virginia to northern Florida and the lower Mississippi Valley. It is common throughout the Coastal Plain in North Carolina.

The recorded range and habitats of the fossil species show clearly that it is either the ancestor of these two species or that the fossil records represent both of these species, which have not been discriminated. It appears not improbable that with the Pleistocene submergence of much of the Coastal Plain and its subsequent emergence *Quercus predigitata* diverged into the two familiar dry and wet soil types.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County. Wicomico formation, 1¼ miles east of Weldon, Northampton County.

***Quercus palustris* DuRoi**

Plate XLIX, Figures 4-6

Quercus palustris DuRoi. Mercer, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 11, pp. 277, 281, fig. 8², 1899.

Berry, Jour. Geology, vol. 15, p. 342, 1907; Torrey, vol. 15, p. 207, 1915.

This species is represented by characteristic leaves in the Chowan formation of North Carolina. It has been previously recorded from the Pleistocene deposits of the cave at Port Kennedy, Pa., where it is represented by a cupule, and the Talbot formation of Maryland.

In the existing flora this species occurs in swamps and wet places from Massachusetts westward to Wisconsin and southward to Florida. It is not uncommon in the Coastal Plain of North Carolina.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

***Quercus nigra* Linné**

Plate LI, Figures 1-7

Quercus nigra Linné. Berry, Jour. Geology, vol. 15, p. 342, 1907; Am. Naturalist, vol. 41, p. 693, pl. 1, figs. 3, 4, 1907; Am. Jour. Sci., 4th ser., vol. 29, p. 394, 1910; U. S. Geol. Survey Prof. Paper 98, p. 201, pl. 46, fig. 11, 1916.

Quercus marylandica Berry, Jour. Geology, vol. 15, p. 342, 1907.

Leaves of this species are common in the Chowan formation, and some of the larger ones were referred to *Quercus marylandica* in 1907, although it is now

believed that all these represent the leaves of the water oak. They show considerable variation in outline and in the tendency toward a trilobate form, as, for example, in the leaf shown in Figure 1; others show an unusual narrowing and elongation of the base, as in Figures 3 and 6.

The oldest deposit in which this species has been found is the Pliocene Citronelle formation of southern Alabama, and its leaves and cupules occur at several Pleistocene localities in Alabama.

In the existing flora it is found on sandy wet soil along streams and swamp borders from southern Delaware southward to Florida and eastern Texas and up the Mississippi Valley to the mouth of the Ohio. In North Carolina it is common throughout the Coastal Plain and in certain areas in the southeastern part of the Piedmont region.

Occurrence: Chowan formation, right bank of Neuse River $4\frac{1}{2}$ miles above Seven Springs, Wayne County.

***Quercus phellos* Linné**

Plate LI, Figures 8-23

Quercus phellos Linné. Berry, Jour. Geology, vol. 15, p. 342, 1907; Am. Naturalist, vol. 41, p. 694, pl. 1, fig. 1, 1907; Am. Jour. Sci., 4th ser., vol. 29, p. 394, 1910; Torreya, vol. 10, p. 265, 1910; vol. 14, pp. 161, 162, 1914.

The willow oak is not uncommon in the Pleistocene of southeastern North America and has been previously recorded from New Jersey, Alabama, and Mississippi. Both leaves and acorns have been found in the Pleistocene of North Carolina.

The great variety of leaves of this species are partly shown in the accompanying illustrations. None found can be attributed to the water oak, *Quercus laurifolia* Michaux, which might be expected to occur in the North Carolina Pleistocene but which has not been encountered.

In the existing flora *Quercus phellos* is common in low wet situations bordering streams and swamps and to some extent on moist sandy uplands from Long Island to Florida and thence westward to eastern Texas and up the Mississippi Valley to southeastern Missouri. In North Carolina it is exceedingly common in the Coastal Plain and is sparingly present in the Piedmont region.

Occurrence: Chowan formation, right bank of Neuse River $4\frac{1}{2}$ miles above Seven Springs, Wayne County (leaves, common); Dupree Landing, Tar River, Pitt County (acorns and cupules).

***Quercus prinus* Linné**

Plate LII, Figures 5-8; Plate LIV, Figure 9

Quercus prinus Linné. Berry, Jour. Geology, vol. 15, p. 342, 1907; Am. Naturalist, vol. 41, p. 693, pl. 1, fig. 1, 1907; Am. Jour. Sci., 4th ser., vol. 29, p. 394, 1910; Pan-Am. Geologist, vol. 41, p. 106, 1924.

I am not sure that this species can be distinguished from *Quercus michauxii* by the leaves in the fossil

state, but inasmuch as characteristic acorns are associated with the leaves in the Pleistocene of Alabama, I have considered the narrower, longer-petioled leaves of the Pleistocene of North Carolina to represent *Quercus prinus*.

In the existing flora the rock chestnut oak is found in rocky woods from Maine and Ontario to Georgia and Alabama. In North Carolina it is a denizen of dry soils and is found chiefly in the western part of the State, being replaced in the Coastal Plain by the swamp chestnut oak, *Quercus michauxii*, which is also abundant in the Pleistocene forest flora of the State. Inasmuch as there was a crowding together of present-day Coastal Plain and Piedmont types during the Pleistocene epoch, when considerable areas of the Coastal Plain were submerged, and a less clear demarcation between dry and wet soil types, as shown in several localities, the probability is strong that these fossil leaves represent *Quercus prinus*, although this identification can not be said to be absolutely proved. *Quercus prinus* has been recorded from post-glacial deposits near Staunton, Va.

Occurrence: Chowan formation, right bank of Neuse River $4\frac{1}{2}$ miles above Seven Springs, Wayne County.

***Quercus lyrata* Walter**

Plate L, Figures 6-9

Quercus lyrata Walter. Berry, Jour. Geology, vol. 15, p. 342, 1907.

Characteristic leaves and four flattened acorns of this species, which is not otherwise known in the fossil state, were collected from the North Carolina Pleistocene. It is possible that the acorns from the Port Kennedy cave in Pennsylvania, identified by Stewardson Brown⁶ as *Quercus macrocarpa* Michaux, may represent *Quercus lyrata*, as the mossy cup or bur oak is a northern species.

The swamp post oak or overcup oak, *Quercus lyrata*, is found in swampy habitats in the existing flora and ranges from New Jersey and Missouri to Florida and Texas. In North Carolina it is found throughout the Coastal Plain and in the southeastern part of the Piedmont region of the State.

Occurrence: Chowan formation, right bank of Neuse River $4\frac{1}{2}$ miles above Seven Springs, Wayne County.

***Quercus michauxii* Nuttall**

Plate LII, Figures 1-4

Quercus michauxii Nuttall. Berry, Torreya, vol. 9, p. 71, 1909; vol. 15, p. 207, 1915.

Quercus prinoides Berry, Jour. Geology, vol. 15, p. 343, 1907. *Quercus platanoides* Berry, idem.

Leaves and cupules of this species are found in the Chowan formation of North Carolina, and the species is also recorded from the Talbot formation of Mary-

⁶ Mercer, H. C., Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 11, pp. 278, 281, fig. 8, 1899.

land. To it I now refer specimens from North Carolina that were formerly referred to *Quercus prinoides* and *Quercus platanoides*.

The cow oak or swamp chestnut oak is a dweller on moist soils such as swamp borders and river bottoms. In the existing flora it ranges, chiefly in the Coastal Plain, from Delaware to northern Florida and through the Gulf States to Trinity River in Texas and up the Mississippi Valley to southeastern Missouri and the lower Wabash. In North Carolina it occurs abundantly throughout the Coastal Plain and in the swamps of the eastern half of the Piedmont Plateau region.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Quercus velutina Lamarck

Plate XLIX, Figures 1-3

Quercus velutina Lamarck. Penhallow, British Assoc. Adv. Sci. Rept., 1900, p. 336.

Quercus tinctoria Bartram. Penhallow, Roy. Soc. Canada Trans., vol. 10, sec. 4, p. 74, 1904.

This species is represented in the Pleistocene of North Carolina by both leaves and cupules. The only fossil occurrence previously recorded is that in the interglacial deposits of the Dan Valley in Ontario.

In the modern flora this species, which has probably the most variable leaves of all the black oaks, is found on dry soils from Maine and Ontario to Minnesota and Nebraska and southward to northern Florida and central Texas. In North Carolina it is a common tree in the Piedmont and mountain regions but is less abundant in the Coastal Plain.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County. Wicomico formation, 1¼ miles east of Weldon, Northampton County.

Order URTICALES

Family ULMACEAE

Genus ULMUS Linné

Ulmus alata Michaux

Plate LIV, Figures 1, 2

Ulmus alata Michaux. ?Lesquereux, Am. Jour. Sci., 2d ser., vol. 27, p. 365, 1859.

Berry, Jour. Geology, vol. 15, p. 343, 1907; Am. Naturalist, vol. 41, p. 694, pl. 1, figs. 6, 7, 1907; Am. Jour. Sci., 4th ser., vol. 29, p. 396, 1910.

Leaves of the wahoo or winged elm are not uncommon in the Chowan formation of North Carolina. This species was recorded many years ago by Lesquereux from the Pleistocene of the Mississippi bluffs near Columbus, Ky., but as there is some question regarding this record it is queried in the above citation. *Ulmus alata* is not uncommon in the Pleistocene of Alabama.

In the existing flora this species occurs in both wet and dry soils from southern Virginia to western Florida and westward to Texas, Missouri, and Arkansas. In North Carolina it is found along streams and swamp margins and is common throughout the State, except in the northwestern part of the Piedmont Plateau and in the mountain region.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Genus CELTIS Linné

Celtis occidentalis Linné

Plate LIV, Figure 3

Celtis occidentalis Linné. Berry, Am. Naturalist, vol. 43, p. 435, 1909.

A single fragment of a leaf of this species was found in the Chowan formation. In the existing flora the species occurs in dry soils from southern Canada southward to Florida and Texas. A stone of this species has been recorded from the Talbot formation of Virginia. Another species is recorded from the Sunderland formation of Maryland, and *Celtis mississippiensis* has been found in the loess of Mississippi. The genus is an old one, not uncommon in the Tertiary of both North and South America.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Genus PLANERA Gmelin

Planera aquatica (Walter) Gmelin

Plate LIV, Figures 4, 5

Planera gmelin Michaux. Lesquereux, Am. Jour. Sci., 2d ser., vol. 27, p. 365, 1859.

Planera aquatica Gmelin. Hollick, Torrey Bot. Club Bull., vol. 19, p. 332, 1892.

Berry, Jour. Geology, vol. 15, p. 343, 1907; U. S. Geol. Survey Prof. Paper 98, p. 201, pl. 47, figs. 1-4, 1916.

Somewhat doubtfully determined leaves of this species occur sparingly in the Chowan formation of North Carolina.

The water elm is one of those interesting relics of a genus otherwise extinct, which attained an extensive distribution during the Tertiary but is now represented by only this single surviving form, which is apparently less wide ranging to-day than it was during Pleistocene time. It appears in the Pliocene Citronelle formation of southern Alabama and in beds of about the same age in southern New Jersey, and it has been found in the Pleistocene of Kentucky and North Carolina.

In the modern flora it is found in more or less inundated swamps and river bottoms from southeastern North Carolina southward in the Coastal Plain to western Florida and westward to Trinity River, Texas, and up the Mississippi Valley to southeastern Missouri and western Kentucky, though usually rare away from the coast. In North Carolina it is found only in the lower valley of Cape Fear River and is no longer present in the valley of Neuse River.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Order PLATANALES

Family PLATANACEAE

Genus PLATANUS Linné

Platanus occidentalis Linné

Plate LV, Figures 1-9

Platanus aceroides Hollick (not Goeppert), Maryland Geol. Survey, Pleistocene, p. 231, pls. 73, 74, 1906.

Platanus occidentalis Linné. Knowlton, Am. Geologist, vol. 18, p. 371, 1896.

Penhallow, Roy. Soc. Canada Trans., 2d ser., vol. 2, sec. 4, pp. 68, 72, 1896; Am. Naturalist, vol. 41, p. 448, 1907.

Mercer, Acad. Nat. Sci. Philadelphia Jour., 2d ser., vol. 11, p. 277, 1899.

Berry, Jour. Geology, vol. 15, p. 344, 1907; Am. Naturalist, vol. 41, p. 695, pl. 2, fig. 5, 1907; Am. Jour. Sci., 4th ser., vol. 29, p. 397, 1910; Torreya, vol. 14, p. 161, 1914; vol. 15, p. 207, 1915; Pan-Am. Geologist, vol. 41, p. 106, 1924.

Emerson, U. S. Geol. Survey Bull. 597, p. 148, 1917.

This species is one of the commoner elements of the Pleistocene flora of southeastern North America, being recorded from the oldest Pleistocene of Maryland (Sunderland formation), the interglacial deposits of the Don Valley in Ontario, and postglacial deposits in Massachusetts and Virginia. It is also found fossil in the Talbot formation of Maryland, in the Port Kennedy cave in Pennsylvania, in West Virginia, at various localities in Alabama, and in the Chowan formation of North Carolina, where its leaves are exceedingly common and the flattened fruits or button balls are not rare.

It belongs to an exceedingly interesting genus, which originated in Upper Cretaceous time and represents an order of flowering plants now largely extinct. *Platanus* has many extinct species and attained a holarctic distribution during the Tertiary period. The six or seven surviving species are confined to southwestern Asia and eastern and western North America, with survivors of its once more extended range in the uplands of Mexico and Central America.

The American plane tree or sycamore grows on rich bottom lands from New England to Kansas and Nebraska and southward to Florida and Texas. It is said by Pinchot and Ashe to reach its maximum of size and abundance in North Carolina in the alluvial swamps of the Piedmont Plateau region, but observations show that it is exceedingly common along the Coastal Plain rivers of the State.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Order POLYGONALES

Family POLYGONACEAE

Genus POLYGONUM Linné

Polygonum sp.

An achene, determined by W. L. McAtee as referable to the genus *Polygonum*, is present in the collections from the Neuse River locality in Wayne County. Fossil forms have been recorded from the Pleistocene of Ontario,⁷ Maryland,⁸ the District of Columbia,⁹ and Florida.¹⁰

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Order RANALES

Family MAGNOLIACEAE

Genus LIRIODENDRON Linné

Liriodendron tulipifera Linné

Plate LIV, Figures 6-8

Liriodendron tulipifera Linné. Berry, Am. Naturalist, vol. 41, p. 695, 1907; Torreya, vol. 9, p. 71, fig. 1, 1909; Am. Jour. Sci., 4th ser., vol. 29, p. 396, 1910; Torreya, vol. 15, p. 208, fig. 1, 1915.

The tulip tree or so-called yellow poplar was another common type in the Pleistocene floras of southeastern North America, where it has been recorded from Maryland, North Carolina, and Alabama, and is represented by both leaves and fruit.

In the existing flora it inhabits deep, rich, moist soil of divides and slopes from Rhode Island to Illinois and southward to Mississippi and northern Florida. In North Carolina it is found throughout the State but reaches its largest size on the slopes of the western mountains.

Liriodendron is another one of those genera of forest trees that have come down to us from the distant past in a greatly diminished way. It was exceedingly abundant and varied during Upper Cretaceous time and attained a holarctic distribution during the Tertiary, which apparently it retained until the close of that period, having been recorded by the Reids¹¹ from the Pliocene of Holland, and by Schmalhausen¹² from the Pliocene of central Asia. To-day it is restricted to southeastern North America and southern China.

Occurrence: Wicomico formation, 1¼ miles east of Weldon, Northampton County.

⁷ Coleman, A. P., Geol. Soc. America Bull., vol. 26, p. 247, 1915.

⁸ Hollick, Arthur, Maryland Geol. Survey, Pleistocene, p. 231, 1906.

⁹ Berry, E. W., Washington Acad. Sci. Jour., vol. 14, p. 19, pl. 1, figs. 19-23, 1924.

¹⁰ Berry, E. W., Jour. Geology, vol. 25, p. 662, 1917.

¹¹ Reid, C. and E. M., Pliocene flora of the Dutch-Prussian border, p. 93, pl. 8, figs. 1-5, 1915.

¹² Schmalhausen, J., Ueber tertiäre Pflanzen aus dem Thale des Flusses Buchtorra am Fusse des Altaibirges: Palaeontographica, Band 33, p. 211, pl. 21, figs. 20, 21, 1887.

Order ROSALES

Family HAMAMELIDACEAE

Genus LIQUIDAMBAR Linné

Liquidambar styraciflua Linné

Plate LVI, Figures 9, 10

Liquidambar europaeum Lesquereux (not Alexander Braun),
U. S. Nat. Mus. Proc., vol. 11, p. 36, 1888.

Liquidambar styraciflua Linné. Hollick, Torrey Bot. Club
Bull., vol. 19, p. 331, 1892.

Knowlton, Am. Geologist, vol. 18, p. 371, 1896.

Berry, Jour. Geology, vol. 15, p. 343, 1907; Am. Jour.
Sci., 4th ser., vol. 29, p. 397, 1910.

The sweet or red gum is another of our forest trees that was common during the Pleistocene epoch in southeastern North America, when it was scarcely if at all distinguishable in its foliar characters from its wide-ranging Tertiary ancestors. Its oldest occurrence in this region is in the Pliocene of southern New Jersey. It has been recorded from Pleistocene deposits in West Virginia, North Carolina, and Alabama, and in the last two States it is represented by both leaves and fruits.

In the existing flora it grows on the wet soils of bottom lands, ranging from Connecticut to southeastern Missouri, Florida, and eastern Texas. It is essentially a Coastal Plain species, although it reappears in southern Mexico and the uplands of Guatemala, showing that it existed before the development of the wide belt of arid country in southwestern Texas and central and northern Mexico which now divides its once continuous range. It gives to the woods of the South Atlantic States an autumnal brilliancy that is unsurpassed by that of the red maple of the Middle and North Atlantic States.

In North Carolina the sweet gum is found throughout the area east of the mountains but is most abundant and of largest size in the Coastal Plain.

The leaves decay readily, in my experience much more rapidly than those of most of our other forest trees, but the fruits or gum balls are more resistant and are frequently found in the fossil state. The genus goes back at least as far as the Eocene, and it attained a holarctic distribution during the Tertiary period. Survivors of this Tertiary dispersal are still living in southeastern North America and southwestern and southeastern Asia.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Family ROSACEAE

Genus RUBUS Linné

Rubus sp.

Plate LVI, Figure 8

Rubus sp. Berry, Jour. Geology, vol. 15, p. 344, 1907.

Prickly twigs, referred to *Rubus* with some hesitation, occur in the Chowan formation of North Caro-

lina. The genus comprises many existing species of herbs, shrubs, or vines and has a wide geographic distribution. The characteristic seeds of various species have frequently been recorded from Pliocene and Pleistocene deposits in Europe, and doubtless several species were present during Pleistocene time in southeastern North America, but because of the neglect of this field of research in North America, little is known regarding them. Characteristic seeds were recently discovered in abundance in the Wicomico formation of the District of Columbia.¹³

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Family POMACEAE

Genus MALUS Hall

Malus coronariaefolia Berry

Plate LVI, Figure 3

Malus coronariaefolia Berry, Jour. Geology, vol. 15, p. 344, 1907.

Leaves triangularly ovate, widest below the middle, narrowing to the acute apex. Base broadly rounded, toothed. Length about 4 centimeters. Maximum width about 3 centimeters. Margins with four or five incised lobes on each side, which are finely salient-serrate. Midvein relatively slender. Secondaries about four pairs, slender, ascending; they diverge from the midvein at angles ranging from 45° in the basal pair to half this amount in the distal pair; they are rather straight in their courses and craspedodrome, terminating at the acute tips of the lateral lobes. Tertiaries obsolete.

This species appears to be referable to the genus *Malus*, and its resemblance to the leaves of the existing American crab apple, *Malus coronaria* (Linné) Miller, has suggested the specific name proposed. The latter is a species of moist glades which ranges from Ontario to Potomac River and southward along the Alleghany Mountains to central Alabama. I am not at all sure that the resemblance between the fossil form and this recent species can be considered as an indication of close relationship.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Malus pseudoangustifolia Berry, n. sp.

Plate LVI, Figures 1, 2

Leaves small, somewhat variable in outline, generally ovate, ranging from 2.75 to 4 centimeters in length and 1.25 to 2 centimeters in maximum width, which is usually below the middle. Midvein stout below, becoming thin distad. Secondaries immersed. Apex acute. Base rounded. Margins with rather prominent dentate teeth.

¹³ Berry, E. W., Washington Acad. Sci. Jour., vol. 14, p. 20, pl. 2, fig. 1, 1924.

This is a form of somewhat uncertain botanical affinity, named from its resemblance to the existing *Malus angustifolia*, a Coastal Plain species ranging from Pennsylvania to northern Florida and westward to Louisiana. The resemblance is not exact, and it is possible that the fossil may represent some Pleistocene species of *Crataegus*.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Genus **CRATAEGUS** Linné

Crataegus spathulatoides Berry

Plate LVI, Figure 4

Crataegus spathulatoides Berry, Jour. Geology, vol. 15, p. 344, 1907.

Leaves relatively small, obovate to spatulate. Apex acute to rounded. Base gradually narrowed and acuminate. Margins rather coarsely crenate above the middle. Length about 4 centimeters. Maximum width about 1.5 centimeters. Petiole short and stout. Midvein stout. Secondaries relatively stout; a few ascending pairs diverge from the midvein at acute angles and are camptodrome.

This form is very similar to the leaves of the existing small-fruited haw, *Crataegus spathulata* Michaux, and probably represents that species. Because of the subjective features on which many of the host of recently described species of hawthorn are based, it has seemed likely to be less confusing to give the fossil a new name which shall suggest its resemblance to *Crataegus spathulata*. The latter is a small tree found in rich moist soils, usually stream banks or swamp borders, in the Coastal Plain from southern Virginia to northern Florida and eastern Texas.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Crataegus coccineafolia Berry

Plate LVI, Figures 5-7

Crataegus coccineafolia Berry, Jour. Geology, vol. 15, p. 345, 1907.

This species is based upon leaves and associated thorns. The leaves are relatively small, ovate in general outline, widest medianly, tapering upward to the acute tip and downward to the narrowly cuneate or slightly decurrent base. Margins incised to form two or three triangularly acute lobations on each side, with prominent serrate teeth, which die out in the cuneate base. Length about 3.75 centimeters. Maximum width about 2.25 centimeters. Petiole not preserved. Midvein slender, curved. Secondaries thin, three or four pairs, diverging from the midvein at acute angles, rather straightly ascending, craspedodrome. The thorns, attached to broken pieces of branches, range from 1 to 3.5 centimeters in length and are stout, conically tapering, acutely pointed, and often slightly curved distad.

Both leaves and thorns are practically identical with the corresponding parts of the existing scarlet thorn and certainly represent it or something closely related to it. In view of the maze of existing species into which the thorns have been segregated it has not been deemed profitable to attempt too close correlations between them and the fossil species, as many southern species have very similar foliar characters.

The scarlet thorn is a small bushy tree of rich, well-drained soils and a northern distribution. It ranges from Newfoundland to Connecticut near the coast and up the valley of the St. Lawrence to western Quebec and hence is remote from North Carolina. Could the identity between this existing species and the fossil species be established with certainty the fossil would constitute a conspicuous exotic element in the flora of the Pleistocene of North Carolina and might be considered indicative of a considerable climatic contrast between the North Carolina of Pleistocene time and that of to-day. As such a contrast is not borne out by the associated fossil plants and as many so-called modern species of *Crataegus* have similar leaves and thorns, no dependence can be placed on the resemblances pointed out above.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Family **CAESALPINIACEAE**

Genus **CERCIS** Linné

Cercis canadensis Linné

Plate LVII, Figures 10, 11

Cercis canadensis Linné. Penhallow, Am. Naturalist, vol. 41, p. 446, 1907. Berry, Torreya, vol. 11, p. 72, fig. 2, 1909.

Fossil leaves of the redbud or Judas tree have been found in the interglacial deposits of the Don Valley in Ontario and in North Carolina.

In the modern flora this species is said by Sargent, Britton, and Small to range northward as far as southern Ontario, whereas Sudworth gives its normal northern range as the lower valley of the Delaware and southern Michigan. Thence it ranges westward to Nebraska and southward to Florida, Texas, and the Sierra Madre of Nuevo Leon. In North Carolina it is found in both the Piedmont and Coastal Plain regions. It is essentially a warm temperate type, reaching its largest size along Sabine River and having many tropical relatives.

The genus goes back to Eocene time and is represented by existing species in Europe and Asia, as well as in both eastern and western North America. The south European *Cercis siliquastrum* Linné, like its relative in southeastern North America, is represented in the Pleistocene.

Occurrence: Wicomico formation, 1¼ miles east of Weldon, Northampton County.

Order SAPINDALES

Family ILLICACEAE

Genus ILEX Linné

Ilex opaca Aiton

Plate LVI, Figures 11, 12

Ilex opaca Aiton. Hollick, Torrey Bot. Club Bull., vol. 19, p. 331, 1892.

Berry, Jour. Geology, vol. 15, p. 345, 1907; Am. Naturalist, vol. 41, p. 696, pl. 2, fig. 1, 1907; Washington Acad. Sci. Jour., vol. 14, p. 21, pl. 2, figs. 4, 5, 1924.

The holly, represented by both leaves and characteristic seeds, has been recorded from the Wicomico formation of the District of Columbia, the Chowan formation of North Carolina, and beds at a corresponding horizon of the Pleistocene in Alabama, the coriaceous spinous leaves being well suited for preservation. In the modern flora it is found in drier situations toward its northern limits, but to the south it occurs chiefly in rich moist soil of woods and bottoms. It ranges from Massachusetts to Florida and Texas. It is common throughout North Carolina except in the mountain region.

The genus *Ilex* goes back to the Upper Cretaceous and contains many extinct species. In the existing flora it comprises very many species, which are widely distributed throughout the world. It is most abundant in Central and South America. Asia also contains numerous species, but there are comparatively few in Europe and Africa.

In addition to *Ilex opaca*, which has been found in the Pliocene of southern New Jersey, several other species of *Ilex* have been recorded from the Pleistocene of southeastern North America, and the genus is also represented in the Pleistocene of Europe.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Order RHAMNALES

Family VITACEAE

Genus VITIS Linné

Vitis sp. Berry

Plate LVII, Figure 6

Vitis sp. Berry, Jour. Geology, vol. 15, p. 345, 1907.

The genus *Vitis* is represented in the Chowan formation by the tendril figured, which is almost certainly that of some grape. It is strange that seeds have not been discovered in the Pleistocene of North Carolina, for they are exceedingly abundant in deposits of this age in southeastern North America, where they have been recorded from New Jersey,¹⁴ Maryland,¹⁵ the District of Columbia,¹⁶ and Virginia.¹⁷

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

¹⁴ Berry, E. W., Torrey, vol. 10, p. 266, 1910.

¹⁵ Hollick, Arthur, Maryland Geol. Survey, Pleistocene, p. 235, 1906.

¹⁶ Berry, E. W., Washington Acad. Sci. Jour., vol. 14, p. 21, pl. 2, figs. 6-9, 1924.

¹⁷ Berry, E. W., Torrey, vol. 6, p. 89, 1906.

Order THYMELEALES

Family LAURACEAE

Genus PERSEA Linné

Persea pubescens (Pursh) Sargent

Plate LVII, Figure 5

Persea pubescens Sargent. Berry, Jour. Geology, vol. 15, p. 345, 1907.

The swamp bay is a slender tree of pine-barren swamps occurring from North Carolina to Mississippi and Florida, near the coast, and unknown in the upper valley of the Neuse, where it was found fossil.

The related red bay, *Persea borbonia* Sprengel, ranges as a larger tree in somewhat similar situations from Virginia to Florida, Arkansas, and Texas and is believed by some botanists to be an older species than *Persea pubescens*. The foliage of the two is much alike, and it is possible that the fossil may represent the former, although it agrees more perfectly with the leaves of the latter. Neither is otherwise known in the fossil state, although *Persea* is an old genus with many extinct species and has been continuously present in southeastern North America since early Eocene time.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Order UMBELLALES

Family CORNACEAE

Genus NYSSA Linné

Nyssa biflora Walter

Plate LVII, Figure 4

Nyssa caroliniana Poiret. Hollick, Torrey Bot. Club Bull., vol. 19, p. 331, 1892.

Nyssa biflora Walter. Hollick, Maryland Geol. Survey, Pleistocene, p. 235, pl. 69, fig. 5, 1906.

Berry, Torrey, vol. 6, p. 90, 1906; Jour. Geology, vol. 15, p. 345, 1907; Am. Jour. Sci., 4th ser., vol. 29, p. 398, 1910; Torrey, vol. 10, p. 266, 1910.

This species, which is often confused with the more widely ranging *Nyssa sylvatica* Marsh, is said by Sargent to be restricted to pine-barren ponds near the coast from North Carolina to Louisiana. Britton gives its northern range as New Jersey, and Shreve records it as common in the river swamps of the Eastern Shore of Maryland.

Leaves or stones have been recorded from the Pliocene of New Jersey and from the Pleistocene of New Jersey, Maryland, and Alabama. In North Carolina fragmentary leaves were collected at the Neuse River locality and stones at the Roanoke River locality.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County. Pamlico formation. Old Mill Landing, left bank of Roanoke River 8 miles above Williamston, Bertie County.

Order ERICALES

Family ERICACEAE

Genus XOLISMA Rafinesque

Xolisma ligustrina (Linné) Britton

Plate LVII, Figure 12

Xolisma ligustrina Britton. Hollick, Maryland Geol. Survey, Pleistocene, p. 236, pl. 69, fig. 6, 1906.
Berry, Jour. Geology, vol. 15, p. 346, 1907; Am. Naturalist, vol. 41, p. 696, pl. 2, fig. 6, 1907; Am. Jour. Sci., 4th ser., vol. 29, p. 398, 1910.

This species, which was referred by Linné to *Vaccinium* and is a type that paleobotanists usually refer to *Andromeda*, has been recorded from the Talbot formation of Maryland and from the Pleistocene of Alabama.

In the existing flora it is a species that inhabits swamps and hillsides, and it ranges from Canada to Florida and Arkansas. Still other species occur in the South Atlantic and Gulf States.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Genus DENDRIUM Desvaux

Dendrium pleistocenicum Berry

Plate LVII, Figures 1, 2

Dendrium pleistocenicum Berry, Jour. Geology, vol. 15, p. 346, 1907; Am. Naturalist, vol. 43, p. 436, 1909.

Small, narrowly elliptical leaves, with a rounded apex and base and conspicuously undulate margins. Texture conspicuously coriaceous, and the venation consequently more or less obsolete in the smaller specimens. Midvein in the larger leaves thin and curved, giving off numerous thin wide-angled camptodrome secondaries.

Dendrium is a small genus of shrubs of southeastern North America which are known as sand myrtles. *Dendrium buxifolium* (Bergins) Desvaux is found in sandy pine barrens from New Jersey to North Carolina. A second species, *Dendrium hungeri* Small, with larger leaves, is found in the mountains of North and South Carolina. The leaves of *D. hungeri* agree rather well with those of the fossil, which is regarded as the Pleistocene ancestor of these two modern forms and which inhabited the Piedmont Plateau and the part of the Coastal Plain then above sea level. *Dendrium hungeri* represents a modern upland type much like the Pleistocene form, and *Dendrium buxifolium* represents a pine-barren modification with reduced leaves. This same species has been recorded from the Talbot formation of Virginia.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Family VACCINIACEAE

Genus VACCINIUM Linné

Vaccinium corymbosum Linné

Plate LVII, Figures 8, 9

Vaccinium corymbosum Linné. Hollick, Maryland Geol. Survey, Pleistocene, p. 236, pl. 69, figs. 7-9, 1906.
Berry, Jour. Geology, vol. 15, p. 346, 1907; Am. Jour. Sci., 4th ser., vol. 29, p. 398, 1910; Torrey, vol. 17, pp. 161, 162, fig. 2, 1917.

This species has been recorded from the Pleistocene of Maine, Maryland, North Carolina, and Alabama. In the existing flora it is found in meadow swamps and moist woods and ranges from Newfoundland to Minnesota and southward to Florida and Louisiana.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County. Pamlico formation, Old Mill Landing, left bank of Roanoke River, 8 miles above Williamston, Bertie County.

Vaccinium spatulatum Berry

Plate LVII, Figure 3

Vaccinium spatulata Berry, Jour. Geology, vol. 15, p. 346, 1907.

Small obovate to spatulate leaves, widest above the middle, with broadly rounded apex and narrowly cuneate base. Margins entire, somewhat irregular. Texture subcoriaceous. Length about 2.5 centimeters. Maximum width about 1.2 centimeters. Petiole short and stout, only about 1 millimeter long. Secondaries remote, two or three ascending camptodrome pairs. This leaf has the features of *Vaccinium* and appears to represent an extinct form.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Vaccinium arboreum Marsh

Plate LVII, Figure 7

Berberis sp. Berry, Jour. Geology, vol. 15, p. 343, 1907.
Vaccinium arboreum Marshall. Berry, Torrey, vol. 9, p. 73, 1909; Am. Jour. Sci., 4th ser., vol. 29, p. 398, 1910; vol. 34, p. 222, 1912.

A single broken specimen from the Chowan formation of North Carolina, referred originally to *Berberis*, unquestionably represents the sparkleberry. It has subsequently been found fossil in the Pleistocene of Alabama and the Great Valley of Virginia.

In the existing flora *Vaccinium arboreum* is often a small tree of sandy soil, ranging from North Carolina to Kentucky and southward to Florida and Texas. It is sometimes removed from the genus *Vaccinium* and placed in the genus *Batodendron* Nuttall, as by Small.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Order RUBIALES

Family CAPRIFOLIACEAE

Genus VIBURNUM Linné

Viburnum molle Michaux

Viburnum cf. *V. molle* Michaux. Berry, Torrey, vol. 14, p. 160, 1914.

Two stones that appear to be referable to this species were found in the Chowan formation.

In the modern flora *Viburnum molle* ranges from eastern Massachusetts, to Florida and Texas near the coast.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

Viburnum nudum Linné?

Viburnum nudum Linné. Berry, Torrey, vol. 14, p. 160, 1914; Jour. Geology, vol. 25, p. 662, 1917; Florida Geol. Survey Ninth Ann. Rept., p. 29, 1917; Torrey, vol. 22, p. 11, 1922; Washington Acad. Sci. Jour., vol. 14, p. 23, pl. 2, fig. 25, 1924.

Stones of this species are not uncommon in the Pleistocene of southeastern North America and have been recorded from the Wicomico formation of the District of Columbia, the loess of western Tennessee, and the low-level terrace at Vero, Fla. Two stones that appear to represent this species were collected from the Chowan formation in North Carolina.

In the existing flora it ranges from Long Island to Florida and Louisiana.

Occurrence: Chowan formation, right bank of Neuse River 4½ miles above Seven Springs, Wayne County.

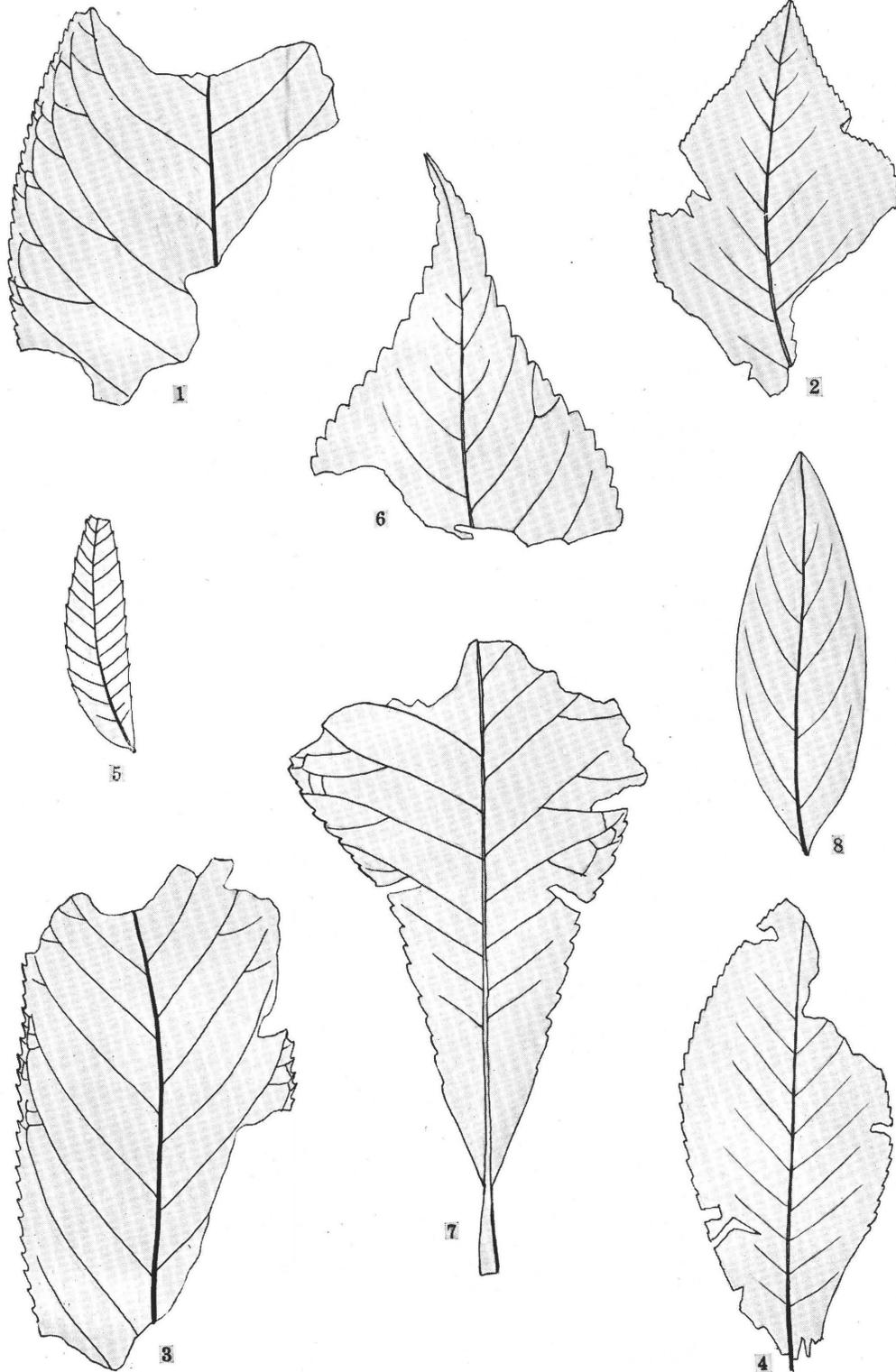
PLATES XLV-LVII

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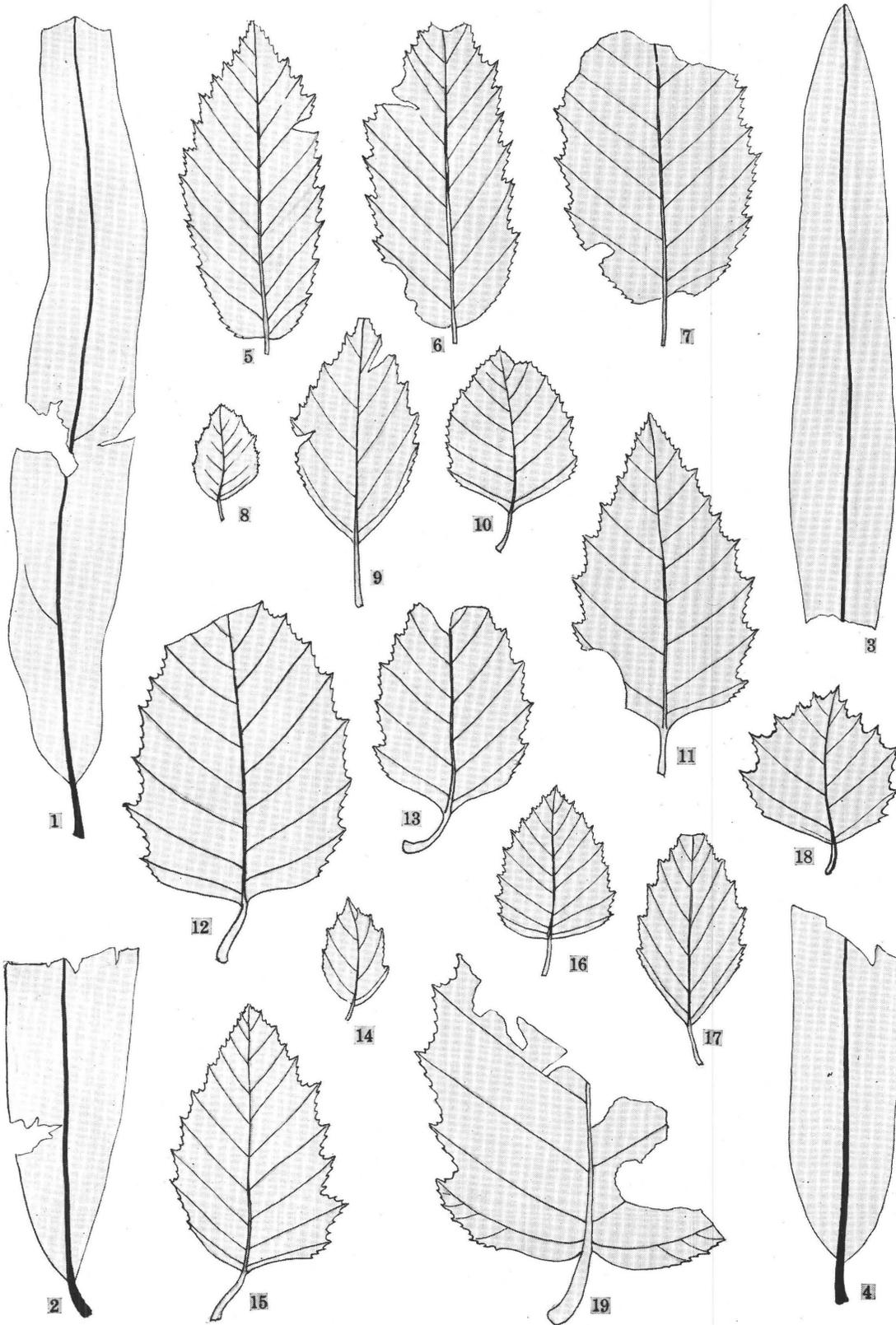
PLEISTOCENE PLANTS FROM NORTH CAROLINA

1-8. *Taxodium distichum* (Linné) L. C. Richard (p. 105). (Figs. 6, 7 after Hollick.)
9. *Pinus serotina* Michaux (p. 105).



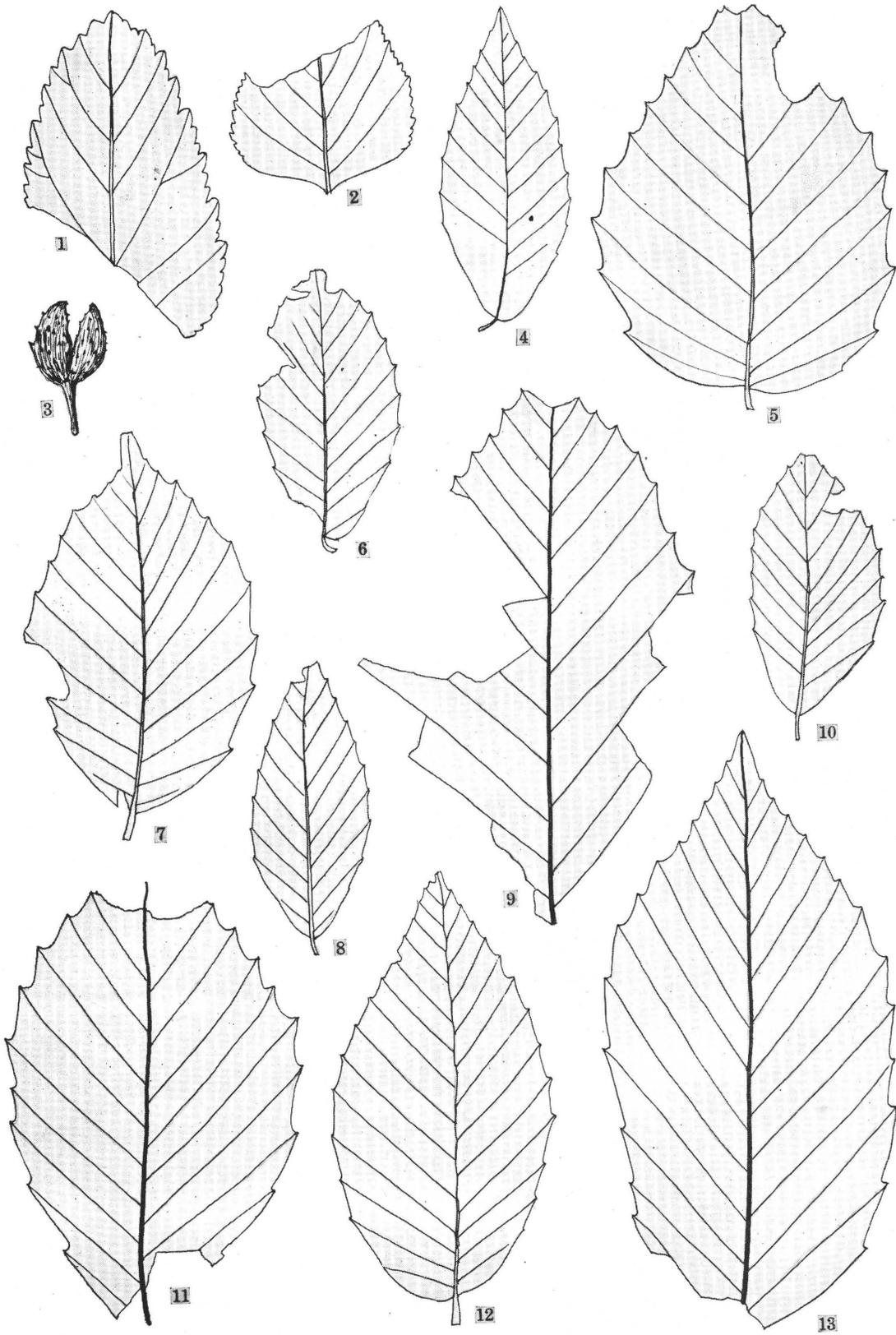
PLEISTOCENE PLANTS FROM NORTH CAROLINA

- 1-4. *Hicoria glabra* (Miller) Britton (p. 106).
- 5. *Hicoria aquatica* (Michaux son) Britton (p. 106).
- 6-7. *Hicoria ovata* (Miller) Britton (p. 106).
- 8. *Salix bebbianaformis* Berry, n. sp. (p. 107).



PLEISTOCENE PLANTS FROM NORTH CAROLINA

- 1-4. *Salix viminalifolia* Berry (p. 107).
- 5-7. *Carpinus caroliniana* Walter (p. 108).
- 8-19. *Betula nigra* Linné (p. 107).



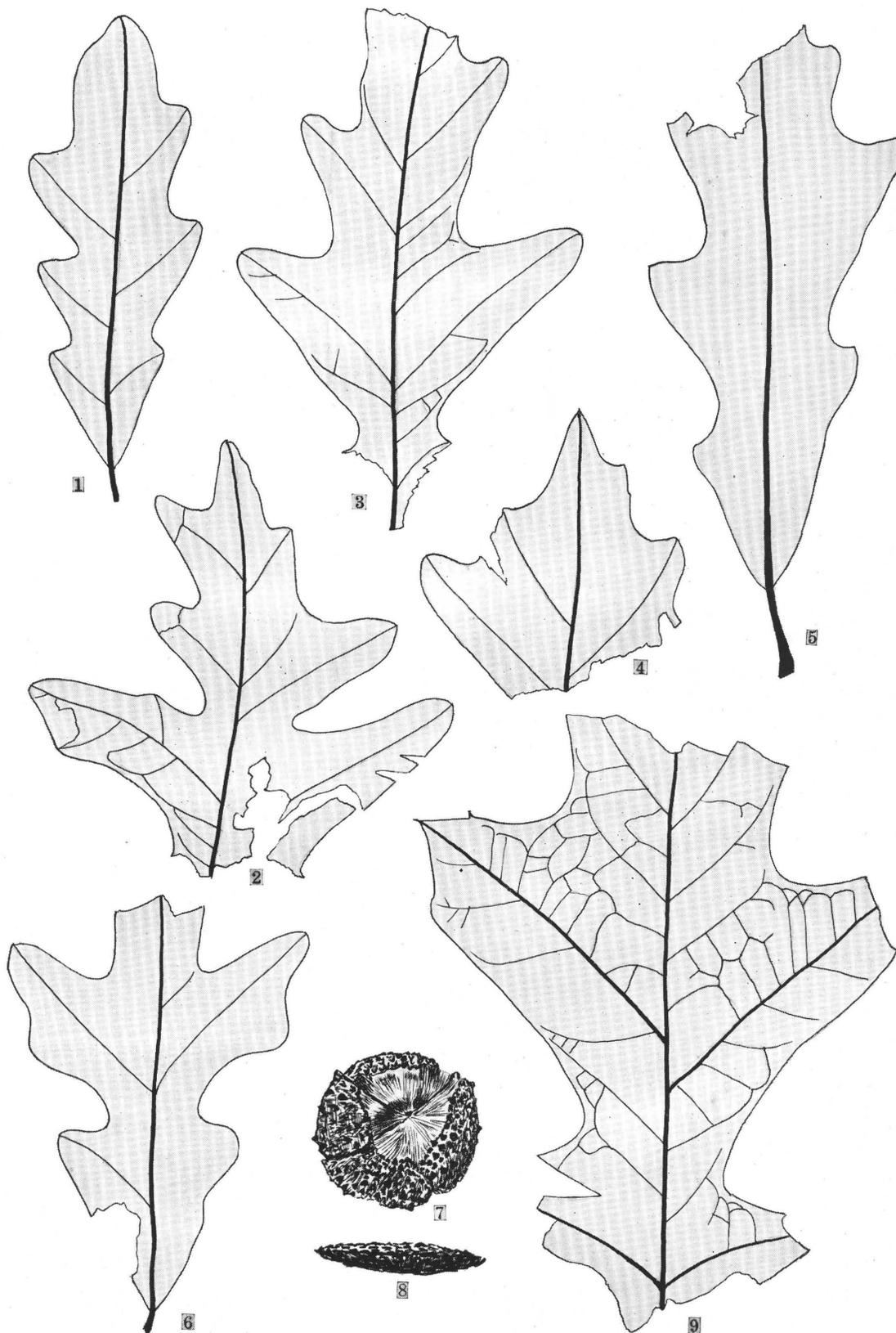
PLEISTOCENE PLANTS FROM NORTH CAROLINA

- 1-2. *Betula pseudofontinalis* Berry (p. 108).
- 3-13. *Fagus americana* Sweet (p. 108).



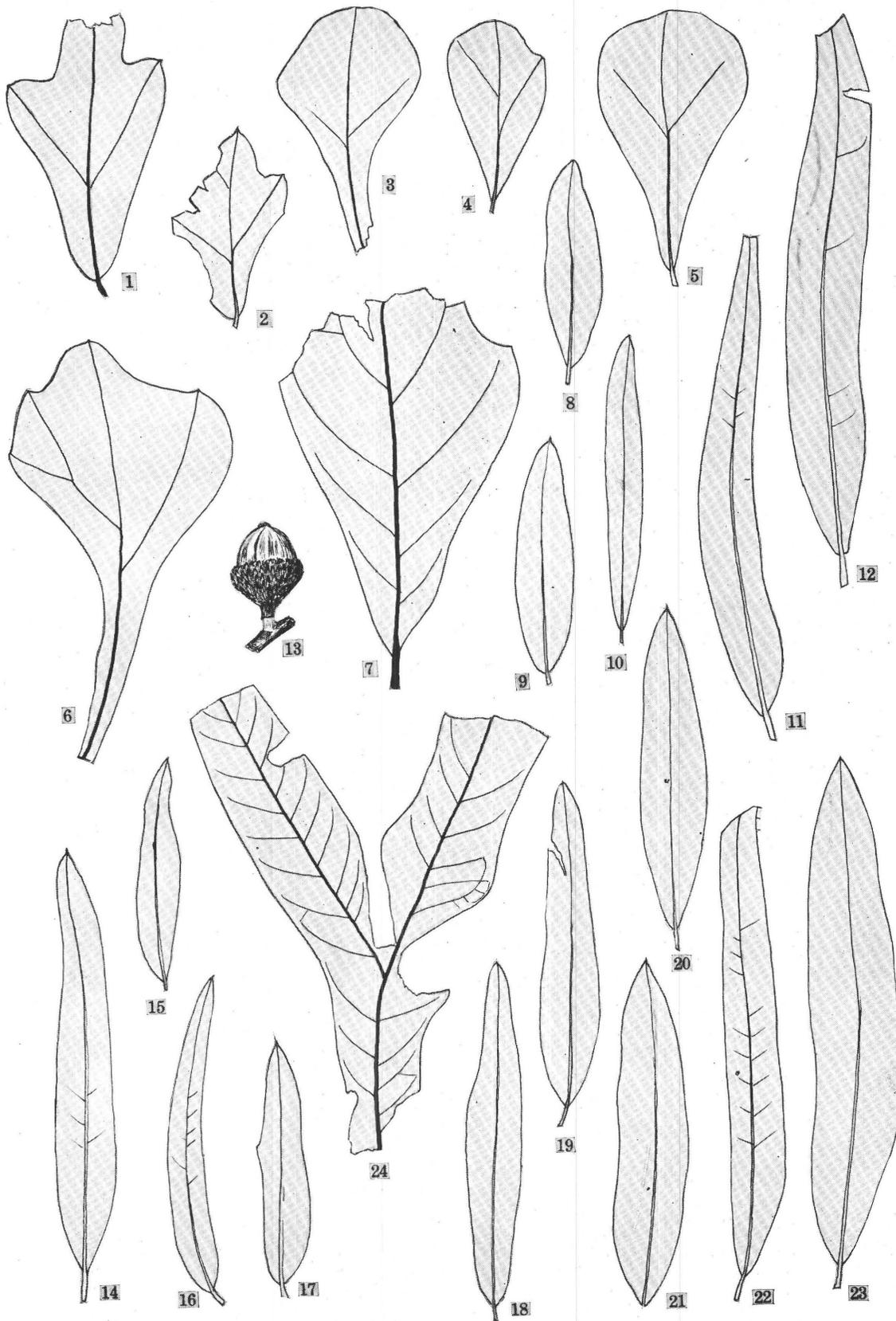
PLEISTOCENE PLANTS FROM NORTH CAROLINA

- 1-3. *Quercus velutina* Lamarck (p. 111).
4-6. *Quercus palustris* Du Roi (p. 109).



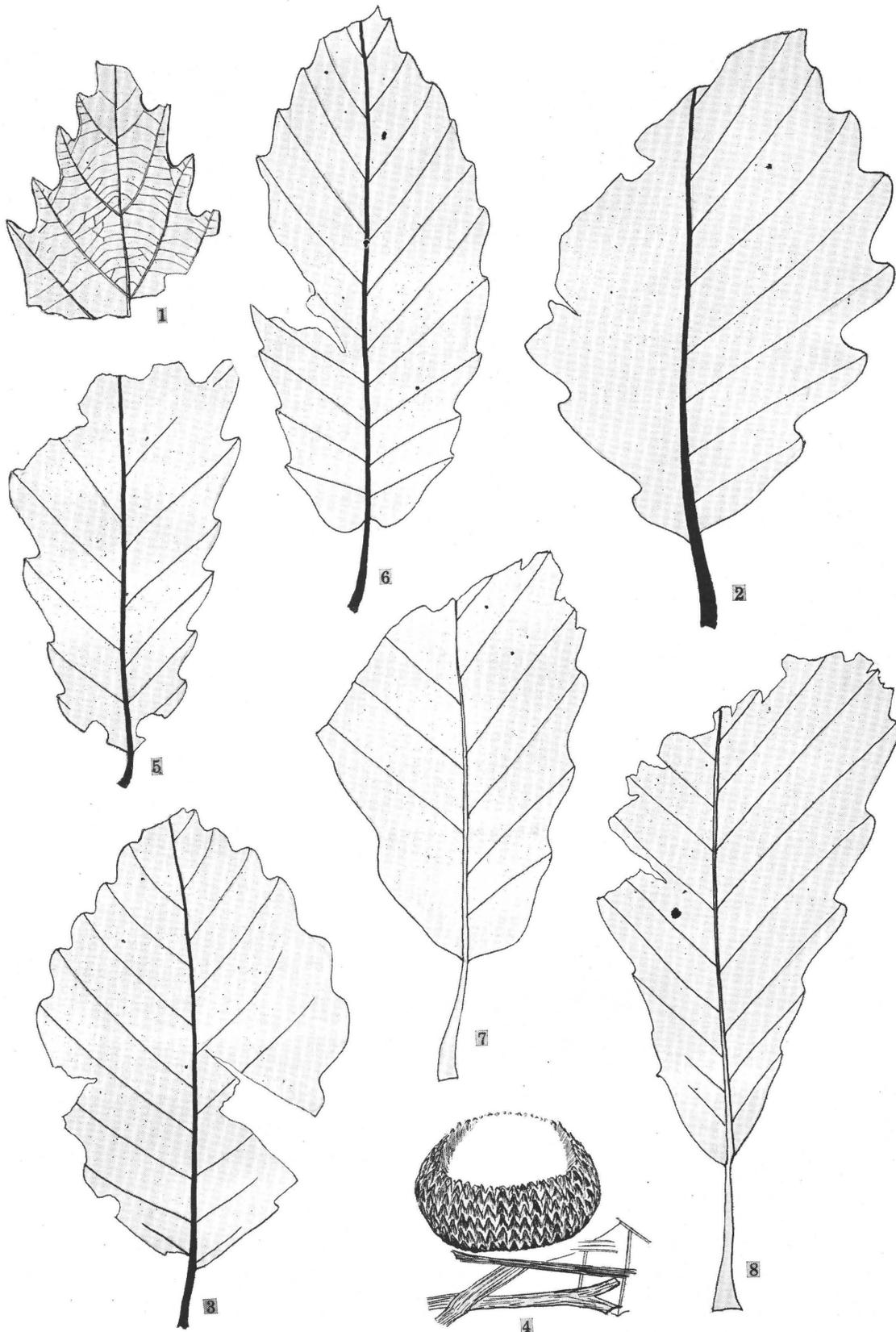
PLEISTOCENE PLANTS FROM NORTH CAROLINA

1-5. *Quercus alba* Linné (p. 108).
6-9. *Quercus lyrata* Walter (p. 110).



PLEISTOCENE PLANTS FROM NORTH CAROLINA

- 1-7. *Quercus nigra* Linné (p. 109).
 8-23. *Quercus phellos* Linné (p. 110).
 24. *Quercus abnormalis* Berry (p. 109).



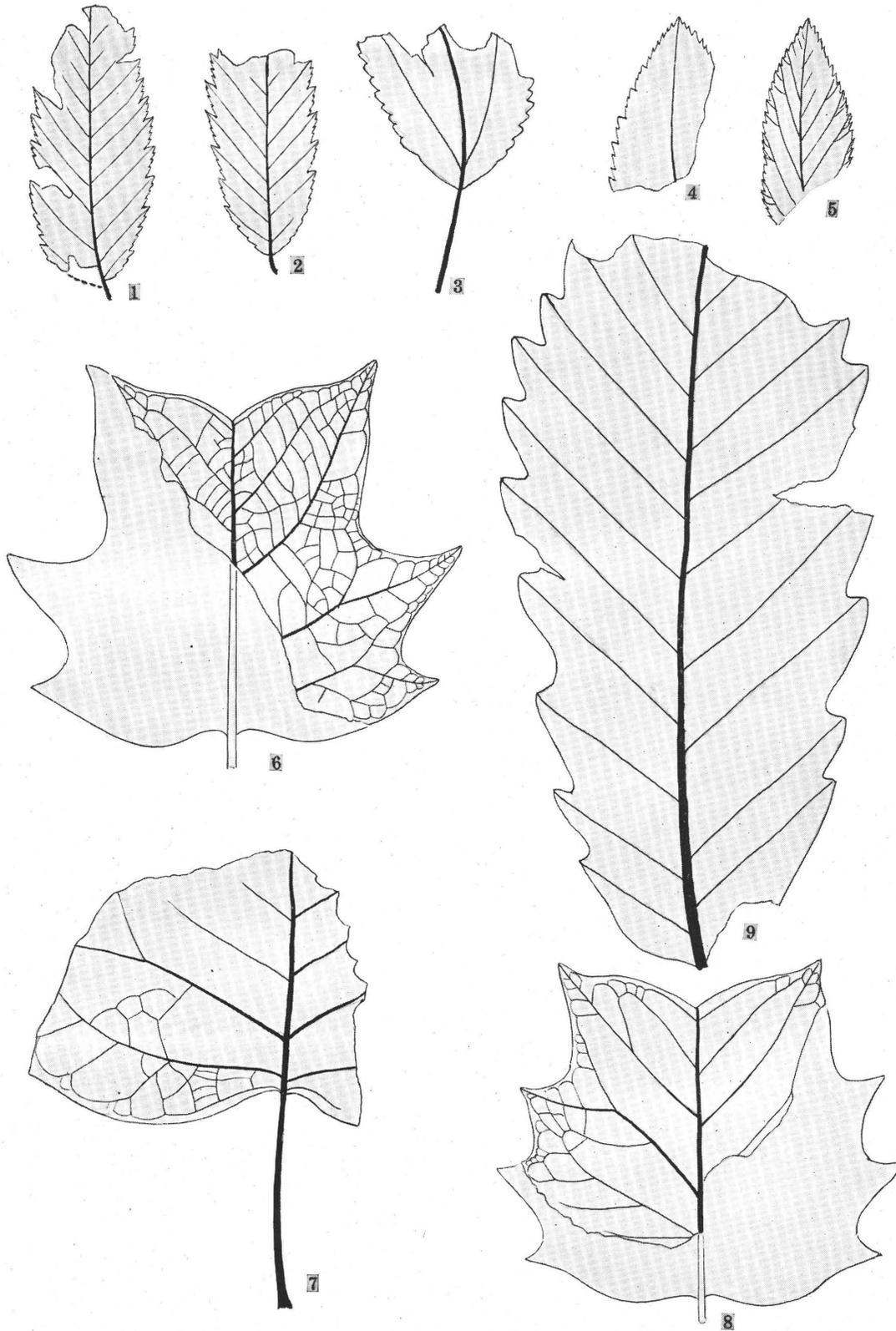
PLEISTOCENE PLANTS FROM NORTH CAROLINA

- 1-4. *Quercus michauxii* Nuttall (p. 110).
- 5-8. *Quercus prinus* Linné (p. 110).



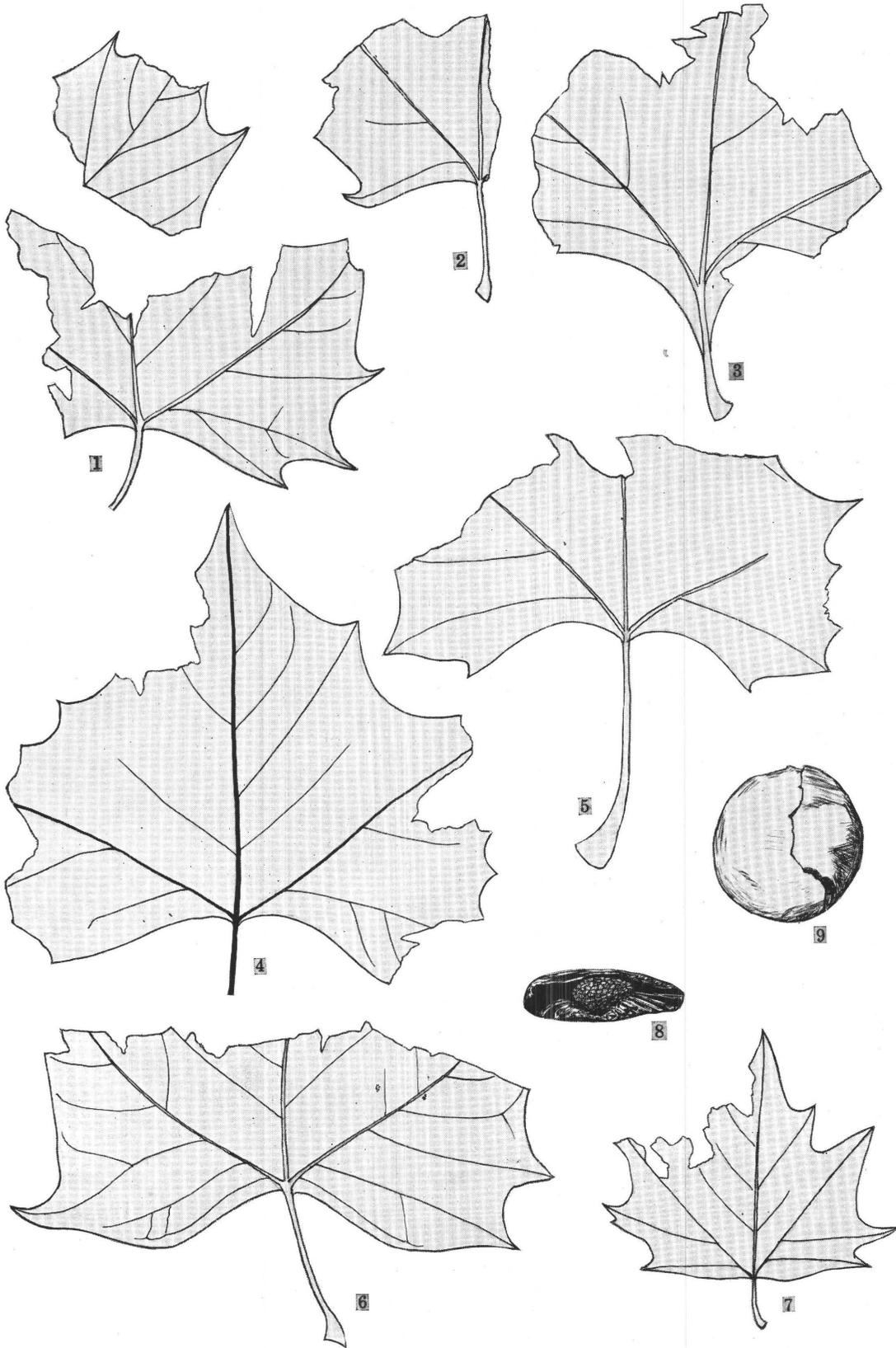
PLEISTOCENE PLANTS FROM NORTH CAROLINA

1-6. *Quercus predigitata* Berry (p. 109).



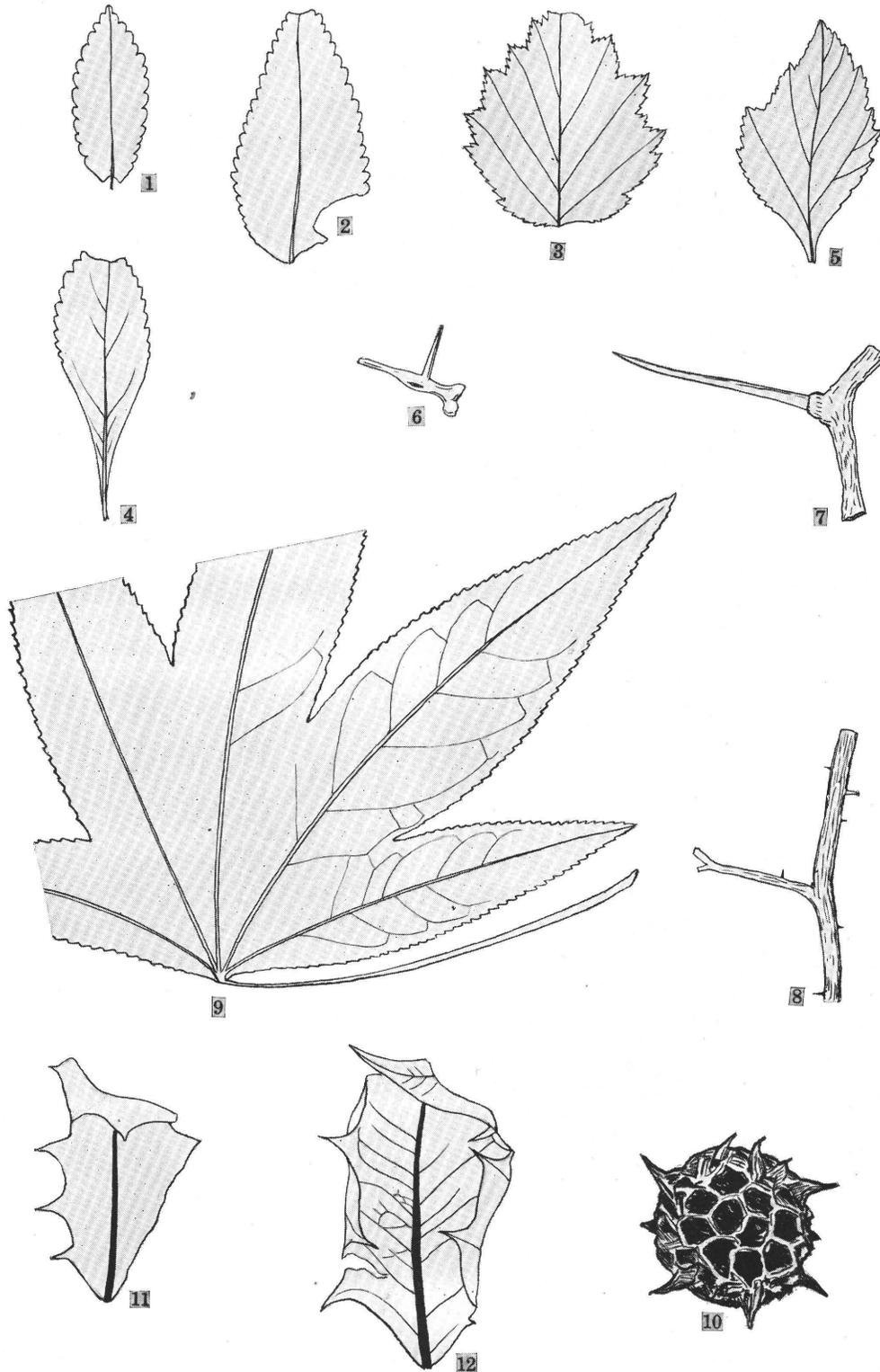
PLEISTOCENE PLANTS FROM NORTH CAROLINA

- 1-2. *Ulmus alata* Linné (p. 111).
- 3. *Celtis occidentalis* Linné (p. 111).
- 4-5. *Planera aquatica* (Walter) Gmelin (p. 111).
- 6-8. *Liriodendron tulipifera* Linné (p. 112).
- 9. *Quercus prinus* Linné (p. 110).



PLEISTOCENE PLANTS FROM NORTH CAROLINA

1-9. *Platanus occidentalis* Linné (p. 112).



PLEISTOCENE PLANTS FROM NORTH CAROLINA

- 1-2. *Malus pseudoangustifolia* Berry, n. sp. (p. 113).
- 3. *Malus coronariafolia* Berry (p. 113).
- 4. *Crataegus spathulatoides* Berry (p. 114).
- 5-7. *Crataegus coccineaefolia* Berry (p. 114).
- 8. *Rubus* sp. (p. 113).
- 9-10. *Liquidambar styraciflua* Linné (p. 113).
- 11-12. *Ilex opaca* Aiton (p. 115).



PLEISTOCENE PLANTS FROM NORTH CAROLINA.

- 1-2. *Dendrium pleistocenicum* Berry (p. 116).
- 3. *Vaccinium spatulatum* Berry (p. 116).
- 4. *Nyssa biflora* Walter (p. 115).
- 5. *Persea pubescens* (Pursh) Sargent (p. 115).
- 6. *Vitis* sp. Berry (p. 115).
- 7. *Vaccinium arboreum* Marsh (p. 116).
- 8-9. *Vaccinium corymbosum* Linné (p. 116).
- 10-11. *Cercis canadensis* Linné (p. 114).
- 12. *Xolisma ligustrina* (Linné) Britton (p. 116).