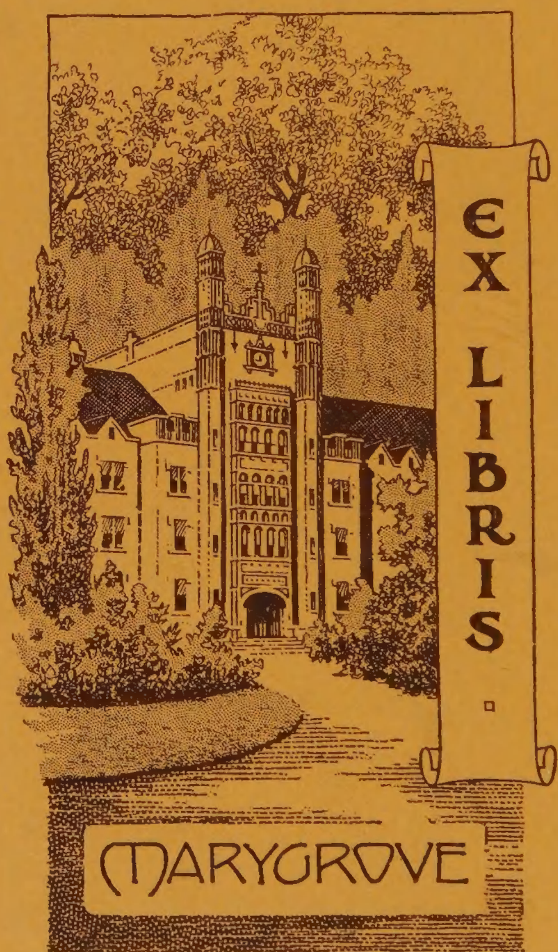
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MARYGROVE

The Giant Bald Cypress of Santa Maria del Tule

Courtesy of the Missouri Botanical Garden

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TREE ANCESTORS

A GLIMPSE INTO THE PAST

BY
EDWARD WILBER BERRY
Professor of Paleontology in the Johns Hopkins University

" For it had bene an ancient tree,
Sacred with many a mysteree."
Shepheards Calender: Februarie, 197, 198

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CHAPTER I

Introduction

St. Bernard said: "Trees and rocks will teach what thou canst not hear from a master," and Tennyson has expressed the same thought, of the mystery and romance of biology wedded to geology, more sonorously in the following lines:

> There rolls the deep where grew the tree.
>   O earth what changes hast thou seen!
>   There where the long street roars, hath been
> The stillness of the central sea.
>
> The hills are shadows, and they flow
>   From form to form and nothing stands;
>   They melt like mists, the solid lands,
> Like clouds they shape themselves and go.

These two verses compress into cinema-like rapidity what went on at a slow rate over a period of millions of years, and it is these glimpses into the long ago that stimulate the student of geology like new wine, and make him wonder why all the world does not forsake the trivial affairs of life and spend their time in making bricks for the temple of science and the master builder.

The sketches which follow are an attempt to interest the general public in the marvellous history of some of our trees. Although we, as a nation, probably because of our seeming limitless natural resources, have been somewhat slow in awakening to the necessity of scientific forestry, there has always been a large public interested in our forest trees, as witness our numerous tree books. In none of the latter, however, will the reader get any idea that the various tree stocks are many thousands of years old, or that their abundance and geographical distribution have not always been much as we find them today.

The selection of forms in the following pages may seem arbitrary and many will look for some special favorite to find it omitted, since I have chosen forms whose history was better known, but not worn threadbare, and omitted others where the evidence was incomplete or conflicting, as in the case of the pines, spruce, and their allies.

The reader need know no geology or botany as all unnecessary technicalities have been avoided. One cannot, however, discuss history without some sort of a chronology, and I have therefore given a simplified geological time table in Chapter II which will be sufficient after it has been understood to render clear such references as appear in the following pages.

The main theme then will be the geological or distribution in time, and the geographical or distribution in space, of the trees. Although I will not refrain from mentioning the usefulness of the trees to us humans, it should be remembered that a tree is no longer a tree when it has become timber, and it is only in deference to a practical people and to a forestry which regards our woodlands as so many potential board feet that utility may be considered as a possible avenue to a more general appreciation of the wonders of their present state and the grandeurs of their past history.

CHAPTER II

Geological Principles

When we visit the Garden of the Gods and learn the history of the beautiful and weird shaped masses of red sandstone to which the locality owes its romantic name—how they were deposited originally as loose sands in horizontal beds, were subsequently solidified and bent by the forces that built the Rocky Mountains so that the original horizontal bedding became perpendicular, and were subsequently carved to their present proportions from solid sheets of rock by the slow action of rain, wind and frost, it may readily be believed that strange and unknown forces of great magnitude were operative in past times. The same feeling is aroused by the grandeur of the Grand Canon of the Colorado or by the columnar lava of Fingalls Cave and the Giants Causeway, or even by the majestic lava sheet that forms the Palisades of the Hudson. And if we have ever seen the overturned folds of rock common in most mountain regions or especially the great double fold in the Glärner Alps south of Lake Zurich, we may feel justified in concluding that very different and titanic physical forces were operative on the earth before the advent of man, just as we know gigantic animals flourished in past geologic times and just as the plants allied to our modern lowly club mosses and mares tails were tall trees during the coal period.

This is exactly what the earlier students of the earth thought. When they found the remains of marine shells in the rocks of the mountain tops they concluded that vast caverns in the earth's crust had swallowed the waters of the primeval universal ocean. When knowledge had progressed so that men knew that the traces of former life in each succeeding layer of rocks differed from all others both earlier and later they concluded that mighty cataclysms or revolutions of nature had repeatedly swept the life off of the face of the earth and that each time this had happened it had been subsequently renewed by special divine creations.

These conclusions were all rational enough in their day, especially when the belief was well nigh universal that the earth was only about 6000 years old as estimated from the biblical chronicles. When, however, it was finally realized that nature had almost limitless time at her disposal students began to perceive that the apparently insignificant forces which we still find at work—the action of air and water and vulcanism, and the slow changes wrought by evolution, were the agencies that had accomplished such tremendous results in past times.

This belief in the uniformity of factors and the interpretation of the past in terms of nature's forces that we find acting today was christened uniformitarianism and the late Sir Charles Lyell (1797–1875) may be regarded as the high priest of this belief. It is quite possible that the forces of nature may have apparently accomplished more rapid results at certain times in the history of the earth but it is very doubtful if, during the time when the ancestors of our forest trees have flourished physical or organic history moved any faster or by any different means than it moves today.

This is one of the great principles of geology—that we may legitimately utilize present conditions in the interpretation of the past, or in what Huxley called retrospective prophecy. We may rest assured that boreal or temperate forests did not flourish in proximity to tropical marine waters, and that insolation, humidity, rainfall, and all the other factors of environment had effects on the trees of past ages similar to their effects on the forests of today. It is as unscientific to assume that trees did not react to their environment during the Eocene as they do at present as it would be to assume that the carrying power of water was not conditioned by its velocity during Eocene time.

A second principle the enunciation of which will be helpful throughout the subsequent discussions relates to climate. The human race since its reached the stage of written traditions has lived under climatic conditions which in general are like those of the present, with the familiar transition from torrid through temperate to polar climates in passing from the equator to the poles. It is most difficult to think of past climates as in any way different from those that we have known since childhood. Hence when we hear of the remains of bread fruit and camphor-trees in latitude 73° north, or coal seams formed by the accumulation of plant remains in both the Arctic and the Antarctic regions it might seem as though the poles must have been somewhere else at the time when Greenland was the land of verdure that its name would seem to indicate. There have been students who subscribed to the theory of wandering poles but it can not be said to have many adherents at the present time and physicists assure us that it is impossible. The truth seems to be that geological climates in general were much more uniform than they are today—milder in the polar regions and less torrid in the equatorial regions. This may seem to be an exception to the principle of uniformity just enunciated, but this is only apparent. Through a combination of causes such as extension and elevation of the land surface of the earth and a consequent restriction of the oceanic areas, and other causes not yet satisfactorily formulated there have been, at widely separated intervals, periods of glaciation which have interrupted the normal more uniform climates that were the rule. One has been recognized in the pre-Paleozoic, another is thought to have occurred in the early Paleozoic but this may be confused with the earlier one just mentioned. A third was ushered in many millions of years later near or at the close of the Paleozoic, and the fourth and most widely known glaciation is the one which after the lapse of many more millions of years immediately preceded the historic period and witnessed the radiation of the men of the Old Stone Age in Europe. Men of this Old Stone Age were witnesses of the great Rhone glacier and of the ice sheet that covered Britain, Scandinavia and the north German plain.

This last great glacial period of which the ice cap of Greenland is probably a surviving remnant continued for many thousands of years and was marked by at least four periods of prevalent ice sheets and mountain glaciers and by intervening interglacial periods of long duration during which the climate was no more severe than it is at present. These were much longer than the time that has elapsed since the last ice sheet dammed the valley of the St. Lawrence, and many students believe that we are today living in a fourth interglacial period. This would account for the present climate with which man is familiar, a climate anomalous when compared with that of the Tertiary or the Cretaceous, since the glacial periods partially due to the extension of land masses and elevation are the result of the consequent changes in the atmospheric and oceanic circulation.

Thus a second principle may be set forth, namely, that throughout the bulk of geologic time climates were more uniform than they are at present. The truth of this statement will be abundantly shown when the former distribution of our forest types is passed in review, although the actual amount of change has usually been overestimated.

Geologists in dealing with the rocks of the earth's crust and their succession in time divide them into geological formations which are thus the units of geological history and each formation may be considered as a page of earth history or a phase of geological time. From the remains of animals and plants that were preserved in the rocks of a geological formation, i.e., its fossil content, and from the nature of the enclosing rock that constitutes the matrix of the fossils, i.e., their physical and mineralogical character, and from their relations to adjacent rocks, it is possible to in a measure restore the environment which existed at the time that they were deposited, namely the topography, temperature, rainfall, forestation, etc.

These stratigraphic units or formations representing phases of time are grouped together in larger units known as stages (étages) representing what are called ages of time and these in turn are grouped into units of still larger magnitude known as epochs of time or series of stages, as for example the Eocene, Oligocene and Miocene series of stages or epochs of time. These series or epochs are further grouped into systems of series (rocks) or periods of time, as for example, the Carboniferous system or coal period, the Cretaceous system or chalk period, and so on. The Eocene, Oligocene, Miocene and Pliocene series collectively constitute the Tertiary period during which both the Mammals or warm blooded non-avian animals and the Angiosperms or flowering plants under-went their most obvious differentiation and distribution over the face of the earth.

These systems of rocks representing the history of periods of time are themselves gathered together into groups that represent what are called eras of time, thus the Triassic, Jurassic and Cretaceous periods constitute the Mesozoic group of periods or the Mesozoic era of time—the era of gymnosperms (more familiarly conifers) among plants and the era of reptiles among animals.

All this may seem complicated and abtruse to the non-geological reader, but it must be obvious that we cannot discuss the noble races of trees that have passed across the face of nature in past ages without a definite chronology and nomenclature, any more than we could live our daily lives and transact its affairs comfortably and effectively without time pieces and calendars. Nor can we compare the contents of the rocks of different countries and determine the place of origin or the subsequent history of the migrations and extinctions of plants or animals without a carefully worked out chronology. Without such our situation might be compared to that in civil life before standard time was adopted.

The following somewhat abbreviated table will furnish the reader with the geological divisions that it will be necessary to use in trying to picture the history of the ancestors of our trees. It also gives a few of the facts of earth history and organic history that will serve to emphasize and fix the former in mind.

To those who notice the fate of the leaves each autumn it may seem that for any adequate geological record of bygone vegetation the conditions for the successful preservation or fossilization of parts of plants must have been very different in the past from what they are at the present time. Except for the fact that the continental masses are somewhat larger now than was the case for the greater part of geological time this is not so. The facilities for fossilization in inland and upland regions have always been limited to lake and flood-plain (river overflow) deposits. Mountain lakes have frequently preserved marvellous records of the contemporaneous life as that of the Miocene lake of Florissant in the heart of the Colorado Rockies or the even more celebrated Miocene

CENOZOIC ERA Mammals and Flowering plants	Quaternary period	Pleistocene epoch	Time of the Ice age and the ancestors of man. Extinction of many large animals and trees. Evolution of herbs. Elevation and extension of the continents.
	Tertiary period	Pliocene epoch	Cosmopolitan forest types. Elevation of the Andes.
		Miocene epoch	Zenith of development of forests. Elevation of the Swiss Alps.
		Oligocene epoch	Culmination of Eocene types. Warm climate with some aridity. Elevation of the Pyrenees.
		Eocene epoch	Forests in the polar regions. Beginning of elevation of Cordilleras. Community of Holarctica.
MESOZOIC ERA Reptiles, Cycads and conifers	Cretaceous period	Earliest known palms. Beginnings of the modern forests flora mixed with survivals from the fern, cycad and conifer flora of the older Mesozoic.	
	Jurassic period	Widespread warm seas, marine faunas and terrestrial floras. Origin of the dicotyledons. Beginning of the Sierra Nevadas.	
	Triassic period	Shallow seas and lagoons. Widespread red continental deposits. Igneous activity and mountain making. Land extension.	
		Appalachian revolution.	
PALEOZOIC ERA	Fishes, ferns and fern-like plants. Giant club mosses and horse tail rushes. Origin of the seed plants. Old folded mountain systems of the world such as the Caledonian, since worn flat. Radiation of invertebrate phylae, origin and evolution of fishes and amphibians.		

lake of Oeningen in Baden near the present Lake Constance. In both of these fossil lakes thousands of delicate insects and the floral and foliar organs of plants, as well as other forms of life were preserved in great variety and perfection. Great numbers of plants were preserved in the continental deposits of our own western Tertiaries and amber or other exudations of the gum of trees has frequently hermetically sealed a variety of delicate and otherwise unknown fossils.

Any one who has noticed the amount of variety of leaves in the bayous and estuaries of our coastal plain, particularly after a wind storm, or the quantities that are buried by fine mud in the spring freshets of the rivers have little difficulty in picturing conditions favorable for fossilization in past times. When it is further realized that the geological record accumulated not through a few but through thousands of years it is seen that this record is not nearly as inadequate as it seemed at first thought.

CHAPTER III

Methods of Preservation of Fossil Plants

The seasons, whether cold and warm or wet and dry, succeed one another in a never ending series ages long. Trees ripen their fruits and seeds and shed their leaves, some rapidly and some slowly. Winds contribute windfalls or branches to the forest litter. These and allied processes have been happening since plants first came up out of the primitive oceans and covered the dry land.

In regions remote from water—either rivers, lakes or ocean—there is but slight chance that this forest litter will be preserved. It is attacked by hosts of insects, and lower plants ranging from bacteria to fungi, and the greater portion is finally partially or wholly oxidized. Swamps may preserve logs as lignite, or scraps of vegetation such as the more resistant seeds, or cuticles and pollen grains, but the great bulk of the swamp accumulations become more or less amorphous carbonaceous masses such as those from which coal beds have been formed.

Fruits and seeds are designed for the perpetuation of the species, but mortality among seeds is on a vast scale. They have to fall or be carried to a suitable situation in order to sprout. All the non-carnivorous higher animals levy upon the products of the forest. It may be bears coming down into the swamps in the fall for the gum berries (Nyssa), the ever present squirrels and their allies busy with the oaks, walnuts and hickories, swine devouring the beech and oak mast, or it may be birds or fruit bats according to species and clime. While man has been on the scene for but a relatively short time he has probably wrought more damage than any other agency. Consequently it might seem that but few relics of the present forests are being fossilized or that we can never accumulate much evidence regarding the bygone forests that clothed the earth.

While in a general way deserts, prairies, open savannas and pampas have always been present in certain areas it remains true that in a geological sense they were for the most part short lived features and that the bulk of the earth's surface has been forested until modern times. .

The agents of fossilization have been and are streams, lakes, lagoons and seas. A constant shower of life falls on the bosom of the waters. Trees have their roots undermined by erosion and topple bodily into the streams; leaves, fruits and sticks make up a large percentage of the river drift. This river drift may travel near or far, much of it rots beyond recognition, but always something is saved. Logs and branches are stranded and buried in river bars where some become petrified. Leaves and fruits become water logged and sink in slack waters where they are covered with mud, or the forest litter on bottom lands may be spread with a mantle of alluvial mud during periods of high water and thus be preserved. Anyone who has seen the variety of leaves and fruits that streams are constantly carrying in our own country or the vast amount of vegetable drift in such estuaries as the Guayaquil, the Amazon or the Orinoco cannot doubt that the present is preserving its records for the future or that the past similarly has not failed us. The forests near the coast contribute like things to the bayous, estuaries and lagoons or carry a part out to sea, and the same processes are taking place around all the innumerable lakes and ponds.

The actual methods of preservation are divided into two categories—one termed infiltration and the second known as inclusion. In the first the plant tissue of whatever sort from trunk to seed is more or less completely permeated or replaced molecule by molecule by silicic acid, calcium carbonate or other mineral substances such as magnesium, pyrite, marcasite, limonite, etc. According to the completeness of this replacement the internal structure is preserved with more or less fidelity, often to such an extraordinary degree that the histology is completely decipherable, and such delicate objects as the mycelial threads and spores of parasitic fungi or even bacteria are recognizable. Remains preserved as petrifactions are relatively uncommon although characteristic of regions of thermal activity like the Yellowstone Park. Calcified plant tissues characterize certain horizons in the coal measures especially in England, Westphalia and Moravia. Silicified plant tissues have rendered the Permian of St. Etienne and Autun in France famous, and quantities of Mesozoic cycads have been similarly silicified especially around the rim of the Black Hills. Fossil woods are commonly silicified, opalized or jasperized at very many localities and geological horizons, as in the Arizona National Park, where they are of Permian or Triassic age, or in the Yellowstone Park where they are Tertiary in age. Scattered trunks and fragments of petrified wood are abundant in all sandy formations.

The second general method of preservation, by far the most common mode of occurrence of fossil plants, is by simple inclusion in clay, shale, amber or other material, and is often known as incrustation. The bulk of the fossil plants with which the general public is familiar are of this type of preservation which often furnishes the most beautiful impressions of foliage or even flowers —the finer grained the sediment in which the plant remains were entombed the more perfect the impression. Thus a flocculent calcareous mud or lithographic stone will preserve every detail of form, or a fine mud like that of the fire clays beneath coal beds or the roofing shales above them will be crowded with the delicate remains of the plants that formed the coal, or a fine volcanic dust falling in a lake will preserve most beautiful specimens. Travertines will encrust the vegetable débris of deep ravines in a limestone country as in the case of the celebrated early Eocene travertines of Sézanne in France, or the younger travertines of northern Italy, or stalagmite will preserve the litter of burrows or dens of animals or of men of the Old Stone Age that lived in rockshelters.

Plant remains preserved by inclusion or incrustation may have some of their substance preserved as carbon, it may be replaced by salts of iron or other mineral, or it may be entirely dissipated leaving only the impression or cavity. Lignite beds and coal seams, or the impure peats of buried swamps so common in our Pleistocene deposits, are examples of inclusion (incrustation) of plants en masse. Occasionally such swamp deposits of great age like those of Brandon, Vermont, or of the German lignites, both of

Tertiary age, will furnish quantities of the fruits and seeds of bygone forests that flourished on their sites. Peat bogs are veritable mines of more recent vegetable history and where their contents are studied intensively as in some of the European countries they record the changes from sphagnum to rushes and the succession of willow, birch, pine and hazel much more certainly decipherable than the early written records of human history. Amber and other gums frequently contain small plant fragments in an exquisite state of preservation but the great bulk of fossil foliage was buried in shallow water muds of flood plains, lakes, bayous and estuaries and lagoons. Occasionally lignified wood may retain its internal structure and by special methods of treatment it may be sectioned and studied microscopically.

The details of the past history of our forest trees will doubtless always remain imperfectly known but this knowledge is increasing rapidly and we can already sketch the broader outlines of the history of a large number of our trees as the present sketches bear witness, and we can leave to the future the filling in of the details of these pictures when we know that these broader outlines are not founded upon fancies or theory, but upon facts.

CHAPTER IV

Geological Time and Methods of Reckoning

There are a great many ways of estimating the duration of geological time or the age of the earth. This is a fascinating subject that has always invited speculation by physicists and biologists as well as geologists. Most of these methods are dependent on the data furnished by the comparison of past processes with present processes, such as the rate of the formation of peat in bogs, or of stalactites in caverns, or the rates of accumulation of different kinds of sedimentary materials. Other methods take as their basis the rate of cooling of lavas, the amount of salts in solution in the oceans compared with the rate at which rivers are bringing them down to the seas, the effects of tidal stresses in retarding the earth's rotation, the rate at which the sun is supposed to be losing its heat, and by other less obvious methods, such as the state and rate of change of radium minerals in rocks.

These various estimates vary through very wide limits since no method has been discovered that does not involve a variety of unknown factors. There is, however, a certain amount of concordance in them all and it is possible by carefully estimating the total thickness of the sedimentary rocks and comparing the rate of accumulation at the present time of the different kinds of rocks such as limestones, sands and clays to get a rough approximation of the time necessary to account for the deposition of similar materials in past times. That the results are not accurate is obvious when it is recalled that conditions of erosion, amount of material and all of the other factors of the environment vary greatly so that one limestone may accumulate rapidly and another slowly. Furthermore very little account can be taken of the time that is represented by the numerous intervals in geological history when the rocks were being worn away by erosion and the resulting deposits are beyond our ken, or when the surface of the land was so nearly flat that but little sediment was being carried into the seas and lakes and being deposited.

It is obvious, however that this method while very inexact is, when carefully done, much better than no estimates, and when the results are expressed in ratios rather than in actual durations of so many years and we say that one geological period was twice as long as another, or that the time that has elapsed since the last glacial period is but one twenty-fifth of the duration of the whole Pleistocene, we are naming results which while gross from the viewpoint of a mathematician, physicist or chemist, are very satisfactory for the coarse scale of geological work.

Geologists have grouped the rocks of the earth's crust into the following five major divisions, of which the two earlier are omitted in the table given on a preceding page. These five divisions are in the order of their age: Archeozoic, Proterozoic, Paleozoic, Mesozoic, and Cenozoic. The stratified rocks that contain any abundant display of the life of their time are embraced in the Paleozoic (rocks with ancient life), Mesozoic (rocks with middle life), and Cenozoic (rocks with modern life). If 5 be taken to represent the duration of the Cenozoic, then the Mesozoic will be represented by 12 and the Paleozoic by 27. Unity is commonly considered as a million years but it may be more—it certainly is not much less.

CHAPTER V

The Later Geological History of North America

The present flora of North America, while it probably antedates the arrival of man upon this continent, has not remained unchanged for many thousands of years but has been constantly changing and was preceded by other and ancestral floras in which the grouping of genera, the abundance of specific types within these genera, and the range of the latter, was markedly different from what it is today. Glimpses into these floras of the past, extending back several millions of years, are obtained by piecing together the evidence furnished by the fossil remains of leaves, fruits and stems preserved in the rocks of the various geological formations.

The majority of our present forest types, those belonging to the class Dicotyledonae of the Angiosperm phylum (i.e., flowering plants with closed seed vessels) have an ancestry extending well back into the later Mesozoic or Secondary age, as the old geologists called it. The conifers (pines, spruces, hemlocks, etc.) while less numerous in existing genera and species than the hardwood deciduous trees, making up for it in a measure by their individual abundance, are of enormous antiquity, representatives of this group being present in the rocks of the most ancient deposits in which land plants have been found.

The Mesozoic age, mentioned above, was probably the scene of origin of the Angiosperms, which became abundant before its close. It is often referred to as the age of conifers (more properly gymnosperms) because of the abundance and variety of coniferous types at that time. Faunally it is known as the age of reptiles among vertebrates and the age of ammonites among invertebrates. The diagram shown on page 8 serves to graphically portray the various divisions into which geological time has been divided. In this diagram I have given the sub-divisions of the geological periods for the later ones only as those are the ones with which we are especially concerned in discussing the ancestors of our forest trees.

Continental outlines have changed greatly during the vast lapse of geologic time, but the student of modern floras need not concern himself with the earlier and more profound changes due to the past movements of the strand. Those changes in geography, topography and climate which have gone hand in hand with the development of the present flora of North America may be sketched in a few words and need not be carried back farther than the Mid-Cretaceous.

The Mid-Cretaceous shows in the character and distribution of its rocks that the continental outline of North America had assumed much its modern form except for the extension of the Gulf of Mexico over Texas and into Colorado and Kansas as is indicated upon the accompanying sketch map (fig. 1). The waters of the Pacific had submerged a narrow strip along the western coast and the Coast Range was not yet elevated. In marked contrast with modern conditions the present Rocky Mountain region was then one of low relief upon which were being deposited scattered fluviatile, lacustrine, swamp and terrestrial sediments.

As time passed both the Atlantic and more of the Pacific continental borders became submerged and the waters of the Gulf of Mexico passed northward over the present sites of the Great Plains and Rocky Mountains to become mingled with the waters of the Arctic Ocean which had advanced up the valley of the Mackenzie River, thus forming a vast but extremely shallow Mediterranean Sea and widely separating northeastern North America from the Pacific coast strip which was connected directly with Siberia across what is now Bering Sea. This stage in the history of North America is shown in the sketch map, figure 2.

The whole continent at that time was low and heavily wooded, and enjoyed an abundant rainfall throughout and a climate that was much more uniform than it is at the present time. There seems to have been a total absence of frost, and palms and figs were able to flourish far to the northward of the present international boundary. Naturally this flora was very different from that of today as it contained many elements which are now extinct as well as others which are no longer American, and a curious mixture of types

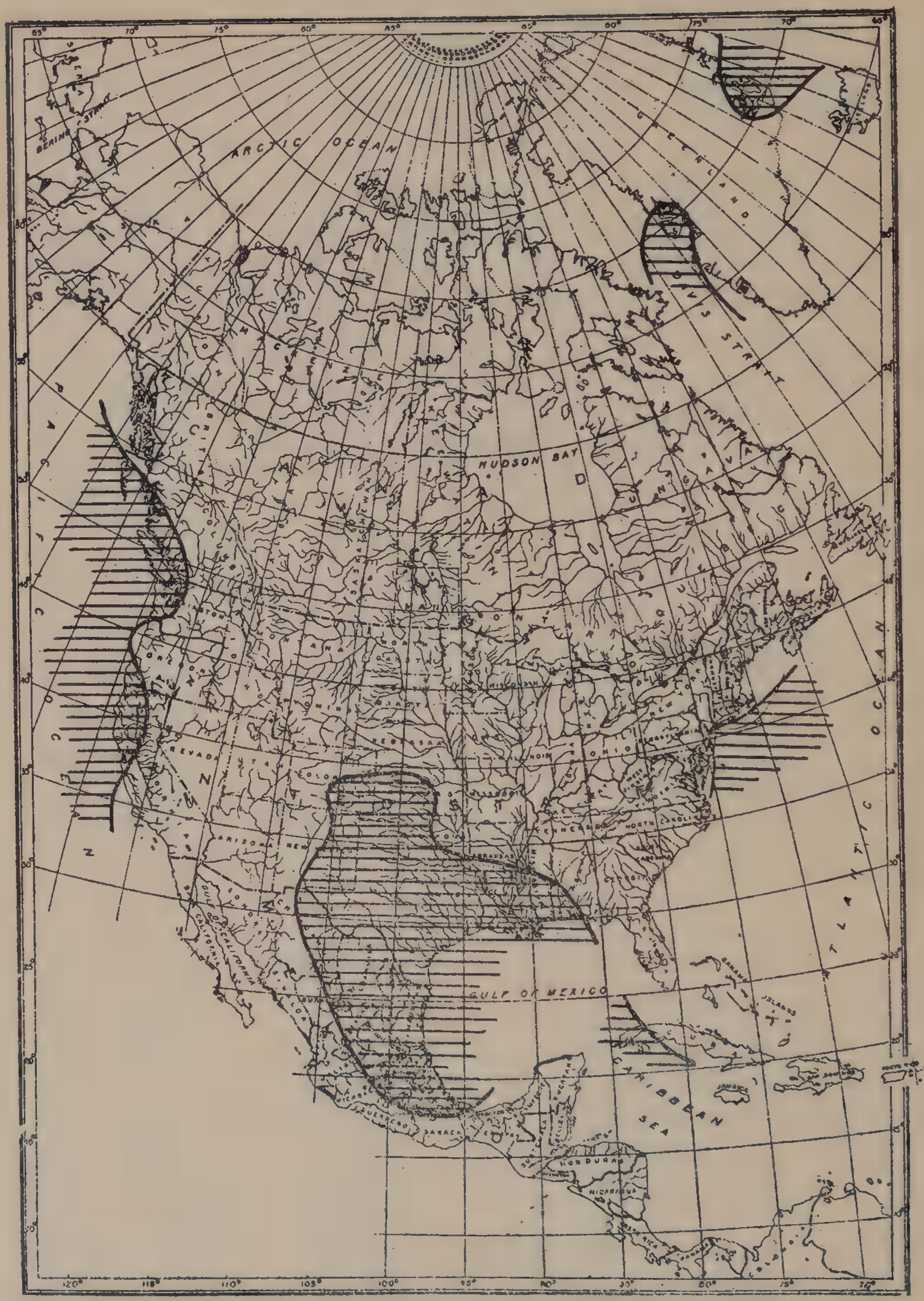

FIG. 1. MAP SHOWING THE EXTENT TO WHICH THE SEA ENCROACHED ON NORTH AMERICA IN THE EARLY UPPER CRETACEOUS

which subsequently became climatically segregated as the climates became less uniform.

At the time of which we are writing the sheep-berry and camphor tree, the willow and alligator pear, the oak and Sterculia (a tropical genus), the tulip-tree and the fig, the walnut and the palm, and many other types which we now regard as essentially tropical on the one hand or temperate on the other, flourished side by side. A somewhat analogous grouping of temperate and tropical forms occurs in certain modern forest such as those of southern Japan, New Zealand, southern Chile, etc., where warmer temperate areas by reason of the water vapor in the air and the heavy rainfall, have a more uniform climate than is normal to their latitude and support a vegetation of mixed types much like that of Upper Cretaceous times.

Some of the forms of the Rocky Mountain area Cretaceous flora such as the magnolia, sassafras, fig, persimmon and tulip-tree still flourish in other parts of the American continent, while others such as Araucaria, Dammara, and various Proteaceae and Myrtaceae once abundant throughout the Northern Hemisphere, became, with the lapse of time, gradually extinct except in certain isolated areas in the Southern Hemisphere. Many of these Cretaceous genera were more diversified than they are in the modern flora. Thus there were over ten species each of magnolia, sassafras and tulip-tree in this region at that time. Sequoia was also an abundant element throughout the Cretaceous and the greater part of the Tertiary period. Cretaceous fan palms, sometimes beautifully preserved, have been found in Wyoming, Colorado, Vancouver, New Jersey, Maryland, and elsewhere.

The fortunate discovery of extensive beds of fossil plants of this age along the west coast of Greenland in latitude 71° shows that much the same assemblage of plants grew in the far North at that time as are found in beds of this age along our Atlantic coast from Martha's Vineyard to Texas, and there are many additional facts pointing to the conclusion that there were no climatic or marine barriers between northeastern North America and Europe nor between northwestern North America and Asia. This leaves

FIG. 2. MAP SHOWING THE MAXIMUM EXTENT OF UPPER CRETACEOUS SEAS ON THE NORTH AMERICAN CONTINENT

us the choice of two areas as the place of origin of the flowering plants. These are the Arctic region, or the vast and geologically unknown Asiatic region.

As Upper Cretaceous times drew toward their close the continental seas became more restricted and the shores withdrew from positions indicated by the solid lines indicated on the accompanying map (fig. 2). At this time the Rocky Mountain region within the lined area on the map became a region of delta and coastal swamp deposits, which, as the shallow seas silted up or were drained, extended eastward until the whole of the present plains region was one of scattered swamps. This is why we now find the widespread and valuable lignitic coals throughout this area. These events brought to a close the last of the many marine submergences of the interior of North America. Henceforward the subsequent marine invasions of North America were strictly marginal and of relatively small and progressively decreasing extent.

With the geological changes which marked the close of the Cretaceous in North America and with the gradual elevation of the Rocky Mountains during the Tertiary a very different flora came to occupy the site of the old lowland warm temperate forest. This flora during the early Eocene was largely temperate in its character and appears to have invaded western North America from the north. Figs, magnolias and palms were still present in that region but in dwindling proportions and the forests contained very many species of cottonwood, sycamore, hazel, sheep-berry, etc. The coniferous trees Glyptostrobus, sequoia and the bald cypress (Taxodium) were present in abundance, and a curious feature was the presence of Ginkgo of which only a single Asiatic species survives in the modern flora.

Southeastern North America had, at this time, a much enlarged Gulf of Mexico as shown on the accompanying sketch map of the Eocene geography (fig. 3). The low shores of this primitive Gulf of Mexico were covered with a warm climate strand flora and contained but few representatives of our familiar trees. A great variety of tropical types had invaded that region from the south, many of which like the bread-fruit and Nipa palm are no longer found anywhere in the Western Hemisphere.

FIG. 3. MAP SHOWING THE MAXIMUM EXTENT OF EOCENE SEAS ON THE NORTH AMERICAN CONTINENT

Toward the close of the Eocene and in the early Oligocene the climate seems to have reached its maximum of warmth—the forests along the Gulf coast are sub-tropical, coral reefs are found in Georgia and temperate forests covered Alaska, Greenland and even the lands as far north as Spitzbergen. At this time there was again a free interchange of life, both animal and vegetable, between North America, Europe and Asia.

With the continued elevation of the Rocky Mountain region great changes in climatic conditions were brought about in the West and the plains type of country became developed over large areas. This was important since it represents the beginning of that cleavage between the modern Atlantic and the Pacific forest and general floral provinces which exhibit so many striking contrasts. The accompanying map (fig. 4) shows the extent of the Oligocene seas and the area of the plains country which was called into existence by the rising mountains which cut off the moisture laden winds from the Pacific and caused the forests to be gradually replaced by the prairies.

During the succeeding Miocene and Pliocene periods many identical trees persisted in the East and the West but they were effectually cut off from intercommunication except in the far North by the central arid region and each area has henceforward had a history entirely its own.

Fossil floras of these later Tertiary times are rather rare and are only found in local deposits in some favorably situated mountain lake basin or river flood plain or in the chance burial of drifted vegetable débris in the predominantly marine deposits of the continental borders. The most extensive of these local floras is that preserved at Florissant, Colorado, where successive showers of volcanic ashes have preserved remnants of a large lake and riverside upland flora. The climate appears to have been somewhat warmer than it is at the present time in the heart of the Rockies and this flora includes species of figs, magnolias, soapberry, persimmon, ailanthus, beech, elm, maple, locust and oak. Libocedrus or incense cedar is still present and the sequoia trunks which were silicified at the same time that the foliage was preserved in the

FIG. 4.. MAP SHOWING OLIGOCENE SEAS ON THE NORTH AMERICAN CONTINENT

lake laid volcanic ashes show that these Colorado sequoias rivalled in size the present big trees of California. Many additional genera testify to the changes that have taken place in the flora of the Rocky Mountain region since Miocene times.

A few Pliocene plants have been preserved in New Jersey and along the Gulf coast in Alabama. These show that the forests in those regions were much like they are today with some survivors from the older days that have since disappeared.

The Tertiary period was succeeded by the Quaternary period which corresponds roughly with what is called the Pleistocene and which in turn corresponds approximately to the glacial period or Ice Age. The Pleistocene is often divided into: (1) an earlier or preglacial stage which shows in general a mingling of warm temperate, and cool temperate forms; (2) a middle or glacial stage with alternating interglacial periods in some of which the climate was above the normal modern optimum for the same latitudes, and during which the biological record shows a succession of forest, field, barren ground, steppe, tundra, and arctic types in some more northern or montane regions; with increasing glaciation and the same succession in an inverse order with the retreat of the glaciers; and finally there is (3) the so-called postglacial, late or Upper Pleistocene stage which merges with the Recent, and during which our modern flora assumed its present distribution. The postglacial and Recent may be compared with the previous interglacial stages and there are many arguments in favor of considering that we are now living in a fourth interglacial period since the time that has elapsed since the last ice sheet covered northeastern North America is less than the duration of some of the previous interglacial periods.

Geologically the Pleistocene deposits are typically glacial in the north and in the more elevated mountainous regions, namely, boulder clay or drift, gravels, till, loess, peat bogs; and in the South, lake, river, eolian, swamp, cave and marine terrace deposits. In the North the floral record is still largely hidden in the for the most part unstudied peat bogs. Farther south it is furnished by the river clays and prehistoric cypress swamps.

A moment's reflection will convince the reader that an ice cap like that of modern Greenland with centers of radiation in Labrador, west of Hudson Bay and in the Cordilleras and extending southward to New Jersey and Kentucky was a most profound factor affecting the present flora of North America both as regards the present distribution, the extinction of old, and the evolution of new types. The effect of glaciation was even more marked in Europe than in America for in the former the mountain chains run in an east-west direction and with the Mediterranean, Black and Caspian seas effectually blocked the retreat of the flora to the southward. Hence there are many types of trees that are exclusively American and Asian in the existing flora that were common to Europe in pre-Pleistocene and a part of Pleistocene times. Some of these are the magnolia, locust, sassafras, bald cypress, black walnut, butternut, etc.

The accumulated data are quite insufficient to enable us to trace the waves of plant and animal life that swept back and forth across North America with the fluctuations of the climate. We know that the sweet birch and the larch got down into Georgia during an advance of the ice sheet and we have found spruce cones in the Pleistocene deposits at Chicago. We find the red bud, osage orange and other warm temperate types as far north as Toronto, Canada, during an interglacial period, and specimens of a fig in fruit has been found in interglacial deposits as far north as the Kootenai Valley in British Columbia. We have such facts as the presence of fossil wood of Pseudotsuga near Kansas City, Missouri, and the wood of the black spruce (*Picea mariana*) and the cones of the white spruce (*Picea canadensis*) beneath the drift of the Kansas ice sheet or second glacial advance in Iowa.

Away from the ice covered regions the climate was probably not severe and if there was any pronounced secular lowering of temperatures it appears to have been offset by increased humidity and the dense stands of timber in the lowlands. We infer this from the fact that in deposits of Pleistocene age in the region to the southward of the ice sheet scarcely ever do the fossil plants indicate any appreciable differences from present day temperatures.

It seems probable that the great majority of our arborescent flora or forest trees were already in existence before the close of the Pleistocene, if not in the preceding Pliocene, such changes as have occurred since that time relating almost entirely to their distribution.

The making available for occupation of large areas covered by the ice sheet or submerged along the continental border and the resulting complexity of glacial soils was doubtless a great stimulus to evolutionary activity, which was, however, confined almost entirely to the herbaceous vegetation.

In the preceding very brief sketch the aim has been to convey in a concrete manner the cardinal fact, often overlooked, that our present forest flora is but one of many that have flourished in this country and that its beginnings may be traced back several millions of years, rather than to present a detailed picture of the floral history of North America since the Cretaceous. No attempt has been made to make the following sketches exhaustive even for the forms that are discussed, and while the separate discussion of the different forest trees necessitates a certain amount of repetition this will serve to amplify and fix the facts of the foregoing brief outline of the later history of our continent and its relations to the other continents.

CHAPTER VI

The Present Forests of North America

The United States occupies the second place among the nations of the Northern Hemisphere in the extent of its forests, Russia having first rank and Canada third, so that North America as a whole probably ranks first in forest resources among the northern continents.

North America may be conveniently divided for a consideration of its forests into four major regions. These are: (1) A northern sub-Arctic region; (2) a temperate Atlantic region; (3) a temperate Pacific region, and (4) a Central American-Antillean region. Each of these regions naturally embrace a great variety of soils, climate and topography and consequently a variety of different forest associations. All become modified toward their limits and are not to be sharply bounded except by broad and gradually changing transition zones, but in their typical expression they are exceedingly well marked.

The Northern region is essentially a part of that Holarctic belt of vegetation that encircles the globe in the region bordering the Arctic tundra. In North America it constitutes a broad belt of sub-Arctic (Hudsonian) woodland extending from the tundra or northern limit of tree growth southward to a rather indefinite boundary at about latitude 53° and hence covering between 10° and 15° of latitude. It stretches across the continent from southern Labrador, south of Hudson Bay and then northwestward to within the Arctic Circle in the lower Mackenzie basin and in northern Alaska, reaching the Pacific at Cook Inlet.

This whole area receives an ample rainfall except toward its southwestern limits. It occupies throughout nearly its whole extent a glaciated area with innumerable lakes, streams, and extensive swamps, especially in the region between Hudson Bay and Lake Winnipeg, where the country is largely swampy with a tree growth of willows and tamarack. The topography and low mean temperatures serve to limit the number of arborescent species, which is also influenced by the character of the soil, and as the more northerly parts of the belt are reached the forests become more and more open and stunted until the black spruce becomes a shrub associated with dwarf willows and birches.

Floristically this northern region has been divided into the following four illy defined and not clearly marked districts: (1) The Labrador District; (2) the Hudson Bay District; (3) the Mackenzie District; and (4) the Alaska District. As regards the tree species these districts are not distinct for of the eight common types found in Labrador the following five range from the Atlantic to the Pacific: the white spruce (*Picea canadensis*), the black spruce (*Picea mariana*), the canoe birch (*Betula papyrifera*), the aspen (*Populus tremuloides*), the balsam poplar (*Populus balsamifera*). The tamarack (*Larix laricina*) ranges west as far as the Mackenzie River: the jack pine (*Pinus divaricata*) and the balsam fir (*Abies balsamea*) range west to the Mackenzie River and are replaced in Alaska by the lodgepole pine (*Pinus murrayana*) and the alpine fir (*Abies lasiocarpa*) respectively.

The forests show local variations from place to place dependent upon the temperature, altitude and soil. In general the stand becomes larger and closer southward and more open and stunted northward. For example in Labrador the forests are continuous in the southern part decreasing northward until at latitude 55° the trees are confined to lake margins and river valleys. Here black spruce is the most abundant tree and constitutes fully 90 per cent of the forest on sandy soils, both wet and dry, of the pre-Paleozoic area. The tamarack is always an inhabitant of cold swamps and in the region southwest of Hudson Bay tamarack swamps and willow thickets cover most of the country. The aspen is found on ridges of till in the east, it borders the northern extension of the prairie in Athabasca and on the plains along the Mackenzie River. The balsam poplar frequents the heavy clay soils in the wide valleys and river bottoms and tends to be run out in places by the white spruce which also clothes the low divides. The canoe birch forms glade thickets, and most of the bottom lands support thickets of shrubby willows (*Salix adenophylla, balsamifera, chlorophylla,* etc.). The treeless moors are characterized by dwarf willows (*Salix myrtilloides*) and dwarf birches (*Betula nana*) and by *Cassandra calyculata, Kalmia glauca, Ledum palustre,* etc. Although the forests of this northern region are of little economic importance at the present time in the thinly settled condition of most of this vast region they are destined to be of incalculable value for fuel and domestic construction and probably for pulpwood, mine props and other purposes when the country shall have become opened up and more thickly settled.

THE ATLANTIC REGION

The Atlantic region comprises that part of North America extending from about latitude 53° north southward to the Gulf of Mexico and from the Atlantic seaboard westward to the prairie country of the Mississippi valley, or to about the 95th meridian. This region includes a very great variety of topography, climate, and soils, covering as it does more than 40° of longitude and more than 25° of latitude. Along its northern margin the transition to the sub-Arctic region is fairly well marked, but the western boundary is to be found somewhere in the transition zone from forest to prairie—grass lands extending far to the east in Illinois and the eastern forest extending long distances to the west along the valleys of the principal streams of the prairie states.

Physiographically this vast area includes the Laurentian Upland, the Atlantic Plain, the Appalachian Highlands, the Interior Low Plateau, and parts of the Central Lowlands and the Interior Highlands (Ozark and Ouchita).[1] The Atlantic region may, however, be divided into three areas which are fairly well marked by the character of the woodland. These are: (1) the Northern Evergreen Coniferous forest; (2) the Deciduous or Hardwood forest,

[1] The terminology is that of the Committee of the Association of American Geographers. Fenneman, N. M., Annals Assn. Am. Geog., vol. 6, pp. 19–98, 1917.

and (3) the Southeastern Evergreen Coniferous forest. The character of the topography, soils and climate as well as the geological history of the forests have resulted in interfingered areas and outliers of one type within the area of another, and their boundaries are in most cases covered by a broad transition zone between forest and prairie or between evergreen needle leaved and broad leaved deciduous forest.[2]

The Northern Evergreen Coniferous forest extends from Newfoundland west to the 96th meridian, and from James Bay southward beyond the Great Lakes. On the east its southern limits include most of Maine and areas in New Hampshire, Vermont and New York, with a southern extension along the higher Appalachian ridges to West Virginia, and isolated patches to the southward along these mountains in the Great Smoky Mountain region along the North Carolina-Tennessee boundary.

In its typical development this forest is characterized by pure or nearly pure stands of needle leaved conifers among which the white pine (*Pinus strobus*) is the most important if not the most widely distributed tree. Virgin stands range 60 to 125 feet in height and vary from heavy stands with a shaded floor almost devoid of undergrowth to more open stands with an undergrowth of deciduous under-trees and shrubs. Nearly pure stands of the black spruce are also important features of this region, especially toward the north.

Within this area the hemlock (*Tsuga canadensis*), the arbor vitae (*Thuja occidentalis*) the basswood (*Tilia americana*), the black ash (*Fraxinus nigra*), the white ash (*Fraxinus americana*), the sugar maple (*Acer saccharum*) and several species of birch (*Betula*) and elm (*Ulmus*) reach their northern limits and the center of their maximum distribution. The hickories and oaks, so characteristic of the deciduous forests of the Atlantic region, reach their northern limits of distribution in this area of Northern Evergreen Coniferous forest as do the chestnut (*Castanea dentata*), the hornbeam (*Ostrya virginiana*), the sassafras (*Sassafras sassafras*), the

[2] See Shreve, F., A Map of the Vegetation of the United States. Geographical Review, vol. 3, pp. 119–125, pl. 3, 1917.

tulip-tree (*Liriodendron tulipifera*), the cucumber-tree (*Magnolia acuminata*), the red cedar (*Juniperus virginiana*), the black gum (*Nyssa sylvatica*), the sycamore (*Platanus occidentalis*), the witch hazel (*Hamamelis virginiana*), the beech (*Fagus atropunicea*), and other important deciduous tree species.

Commercially this region has been the scene of very extensive lumbering operations and its advantageous situation enable it to still furnish an enormous annual production.

THE DECIDUOUS FOREST

The Deciduous or Hardwood forest area of the Atlantic region extends with varying elements from southern Maine and northern New York to Texas, and from about the fall-line of the South Atlantic Coastal Plain inland across the uplands to the Ohio and the lower Mississippi drainage basins, the western limit being determined by the lessened rainfall, the former prevalence of forest fires, the force of the winds and the difficulty of regaining a foothold in the compactly sodded prairie region where the geological record shows that a similar forest once held undisputed sway. This western boundary is essentially a broad transition zone, the woodland becoming more and more open and finally becoming restricted to the river bottoms. The extreme western boundary runs through the eastern Dakotas, Nebraska, Kansas, etc., but the actual boundary of the forested area where the woodland covers more than 20 per cent of the area extends from the southern end of Lake Michigan, across southern Illinois, southeastern Missouri and includes parts of Arkansas, Oklahoma and Texas. Toward both its northern and its southern limits the Deciduous forest is bordered by a transition zone of mixed deciduous and coniferous trees.

In typical stands the Deciduous forest comprises broad leaved species of oaks, hickories, walnuts, ashes, maples, magnolias, cherry, tulip-tree, sycamore, beech, linn, chestnut, etc. On the slopes of the southern Appalachians, in the valley of the lower Ohio and in the valley of the lower Red River, these deciduous types attain their greatest variety as well as their maximum development.

Outliers of the deciduous forest occur on the Michigan peninsulas. The southern boundary extending from North Carolina to Mississippi and reappearing west of the river of that name in Arkansas, Louisiana and Texas, passes gradually into a transition zone where there is a nearly equal commingling of the deciduous and the evergreen species of the adjacent regions. Locally, as determined by soil conditions, nearly pure stands of one of the other will dominate. The commonest conifers in such situations are the loblolly pine (*Pinus taeda*) or scrub pine (*Pinus echinata*) while the most common deciduous species are the post oak (*Quercus minor*), the spanish oak (*Quercus digitata*) and the blue jack oak (*Quercus brevifolia*).

The southeastern Evergreen Coniferous forest extends from the mouth of the Chesapeake Bay southward along the Coastal Plain of the Atlantic and Gulf states in a belt from 100 to 200 miles in width until it is interrupted by the bottom lands of the Mississippi River, reappearing in Louisiana and southeastern Texas. Outside the river bottoms with their variety of deciduous species this belt is characterized by the extensive areas of nearly pure but open stands of the long leaf pine (*Pinus palustris*) or the cuban pine (*Pinus caribaea*). The coastal margin is characterized by the live oak, the sand pine, the palmetto, etc., while the bottoms and shallow ponds contain various gums, hickories, water oaks, ashes and the sycamore and bald cypress—the latter and the long leaf pine being undoubtedly the most valuable commercially.

THE PACIFIC REGION

The Pacific forest region may be considered as comprising all of western North America between the Rocky Mountain front and the Pacific coast. This is a vast area and one containing an unusual variety of topography, climate and soils. The major influence that has determined the presence or the absence and the relative density of tree growth is the peculiar distribution of the climate as expressed more especially in the rainfall. The northwest coast from northern California northward is a region of very heavy rainfall and consequently it has a dense forest cover of large evergreen conifers. Along the coast to the southward the rainfall decreases progressively until in southern California land temperatures so far exceed ocean temperatures that more or less of the year is without precipitation. The north and south trend of the mountain ranges govern the rainfall of the interior, consequently a large part of the country except the higher chains are entirely or nearly rainless. Woodlands are consequently confined to the flanks and summits of the mountains. The resulting effects upon the vegetation are succinctly summarized in Shreve's (op. cit.) segregation of these arid or semi-arid areas into seven units. These are: (1) The California Desert—a region of low and open small leaved shrubs like the creosote bush (Covillea); (2) the Great Basin Desert—a region of stunted shrubs, among which the dominant plant is the sage bush (Artemisia); (3) the Arizona Desert—a region of mixed small leaved shrubs such as the creosote bush, and the palo verde (Parkinsonia), succulent stemmed cacti, such as Carnegiea and Opuntia; (4) the Texas Desert of mixed small leaved shrubs and succulent or semi-succulents such as Agave, Dasylirion and Yucca; (5) the California semi-desert, a region of great diversity, ranging from open woodland, chiefly evergreen oaks, through chaparral to true desert; (6) the Texas semi-desert, a region of interspersed grassland and scrub made up largely of mesquite (Prosopis) with some succulents; (7) desert to Grassland Transition, a region of grassland with ephemeral or root perennial herbs and more or less succulent or semi-succulent types.

The forests, as distinct from the vegetation areas, are considered by Sargent[3] to be separable into three regions which he terms: (1) The Coast forest; (2) the Interior forest; and (3) the Mexican forest.

The Coast forest is the heaviest, although not the most varied, forest on the continent. It extends along the coast from about latitude 60° to about latitude 40°, ranging eastward at the International boundary following the eastward extension of heavy rain-

[3] Sargent, C. S., Forest Trees of North America. Tenth Census, vol. 9, 1884. This author's fourth category, the Northern forest, has already been discussed as the western part of the sub-Arctic forest.

fall over the Gold, Selkirk, Coeur d'Alene, Bitter Root and other interior ranges. It consists largely of a few coniferous species and nowhere do broad leaved deciduous trees form extensive stands as they do in the Atlantic region. The latter are generally confined to the stream valleys and are of slight importance from the viewpoint of the timber industries. Towards the north the yellow cedar (*Chamaecyparis nootkatensis*), the Sitka spruce (*Picea stichensis*) and the hemlock (*Tsuga heterophylla*) are the most important trees. To the southward more southern forms gradually assume a predominance.

The "red fir" (*Pseudotsuga nobilis* and *magnifica*) is the prevailing tree in the vicinity of Puget Sound and southward in Washington and Oregon. The "red cedar" (*Thuja plicata*), white fir (*Abies grandis*), mountain hemlock (*Tsuga pattoniana*) and red wood (*Sequoia sempervirens*) are also abundant and of large size. The river bottoms contain heavy growths of maple, cottonwood, ash, etc., and the narrower interior valleys an open growth of oak. Farther south the sugar pine (*Pinus lambertiana*), Libocedrus and *Chamaecyparis lawsoniana* add variety and value to the Coast forest, while along the California coast between the summit of the Coast Range and the ocean and extending to latitude 37°, the redwood is the predominant tree. Here several species of singularly restricted distribution are represented (*Cupressus macrocarpa*, *Pinus radiata*, *Abies venusta*, *Pinus torreyana*, *Tumion californicum*, etc.).

South of the 35th parallel the increasingly arid climate checks the coast forest and the scanty woodland of the higher elevations of the Coast Range farther south are of the Sierra rather than the Coast type. A dense forest covers the western slopes of the Sierra Nevada. The characteristic species are the sugar pine, yellow pine, red fir, Abies, Libocedrus, the giant Sequoia, with valley forests of scattered oaks. The eastern slopes are characterized by a variety of large and valuable pines.

The Interior forest extends from the sub-Arctic forest region of the north southward into Mexico, and is confined to the slopes and canons of the numerous mountain ranges—the valleys except for the immediate river bottoms are practically treeless. These forests are destitute of variety and for the most part stunted. They are characterized by cottonwood (Populus), nut pine (*Pinus edulis*), white fir (*Abies concolor*), lodgepole pine (*Pinus murrayana*), various spruces (*Picea Engelmanni* and *parryana*), etc.

The greater part of Mexico, including Baja or Southern California, is occupied by vegetational areas which are the southward continuation of those of the southwestern United States. Nowhere down to latitude 22° can the term forest be applied to the plant cover except in the higher elevations of the Eastern and Western Sierra Madre that bound the Anahuac Desert Plateau. Above 7000 feet there are open pine forests (*Pinus arizonica, chihuahuana, microphylla, cembroides*) and clumps of scrub oak (*Quercus gisea* etc.), with aspens and a few broad leaved temperate types. At about latitude 23° the broken transverse volcanic chains of high mountains strike at almost right angles to the trends of the Sierra Madre. This is the region termed volcanic by Thayer[4] and United Cordilleran by Harshberger. The higher elevations are covered with open pine forests and the subordinate slopes by oak forests with a mixture of other broad leaved temperate types and some stragglers from the tropical forests to the southward. The Gulf Coastal Plain, more or less covered with chaparral in its northern extent passes gradually into a typical tropical forest toward the south, while on the West Coast the Jaliscan Coastal Plain furnishes wild figs and Taxodium in the bottoms and chaparral on the divides, with open growths of oak and pine at higher elevations.

CENTRAL AMERICAN ANTILLEAN REGION

This is somewhat of a composite of insular and continental areas with typical tropical lowland forests and with a few representatives of temperate types in the higher uplands. It cannot be properly described without going into more detail than is warranted in the present connection, and while it is a region of surpassing

[4] Thayer, Physiographic Provinces of Mexico. Jour. Geol., vol. 24, pp. 61–94, 1915. Harshberger, J. W., Phytogeographic Survey of North America, 1911.

interest both in regard to its present botanical features and their bearing on the geologic history of the North American flora, these problems do not enter to any large degree into a discussion of the particular forest trees considered in the present work.

This region comprises tropical North America which includes all of Central America; the Antilles, Bahamas and Bermudas; and the narrow Atlantic and Pacific Coastal plains of Mexico. Practically the only types of this region that reach the United States are found in the narrow strips along the coast and keys of peninsular Florida which extend northward to about Cape Malabar on the East Coast and to Tampa Bay on the West Coast. This flora is rich in composition but is here of slight economic importance. Some of the sub-tropical forms do not reach these limits and others extend a degree or two farther north. Among the more important trees are the royal palm, mahogany, sea grape, Jamaica dogwood, machineel, mangrove, etc.

Throughout the Bahamas and Bermudas true forests are absent and are replaced by coppice growths of a variety of tropical species. The larger islands of the Antilles, at one time probably largely in forest, have suffered greatly from agricultural encroachments, and former primitive practices of making new clearings every few years, which, combined with charcoal burning and the general failure to regard the forests as anything but an enemy of man, have resulted in limiting the forest to the more inaccessible or less readily cultivated parts of the islands, as is conspicuously the case in Porto Rico. In Cuba the largest of the Antilles, savannas alternate with open forests of Ceiba, Bursera, Spondias, Cedrela, Swietenia Pithecolobium, Lysiloma, Lonchocarpus, and many other tropical species. Tropical jungle or rain forest is less extensive than on the mainland, but is more or less developed on all of the larger islands.

Central America may be divided into three principal botanical regions although the general type of the forests, disregarding individual elements, is much the same throughout and has been similarly more or less marred by primitive agriculture dating back to a time remote enough to permit so-called virgin forests to cover its sites, and modified by the great extension of organized cultivation of bananas, cane, coffee, rubber, citrus fruits, etc.

These three regions are the Costa Rican, Guatemalan and South Mexican Gulf regions. The Costa Rican region comprises Panama, Costa Rica and southern Nicaragua. Vast and dense tropical rain forests or impenetrable jungles once covered the Atlantic watershed, which includes most of the area since the divide is near the Pacific coast. Many South American types are present, as for example, Podocarpus (*taxifolia* and *salicifolia*) which replaces the pines of the mountains of Guatemala. Oaks are still abundant above 7000 feet, but most of the North American broad leaved types that are represented reach their southern limits in Costa Rica. The rain forest is dense and almost infinitely varied—the trees with buttressed roots, the undergrowth thick, and a great variety of lianas and epiphytes. Some of the commoner trees are Ceiba, Hura, Cedrela, Haematoxylon, Erythrina, Guaiacum, Castilloa, Achras, Pithecolobium, Leucaena, Inga, Ficus, etc., with a great variety of palms.

The Guatemalan region, which includes the state of Chiapas (Mexico), Honduras, Salvador, Guatemala, and northern Nicaragua, is similar to the preceding except that the oaks are more abundant in the uplands and pines replace the podocarps. The rain forest, rich in species and with a great diversity of palms, contains many valuable species destined at some time to be of much more commercial value than has as yet been realized. The northward extension of this forested area along the Gulf coast of Mexico reaches to about Tuxpan, and it is practically identical in character with that of the lands farther south. The climate is hot and wet, the vegetation evergreen and dense. The mangrove swamps of the lagoons are replaced inland by the jungle except where it has made way for banana, cane, rubber, mango, and other cultivated crops. This is the center of the vanilla industry. Above 2000 feet small oaks appear, becoming more prominent with increasing altitude until at about 6000 feet evergreen oak forests with a tropical undergrowth are typical. At about this elevation pines mingle with the oaks and above 7000 feet the pines predominate.

CHAPTER VII

The Sequoias or Big Trees

"A living thing,
Produced too slowly ever to decay,
Of form and aspect too magnificent
To be destroyed."

—Wordsworth.

It is most fitting to commence these sketches of tree ancestors with an account of the sequoia which has the most ancient lineage of any of the trees described in the following pages. In the days when the world was considered to be only about six thousand years old and when the few known fossils were thought to be the visible evidence of Noah's flood, as was first suggested by Martin Luther, it was scarcely remarkable that no one was interested in tree ancestors. In fact there were no such things as ancestors for an anthropomorphic deity had supplied them ready made for the Garden of Eden, and each had produced according to its kind from that delightful time with only this by no means trifling and wholly unexplained exception that there had been no weeds or harmful trees until Adam's fall at which time all nature fell and the forest trees which formerly had all produced delightful fruits changed their nature and now yielded worthless or poisonous fruits, thistles and all the hosts of agricultural pests were born and man has since been born to trouble as the sparks fly upward—the words are those of Job.

In modern days with the passing of most of the virgin forests of the temperate zones, and the great interest in preserving some of our threatened trees such as the sequoia, black walnut, long leaf and white pine, from total extermination, it is a matter of surprise that the thought that these noble races of plants had ancestors and a partly known genealogy is but rarely entertained.

Tree genealogies it is true present little of the dramatic as compared with the wonderful evolutionary tree of the elephants, horses or camels, and yet most of our familiar forest trees are of more ancient lineage, and some, such as the sequoia, go back almost to the dawn of the tiny original progenitors of the warm blooded animals. Although the book of the future is tightly sealed that of the past needs but understanding wedded to imagination to be legible, even though its torn pages are the rocks of the earth's crust. The chapters of this great book of history where the records of the sequoia occur are those chapters, pages upon pages of heaped up shales, sandstones and swamp deposits, commencing with late

Fig. 5. Cone-bearing Twig of the Big Tree of the Sierra Nevadas (About ⅔ Natural Size)

Jurassic time and continuing down the ages to the present. The entries of the sequoia ancestry comprise innumerable leafy twigs, many cones, fragments of wood, sometimes seeds, and occasionally, as in Yellowstone Park and at Florissant, Colorado, mighty silicified trunks, buried by tremendous showers of volcanic ashes and petrified in successive upright layers into forests of stone.

Sequoia remains resist decay admirably, probably because of the great amount of tannin that they contain, so that their chances of preservation as fossils in the rocks are much better than the average run of plants. The cones, especially, are very common in the geological record, and one of the common methods of preservation is as ferruginized mud casts, that is the fine mud penetrated and completely surrounded the axis and scales of the cone, the chemistry of slow decay caused an impregnation of salts of iron thus rendering the cones more resistant than the matrix. I have collected such cones from the Lower Cretaceous of Maryland, from the Upper Cretaceous of Kansas and from the early Tertiary of Dakota. Such cones almost exactly like those of the existing redwood can be found in abundance in the coulees of the present arid badlands of western Dakota where they have weathered out of the surrounding rocks and where their presence indicates a very different environment and climate once where now the dry farmer faces often heart breaking failure.

The big trees, as both of our sequoias deserve to be called, have furnished a theme for song and story and have been a Mecca for the tourist for so long a time that any remarks regarding the size or longevity of the far famed trees of Mariposa and Calaveras may seem trite. Their present isolation—for they are but few in number and do not seem to be holding their own in the struggle with nature and the cupidity of civilization—but adds to their majestic grandeur.

To the traveller who journeys to California and for the first time stands in their mighty presence many questions may suggest themselves—the number is the I.Q. of our civilization. How long has it taken these giants of the forest to reach up some 400 feet above mother earth? Were they created thus? Were they just entering upon a career when the red-man's fire or the pale-face's ax checked them, or are they the survivors of a long existing line, struggling to maintain themselves in their last mountain stronghold?

The records of their descent are locked up in the rocks and clays of the world, bits of branches, cones and pieces of wood that floated down to the ancient seas and were entombed in the sand and mud, to become preserved as fossils for the edification of later ages. Exploration has unearthed a part of this record. Sequoia remains have been found at almost every locality where later Mesozoic fossil plants have been discovered. This is especially true of the tiny cones, in fact the fossil cones of the sequoia were described in Europe away back in the first quarter of the nineteenth century, before the big trees of California had been discovered or described.

The book of life which is the sedimentary rocks teaches us that death has played sad havoc in their noble line and almost entirely swept away their principality. Some have been dead about seven million years, with thousands of feet of rock lying vertically over their graves. Everywhere over the broad land areas of the Northern Hemisphere they are seen to have been replaced by other races. But before turning to their ancestors let us take a glance at the surviving heirs—the living trees.

Their scientific name was formed from Sequoiah, the inventor of the Cherokee alphabet. Popularly they are known as THE big trees. There two species—the real giant, *Sequoia washingtoniana*, sometimes called *Sequoia gigantea*, and sometimes *Sequoia wellingtonia*, although the first name is the most appropriate for what John Muir called "Nature's forest masterpiece;" and the redwood, *Sequoia sempervirens*. Barring the technical features which amply distinguish the two they are superficially very similar, the second seeming merely a slightly smaller edition of the first. Both are evergreen with small leaves and small cones; columnar massive trunks, buttressed below, and covered with a great thickness of reddish fibrous bark—that of the redwood being a cinnamon red and that of the big tree somewhat lighter in color. Both are cultivated as ornamental trees in temperate countries, especially in central and southern Europe.

The redwood occasionally occurs as pure stands on protected flats and terraces along streams, in sheltered moist coastal plains from southern Oregon to Monterey County, California, near the Pacific coast. More often it is found scattered among Douglas fir, tanbark oak, and other species. It is closely confined to the humid regions subject to frequent and heavy sea fogs. Like its elder brother it is not at all tolerant of shade. The redwood produces a normal number of seeds but foresters have found that less than a fourth of these seeds are viable (or will sprout in other words). It makes up in a measure for this lack of seed vitality by sprouting rapidly and abundantly from either old or young stumps, or wind broken tops—a habit almost unique among conifers. The height of large redwoods ranges from 200 to 350 feet in exceptional cases. The average is less, and the usual trunk diameter of large trees is 10 to 15 feet, although widths of as much as 28 feet have been recorded. Little is known of its longevity. A large tree whose rings were counted by the Forest Service showed 1373 which are quite likely to represent annual rings in a region of rainy winters and dry summers.

The leaves are flat and two ranked on the twigs, not unlike those of the bald cypress of our eastern swamps but stiffer and decurrent at their bases. The wood is heavier than that of its brother the big tree, very soft, moderately fine grained, exceedingly brittle, and a purplish clear red-brown in color. It is of great commercial importance because of its ease of working, its very great durability and the large sizes of clear wood obtainable, so that the redwood no less than its brother is in great need of official protection to prevent its being lumbered entirely off of the face of the earth, and there is a rising volume of popular protest against its destruction.

The big tree is much more limited in individuals and in range than the redwood, occurring only as scattered groves on the western slopes of the Sierra Nevadas from southern Placer to Tulare county, California, generally at elevations of from 5000 to 8500 feet in the Sierra fog belt. The leaves are more needle-like and less spreading than those of the redwood, running round the twig and not arranged in two apparent rows on opposite sides. The cones are slightly larger, but still tiny for so great a tree. The dimensions of the big trees are popularly much overestimated. Usually, mature trees average about 275 to 300 feet tall and with a trunk diameter of about 20 feet. Occasionally they reach heights 50 to 75 feet greater and diameters of 35 feet. They are therefore normally about 75 feet taller than the average old redwood, and with a trunk almost twice as massive. The big tree produce abundant seed at short intervals interspersed with especially heavy seed years. The seeds, unlike those of the redwood, possess great vitality, and being small, slightly winged and formed high in the air, they are widely scattered by the wind in the late fall and early winter, and grow rapidly the following season if they happen to

Fig. 6. Cone-bearing Twig of the Modern Redwood (About ⅔ Natural Size)

have fallen in cleared areas with full light, where they may reach a height of six feet in as many years. It may be noted that the big trees live in a cooler, drier habitat than does the redwood and in a temperature ranging in its extremes from $-12°$ to $100°$ Fahrenheit, so little that is precise can be deduced with respect to the geological climates that fossil sequoias indicate.

The wood is a brilliant rose-purple red when first cut becoming somewhat duller later. It is very light and brittle, coarse for the first four or five hundred years of early more rapid growth, becoming somewhat finer grained with age. It and the bark, which is enormously thick, contain very large amounts of tannin, which explains why prostrate trunks will lie on the ground for centuries without decay affecting anything but the sapwood, and I have already called attention to this imperishability as a factor in fossilization. The wood is much sought after by lumbermen, passing in the market as "redwood," although lighter and more brittle. In fact the big tree wood is so brittle and the tree so large that when it goes down its enormous weight often almost completely demolishes it. According to the records of the forestry bureau in no case is more than 25 to 30 per cent of saw timber obtained, so that lumbering it is not only a crime against civilization but wanton wastefulness.

Fortunately some of the groves are on reservations and receive protection, but constant vigilance of patriotic citizens is reguired, since as recently as the 1922 congress, a bill ostensibly to bring more areas of big trees under government control by changing the boundaries of the big tree park, has been attacked as a gerrymander to make available for lumbering some choice protected groves while adding areas of no or few trees to the reservation. This is denied, however, and must be viewed with due reservation.

Huge as the big trees are, their size is less wonderful than their longevity. Under a thousand years of age they are youngsters. Huntington counted the rings of 79 that were over two thousand years old and 4 that were over three thousand. Estimates of the still standing giants place the age of some of them at from four to five thousand years, but Sudworth states that it is doubtful if any of the standing trees are over four thousand years old. The only good that has come out of lumbering the big trees has been the opportunity it has given scientists of measuring the annual rings and thus getting a climatic record of local accuracy covering a two to three thousand year period—the thickness of the annual ring being directly related to the amount of precipitation and humidity.

Huntington, who has made climatic studies in both hemispheres asserts that he can see the cause of the famine in the days of Elijah; the good crops of Mediterranean countries at the time of Christ; the long period of drought which stimulated the Arabs, unified by Mohammedanism, to overrun their former limits; and many other historic events of the Old World, in the climatic curve made by measuring the sequoia rings.

Year after year the sequoias have been adding layer after layer to their girth in ever widening circles. The thousands of tons of bark shed by each tree during its long career; the tens and hundreds of thousands of tons of sap that have coursed through their venerable trunks; and the innumerable progeny of a single tree in the older more propitious days—a contemplation of these questions assists us in realizing the true proportions of these forest monarchs. Imagination, however, falls short in its attempt to picture the exquisite beauty of the virgin forest, standing age after age in all its unsullied glory—a veritable forest primeval.

Some of the California trees were still in their youth and others were approaching middle age when the various hordes of barbarians overran Europe. They had almost reached their full growth at the time of the War of the Roses and the discovery of America. They had reached their present height and girth and ripe old age before modern science had commenced its renaissance; in fact every avenue of human endeavor—social, religious, industrial and intellectual—has shown its most marvellous progress during the time that it has taken the sequoias to add but a few feet to their already giant frames.

Turning now to the ancestral line of the sequoias and to the more genial days of long ago when they were not restricted to a small area in a single state but ranged over at least four continents, it may be noted that the earliest positively identified sequoia that is known was found a few years ago in the upper Jurassic of France, in the deposits of which age it is represented by characteristic cones. When we say that sequoias flourished in the upper Jurassic we have a dim idea that they must be a pretty old type and that, although compared to the most ancient known rocks the Jurassic rocks are mere infants, still the Jurassic age came to a close several million years ago. But we can no more form a concept of the duration of several million years than we can of astronomical distances, and it is only by glancing at the progress of life on the globe during all those years that we get any sort of an idea of the remoteness of the Jurassic period.

Could imagination transport us to Jurassic times and set us down near the mouth of where the Hudson now flows, we should find little that was familiar in either the fauna or the flora. The sediments which now exist as the red sandstones and shales of the Connecticut valley and New Jersey had already been deposited. Volcanic activity had been considerable and vast quantities of molted rock had been forced through the outer crust of the earth, forming, among others, the Orange Mountains of New Jersey and the noble line of Palisades along the Hudson. However, it is quite probable that one would have been as little disturbed by earthquakes seven or eight million years ago than are the inhabitants of New Jersey at the present time by the sinking of their eastern coast. Events moved with inconceivable slowness then as now. Our Jurassic sojourner would have found everything strange. In the marshes flourished great ferns competing with an amazing variety of forms known as cycads—curious and ancient plants of which the commonly cultivated sago palm is a familiar example. In the dryer areas, along with the majority of the cycads there flouirshed the numerous ancestors of the ginkgo, the maiden-hair tree, that unique relic of bygone days, which has been saved from extinction in modern times by the loving care of the priests about the temples of China and Japan.

There were apparently no representatives of those plants which are dominant in the world today—the flowering plants or angiosperms as they are called. Ancient lung-fishes, gar pikes and crocodiles haunted the rivers. At sea were swarms of sharks and ganoid fishes. Bat-like flying reptiles were the common denizens, no true birds being known from North America at this early date, although the lizard tailed bird or Archaeopteryx the missing link between birds and reptiles haunted the reefs of Solnhofen in Bavaria at this time. Somewhat later we find the curious toothed birds of western North America. Sea-inhabiting reptiles of gigantic size, long necked, sea serpent-like plesiosaurs and dolphin-like ichthyosaurs, land inhabiting dinosaurs (the name means terrible lizard) of immense size and bizarre form were the dominant creatures, while the noble class of mammals with man at their summit was still but a promise and, so far as the fossils indicate, represented by only a few forms of mouse-like size. The continents had not yet assumed their modern forms. Such great mountain chains as the Andes, Alps, Himalayas and Rockies had not been elevated; and yet the sequoia flourished and its cones then were not very different from those grown in California at the present time.

The next succeeding geological period, the Cretaceous, continued to be the age of gigantic reptiles. Occasional bones and teeth of these and other related creatures are found in the marl beds that were deposited in the shallow seas along the eastern coast of those days, and still more are found in the chalky deposits of the Cretaceous sea which then covered our great plains country. The Mississippi valley was a part of a great gulf that extended northward from the present Gulf of Mexico almost to the Arctic Circle, and which was a veritable summer sea, peopled with gigantic sea-lizards, mosasaurs, and with a host of strange forms. Flying reptiles with a spread of fifteen to twenty feet circled overhead.

The vegetation, however, particularly during Upper Cretaceous times began to assume a more modern aspect and we find along with ancient types of ferns, broad leafed conifers and juniper-like evergreens, numerous leaves of willows, figs, magnolias and sassafras. The earliest known palms as well as the first leaves of many of our modern hardwoods date from this time. The Cretaceous clays that skirt Raritan Bay in New Jersey abound with these layers of leaves, as do also the Dakota sandstone of the middle west. The fine sequoia with the large cone and needle-like curved leaves figured is from clays near Cliffwood, New Jersey, where the twigs are among the most abundant fossils, looking like elegant lithographs against the background of dove-colored clay. This species, which is known as *Sequoia Reichenbachi*, had cones almost exactly like those of the living California big tree, and the foliage was somewhat similar. It was a very wideranging form both in this country and Europe, and is considered to have been the source, in part at least, of the amber which is so common in the Cretaceous of the Atlantic Coastal Plain.

A number of other fossil species of sequoia show an equally wide range. One of these has an appearance so much like its descendent the existing redwood that I have not figured the fossil, which is

FIG. 7. CONE-BEARING TWIG OF A WIDESPREAD CRETACEOUS BIG TREE, SEQUOIA REICHENBACHI (ABOUT ½ NATURAL SIZE)

known as *Sequoia Langsdorfii*. Its leafy two-ranked twigs and small cones have been found almost everywhere throughout the Northern Hemisphere where plants beds occur, and it ranges pretty well through Tertiary time, its range, both chronologically and geographically being greater than that of any other known sequoia. Another very abundant Tertiary form, also widely spread is *Sequoia Couttsii*, which is shown in the accompanying illustration. It is of especial interest because of its peculiar foliage, and also from the fact that only recently has it been definitely proved to be a true sequoia in the face of considerable botanical differences of opinion.

During the three to five million years of Cretaceous time the sequoias had flourished and become widespread. They saw many changes taking place in the world about them. Beneath their shade new races were springing up; the plants of a modern type which were destined to replace all others in the struggle for existence had obtained their start; animals gamboled about their

Fig. 8. Cone-bearing Branch of a Common Miocene Big Tree, Sequoia Coutsii (About ½ Natural Size)

trunks or climbed in their branches that were destined to replace the unintelligent and clumsy reptiles and bye and bye to give rise to the horses, dogs and cats of a later day, and finally to produce that animal which was to attain universal distribution, and to be the destroyer of countless other species—man.

Remains of sequoias from the lower beds of the Cretaceous have been found in western Europe, in Spitzbergen, in Texas and in the eastern United States. In slightly more recent deposits we find them in Greenland, Canada, in the Black Hills and in Montana. By the middle of the Cretaceous we find over a dozen different species spread over the United States, with still others in Greenland and in central and western Europe. Their remains are often extremely common, whole branches bearing numerous cones, and innumerable twigs, often beautifully preserved, being common fossils. The warm humid climate of the period seems to have been very favorable for their development, and the elevation of the land, by which natural bridges, such as those closing Bering Straits and the English Channel, enabled them to spread all over the northern hemisphere and even into the southern, for in the next age, the Eocene, we find their remains in far-off Australia and New Zealand,[1] while others occur in Alaska, stragglers from the migration into Asia.

The great frozen north of today had not yet been hinted at, a warm climate prevailed even in the far north, and Greenland was the garden spot that its name implies. On its western coast many plant-beds have been discovered, containing the remains of tree-ferns, cycads, incense cedars, figs, camphor trees, magnolias, and other natives of warmer climes. This northern region with numerous land connections to lower latitudes was probably the original home of our modern floras and faunas, which spread southward in successive waves of migration. We know that the Mid-Cretaceous witnessed the apparently sudden appearance of a host of new and higher types, and the basal Eocene witnessed a like sudden appearance of mammalian types and a second and more profound modernization of the floras. It is in the frozen North or the unexplored heart of Asia that we look today, hopeful that in one or the other of those strategic regions that we will find the fossils that will shed their light on our problems of descent and distribution.

[1] The identification of these antipodean remains is not entirely beyond question.

With the ushering in of the Eocene period the gigantic reptiles are entirely replaced by higher types; small mammals, some races of which soon attained great size, uncouth beasts long since passed away, besides the remote and generalized ancestors of some of our modern animals. It is in the rocks of this period that we find the dainty little four-toed ancestor of the horse. The Eocene, together with the next period, the Oligocene, represent a couple of million years, during which the sequoias were almost as abundant and widespread as are the pines in our existing flora. In the far west this was a time of plains, rivers, and lakes, suggesting the Louisiana country of the present. Sequoia cones almost identical with those of the existing redwood are sometimes excessively abundant where now the country is semi-arid and practically treeless.

Along with the sequoias were many hardwood trees—oaks and maples, hickory and ash; alligators pushed their way through the sedges; the cypress and palmetto grew in Colorado, Montana, and British Columbia. Stately palms furnished shade for primitive rhinoceroses, tapirs and camels; around the water courses grew swamp maples and alders, gum trees and mulberries; figs still flourished in the latitude of Puget Sound. Monkeys swung from branch to branch and gathered fruits, where today there is nothing but the barren wastes of the alkali "bad-lands."

The next period, the Miocene, witnessed the zenith of sequoia development. Contemporaneous with the tapirs, rhinoceroses, horses, the trees ranged farther than their active associates and are found from Tasmania (?) to Spitzbergen, and from Ireland to Japan. Their remains are everywhere—in France, Italy, Greece, America—they had even found their way across the equator and down along the South American coast as far as Chile.

In the Yellowstone region whole forests have been changed to stone by the mineral waters, or buried in the showers of ashes from the active volcanoes in the vicinity. The remains of the trunks are still from 6 to 10 feet in diameter, and the erect butts are often 30 feet or more in height, standing just as they grew, a veritable Aladdin's forest turned to stone. From a microscopic study of the wood we find that these Yellowstone trees are scarcely to be distinguished from the Californian redwood and it seems a reasonable inference that they represent its direct ancestor, particularly as other petrified woods from western Canada are likewise closely related to the redwood. The Miocene, like the Eocene and Oligocene periods, was characterized to a large exent by vast continental deposits laid down chiefly by streams, small lakes and wind action. To the westward the Rocky mountains were rising and bringing about the development of the great plains type of country.

The volcanic eruptions, which first became a prominent feature during the Cretaceous, culminated during the Miocene, as the immense number of extinct cones in the western half of North America give abundant evidence. The interval between the close of the Miocene and the modern sequoias is imperfectly known. Climates were becoming cooler and the sequoias were on the wane, although they are not at all uncommon even at this late time in Germany and Holland. But few fossils are found and it is presumed that the elevation of mountain ranges shutting off the vernal breezes and the consequent alterations in humidity, as well as the vast changes attendant upon the coming of the ice fields of the glacial period, were sufficient to all but extinguished the noble sequoia family.

At about the time the Neanderthal skull housed the brain of a cave dweller who fashioned the paleolithic flints, and who dwelt in the fear of the great hairy mammoth, the cave bear, the hyæna and the wooly rhinoceros, or shortly thereafter, the present sequoias reached their habitation in California. Could they but hand down to us the record of history embraced in a generation or two, each lasting between two and four thousand years, what a tale they might unfold. Tradition has it that Napoleon encouraged his soldiers before the battle of the pyramids with the picturesque phrase 'forty centuries look down upon you,' and yet the span of a single sequoia about equals what to the biblical chronologies of Napoleon seemed the limit of time. Many of the still vigorous and growing trees sprouted about the time that Christ was born at Bethlehem in Judea. Most of those still standing had commenced to grow at least before the fall of Rome. We can count the annual layers in the wood of those which have been cut down, and calculate with considerable accuracy their age and the varying rapidity of their growth. For instance, the huge section on exhibition at the American Museum of Natural History shows that the climate of California was very propitious about the time that Charlemagne was crowned by Pope Leo on Christmas day, A.D.

FIG. 9. SKETCH MAP SHOWING PRESENT RANGE (SOLID BLACK) AND PAST DISTRIBUTION OF THE SEQUOIAS (LINED AREAS) AND THEIR PROBABLE PATHS OF MIGRATION

800, as is evinced by the rapid growth of the tree at that time shown by the comparatively thick layer it added to its girth.

We can but wonder at the persistence of this type practically unchanged, for eon after eon, while all around were dissolution and evolution. Their early contemporaries are almost without exception cut off, and were we to go still further back to the probable ancestors of the sequoias, the Voltzias of the earlier ages, we could carry the genealogy back several million more years, almost to the coal period.

And yet the vicissitudes of time have not succeeded in wholly obliterating these ancient records preserved in the great book of history whose torn pages are the solid rock, and we are able to decipher a line here and a broken chapter there, gradually piecing together the main facts of the story, the reading of which becomes not only a labor of love, but a task of the most absorbing interest.

That we do not treasure the sequoias or any of our forest trees sufficiently is a reflection upon our democracy. I sometimes wish we moderns were less pragmatic and that our bump of reverence was less vestigial for then not only the redwoods but all of our trees might become as sacred as they deserve to be and even a lumber trust might hesitate to turn these abodes of the gods into waste places. Our forests like the stars or the changing season are wonders whose lessons and value have become dimmed because of long familiarity. If we saw them but once or twice in a lifetime they would be treasured accordingly. One has but to dwell in a treeless desert for months to have awakened such a love for the forests as will last forever.

The accomanying map of the world shows the tiny black area on our Pacific coast where the sequoia has lingered into modern times, the lined area the region over which it spread during its past history, and the arrows indicate the probable directions of radiation.

CHAPTER VIII

The Bald Cypress

Lumberman spare the forest—the glory of days long past, the primeval home of the race.

There are a considerable number of plants and animals that well deserve to be called living fossils because their living representatives are the last of a very long line that flourished over millions of years of earth history during which they were more abundant and varied than they are today. The cycads are such living fossils their ancestry going back to the far off days of the Coal Measures, as does also the ginkgo or maidenhair tree of our parks, the latter, a once cosmopolitan type, now existing as a single species whose native home is eastern Asia.

It may almost be considered axiomatic in tree studies that when a particular type is represented in the modern flora by a very few species of restricted and disconnected range, like the magnolia, tulip-tree or sassafras, and many others might be mentioned, such a type will be found to have had a long and most interesting geologic history, and we can often make such a prediction of a tree species even if we have not been fortunate enough to discover the fossil relics of its ancestral forms.

The bald cypress is a striking illustration of this principle. Its botanical name, Taxodium, was bestowed in the first instance because of its resemblance to the old world yew (Taxus),[1] although the former is a much more imposing and graceful tree and altogether lacks the funerial aspect of the yew. It is a close relative of the sequoia and the cypress and sequoia have come down the ages, very often in intimate association.

The bald cypress of today is a large tree with a tall columnar tapering trunk and a pyramidal form which becomes round crowned

[1] The genus Taxus is not confined to the Old World, but the species familiar to Anglo Saxons whose foliage the cypress was considered to resemble is.

in old age. Botanists generally recognize three species—our common bald cypress which ranges from the Coastal Plain of southern Delaware and Maryland to the tip of the Florida peninsula, and westward along the Gulf Coastal Plain to Texas, extending up the Mississippi and its tributary bottoms to those of the lower Wabash River. Concerning its appearance I can do no better than quote the quaint remarks of William Bartram, the pre-Revolutionary traveller, who speaks of it as "in the first order of North American trees. Its majestic stature is surprising. On approaching it we are struck with a kind of awe at beholding the stateliness of its trunk. . . . . The delicacy of its color and the texture of its leaves exceed everything in vegetation. . . . . Prodigious buttresses branch from the trunk on every side, each of which terminates underground in a very large, strong, serpentine root, which strikes off and branches every way just under the surface of the earth, and from these roots grow woody cones, called cypress knees, 4, 5 and 6 feet high, and from 6 to 18 inches and 2 feet in diameter at the base."

This basally expanded butt, the horizontal root system with the upright pointed knees which project into the air from the shallow roots when the tree is growing in its natural habitat in wet soil, have served to impart to the tree a weirdness, enhanced by the swampy habitat and often by a shroud of Spanish moss, that would have amply justified a Druidical or similar cult had this part of North America been inhabited by aborigines who had progressed beyond the stone age of culture. There is considerable romance and folk song associated with the bald cypress in our South, particularly in the negro South.

One of the characteristics of the bald cypress that impresses the observer is its vitality despite the fact that it is the last representative of its race and one whose area of distribution seems to be slowly shrinking. Latrobe noticed this vitality in the buried trees in his description of the Cape Henry (Virginia) sand dunes in 1799. Similar instances may still be seen in the same region, and the nearby patriarchal cypress group of Lake Drummond in the Dismal Swamp tell the same story. The few that remain in the

Lake are survivors from a bygone day when the water level was lower, and although they are for the most part much wasted and reduced to hollow shells, they bravely put forth their leafy twigs each season. I have noticed comparable instances along some of our southern rivers where small cypress trees that had been undermined and carried down stream by floods had been able to partially right themselves in the subsiding waters by means of their heavy expanded butts and which were occupying, apparently not greatly harmed, as involuntary squatters, the narrow shingle of the river sand bar.

The bald cypress, *Taxodium distichum*, in allusion to the distichous or two-ranked arrangement of the leaves on the twigs, frequently reaches a height of 150 feet, and usually has a trunk diameter of 4 to 5 feet and may reach as much as 12 feet, measured above the expanded buttresses and often hollow base. It is much sought by lumbermen but its swampy habitat protects it to some extent from the wholesale destruction that is visited upon some of our hardwoods. The excellence of cypress wood is proverbial, well meriting its reputation, now much advertised as "the wood eternal."

Our second native species, not recognized as distinct by many botanists, is the pond cypress, or *Taxodium imbricarium*, in allusion to the somewhat imbricated, or at least, appressed habit of the leaves. It is a smaller and much less important a tree with less flat and more appressed leaves and enormously expanded butts, and frequents ponds rather than river bottoms—the favorite abode of its more noble relative.

The third existing species is the Mexican cypress or *Taxodium mucronatum*, *Taxodium montezumae* or *Taxodium mexicanum* as it has been christened by different authorities. It does not occur within the limits of the United States, but is now confined to scattered localities on the Mexican Plateau, especially toward its southern end. It seems probable that the Mexican cypress is a close relative of our familiar species which, in prehistoric times, perhaps urged by the Pleistocene glaciation of the North country, invaded Central America, the continuity of its range having been subsequently broken by the progressive aridity of the great belt of dry country of northern Mexico and our border States.

Among these Mexican trees there are a number of extraordinary size that have attracted the attention of all travelers. Among these is the cypress of Atlixco described by Humboldt, the cypress of Montezuma at Chapultepec which was a notable tree four centuries ago. Another cypress in the village of Popatela near Mexico City, is noted for its association with Cortez at the time of his reverses during the Conquest, and is picturesquely named Arbol de la Noche Triste.

The most famous of these Mexican cypress, the largest one known, and perhaps the oldest living tree in the world is the great cypress of Santa Maria del Tule in the village of that name near the capital of the State of Oaxaca in southern Mexico. This remarkable tree, a photograph of which serves as a frontispiece of the present work, was described by Humboldt in 1803, who affixed a plate in one side 12 feet from the base, and now nearly entirely grown over. There have been a number of measurements of this famous tree in addition to those of Humboldt. Probably the most accurate are those made by von Schrenk, to whom I am indebted for the accompanying photograph, and who visited Santa Maria del Tule just one hundred years after Humboldt's visit. The diameter of the trunk of this old giant above the swollen and buttressed base was slightly over 41 feet, and the estimated age of the tree has been placed as between four thousand and six thousand years.

It is held in great veneration throughout the country-side as it should be, and seems to be perfectly vigorous and healthy notwithstanding its great age. It is hard to picture an organism that has been growing since before the flowering of Greek civilization and perhaps antedating the first dynasty of Egypt. A tree associated with the Maya culture, which has come and gone, with the empire of the Aztecs, with the coming of the Conquistadores, the Colonial period, and, I was about to add, the Petroleum period. If ever misfortune overtakes this patriarch among trees it is to be hoped that some scientist will happen along and measure its growth rings, for they would shed much light on the climatic fluctuations of the last few thousands of years. The wood of this Mexican species is soft and relatively weak and not to be compared with that of our commercial species, which is perhaps fortunate or some vandal would ere now, probably have sacrificed these memorials of the past as so many of our sequoias have been sacrificed.

The cypress line is a very ancient one, in fact the family to which it belongs, known as the Taxodiaceae, is characterized throughout by an ancient lineage, a peculiar modern distribution, and the isolation of its various members. Most of them have many extinct species and there are several totally extinct genera. Only two of the genera have as many as three existing species (Taxodium and Athrotaxis); three of the genera have but two existing species (Sequoia and Glyptostrobus); and four have but a single existing species (Sciadopitys, Cunninghamia, Taiwania and Cryptomeria). Their present distribution is also an indication of former greatness. Thus Glyptostrobus is Chinese though once cosmopolitan; Sciadopitys is Japanese; Taiwania is confined to the Island of Formosa; Cunninghamia and Cryptomeria are Chino-Japanese although the former was once a member of the North American flora; Athrotaxis is Australian although formerly found in many parts of the world; Sequoia is making its last stand on our Pacific coast; and Taxodium is confined to the South Atlantic and Gulf border region. The family is totally unrepresented in South America, Africa and Europe at the present time, although common enough in Europe as recently as the time immediately preceding the Ice Age.

There are no certainly identified records of ancestral bald cypress in the Cretaceous period, although it is quite possible that some of the similar appearing twigs of fossil conifers that have been referred to Sequoia may really be those of an early cypress. In the absence of preserved cones it would be impossible to decide such a question of relationship. The cypress is therefore less ancient than Sequoia, Sciadopitys, Athrotaxis, Cryptomeria and Glyptostrobus, some of which appear to have appeared in the geological record before the close of the Jurassic period.

In the earliest Tertiary, however, in the days when the primitive mammals were replacing the last of the dinosaurs, we find the cypress in many countries, and it soon comes to be cosmopolitan in so far as the Northern Hemisphere is concerned, although it has never been definitely recognized in the Southern Hemisphere. These Eocene records are very numerous and are based upon the remains of leafy twigs, seemingly thus early to have acquired the deciduous habit for which the bald cypress is notable, and which is rather unique among conifers and only shared by the larch among modern forms, in which however it is the leaves and not the twigs which are shed.

This deciduous habit may perhaps mean that the original home of the cypress was in the far North, possibly during Cretaceous times. In addition to the twigs, cone scales and seeds are frequently found in the rocks, and sometimes wood showing the anatomy of the genus is preserved although anatomy alone is applied with difficulty in the differentiation of some of these genera.

The Eocene range of the cypress is probably more remarkable than anything in its later history, for the Eocene records include Alaska, Alberta, British Columbia, Siberia, Manchuria, Greenland and Spitzbergen. From these relatively high latitudes the cypress seems to have spread southward over Canada to Montana, Wyoming and Nevada, and to the shores of the Mississippi Gulf of that time. Presumably it also spread over Asia at the same time even though we lack the actual records, for it appeared in Europe shortly afterward, or with the dawn of Oligocene time.

Unfortunately we know of but few plant beds in North America of Oligocene age, although we have no reason for doubting the continued presence of the cypress over a large part of North America at that time. In Europe there are a number of Oligocene records and these include southern France and the countries bordering the Baltic Sea. The maximum of development and range of the Cypress was attained during the next geological age—the Miocene. At that time its remains are found from Japan on the East to Austria, Switzerland and Italy on the West. Along with the still more abundant sequoia, the cypress was one of the contributors to the swamp deposits that formed the brown coal so extensively present and utilized in Europe, and especially in Germany.

In North America Miocene cypresses are found in Virginia on the east coast and in Oregon on the west coast. In Virginia the Miocene cypress with leaves, cones and seeds like those of the modern species flourished in the swamps of the low coastal country. Streams were sluggish and erosion slight and consequently great

FIG. 10. SKETCH MAP SHOWING PRESENT (SOLID BLACK) AND PAST (LINED AREAS) DISTRIBUTION OF THE BALD CYPRESS

beds of diatoms—tiny marine plants with siliceous tests, accumulated in the shallow waters along those low coasts. The cypress has never been found in the Southern Hemisphere and apparently did not succeed in penetrating into South America as did the sequoia which is found in the lower Miocene as far south as southern Chile.

During the late Tertiary time which succeeded the Miocene, termed Pliocene by geologists, North America again furnishes us with but few plant beds. The available deposits of this age on this continent are marine shell marls without plant fossils or interior basin deposits with vertebrate fossils in regions of increasing aridity like the western plains or mountain basins, apparently too dry for the cypress. Along our Gulf coast in what is known as the Pliocene Citronelle formation, a series of sands and muds, deposited in lagoons along the sea coast, there occur abundant remains of twigs, cone scales and seeds of a cypress indistinguishable from our existing bald cypress.

In Pliocene Europe on the other hand, there are preserved many plant beds of this age and the cypress was apparently one of the most common denizens of the shores of the greatly expanded Mediterranean Sea, which at that time spread over southern Europe and eastward into Asia. The accompanying sketch map of the world shows graphically the areas occupied by the existing cypress (in solid black) and the approximate area over which it extended its range during Tertiary times (lined areas).

At the close of the Tertiary the long period of more or less widespread equable climates was broken by those climatic changes which inaugurated the extensive glaciation of the Pleistocene. Our records of Pleistocene plant migrations are much scantier than one might wish, but we know that the cypress along with a great many other Miocene forest types became exterminated in Europe by reason of the vicissitudes caused by the repeated ice sheets that spread outward from the Scandinavian highlands and from the higher mountain masses farther south. Why the cypress did not survive in southeastern Asia is a mystery and perhaps it will eventually be found in the not yet thoroughly explored upland valleys of southern central China—a great plant refuge where recently have been discovered the hickory, sassafras and tulip-tree, and many other plants like magnolias, maples and ashes that serve to emphasize the long known and very striking parallelisms between the existing floras of southeastern Asia and southeastern North America.

In North America the forests shrank southward before the ice sheets and spread northward during the Interglacial periods. At those times of pressure from the north on the plant populations of eastern North America—forests had already practically disappeared from what is now and was then the plains country—many tree species ranged southward along the highlands to Central America. Among these southward spreading migrants was the cypress which left a species stranded there as it were when climatic changes occurred in the region which today separates the range of the bald cypress from that of the Mexican cypress.

A very large number of fossil swamp deposits where once were cypress bays have been uncovered by artificial excavations or by natural erosion of sea cut scarps or river cutting in the Pleistocene deposits of the Coastal Plain. These old cypress swamps, often with the stumps of trees of great size, 8 to 10 feet in diameter, are especially common in the tidewater country of Maryland and Virginia. The remains of one of these cypress swamps has been exposed by recent cutting of the Rappahannock River a short distance above the town of Tappahannock, Virginia. The peat which represents the old swamp muck is exposed for a thickness of 4 or 5 feet and is overlain by from 15 to 20 feet of sand and clay. Associated with the cypress stumps, cone scales, and more rarely leaves and catkins, are often found hickory and beech nuts, grape and gum seeds, beetle wings and insect galls, and other evidences of the contemporaneous life.

Another Pleistocene cypress swamp on the Rappahannock River near Waterview shows the old stumps in their peaty matrix planed off and covered by thick beds of sand—a readable record of a once sinking area where the estuary waters advanced over the swamp, killing the seedlings and wasting the old trees, the surface having been eventually scoured smooth by the waves that deposited the sands layer upon layer with the continued subsidence. Subsequently elevation succeeded subsidence and in modern days the river is engaged in cutting away this fragment of Pleistocene history.

Sometimes there are successive levels of these cypress stumps with their roots and knees embedded in the impure peat as in the Pleistocene swamp which grew in an old Cretaceous basin near Bodkin Point on the western shore of Chesapeake Bay, and a similar succession is shown in another such swamp recently discovered in excavating for the foundation of a hotel in the city of Washington. Another most interesting relic of a Pleistocene cypress bay is one that was discovered west of the Blue Ridge in the Shenandoah Valley near Lexington, Virginia, many miles west of the present range of the species.

At the present time the bald cypress is practically confined to what is known as the Coastal Plain and does not extend its range inland beyond the so-called Fall line which marks the boundary between the mostly unconsolidated rocks of the Coastal Plain and the ancient crystalline rocks of the Piedmont Plateau. But during the Pleistocene when the Coastal Plain region was largely flooded by the sea, the forests were forced inland, and the cypress evidently spread up the valley of the James River and through the Gap in the Blue Ridge into the Great Valley of Virginia. Other Pleistocene records of the cypress, far inland from its present range have been found in northwestern Georgia and in central Alabama.

Many other Pleistocene records of the cypress are outside the limits of the present range, one being as far north as Long Branch, New Jersey, nearly 150 miles north of its present northern limit. The area of distribution of the bald cypress in the area east of the Mississippi River, and the known Pleistocene records are shown on the accompanying sketch map.

With the melting of the last Pleistocene ice sheet we find evidence of climatic conditions somewhat warmer than those that prevail at the present time in the same latitudes. This is shown by various subfossil records of both terrestrial and marine organisms that have been discovered at various points from Maryland to Maine, as well as by the isolated occurrences of living animals and plants where they have survived in limited favorable localities many miles north of their present normal range, as in Essex County, Massachusetts, and Newfoundland.

At the present time the bald cypress appears to be perceptibly retreating southward, particularly at its northern limit of range in southern Delaware and Maryland. Here are to be found traces

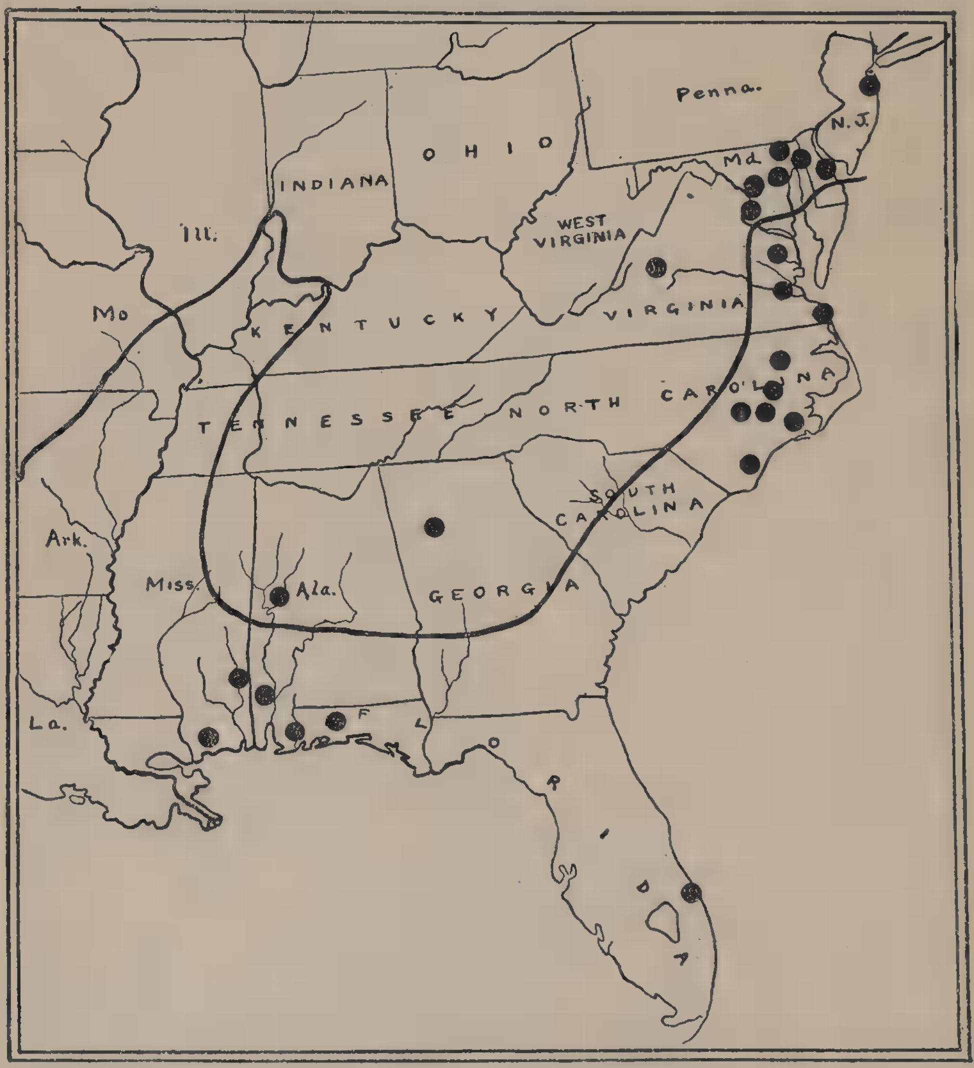

FIG. 11. MAP OF SOUTHEASTERN NORTH AMERICA SHOWING PRESENT NORTHERN LIMITS OF THE BALD CYPRESS AND ITS OCCURRENCE IN THE PLEISTOCENE (SOLID CIRCLES)

of trees where no longer live trees exist, although they appear to thrive when artificially planted as in the parks of Baltimore and Washington. Why they do not do so in Nature is a mystery, probably connected with lack of facilities for seeding and some environmental factor affecting the vitality of the seedlings where they do succeed in getting a start.

The case of the cypress is not an exceptionable one among trees and its past history will be found to be more or less paralleled by many of the forest trees that are discussed in succeeding chapters, whose ancestors reach back several millions of years, and whose present structures, habits and ranges are the result of ages of adjustment to the maze of interacting and constantly changing environmental forces amid which they have run their race—something which I fancy is not generally appreciated by lovers and students of the modern trees.

CHAPTER IX

The Walnuts and Hickories

The walnut family, or Juglandaceae, which includes the walnut, butternut, hickory and pignut, although a relatively small family, is by no means as limited as it seems. According to the current interpretation of the botanists it includes six groups of forms, or genera, and these genera contain, altogether, about two score different kinds, or species. They are widely scattered throughout the warmer parts of the North Temperate Zone, and unlike the majority of their associates they have spread long distances south of the Equator in South America and in the East Indies.

The walnut family is of considerable interest for a variety of reasons, chief among which, aside from the great economic importance of some of them, is their long line of extinct ancestors reaching back some millions of years to the Cretaceous period, and the wide geographical range and abundance of these ancestors, which explain the often curious distribution of the existing forms shown on the accompanying maps.

Not all of the genera have developed the same methods for the dissemination of their seeds and some, instead of forming the huge nuts of our familiar walnuts have kept the seed part of their fruits small and light, thus enabling them to produce large numbers of seeds with the same amount of material and expenditure of energy required for a single walnut. Furthermore, instead of depending altogether on chance or hungry squirrels for the dissemination of their latent progeny, the bracts that are normally present throughout the family have been enormously developed and serve as wings. This state of affairs is best developed in those trees known as Engelhardtias and will be referred to on a subsequent page.

The fruits unmistakably indicate the genera—those of the hickory have smooth shells and a husk which splits more or less readily—the walnuts and butternuts have a pitted rough shell and an entire persistent husk—the other and less well known genera have developed more or less winged fruits with characteristic differences. The leaves of all are what is known as pinnately compound, that is they consist of two rows of leaflets regularly arranged on either side of the leaf stalk. They are much like the leaves of the ash but the two may be readily distinguished by being arranged on the branches alternately, instead of opposite in pairs as in the ash. There are numerous other details that enable the student to distinguish between the leaves of the different forms, and this is fortunate because most fossil plants are represented by leaves in the rocks. More rarely are fruits preserved as fossils, and only in the most exceptional cases do we find flowers or other parts.

THE HICKORIES

The hickories are now referred to the genus Hicoria, proposed in 1808 by that romantic naturalist Rafinesque, although many botanists, especially in the Old World, still use the name Carya proposed by the naturalist Nuttall in 1818 and almost universally used for the hickories until about twenty years ago when the botanists formulated rules governing such matters and decided that the names first proposed should be the ones recognized.

The hickories occupy a unique economic position, for although the consumption of their wood is less in quantity than that of some of the other hardwoods such as white oak or yellow poplar, or of the various coniferous woods like the cypress or pines, it shares with the black walnut the distinction of being the most costly American wood. Hickory wood, although not remarkable for beauty of color or grain, will probably be the most difficult wood to replace when the approaching shortage becomes more acute, since it combines weight, hardness, stiffness, strength and toughness to a degree that is unequalled among commercial woods. The Forest Service estimated that the consumption of hickory for lumber, and for such things as spokes, tool-handles, rims, shafts, sucker rods, etc., amounted to nearly five hundred million board feet during 1908, and this exclusive of the large amount used as fuel, estimated for that year at about a million cords—for hickory is also the best American fuel wood.

With the exception of a single species (*Hicoria cathayensis*) of restricted range in the provinces of Chekiang and Kweichow, China, the existing hickories are entirely confined to North America, and more particularly to the eastern United States, although there is one in Mexico (*Hicoria mexicana*), and three or four others reach

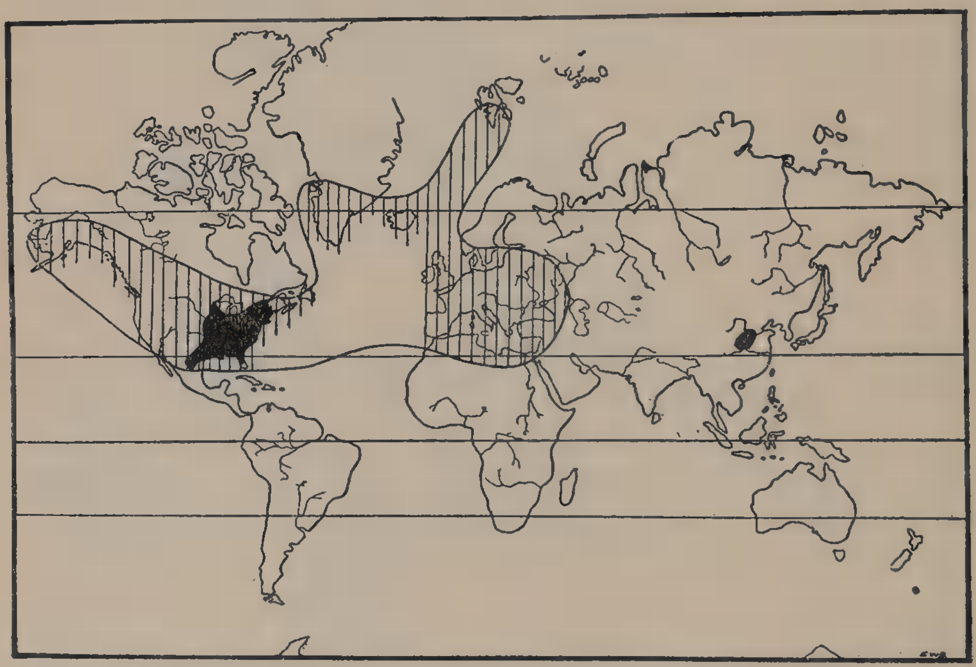

Fig. 12. Map Showing the Areas Where Hickories Are Found at the Present Time (solid black) and the Areas Over Which They Are Known to Have Spread During Their Past History

their northern limit of growth beyond the Great Lakes in eastern Canada. The hickory does not have the legendary qualities or the poetic references of many a less noble tree largely because it had already become extinct in Europe before the human race first invaded that continent in the days of the Old Stone Age. If our European ancestors had known hickory doubtless it would have shared if not replaced the place taken by such trees as the oak or the ash in folklore.

The existing species of hickories number from 8 to 15, according to the rank assigned to the varieties of the 8 or 9 easily distinguished main types. They fall naturally into two groups—the true hickories, and the pecan hickories—groups which were already clearly defined in preglacial Pliocene times.

The true hickories are fine, slow growing trees in general temperate dry soils, and with hard strong wood. The buds are full with overlapping scales, the nuts are generally thick shelled and thick husked, and each leaf consists of from three to nine leaflets. The pecan hickories are trees which require warmth and moisture, and have relatively weak wood. The buds are thin and narrow without overlapping scales, the nuts have thin shells and thin husks, and the leaflets are numerous, slender and falcate.

Over a score of ancestral fossil species are known. Unlike the walnut, the hickory is not certainly known from the Cretaceous period, but it is present in nearly every early Eocene deposit in Wyoming and on our Pacific coast. Hickories occur in the upper Eocene of Central Europe and our Gulf States, and there is a fine large leafed form in deposits of this age at Kukak Bay, Alaska. A form known as *Hicoria ventricosa* is very abundant in the brown coal deposits of Europe of Oligocene age. The late Miocene appears to have been the period of widest extent of these trees, representatives having been found throughout Europe and North America in regions where they no longer exist, as on the former continent, or in Oregon, California and Colorado.

During the succeeding Pliocene period the hickories are as abundant and vigorous as in the late Miocene in Europe although their northern limit appears to have become somewhat restricted. Even as late in geologic time as the upper Pliocene several species were abundant in Italy and Germany, but none survived the Ice Age on that continent. A form resembling the modern pecan is represented by both leaves and nuts in a late Pliocene coastal lagoon deposit in southern Alabama.

We have, in America, numerous Pleistocene records, the leaves being preserved in the clay deposits of the river terraces, and the nuts and husks in the buried swamp deposits. The following still existing species have been recorded from the Pleistocene of this country: the White Hickory (*Hicoria alba*) from a cave in Pennsylvania and from the interglacial beds near Toronto, Canada; the Water Hickory (*Hicoria aquatica*) from North Carolina; the shag bark (*Hicoria ovata*) from Pennsylvania, Maryland and North Carolina; and *Hicoria glabra* from Pennsylvania, Maryland, Virginia, and North Carolina.

The accompanying map (fig. 12) shows the area occupied by the existing hickories in solid black, and the area within which Tertiary fossil forms have been found by vertical lining. It seems probable that extinct forms once spread eastward over Asia because of the single existing species in China thousands of miles from any of its North American relatives but the former continent has been little explored and no records are known.

Although the Ice Age exterminated the hickories throughout Europe and most of Asia they survived safely in North America and are in no danger except from the axe of the woodman. Their great tolerance of shade and their ability to respond to the stimulus of increased light combined with their longevity are important factors in their continued existence. Although rodents consume many of their fruits they have probably done so throughout their whole history, for nuts gnawed by squirrels are not infrequent in Pleistocene deposits. This is not an unmixed evil for various rodents not only distribute the nuts but bury them in afterward forgotten places where they are almost sure to grow. Before the advent of the "civilized axe" many venerable old giants were scattered through our American forests, and there are numerous records of immense trunks showing 350 or more annual rings. There is a record of a pecan at Evansville, Indiana which had a trunk 6 feet in diameter showing 400 growth rings showing that it was already a small tree before Cortez conquered Mexico and had reached a considerable size by the time the Pilgrims landed at Plymouth.

THE WALNUTS

Walnuts belong to the genus Juglans, a contraction of *Jovis glans* or nut of Jupiter, and the specific name of the species known to the Greeks and Romans is *regia*, or royal, and is fittingly applied to the magnificent tree which has been so commonly planted throughout the old world for so many centuries. Its nuts have been found around the Swiss lake dwellings of the Neolithic age, about 7000 B.C. Our two eastern American species are equally royal trees. The black walnut (*Juglans nigra*) ranges from Massachusetts to southern Ontario, Minnesota and eastern Kansas, and southward to Florida and Texas. Its rich edible fruits and handsome dark wood have made it a favorite wherever furniture is used, and in consequence the tree is becoming scarce. It makes a fine growth when planted abroad where it is perfectly at home, perhaps because it was a native of Europe in preglacial time, as is shown by the nuts preserved in the Pliocene deposits of that continent.

The white walnut or butternut (*Juglans cinerea*) yields a wood that is much inferior to that of the Black Walnut, but its fruit is equally or more attractive. It ranges somewhat farther to the northward and not so far to the southward as the black walnut, being found from New Brunswick and Ontario to North Dakota, and southward to Delaware. In the Alleghanian region it extends southward to Georgia and northeastern Mississippi and it is also found in Arkansas. It is distinctly not a coastal plain species. Like the black walnut it is very closely allied to certain preglacial Eurasian fossil forms.

There are several other American species with a more limited range. All are trees, and they include a Jamaican form, and one or two species found in eastern Brazil and in the Andes of Peru and Bolivia. A species of northern Mexico (*Juglans rupestris*) extends into Arizona, New Mexico and the Rio Grande part of Texas, and there is a single species (*Juglans californica*) along the Pacific coast in California. The range of the latter is limited and its seedlings are scarce—the nuts being largely consumed by rodents.

There is also a walnut on the opposite shores of the Pacific in Manchuria (*Juglans mandchurica*) and a second in Japan (*Juglans sieboldiana*).

The genus is apparently one of the earliest of our still existing trees to appear in the fossil record, leaves suggesting it having been found in the Middle Cretaceous. It is well represented in fossil floras from the base of the Upper Cretaceous to the present, the former horizon furnishing several different forms, one of which named *Juglans arctica* ranges from western Greenland to Alabama

FIG. 13. MAP SHOWING PRESENT RANGE OF THE WALNUTS (SOLID BLACK) AND THE AREA OVER WHICH THEY ARE KNOWN TO HAVE SPREAD DURING THEIR PAST HISTORY (LINED)

along the Atlantic coast, and furnishes a striking illustration of the difference between Cretaceous and present day climates.

There are about 25 species of walnut recorded for Eocene times and at that time they are well distributed over the whole Northern Hemisphere. They are found from the Mexican Gulf region to Alaska and Greenland in North America; and from Sachalin Island off the east coast of Asia to western Europe.

The Oligocene walnuts are not quite so plentiful as are those of the Eocene and their records are almost entirely confined to the Old World. This is undoubtedly merely an expression of the incompleteness of the geological records of this time in North America where there are practically no known plant beds of this age.

The Miocene has furnished upwards of two score species, the majority of which are Old World forms distributed from Japan on the East to western Europe. This again is due more to lack of records in North America rather than to the absence of walnuts at that time. There are Miocene species known from Idaho, several from California and Oregon, and no less than four have been found in the lake beds at Florissant, Colorado.

The Pliocene species are also numerous, a number of them having survived unchanged from Miocene times. In all about 25 different forms have been recorded from Pliocene deposits and several of these are very close if not absolutely identical with still existing species. From the late Pliocene of Germany nuts have been collected from the lignite deposits which are exactly like those of our present day black walnut and butternut, and similar nuts occur in deposits as young as the Pleistocene at Aldan in Siberia.

Walnuts are not common in the known Pleistocene deposits, but the fruit of *Juglans regia* is recorded from beds of this age in southern France, and our black walnut has been found in the late Pleistocene of Maryland and Alabama, both occurrences being based upon the characteristic nuts preserved in the impure peat of buried swamp deposits.

The European walnut, although it is extensively planted throughout southern Europe and the Orient, is now native in only the region from Greece, where it is mentioned by Theophrastus, eastward through Asia Minor, Transcaucasia, the northwestern Himalayan region and in northern Burma, although it may eventually be discovered in the mountains of China. It was not introduced into Britain until the sixteenth century. In recent geological times its range has probably become greatly restricted since in preglacial times it is known to have been present in central France A considerable number of occurrences have been recorded from the Pliocene of that region and the Auvergne was evidently clothed with a considerable stand of walnut before the advent of the human race. During the Pleistocene this species left its remains at a number of localities in northern Italy, in Hanover, in southern France (Provence), and nuts found in the Swiss lake dwellings were undoubtedly from wild trees and furnished part of the dietary

FIG. 14. MAP SHOWING THE AREAS OF DISTRIBUTION OF ENGELHARDTIA, OREOMUNNEA, PLATYCARYA AND PTEROCARYA (SOLID BLACK) AND THE AREA OVER WHICH THEY ARE KNOWN TO HAVE SPREAD DURING THEIR PAST HISTORY

Pterocarya is indicated by vertical lining and Engelhardtia (including Oreomunnea) by horizontal lining.

of the first race of which we have record who had domesticated animals and practiced even a rude agriculture.

The manner in which the fossils enable us to obtain a vista into the life of bygone days is furnished by recent discoveries in the Egyptian desert. At a time (latest Eocene or earliest Oligocene) when Libya was separated from Europe and Asia by a vast Mediterranean sea the Fayum was a delta with a heavy rainfall, clothed with forests of an Indo-Malayan type, and inhabited by ancestral elephants and other curious forms of ancient animal life. No less than 8 kinds of figs, as well as laurels and camphor trees have been described from this now arid and desiccated region, and among these a species of walnut furnishes a striking commentary on the changes which time has wrought in this region.

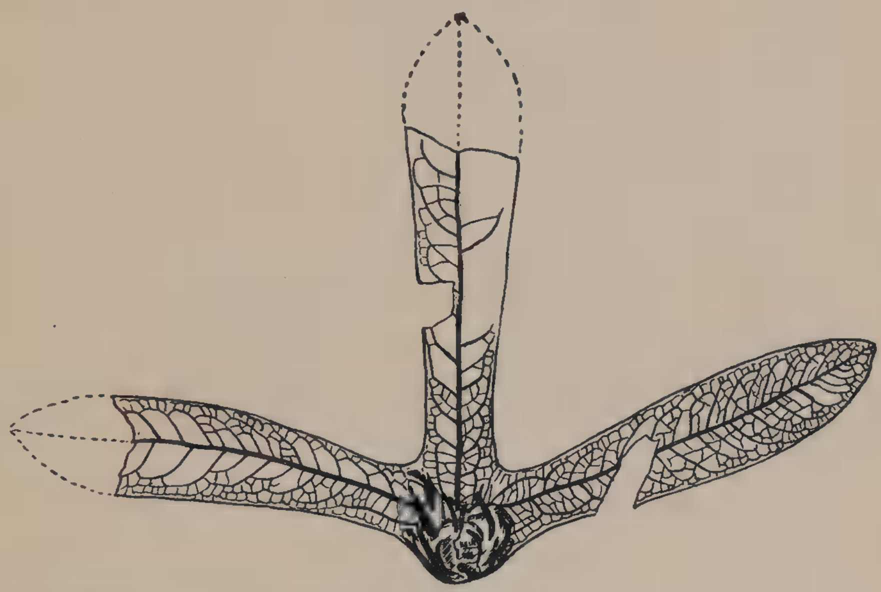

FIG. 15. WINGED FRUIT OF ENGELHARDTIA FROM THE LOWER EOCENE OF MISSISSIPPI

I have attempted to give a graphic summary of our knowledge of the present and past distribution of the walnuts in the accompanying sketch map (fig. 13) where the areas of distribution of the existing forms (somewhat exaggerated) are shown in solid black. It is possible that the part of the range of *Juglans regia* in southern Asia should be extended eastward over Tibet through northern China to Japan. All of the known fossil occurrences of walnuts have been plotted and are enclosed within the vertically lined area. Probably the southern boundary of this area should be extended, far enough at least to include the present homes of the existing South American species. It is readily apparent from this map that the modern species with their disconnected distribution represent the segregated remnants of a once world wide distribution, and that the Glacial period or Ice Age was as unimportant an incident in their history in North America, where there were no mountain or water barriers to cut off their retreat before the ice, as it was a tragic event in Europe, where from Gibraltar to the Caspian a succession of sea and mountains blocked their retreat to the southward greatly restricting the range of *Juglans regia*, and altogether exterminating one or two additional species of walnut, as well as the European hickories and a host of other trees.

The other members of this ancient and noble family are no longer present in our American forests, but some of them once lived here in the distant past, and I have introduced a map of their present and past distribution to show how imperfect is our knowledge if it be confined merely to the present, and to illustrate the principle that closely related trees, or any other kinds of organisms for that matter, which are now found on perhaps opposite sides of the globe, are descended from common ancestors which once spread over the intervening lands.

These members of the family now extinct in temperate North America are Platycarya, a small tree of Japan and northern China

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Fig. 16. Some Fossil Leaves and Nuts of Walnut (About ½ Natural Size)

1. *Juglans arctica* Heer from the Upper Cretaceous of Western Greenland.
2. *Juglans schimperi* Lesquereux from the Eocene of Louisiana.
3. *Juglans rugosa* Lesquereux from the Eocene of Wyoming.
4. *Juglans acuminata* Alex. Braun from the Miocene of Switzerland.
5. *Juglans paviaefolia* Gaudin from the Pliocene of Italy.
6. *Juglans sieboldiana* Maximowicz, nut from the late Tertiary of Japan.
7. *Juglans cinerea* Linné, nut from the Pleistocene of Aldan River, central Siberia.
8. *Juglans cinerea* Linné var *mucronata*, nut from the upper Pliocene lower Main valley, Germany.

9a, 9b. *Juglans cinerera* Linné var *mucronata*, surface and interior view of a nut from the Wetterau lignites of Germany.

FIG. 16

altogether lacking known fossil representatives; Pterocarya, with a few species in Trans Caucasia, China and Japan, represented in the Tertiary in both Europe and North America; and Engelhardtia (including Oreomunnea) which is now found in Asia from the Himalayas to Java and the Philippines, and in the mountains of Central America on the opposite side of the world. Engelhardtia illustrates the extreme development of reduced fruits and enlarged wings, and considerable of its geologic history is known. It appears first in the earliest Tertiary along the shores of the then enlarged Gulf of Mexico in Mississippi and Arkansas. Somewhat later it is found on our Pacific coast and in Europe. A fossil winged fruit from Mississippi is shown in the accompanying figure to illustrate its unlikeness to a walnut or hickory nut. These winged fruits are something like those of the hornbeam (Carpinus) of the birch family, but the proportions and veining are different, as is also the fruit itself, and the wings of the hornbeam are toothed and not entire.

Forestry experts warn us that the commercial hickory is growing scarce, just as the black walnut is already scarce. Aside from our enjoyment of their nuts and the very practical ends which the wood fulfills we should never forget the sentiment which attaches to a family of such magnificent trees, a family with an ancestry, as we have seen, extending back millions of years to a far off time when the dominant animal population of the globe was the uncouth reptiles of the Cretaceous, a time when the evolution of the mammalia had not yet been wrought out, and when man was a far distant promise, not even hinted at in the teeming life of that age.

Although we can never hope to bring back the primeval forests of our ancestors, and it is probably best so, we can at least use the intelligence which the race has so slowly acquired through the ages in conserving these magnificent tree relics of former times.

CHAPTER X

The Willows and Poplars

The willows and poplars, which constitute a separate family and order of plants, are characterized by a number of well marked morphological features. They have soft light wood, astringent bark, watery sap, scaly buds and deciduous leaves—short stalked in the willows, long stalked in the poplars—arranged alternately and with stipules. The flowers are in the form of catkins which bloom in the early spring in advance of the unfolding of the leaves. These catkins are generally upright in the willows and pendulous in the poplars, and the male and female are borne on different plants. The seeds, which are tufted with silky or cottony hairs, are formed in one celled, two to four valved capsules, and are dispersed by the winds.

By reason of their rapidity of growth, tolerance of moisture (the name *Salix* is said to be derived from the Celtic *sal* = near and *lis* = water) and their great adaptability to all kinds of soils they occur in a variety of situations and the different members of the family are found from the north polar region to the equator and beyond. They are gregarious because of the ease with which they grow from suckers and sprouts, their great vitality and free formation of shoots and seeds. About the only inimical condition that proves fatal is shade, of which they are very intolerant, hence in the natural growth of the forest they tend to become replaced by slower growing trees which eventually overtop them. Thus in time they become restricted (especially the willows) to river bars, mud banks, peat bogs, mountain tops and similar unfavorable situations. Both willows and poplars are very fast growers and both are relatively short lived. The majority are not tall trees and the seeds quickly lose their vitality and the trees are much damaged by winds because of their brittle wood.

The willows are far more diversified and more widely distributed than the poplars, and the facility with which hybrids are formed and the trivial specific differentiation of so many of the species makes them a very baffling group for the systematic botanist. Although both willows and poplars come from a very old stock, a stock as old as any of our trees except the conifers, and one much more ancient than that of our familiar warm blooded animals, the willows seem to have reached the zenith of their development in post glacial times, while the poplars on the other hand were more varied and widespread in earlier geologic times.

THE WILLOWS (SALIX)

The name willow suggests to most dwellers in temperate climes the graceful pendulous branches of the weeping or so-called Babylonian willow or the silky catkins of the pussywillows collected in the early springs of our childhood days. We associate the gnarled trunks of willows with Corot's paintings, or, if we have chanced to live in certain districts, we think of the willow chiefly as a cultivated crop the shoots of which are utilized for the making of baskets, wicker furniture and willow-ware. Possibly in youthful chemical experiences we have tried to make gunpowder from willow charcoal, or charcoal crayons, and what American boy does not know that willow wood makes good baseball bats or that whistles can be manufactured from the twigs. Willow, of course, enters into a great variety of uses, some of which will be enumerated, but probably its oldest use was the plaiting of its shoots into baskets or similar articles. I have no doubt that the men, or more likely the women, of the Old Stone Age made baskets of willow twigs, since plaiting is part of the art of the most primitive of existing peoples. Basket willows were cultivated by the Romans, who used the shoots for making bee hives, baskets, garden and vineyard trellises. The light elastic wood they covered with rawhide and bossed with brass for the shields of their legionaries. Pliny mentions four species of willow so used in his day (*Salix fragilis*, *S. purpurea*, *S. amygdalina*, and *S. viminalis*).

During the Middle Ages the basketmakers guilds were of considerable importance particularly in France, Germany and the

Low Countries. These sank into insignificance during the seventeenth and eighteenth centuries when they were replaced by itinerant basket makers, whose activities sufficed for supplying the local demand. With the advent of the factory system and the simultaneous great increase in trade and communications, the demand for baskets and hampers for parcel shipments of all kinds gave a great impetus to basket making, particularly in Europe where labor was so much cheaper than in America. This, coupled with the constantly increasing popularity of wicker furniture, has resulted in a constant and increasing demand for willow shoots. Napoleon's embargo stimulated willow culture in Britain, and considerable areas in our own eastern States have long been devoted to this purpose, usually however with little selection as to species cultivated or cultural methods.

Willows, particularly pollard willows, play a great part in landscape painting, especially in the art of France and that of the Low Countries where they are such familiar objects lining roads, canals and drainage ditches. The association of sadness with willows probably survives from the captivity of the children of Israel "by the rivers of Babylon." At the Feast of the Tabernacles they were commanded to take, on the first day, branches of palm trees and willows of the brook. The so-called weeping or Babylonian willow is a favorite graveyard tree, so much so that "she is in her willows" was a common expression applied to widows throughout rural England. Shakespeare has Ophelia drowned by a willow, and Fuller says of it: "A sad tree, whereof such who had lost their love make their mourning garlands."

There are more than 200 existing species of willows of all grades of stature, and while we think of them as especially characteristic of the North Temperate Zone they are by no means confined to it but range from the Arctic Circle southward across the equatorial regions into the South Temperate Zone. In America there are upwards of 100 species, ranging in size from tiny plants a few inches high under the Arctic Circle to trees 140 feet tall and 4 feet in diameter in more genial situations, as in the bottom lands of the lower Mississippi Valley. About a score of these are trees.

They are found from tidewater to the snowline of mountains and from the Arctic through Canada and the United States to the Gulf, and from the Alantic to the Pacific. They occur in the West Indies and Central America and southward to the Chilean Andes. In the Old World they range from Arctic Europe and Asia southward over both of those continents to Madagascar and South Africa, and from the Himalayan region southeastward through Malayasia to Java.

Aside from the older uses of willow as cover to prevent erosion or for basketry or charcoal, its utilization for lumbering has had a relatively modern development. At the present time low grades are largely used for box and cooperage material while the higher grades are employed for furniture drawers and backing, as well as for refrigerators, cabinet work and cheap furniture. Willow planking is satisfactory for purposes where strength is not required, since it does not warp, splinter or check, and this property determines its use for boat parts such as keels, paddles, etc., and for athletic goods, cutting boards, toys, etc. Large quantities are also consumed every year by excelsior mills.

The oldest known willows, not certainly identified, are recorded, along with the early representatives of other dicotyledonous plants, from the late Lower Cretaceous of Portugal. During the earlier part of the Upper Cretaceous, the time when the remains of the higher or socalled flowering plants first become prominent in the geological record, a great many species of supposed willows have been found. Upwards of a score of forms have been described, and the ancestral stock during these early days must have possessed some of the vitality that marks the recent forms, for it spread rapidly over North America as well as Europe and probably over Asia as well, although there are no known records from the last continent. It should be noted that four-fifths of the known Cretaceous species are North American and that none have been found in the prolific Cretaceous plant beds of Greenland, although poplars appear to have been abundant at that time in the far North.

Botanists are divided in their interpretation of the willow flower, some regarding its simplicity as a primitive character and others regarding it as reduced by evolution from a more complex type. Whichever view is correct the willows undoubtedly appear early in the geological record.

The oldest Tertiary, or Eocene, deposits have furnished about 25 species of willows, the records including all of the continents of the Northern Hemisphere. Willows had now reached Greenland, where five different species have been discovered. Other Arctic lands also shared this invasion, since willows have been found in beds of this age in Alaska, at the mouth of the Mackenzie River, in Iceland and Spitzbergen. The climate of the earth seems to have been more equable during Eocene times since we find many sub-tropical plants in the Mississippi valley and as far north as southern England, and the Arctic lands at this time were clothed with dense forests of temperate types.

The Oligocene, which succeeds the Eocene in the Tertiary sequence, was a time of prevailingly marine deposition in North America so that few fossil plants are known and there is only one willow among them, although doubtless willows still flourished since they are common in succeeding deposits. In Europe about half a dozen species are known from the Oligocene rocks.

The next period—the Miocene—was a time of great variety and luxuriance of tree growth. Between forty and fifty different willows are known and the actual number in existence must have been much greater for when we get a glimpse into the past in an otherwise unknown area, like that furnished by the tiny lake basin at Florissant in the Colorado Rockies we find an abundance of willows—five having been described from Florissant. They are equally abundant in the lake beds and elsewhere throughout Europe. A few are known from eastern Asia and in America they occur in Virginia on the East coast and in Oregon and California on the Pacific coast.

The Miocene was succeeded by the Pliocene period, a time during which the forests of the Miocene continued practically unchanged. Many willows whose characters foreshadow their existing descendants are known from Asia Minor to Spain, but unfortunately for our history the American Pliocene deposits are for the most part marine marls so that the American Pliocene plant record is almost a blank, although we know that the familiar types must have been present since willows are abundant in the next or Pleistocene period.

The Pleistocene, or period of continental glaciers, was an epic time for all plants and animals, for it was a time during which ice sheets many feet in thickness gradually accumulated in northern America and Europe and in the more elevated mountains. After fluctuating near a maximum for some thousands of years these ice sheets gradually disappeared and were followed by a long genial interglacial stage. This great accumulation and southward advance of the ice was repeated four times and the last ice sheet has been gone only a few thousand years. During these changing times all life forms were subjected to new competitions and great stresses, hence many forms succumbed. Others shifted back and forth with the shifting climatic conditions and still survive. A great many still existing species of willows, as well as other trees, make their appearance in the Pleistocene bogs, lake beds and river terrace deposits and thus serve to record the gamut of changing environments. We find for example the tiny Arctic willows like *Salix polaris*, which today occurs in the Scandinavian mountains and reaches its southern limits in the tundras along the Arctic coast of Russia, present in the Transylvanian and Swiss Alps, throughout Britain, southern Sweden, Denmark and the north German plain, associated with other plants of the far north such as Dryas and animals like the Arctic fox and lemming.

The accompanying sketch map of Europe shows the unusual climatic conditions which enabled this far northern form, now confined to the lined area on the map, to extend southward almost to the Mediterranean. This and other herbaceous or shrubby species of Arctic willows are found at innumerable localities throughout central and northern Europe, where the deposits of this age have been so intensively studied. The conditions were duplicated in North America but as we have devoted so little study to the life of our Pleistocene deposits it is not possible to obtain adequate records of the distribution of our Pleistocene plants.

FIG. 17. SKETCH MAP OF EUROPE SHOWING THE SOUTHERN LIMITS OF THE CONTINENTAL ICE SHEET, THE PRESENT DISTRIBUTION (LINED AREAS) AND THE PLEISTOCENE OCCURRENCES OF SALIX POLARIS (MODIFIED FROM NATHORST, 1891)

1. Vicinity of Edinburgh.
2. Localities in Yorkshire.
3. Localities in Norfolk and Suffolk.
4. Devonshire.
5. Numerous localities in the Alps.
6. Localities in Bavaria.
7. Localities in Jütland.
8. Localities in Zeeland.
9. Numerous localities in North Germany.
10. Localities in Esthonia, Livonia and Vitebsk.
11. Numerous localities in Schonen, Gotland and Jemtland.
12. Felek in Hungary.

Over twenty kinds of willows have been discovered in the Pleistocene deposits and only two or three of these are extinct species. The details of their present range and Pleistocene occurrences are too extensive for the present sketch so that only a few will be mentioned. One or the other of the four herbaceous small leafed Arctic and Alpine species *Salix herbacea*, *S. polaris*, *S. retusa* and *S. reticulata* are found in Pleistocene deposits as far south as New York state in this country, and Switzerland and Galicia in Europe. Three of them occur in Germany. The northern peat bog species *Salix repens* and *S. myrtilloides* are both found in England. The sub-Arctic species *Salix aurita* and *S. caprea* occur respectively in England and Denmark. The osier or basket willow is recorded from France and Württemburg, and a very similar form occurs in the Pleistocene deposits of North Carolina and Kentucky. The white willow (*Salix alba*) and the crack willow (*Salix fragilis*) both occur in France and Württemburg. With the amelioration of conditions following the last retreat of the ice the Arctic forms withdrew to the far North with the sub-Arctic and cool temperate species in their wake, and these far northern forms are circumpolar at the present time, although those willows that attain to the stature of trees and inhabit the Temperate Zone are different in each of the three continents of the Northern Hemisphere.

THE POPLARS (POPULUS)

The poplars, although they show their community of origin with the willows, differ from them sufficiently to be readily distinguishable. They are all trees and on the whole average larger than the willows. The catkins are pendulous instead of erect; there is a rudimentary perianth or flower envelope, and the bracts of the flowers are toothed or cleft instead of entire as in the willows; the leaves are usually broad instead of narrow, being ovate or deltoid and often cordate, and the leaf-stalks are long and often flattened—a feature well exemplified in the quaking aspen.

The generic name Populus is of obscure etymology but was the classical name of the poplar, of which there are several European species. The most important of these is the white, silver poplar, or abele (*Populus alba*), a large tree of the central and southern parts of that continent. The black poplar is also a large tree of central and southern Europe and Asia. An aspen (*Populus tremula*) occurs in central and northern Europe, ranging eastward to Japan, and there are a number of additional European species, including the downy poplar (*Populus canescens*); *Populus monilifera*, which furnished the poplar wood of the Romans; and the so-called Lombardy poplar (*Populus fastigiata*) so often planted in this country as a screen or ornamental tree. The last is probably of oriental origin despite its name, coming originally from the region of the Vale of Kashmir, since it seems to have been unknown in Italy in Pliny's time. It was unknown in England in Evelyn's day and was introduced into that country about the middle of the 18th century. *Populus euphratica* of North Africa, the Altai and Himalayan region is believed to have been the weeping willow of the Scriptures and its wood along with that of the date palm furnished the rafters for the buildings of Nineveh. The bud gum of the European black poplar and of our American balsam poplar has often been employed by herbalists for various medicinal purposes although it has little virtue.

There are in all about twenty-five existing species of poplar, of which half are found in North America. Among these the ones known as aspens have an especially wide range, particularly the quaking aspen, *Populus tremuloides*, which covers 112° of longitude and 41° of latitude, while the European aspen (*Populus tremula*) covers 140° of longitude and 35° of latitude—the two together nearly encircling the globe. They form dense growths in the north woods and furnish most of the drift wood of the Arctic Ocean. Although cut in vast quantities for pulpwood the aspens will probably always form an important element in the more northern forests as they and their ancestors have done during the past three or four million years. They repeat the usual poplar characters of smooth bark, soft weak wood, very rapid growth and sparse broad leafed foliage. They are more gregarious and somewhat smaller at maturity than the other poplars and their long slender leaf stalks cause the lightest summer breeze to set the leaves to quaking or trembling with the characteristic motion and sound that gives them their vernacular names. This gave rise to the tradition that aspen was the wood of the cross—its leaves have quivered ever since. Other interesting poplars are the so-called cottonwoods of the West, where they are almost the only native trees in the river valleys of the prairie country, ranging from Assiniboia to New Mexico. The cottonwood has narrower leaves than the rest of the poplars and in the commonest species it approaches a willow leaf in appearance.

Neither willow nor poplar timber can compete with larger and stronger woods such as pine or spruce or with more durable woods such as oak, cedar, and chestnut. Pulpwood, excelsior, and fuel are their largest uses although for barn floors, boxboard veneer, spools, matches, etc., their qualities of softness, lightness, ease of working and lack of splintering, render them valuable.

The geological history of the poplars is most interesting although somewhat obscure. About 125 fossil forms have been described, in addition to the still existing species that are found fossil in the Pleistocene deposits but a number of these are of questionable identity. The oldest known were the contemporaries of the dinosaurs of the closing days of the Lower Cretaceous. One small leafed form is found at this early day in the Potomac River valley and the other, which was for a long time the oldest known dicotyledon, comes from the Kome beds of western Greenland and was named *Populus primaeva* by Heer, its describer.

These first poplars are rare forms but their geographical separation gives us a hint that their abundance was greater in those early days than the records show, and this is also indicated by the abundance and wide distribution of poplars during the Upper Cretaceous, from which about 30 species have been described. They are much less abundant than the willows in the Upper Cretaceous of Europe but, unlike the willows, they are common in Greenland, and they are exceedingly ubiquitous in North America at this time, especially in the West where they appear to have been very common along the borders of the Upper Cretaceous sea that submerged so much of the then low western country. In addition to the American, European and Arctic records a petrified piece of a poplar root has been described from the Upper Cretaceous of Japan, indicating that Asia had its species then as now.[1]

During the succeeding Eocene period there were upwards of 50 species, or twice as many as are living at the present time. The rising land of what is now the Rocky Mountain country shut off the moisture laden winds from the Pacific and the lessening rainfall made of this vast region a quite different country from what it had been during the Upper Cretaceous. In the continental deposits of the Eocene, that is, deposits laid down on the bosom of the land rather than in the sea—the deposits of wind blown materials and volcanic dust, laid down in lakes, streams, flood-plains, etc.—deposits referred to the Fort Union formation, leaves of poplars are the most abundant fossils.

Poplars appear to have covered at this time all of the plains and mountain country of the West in great variety, extending northward from the western provinces of the United States and Canada to Alaska and the mouth of the Mackenzie River, and encircling the globe in high latitudes. They have been recorded from Greenland, Grinnell Land, Spitzbergen, Sachalin, Siberia and Manchuria. A few are found in central Europe, but the great bulk are American and Arctic, and the climate of more southern lands appears to have been too warm for their presence in any great numbers, for in the abundant Eocene floras of southeastern North America we find no traces of poplars but in their place a warm climate flora of figs, laurels, bread fruit, rain trees and their allies, thatch and date palms, nutmegs, pond apples and similar types unfamiliar to dwellers in the Temperate Zone. This warm flora extends as far north as the mouth of the Ohio in America and a similar warm flora extends to southern England in Europe.

During the Oligocene, which succeeded the Eocene, the scanty records have yielded few poplars. Three species have been described from deposits of this age in the West and 4 or 5 are

[1] Many of these early poplars are thought by some students to represent an altogether different family of plants—the Trochodendraceae.

known from central and southern Europe. Southeastern North America was still too tropical in its climate to permit the existence of poplars and although we lack the proof it may be assumed that the numerous Eocene forms lived on in Arctic lands until they were gradually exterminated or driven southward by the more severe climate that commenced to prevail in high latitudes before the close of the Oligocene.

The poplars are represented during the Miocene period by about 30 species, which are found from Greece westward to Spain in Europe and throughout the western United States and Canada. The Miocene lake of Florissant in the heart of the Colorado Rockies has furnished 7 forms of poplar—one a splendidly preserved cottonwood that may well have been the ancestor of the existing forms that are found at the present time in Colorado. Poplars are found at this time along the Pacific coast, but none are known from the Atlantic or Gulf coasts.

The Pliocene period, which succeeded the Miocene and immediately preceded the Glacial period, has furnished about 16 species

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FIG. 18. SOME FOSSIL WILLOWS AND POPLARS (ABOUT ⅓ NATURAL SIZE)

1. Leaf; 2, fruit of *Salix varians* Goeppert from the Miocene (Tortonian) of Switzerland.

3. *Salix lavateri* Heer from the Miocene (Tortonian) of Baden.

4. *Salix angusta* Al. Braun from the Miocene (Tortonian) of Baden.

5. Staminate catkin of Salix from the Miocene (Tortonian) of Silesia.

6. *Salix reticulata* Linné from the Pleistocene of Germany.

7. *Salix herbacea* Linné from the Pleistocene of Galicia.

8. *Salix polaris* Wahl., from the Pleistocene of England.

9. *Salix myrtilloides* Linné from the Interglacial of England.

10. Leaf; 11, bracts; 12, fruit of *Populus latior* Al. Braun from the Miocene (Tortonian) of Baden.

13. *Populus crassa* (Lesq.) Ckl., from the Miocene of Florissant, Colorado.

14. *Populus balsamoides* Goeppert from the Miocene (Tortonian) of Silesia.

15. *Populus amblyrhyncha* Ward from the Eocene (Fort Union) of Montana.

16. *Populus heliadum* Unger from the Miocene (Tortonian) of Baden.

17. *Populus attenuata* Al. Braun from the Miocene (Tortonian) of Baden.

18. Catkins; 19, leaf; 20, scales; 21, leafy twig of *Populus mutabilis* Heer from the Miocene (Tortonian) of Baden.

22. *Populus balsamifera* Linné from the late Pleistocene of Maine.

FIG. 18

of poplars, several of which are very close to, if not identical with, still existing European forms such as the European aspen, the silver poplar and its downy leafed ally. They are found during this period from Asia Minor to Spain, but there are no known American records, since this country has unfortunately yielded scarcely any Pliocene plants.

The Pleistocene or Glacial period is always of particular interest to students of plant history and distribution since the presence of continental ice sheets and the complex physical conditions which their presence brought about played havoc with the uniformity of development and distribution of the noble races of both animals and plants that had been flourishing for so many thousands of years throughout the Northern Hemisphere.

Poplars are represented in the Pleistocene deposits of Europe and America by wood, leaves, bud-scales and catkins. Only 2 of the 10 species recorded from these deposits are extinct and these are both from the earlier Pleistocene of Maryland and are very similar to existing forms. In Europe the black poplar is recorded from Italy; the downy white poplar has been found in both England and France; and the European quaking aspen occurs in peat deposits at a number of localities in Denmark, Germany, northern Italy, etc. In America the so-called necklace poplar (*Populus deltoides*) has been found in river terrace deposits in Alabama and western Kentucky, and the balsam poplar or Tacamahac, and the large toothed aspen, have been found in the Interglacial beds of the Don Valley in Ontario, and the former has also been found in the blue clays of Maine.

Thus we see that while the life span of both willows and poplars is much shorter than that of most of our forest trees, the stock is a virile one and the race an ancient one. While neither have been objects of veneration or worship like the oaks or ginkgoes, or of surpassing utility like so many of our forest trees, both were the associates of our remote ancestors of the Old Stone Age when the last ice sheets were retreating from northern Europe and the Nordic race was being evolved. Both willows and poplars must have been familiar and useful plants to the Neolithic men that evolved the so-called Robenhausian culture of the Swiss lake dwellers (7000–5000 B.C.), the remains of whose dwellings, built on piles and found so abundantly throughout the region of the Alps and the valley of the Danube, record the time when early man ceased being merely a nomadic hunter and came to occupy fixed abodes and garnered some crops. And when the race passed from lake dwellings to fortified and moated habitations in the swamps and along the rivers of southern Europe, the willows must have been one of the familiar and useful plants in their immediate environment, during what is called the Terramara period, so that they should have at least a sentimental interest for the modern race. Unlike more useful trees to the lumber industry the willows and poplars, because of their efficient seeding habits and rapid growth, do not appear to be in danger of extermination, despite the enormous toll that the pulp mills and forest fires take every year.

CHAPTER XI

Hornbeam, Hazel, Birch and Alder

The various hornbeams, hazels, birches and alders belong to the birch family or Betulaceae, which is a most important one from both the aesthetic and pragmatic points of view. Its numerous species are segregated into 6 main groups or genera, all of which have many common features of wood, leaf, and flower structure. The most uninformed are familiar with some of the birches, alders, hazels and hornbeams—the hop hornbeam (Ostrya) is less well known, leaving the genus Ostryopsis with a single species in eastern Asia as the sole practically unknown member of the family.

All of the genera except the last mentioned have numerous species found in all the northern continents, and all these have numerous extinct representatives. The only member of the family that extends its range into the Southern Hemisphere is the alder (Alnus) which has spread southward through the highlands of Mexico and Central America to the Andes of Peru and Bolivia where it is associated with familiar looking trumpet creepers and blackberries. It will be more illuminating to briefly discuss each of the types mentioned at the head of this chapter separately.

THE BIRCH, "THE LADY OF THE WOODS"

In considering the birches the aesthetic and the practical both struggle for a hearing. Our northern forests are not adorned with more beautiful or graceful trees than the white or silver birches, and in some countries such as Russia and Kamchatka this lady of the woods becomes a maid of all work and serves as many purposes as does the palm in Arabia. Poets generally, unite in its praises, but on the other hand Evelyn has not a word for the beauty of the birch but praises the sovereign effects of its juice when made into birch beer.

The birches constitute the genus Betula, which was the classical name of the European tree. It is the largest genus and gives its name to the family. There are about 30 existing birches recognized by botanists and over four times as many extinct species. They range in size from tiny shrubs under the Arctic Circle, for they extend as far north as any tree genus, to trees 125 feet tall in the case of our northwestern birch (*Betula occidentalis*), and some, like our American white birch (*Betula populifolia*) may be in the far north or on mountains only 2 or 3 feet tall as compared with a height of 40 feet in more favorable situations. Most of the birches are relatively short lived and slender trees, of slow growth, but hardy and freely seeded by the wind, with round slender, often drooping branches, serrate toothed deciduous leaves of a bright green color, with the pollen and seed producing catkins in separate clusters but borne on the same tree, and producing tiny winged fruits. The bark is one of their characteristic features, being in thin layers and readily peeled off, and quite indestructible.

The accompanying map will explain their distribution much more graphically than many words. The dwarf Arctic birches of the Pleistocene and recent barren grounds or tundra reach to within ten degrees of the North Pole in western Spitzbergen, and almost as far on the coasts of Greenland. The white birches extend northward beyond the Arctic Circle in Scandinavia, Siberia, Alaska and the valley of the Mackenzie, and reach their southern limits in Spain, Asia Minor, Japan and California. The remaining birches occupy large detached areas, the smallest being that of the Caucasus and Armenia. In Asia these forms cover a large area extending from eastern Siberia southwestward to the Vale of Kashmir; in North America they extend from the St. Lawrence valley westward to Minnesota and southward to eastern Texas and Florida.

Their twigs are still used extensively in the manufacture of brooms just as in ancient Rome the fasces of the lictors with which they cleared the way for the magistrates, were made of birch rods. Their use among pedagogues was so general in northern Europe and New England that birch is still literally or more often metaphorically the instrument of school room discipline. In

America the birch has all the attendant romance that clusters about the birch bark canoes of the aborigines and early traders and trappers, and they are still indispensable in the North woods. This is strikingly set forth in the eighteenth century journal of Alexander Mackenzie on his journey from Montreal to the Pacific. He relates how he hunted whales in a birch canoe in the estuary of the river which bears his name and how he carried such a canoe across the Rocky Mountains, at least during the intervals when the canoe was not carrying him—probably the first white man to make such a journey.

Living in cities as most of us have the misfortune to do in these modern days, we scarcely realize the number and variety of uses to which our common trees are put in remote parts of the world away from the beaten tracks. We are not quite so uninformed as the slum children who think that apples grow in barrels and peaches in baskets, but what city dweller would dream that some thirty million spoons were each year made out of birch wood in Russia, or that the Russian peasants use about twenty-five million pairs of birch bark shoes annually, or that Kamchatkans grind up the bark and eat it for the contained starch, or that considerable mahogany furniture in the antique shops is of sweet birch, or that eleven thousand cords of paper birch are used each year in New England in the manufacture of shoe pegs. One would be inclined to think that shoe pegs were as obsolete as distaffs or flails, but such is not the case.

Our paper birch (*Betula papyrifera*), also often called the canoe birch, extends through our northern tier of States almost from the Atlantic to the Pacific and reaches northward almost to the shores of the Arctic. It is one of the few American trees that covers more ground at the present time than it did when America was discovered. It owes its spread to the success with which it colonizes spaces that have been opened in the forests by windfalls or fires. Its light winged fruits are produced in great quantities and are carried far and wide by the winds—they may often be seen as tiny bird-like specks on the surface of winters snows. A similar habit of rapidly spreading over clearings and waste places characterizes the European white or silver birch—a closely related but distinct species—which is one of the few trees that grows among the heather, in fact an abundance of seeds widely distributed by the wind characterizes most of the birches and is especially noticeable in the changing cycles of vegetation recorded in Pleistocene deposits which contain the history of bogs and moors changing into forests and back again.

FIG. 19. SKETCH MAP SHOWING ANCIENT AND MODERN DISTRIBUTION OF THE BIRCHES

- - - - - - - Northern limits of Arctic birches.
———— Northern and southern limits of white birches.
x x x x x x Range of other birches (subsections Costatae and Betulaster).
● ● ● ● Fossil occurrences.

A most thrilling story could be written of the part played by the birch bark canoe in the exploration and development of the northern half of our continent, Parkman gives something of this.

We owe the discovery of the Mississippi to its use, and it would be a safe assertion that the settlement of much of this country with its intricate systems of rivers and lakes would otherwise have been impossible. In Hiawatha we read the mythical account of the first birchbark canoe and Longfellow there describes the actual process of building with accuracy. Bark canoes are still made in the backwoods by trappers and Indians, and around some of the lake resorts, and the wood because of the inherited tradition as well as because of its intrinsic worth is similarly used by canoe and small boat manufacturers.

For the manifold uses of birch wood of the various species I must refer the reader to the special literature of forestry—that half a billion board feet are cut by saw mills in the United States each year is an index of its commercial position. For two centuries, and from Maine to Tennessee, much of the finest birch disappeared before the pioneer's axe without any realization of its value other than for fuel. Our most valuable commercial species is probably the sweet or cherry birch (*Betula lenta*) although the various species are often indiscriminately mixed in lumbering. Indians from time immemorable have made birch beer by fermenting its sugary sap, which is copious. Inhabitants throughout its range still utilize the sap in this way, although birch beer can scarcely be said to be an article of commerce. The sweet birch was also the first of the birches whose value was recognized, and the wood was exported to Britain as early as 1791. It enters largely into cabinet and furniture making, into musical instruments, interior finish, boats, billiard cues, mallets, Indian clubs, wooden ware, and from the time of the first cabinet makers it has been a substitute for cherry or mahogany—and a most admirable one.

Our other birches, aside from the uses of the bark of the paper birch, were not recognized as valuable until much later, although the yellow birch (*Betula lutea*) has been an article of commerce for over one hundred years, going into wooden ware, furniture, vehicles, etc. The paper birch goes into clothes pins, toothpicks, woodenware, novelties and cooperage—its largest use being probably the result of the possession of the exacting qualities required in modern winding machines of spools. All of our birches enter more or less into wooden ware, novelty and furniture trades. In Maryland the common river birch (*Betula nigra*) with wood of modest merit goes extensively into berry baskets.

For the past sixty years the distillation of sweet birch bark has furnished an oil so similar to that of the true oil of wintergreen, that it has almost entirely superseded the latter where this flavoring is required. Dry distillation furnishes the oil used in tanning Russian leather and to which the latter owes its pleasant odor. In frontier regions the bark of various species furnishes a substitute for paper, and is used more extensively for roofing and for jars and containers—alike by the American Indian for his maple sugar and by the Russian peasant for both liquids and solids. There are great tracts of birch in Russia where this tree is close to the daily life of the masses and where its leaves are frequently used for fodder.

The birches play a considerable part in geological history. As I mentioned in an earlier paragraph there are about 135 extinct species—the earliest known birch-like forms being referred to a genus known as Betulites, of which a score of species and varieties were described by Lesquereux from the Dakota sandstone of Kansas, in which they are present in large numbers. Supposedly similar forms have been recorded from the Upper Cretaceous of Argentina, but these have never been passed upon by a competent botanist and remain doubtful, although the presence of what Dusen calls Betuliphyllum in the early Tertiary of the Straits of Magellan, lends some support to the idea that the ancestral birch stock may have reached South America from the North during the Upper Cretaceous. But if it did it entirely failed to secure a lasting foothold on that continent.

Other Upper Cretaceous birches, referred directly to the modern genus, number 5 or 6 and come from western Greenland, Nebraska, and western Canada, wood as well as leaves being recorded from the last region. Birches are unknown in the European Cretaceous, but that they reached that continent early, either from Asia or from the Arctic by way of a North Atlantic land bridge, is shown by their presence in the lowermost (oldest) Eocene of the Paris basin.

Birches are a widespread and common type in the Eocene floras, occurring in the earliest rocks of this age in both Europe and America. About 30 Eocene species have been described, and during the northward swing of temperate forests which is one of the most spectacular events of Eocene times, birches penetrated almost to the pole itself, in Spitzbergen, Banks Land, Grinnell Land, Greenland and Iceland, in addition to being exceedingly abundant on all the northern continents, especially in Alaska and the western provinces of Canada. At this time they are supposed to have reached Australia and Tasmania, but these antipodal occurrences are not above suspicion and may merely represent incorrect determinations. In the region of the not yet elevated Rocky mountains was an area still swept by humid Pacific winds, the dwelling place of several typical species of birch whose foliage doubtless helped to furnish the fare of the early browsing mammals, not yet learned in the habit of grazing.

The Oligocene records include some ten or a dozen species, almost entirely European for reasons explained in connection with the history of other trees, and their remains are beautifully preserved in the Baltic amber, as well as in the gypsiferous shales of southeastern France. During succeeding Miocene times the birches reached the acme of their development. Over 40 Miocene species are known, and they left their remains in the deposits of this time on all the larger land masses of the Northern Hemisphere from Japan westward to France, and in Colorado, Oregon and California, being especially abundant throughout southern Europe. They continued in but slightly abated abundance in the last named region throughout the Pliocene, and a species named prenigra since it appears to be ancestral to the modern American river birch, has been found in the Pliocene deposits formed at that time along the then Gulf coast in Alabama.

Birches were unusually numerous during the Pleistocene, about a dozen species having been recorded, largely because they dwelt in regions where their remains could take a part in the numerous peat bogs that were formed at that time. Most of the Pleistocene birches represent still existing species. At this time the dwarf arctic birch (*Betula nana*) retreated southward before the advancing ice sheets and left its remains in England, Scotland, Germany and Galicia. The European white birch (*Betula alba*) has been found fossil in Scotland, Hebrides, Skye, Germany, Italy and Japan. Other fossil species occur in Germany, Galicia, Japan and Hungary. In North America the yellow birch (*Betula lutea*) has been found fossil in Ontario; the river birch (*Betula nigra*) has been found in Virginia, West Virginia, Kentucky, North Carolina, Alabama, and Mississippi; and other species occur in North Carolina and Kentucky.

THE HAZEL

"Hazel buds with crimson gems,
Green and glossy sallows."

The hazel was one of Thor's trees, and together with the witch or wych elm (*Ulmus montana*), was an object of considerable veneration among the Saxons. The name witch hazel applied to the hazel by Nordic peoples, and not to be confused with the true witch hazel of America which belongs to an altogether different tree family, is said to have been derived from the Anglo Saxon wic-en to bend, although the fact that hazel twigs were commonly used as divining rods suggests that the tree had long been associated with magic.

The scientific name of the genus, Corylus, is derived from the Greek, and is in allusion to the helmet-like leafy envelope which in the nut bearing flower enlarges and surrounds the nut, or grows out around it into a tubular beak. There are about 8 existing species and 22 varieties recognized by botanists and many of the latter are often raised to the rank of species. Of these Eurasia has 6 species and 20 varieties, and North America 3 species and 1 variety—one of the American species (*californica*) of Washington, Oregon and California being frequently considered as simply a variety of *Corylus rostrata*, our beaked hazel nut, along with 4 other varieties (or species) of Manchuria, Korea, Japan and

China, which at least illustrates the community of origin of many of the trees of North America and eastern Asia.

The hazels are all shrubs or small trees, especially toward their northern limits, although the beaked hazel frequently reaches heights of between 15 and 20 feet north of the Great Lakes. Commonly, even as far south as southern New England, the hazels are shrubs of rocky thickets or fence rows, seldom attaining the stature

Fig. 20. Existing Range and Fossil Occurrences of the Hazel Outside the Modern Range

of small trees, although some of the foreign species are somewhat larger. Their wood is of no commercial importance, although that of the western species is sometimes used for broom handles. Nor are the nuts much sought after, though this is not the case abroad where hazels are the chief quest of youthful nutting expeditions during the fall of the year, and we import a considerable quantity of hazel nuts under the name of filberts.

Hazel leaves are broadly ovate, with sharply pointed tips and truncate or heart shaped bases. The margins are finely toothed and may be in addition cut into small segments, suggestive of the leaves of the white birch, but coarser and of a different shade of green. The leaves of all the species have a great mutual resemblance and show considerable variability, so that it becomes exceedingly difficult to discriminate the fossil species, which consequently have been multiplied beyond all reason.

Scarcely any of our trees are more interesting in that hazel leaves are very common as fossils in northern lands beyond their present limits, and have the distinction of having been found to within 10° or 12° of the pole, being consequently of much importance in attempts to picture Tertiary geological climates.

Conservatively treated the number of extinct kinds of hazel considerably exceeds the living varieties, and the more spectacular time in their history was at the time of their earliest appearance in the geological record. This was during the early Tertiary, for none are known from the Upper Cretaceous. About 10 species are known from this early Tertiary or Eocene time, and 2 of these, found in the wooded region that at that time covered our prairie country in western Canada, the Dakotas, Montana, etc., are so like our two existing Atlantic species that their leaves are scarcely to be distinguished and have frequently gone by the same names, although of course no tree species has continued unaltered through such a vast lapse of time as that separating the Eocene from the present.

But the chief interest of the Eocene hazels is their northern range. They were exceedingly abundant at that time in the far northern parts of all the continents of the Northern Hemisphere. At least 3 species and many varieties are found in Alaska, where their leaves are among the commonest of fossils. If the Mackenzie River existed in those far off days, hazel thickets lined its bank where it emptied into the Arctic Ocean since their fossil remains are common in the shales near its mouth. Hazels were equally common in western Greenland and between the early Tertiary lava flows on the Island of Mull, and in Siberia. Still farther north their leaves are found in Spitzbergen, and at the farthest northern outpost to which temperate forests are known to have penetrated at that or any other time, namely, to within 10° of the pole itself in Grinnell Land, where two kinds of hazel are preserved in rocks that are today covered with perpetual snow and ice.

These Eocene records are found in a belt between 40° and 80° north latitude, and south of that belt are found traces of a warmer temperate flora—that from the shores of the Mississippi Gulf of that time being sub-tropical. In the present flora of Spitzbergen, among the 130 species of known flowering plants, there is only a single tree genus—Salix, the willow—there only 2 or 3 inches tall. The hazel today ranges from about 31° north (northern Florida) to 55° in North America and to about 60° in southern Sweden. The Middle Eocene was a time of expanded seas and partially submerged continents, and it is believed that the resulting free circulation of the warm ocean waters so ameliorated the climate that the tropics spread into the present temperate zones and the temperate zones spread far toward both poles, without any sharp contrasts except in the interior of the land masses. This was the time of the mildest and most equable climates known during the whole Tertiary period, but it was far from being absolutely uniform, or from being tropical in the far north as some rash students have asserted. At the present time the warm drift of the North Atlantic greatly modifies the climate of Spitzbergen, causing the isotherms to extend far north of their average position—the isotherm of 23° Fahrenheit reaching southern Spitzbergen, and the present cold pole is not at the geographical North pole, but in the severe continental climatic region of northern Siberia.

Obviously the hazel must have originated in some of these northern lands where it was so widely distributed and abundant in those early days, spreading from thence southward with the changing climates of the Oligocene, but apparently never getting nearer the equator than does our common American hazel (*Corylus americana*) or than did *Corylus australis* in the Island of Madeira during Pleistocene times.

During the Oligocene, Miocene and Pliocene, species of hazel continue to be abundant on the northern continents, but they had retreated from the far North and their range is essentially comparable to that of the existing forms. During the Pleistocene the distribution of the common European hazel (*Corylus avellana*) furnishes a valuable commentary on the shifting ice sheets and the probable climates of the interglacial times. The remains of this hazel in several varieties are especially common in the deposits of the third interglacial period in northern Europe, and equally common immediately after shrinking of the last ice sheet. Thus of 224 stations where fossil nuts have been found in Sweden, 219 of these are north of the present range, emphatically proving that the climate has become somewhat more severe in the last few thousand years. An extinct Pleistocene hazel has been described from the Island of Madeira, and the common American hazel has been found in cave deposits in Pennsylvania associated with Pleistocene mammalian bones.

THE HORNBEAM

Carpinus was the classical name of the hornbeam, French charme. Pliny described it and classed it with the maples. The name is said to have been derived from the Celtic car wood, and pin or pen head, from the early practise of using the wood in making yokes for cattle, in fact the common European hornbeam is often called yoke elm.

The latter, which has been much used as an ornamental tree in the northeastern United States, grows naturally in temperate western Asia, Asia Minor, and in Europe northward to latitude 55°. In southern England it is frequently used for hedges and geometrical planting, since it stands clipping well, as testified to by Evelyn, who states: "In the single row it makes the noblest and stateliest hedges for Long Walks in Gardens or Parks, of any tree whatsoever whose leaves are deciduous." The wood is close grained, tough, and hard to work, hence according to Gerard, its name hornbeam. It is a common tree in France where the leaves are frequently used for fodder. Its resemblance to the elm is superficial and is based on the leaf arrangement and the smooth greyish bark.

The pollen bearing and seed bearing flowers are in separate catkins and those of the latter, which are lax and bracteate, develop into small ribbed nutlets while the bracts are enlarging to form the three lobed and normally serrately margined wings.

FIG. 21. SKETCH MAP SHOWING THE EXISTING RANGE AND FOSSIL OCURRENCES OF THE HORNBEAM

The hornbeams are confined to the Northern Hemisphere and have about a dozen existing species, found in America from Quebec to the Central American highlands, and in Eurasia from Sweden to southern Europe, Asia Minor, the temperate Himalayas, central China and Japan.

Of the dozen existing species, only one—the hornbeam or blue beech, *Carpinus caroliniana*, is found in North America. This is not a stately tree, rarely reaching a height of 40 feet, and generally bushy in appearance, with a short fluted trunk, long slender irregularly spreading branches and light brownish-grey bark. It is distinctly mesophytic in habitat and most frequently found along stream or swamp borders, and reaches its largest size on the western slopes of the southern Alleghanies and in Arkansas and eastern Texas, dying out westward in the river valleys of the prairie States and reappearing in the mountains of southern Mexico and Central America.

The number of known fossil species of hornbeam considerably exceeds the number of species now living, and their geographical range was, of course, greater. The hornbeam is not certainly known as early as the Upper Cretaceous, although leaves from the late Cretaceous of western Greenland were described by Heer under the name of *Carpinites microphyllus*, and these may well represent the earliest known hornbeam, although they are not especially convincing. That the hornbeams originated in the North seems reasonable because, with the exception of two supposed species in the early Eocene of France, the most abundant Eocene form is the so-called *Carpinus grandis* which occurs on the Island of Sachalin of the eastern Asiatic coast, in Alaska over 2000 miles from the nearest existing occurrence, in British Columbia, in the lignite deposit of Brandon, Vermont, in western Greenland and Spitzbergen—both the last over 1000 miles north of the existing limits of the genus. Such a distribution would seemingly be impossible if the ancestral forms had originated in low latitudes.

The hornbeam is apparently absent from the extensive Eocene floras of the western United States although discovery may at any time disclose it in that region where it might be expected to have been present. Nor has it been found in the warmer floras of our southeastern States. In succeeding Oligocene times several hornbeams have been found in Russia, Germany, Italy and France.

The Miocene species were more numerous than the existing forms, numbering about a score. They occur in North America from Virginia to Colorado, Nevada and Oregon; and in the Old World from Japan and Siberia to Spain. No less than 17 different hornbeams grew in Miocene Europe, and nearly every country on that continent has contributed its records, although there appears to have been a massing of forms in southeastern Europe in the various states and crown lands that formerly constituted the Austrian empire.

The Pliocene records include 7 or 8 forms of central and southern Europe. That North America has furnished no Pliocene hornbeams as yet, is due to the almost complete absence of suitable Pliocene deposits. That hornbeams were present at that time is proved by their presence in the preceding Miocene and succeeding Pleistocene deposits. Several of the existing hornbeams appear during Pleistocene interglacial periods, in regions where they are still found. Thus *Carpinus betulus* and *Carpinus orientalis* are recorded from the Pleistocene of central and southern Europe, and our American hornbeam has been found fossil in the Pleistocene of Maryland, North Carolina, Georgia and Alabama.

THE HOP HORNBEAM

The hop hornbeam is much like the true hornbeam in appearance and habit, but frequents better drained and aerated soils, and is less northern in its range. The most obvious difference between the two trees is in the seed bearing catkins, which in the hop hornbeam are lax and terminal, with the bracts and bractlets united to form a sac-like envelope to each flower, and these by midsummer have enlarged to form an imbricated green cone-like affair superficially resembling a hop blossom—hence the common name of the tree.

The scientific name, Ostrya, was the classical name of the south European tree. The existing species are few in number and comprise a very restricted form confined to the cañon of the Colorado River in northern Arizona; a similarly restricted tree in Japan and eastern China; the common hop hornbeam of southern Europe, Algiers and Asia Minor; and the common American tree, often called ironwood because of its hard close grained wood. The last is found from the Gulf of St. Lawrence to Dakota and southward to northern Florida and eastern Texas, reappearing in the uplands of southern Mexico (Orizaba, Jalapa) and Guatemala, where they are relics, like the cypress and Carpinus, of the former greater extent of these forms during Pleistocene times or earlier, which have become separated from their fellows by the arid country of the Texas border and northern Mexico.

Our American hop hornbeam, *Ostrya virginiana*, is a handsome tree, of small or medium size, with an open crown, rarely over 70

FIG. 22. SKETCH MAP SHOWING THE EXISTING RANGE AND FOSSIL OCCURRENCES OF THE IRONWOOD

feet tall or 2 feet in trunk diameter, and usually much less. The yellowish green leaves are almost indistinguishable from those of the hornbeam. The wood is heavy, hard and tough, with a close grain, and is utilized to some extent for fence posts, fuel, and small wooden articles such as tool handles and mallets.

The geological record is very incomplete, at least such of it as has been deciphered doubtless partly because of the difficulty of distinguishing Ostrya leaves from those of Carpinus, under which name perhaps some true fossil species of hop hornbeam may be masquerading, since the characteristic winged fruits of the hop hornbeam have been found as far back as the early Tertiary. The oldest of these is from the lower Eocene of Texas. Slightly younger are similar remains described by Heer from western Greenland. Two species have been recognized in the Oligocene of France and no less than 9 species are recorded from the Miocene and Pliocene of Europe and North America. These occur in New Jersey and in the lake basin of Florissant in Colorado in this country; and in France, Baden, Germany, Croatia, and Styria in Europe. The known Pleistocene records are limited to the occurrence of our existing American species in Japan, Ontario and Alabama.

THE ALDER

"But here will sigh thine alder tree."

—TENNYSON.

Alders are not remarkable for either size or longevity, nevertheless they were associated with the early days of the Anglo-Saxon race and have taken their place in its poetry and folk lore. The above quotation suggests something larger than the small shrubby "alders by the brook" that Bryant has immortalized, and as a matter of fact several of the alders reach a height of 40 to 50 feet, and one—the white alder, *Alnus rhombifolia*, of the Cascade and Sierra Nevadas—reaches a height of 80 feet and has a tall straight trunk 2 or 3 feet in diameter. Most of the alders, however, have a distinctly shrubby appearance even when 50 feet tall. Alder wood is dense, but soft and brittle, and largely sapwood, hence it is of slight commercial importance, although the common European, Algierian and Asiatic *Alnus glutinosa* is sometimes a timber tree because of the durability of its wood under water, but even it is of relatively slight importance. The astringent bark and cones are also used to some slight extent in tanning and medicine.

The scientific name, Alnus, is the classical name of the alder. There are about 20 existing forms, half of which occur in the Western Hemisphere, all but 2 or 3 attaining to the stature of trees.

They inhabit swamps, river bottoms and moist valleys and fog belts of high mountains, often forming conspicuous thickets on mountain slopes.

The leaves are relatively large, in general somewhat coarse in appearance, dark green in color and shed green or very tardily taking on autumnal tints. They are straight veined and with toothed margins. The pollen bearing catkins are pendulous form-

FIG. 23. SKETCH MAP SHOWING EXISTING RANGE AND FOSSIL OCCURRENCES BEYOND THAT AREA OF THE ALDER

ing the preceding season and discharging in early spring before the leaves unfold, quantities of golden yellow pollen which is carried by the wind to the female flowers. The latter develop into woody cones, which when preserved as fossils, simulate sequoia cones and have, more than once, been mistaken for them. The seeds, really nutlets, are in some of the forms winged and distributed by the wind, in others they are wingless and distributed by streams.

That these methods are effective is shown by the fact that the alder has penetrated farther into South America than almost any other of our northern trees, and we can merely guess at the vast lapse of time represented by such a journey from Greenland to Bolivia.

The alders are unobtrusive modest trees, very tolerant of shade from their youth, consequently gregarious and successful. Some of them reach farther north at the present time than any other members of the family except the small Arctic birches, and they are the only representatives of this large family that cross the equatorial zone and maintain themselves in the Southern Hemisphere.

They are found in existing floras from Alaska to Labrador and southward to northern Florida and the uplands of Mexico and Central America and down the Andes through Colombia, Ecuador and Peru to Bolivia. That this extension into South America was not due entirely to the stimulus of northern glaciation is shown by the presence of a Pliocene (i.e., a preglacial) species in Bolivia. In the Old World alders are found from Kamchatka to Spain, and from Norway to Algiers and Assam, being present in all the intervening great mountain systems.

The earliest supposed representatives of the alder consist of Upper Cretaceous forms from western Greenland, Silesia, western Canada, and the Dakota sandstone of Minnesota and Nebraska—

FIG. 24. SOME FOSSIL BIRCHES (ABOUT $\frac{2}{3}$ NATURAL SIZE)

1. *Betulites Westii latifolius* Lesq., from the Dakota sandstone of Kansas.

2, 2a. Leaves of the Arctic birch, *Betula nana*, from the Interglacial of Denmark.

3. *Betula grandifolia* Ettings., from the Upper Eocene of Alaska.

4. *Betula coryloides* Ward, from the early Eocene of Montana.

5. *Betula oxydonta* Sap., from the Oligocene of France.

6. *Betula heteromorpha* Knowlton, from the Eocene of Oregon.

7, 7a, 7b. Leaf and fruits of *Betula prisca* Ettings., from Miocene of Austria.

8. *Betula Brongniarti* Ettings., from the Miocene of Austria.

9, 9a. Leaf and fruit of *Betula cuspidens* Sap., from the Upper Oligocene of France.

10. Fruit of *Betula dryadum* Brongn., from the Miocene of Europe.

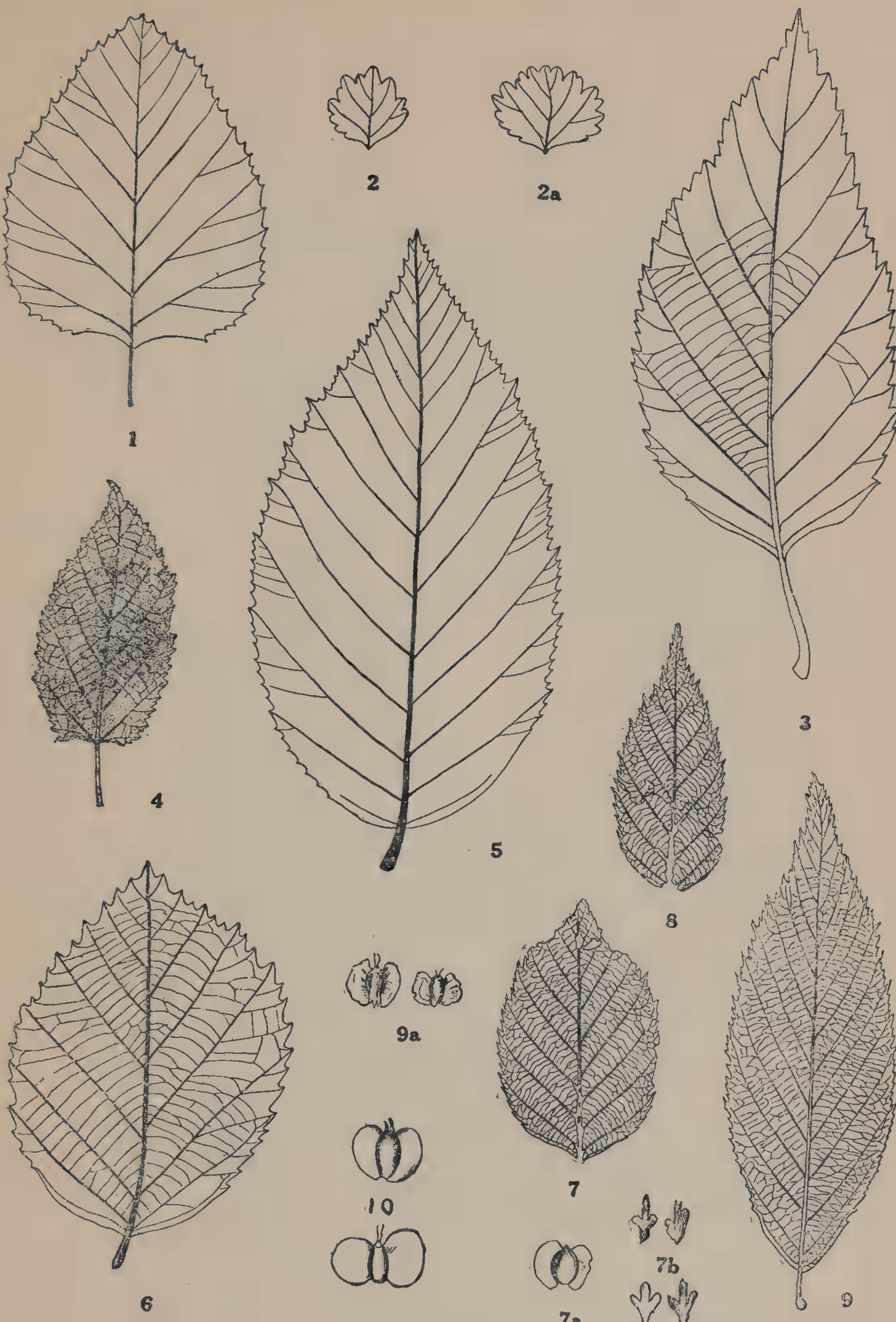

FIG. 24

all of somewhat questionable identity. The alders, like the hazels, make a prominent display in the moist temperate floras of the Eocene, no less than a score of species having been described from the rocks of this age, in which they are represented by leaves, catkins, cones, and wood. True alders appear in the earliest Eocene of France, Wyoming, Montana, Dakota, and Colorado; and they are especially common in the Eocene rocks of Alaska, Sachalin, Greenland, Iceland and Spitzbergen. Tertiary species of alder have been described from both Australia and Tasmania, but these are not certainly identified.

Undoubtedly the earliest flowering plants reached Australia over a land bridge from Asia, but until the plant fossils of that region receive a thorough revision at the hands of a competent botanist, too great reliance cannot be placed on the identifications of the early students of these floras. If authentic these Australian occurrences mark the greatest penetration of the Southern Hemisphere by any members of this family, and almost rival the remarkable southward migration of the beech family.

Oligocene alders number 6 or 7, and are confined to Europe, one being present in the Baltic amber deposits. As I will have occasion to remark in connection with so many of our trees, this paucity of Oligocene records is due to the absence or lack of discovery of Oligocene plant beds in many regions, and especially in North America. However, there is not the slightest doubt but that there were Oligocene alders at that time in both North America and Asia.

During the succeeding Miocene time the geological record becomes profuse again and we find over 20 different species of alders

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Fig. 25. Some Fossil Leaves and Nuts of the Hazel (Slightly Reduced)

1. *Corylus MacQuarrii* Heer, from the Oligocene of France.
2. *Corylus americana fossilis* Newb., from the early Eocene of Montana.
3. *Corylus Fosteri* Ward, from the early Eocene of Montana.
4. *Corylus rostrata fossilis* Newb., from the early Eocene of Montana.
5. Hazel nut from the Oligocene of Saxony.
6. Hazel nut from the Oligocene of Baltic Prussia.

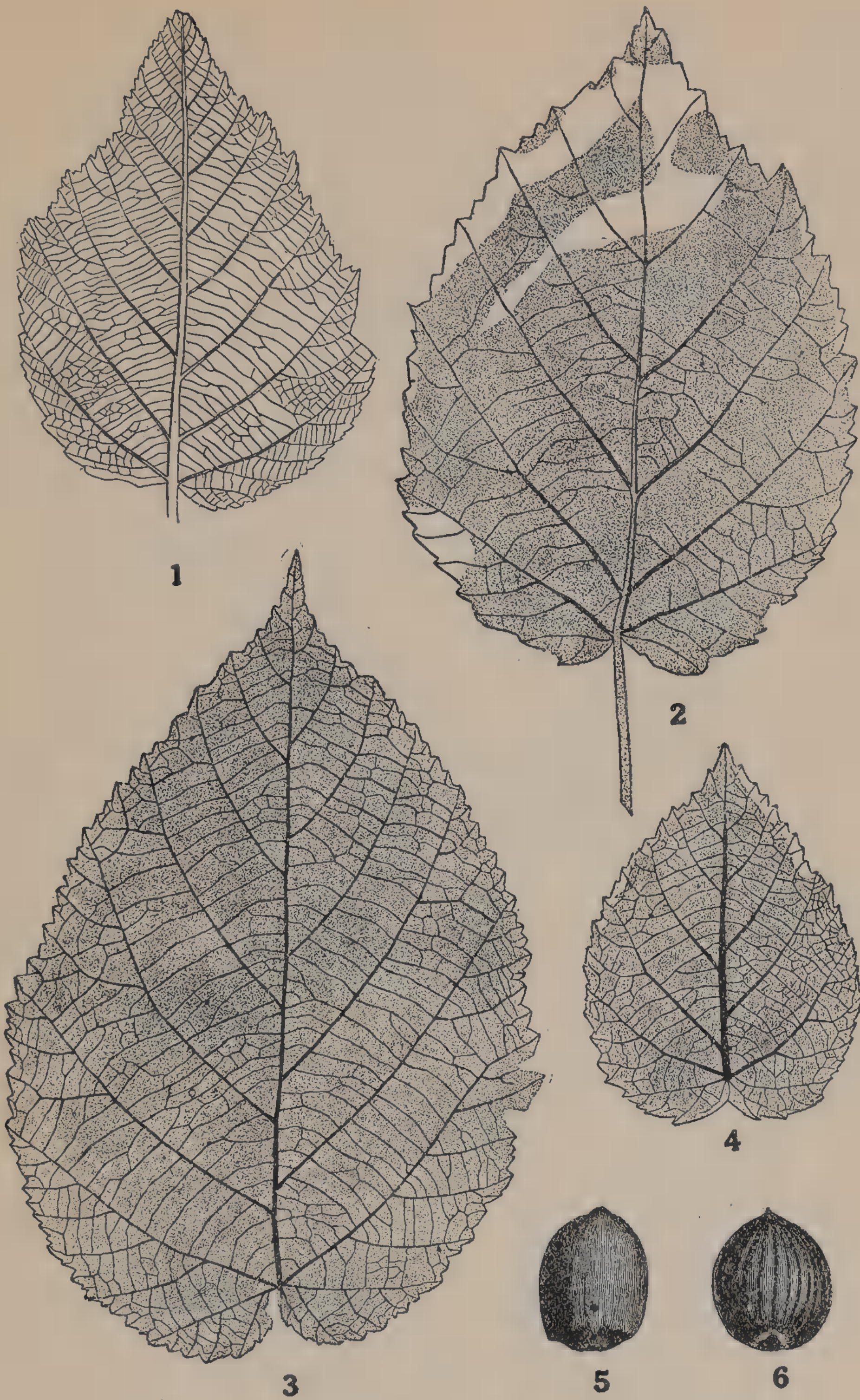

Fig. 25

throughout Eurasia and North America. They are especially prominent in the lignite beds of this age in Europe, which represent fossil swamp deposits. In North America they are found in California and Colorado, eastern North America being especially deficient in Miocene records of terrestrial life.

Except for Japan the numerous Pliocene forms of alders are confined to European localities where they are generally distributed, being especially numerous in France and Italy. At this time again North American plant records are very scanty, although here again there is no reason to doubt the presence of alders on both coasts, since they are found in both regions in the succeeding Pleistocene deposits.

Of the 7 or 8 alders which have been identified from the Pleistocene, all that have been accurately determined represent still existing forms, which were, indeed, distinctly foreshadowed during the Pliocene. The European alder, *Alnus glutinosa*, has been found in the Pleistocene of England, Skye, Germany and Hungary. Another species occurs in northern Italy at this time. The hoary alder, *Alnus incana*, which is today found in all three of the northern continents, occurs in the Pleistocene of Japan. In North America the red alder, *Alnus rubra*, occurs in Alaska; the smooth alder, *Alnus incana*, has been found in Maryland, and a third species has been recorded from interglacial deposits in Ontario.

CHAPTER XII

The Beech

There is no finer sight than an ancient beech woods, or even a single tree, for it has almost the ruggedness of the oak, and a more graceful beauty withal. Its smooth light colored bark fits like a glove, and from time immemorial in regions where there were lads and lasses the boles have been carved with initials, impaled hearts, and lovers' knots. The roots have a habit of spreading near the surface of the ground so that they show, especially on slopes where the shaded ground is subject to wash, giving them the appearance of grimly grasping their mother earth as if afraid of separation.

The members of the beech family (Fagaceae) rival those of the pine family from a utilitarian point of view, and while of later origin they are equally enshrined in the traditions and poesy of the Anglo-Saxon race and in the practices of innumerable crafts from milling and the manufacture of wood-type to shipbuilding—once a craft but now a disease in its iron age of development.

It will perhaps be possible at some future time to define the demarcation between the beeches, oaks and chestnuts that comprise this great family of Fagaceae and to trace the lines of descent among the hundreds of fossil and living species that are involved. It is easier and less confusing to consider the single line to which the beech belongs, not that there are no great gaps in our knowledge of its geologic history, especially its place in the botanical history of the great area of Asia, but because certain striking conclusions can be deduced from the present state of our knowledge. The beeches (the generic name Fagus is derived from the classical φαγειν, to eat) comprise a fairly compact group of species formerly referred to the single genus Fagus (Linné, 1753) well illustrated by the common beeches of Europe, southeastern North America and eastern Asia.

There are four existing species of Fagus in the North Temperate Zone. Two of these occur in the coastal region of eastern Asia. The American beech, formerly much utilized in the manufacture of charcoal, is now largely lumbered for a wide range of special commercial uses such as wooden and laundry ware, handles, clothes pins, shoes, etc., since the wood is hard, tough and strong and does not decay or soften under water. The tree ranges from Nova Scotia westward through Ontario to Wisconsin and southward to western Florida and Texas. It frequents rich uplands and mountain slopes in the northern part of its range and bottom lands in the South, reaching its maximum development in the lower valley of the Ohio and on the slopes of the southern Alleghanies.

Beech was abundant nearly everywhere in Colonial America, but the wood was hard to split and decayed quickly upon exposure to weather, so that the pioneers, with a fence rail point of view, had a very small opinion of it. They soon discovered, however, that it did not decay or soften under water, so that quite early they utilized it for water wheels, and especially for gudgeons and bearings, in their grist and saw mills.

The charcoal burners early learned to utilize beech and we find Peter Kalm, that quaint botanist and explorer whose name is immortalized in the genus Kalmia for the mountain laurel, writing in 1749 that, next to black pine the best charcoal for smithing purposes is made from beech. The wood is difficult to work in carpenter shops, but it finds a large use where freedom from taste is desirable as in butchers, blocks, cutting boards, skewers, ice cream paddles, tubs and pails for butter and lard, and hogsheads for sugar and molasses. Picnic plates are now made by the millions of beech wood, which also takes an important place in the manufacture of kitchen and laundry appliances, blocks, agricultural impliments, furniture, flooring and fixtures.

The fourth existing species is the European beech and its horticultural varieties. It is one of the common forest trees of temperate Europe from southern Norway and Sweden to the Mediterranean, ascending to elevations of five thousand feet in the Swiss Alps. It is common in southern Russia and throughout Asia Minor to northern Persia.

The common name of beech is from the Anglo-Saxon *boc*, *bece* or *beoce*, the German *buche*, the Swedish *box*—all words signifying book as well as beech and derived from the Sanscrit *boko* or letter and *bokos* or writings. This connection of the vernacular name of the tree with the graphic arts is supposed to have originated from the fact that the old Runic tablets were of beechwood. At any rate in beech we probably have the oldest existing name of any wood in the world.

The beech has been utilized by the natives of Europe since prehistoric times, a fact shown by the presence of its remains in the deposits of the Swiss Lake dwellings of the Neolithic period, or younger stone age (about 7000 B.C.). It is one of the largest of British trees, especially on chalky or sandy soils. Beech mast, formerly known as "buck," was not only a subject of medieval local legislation, but it even gives its name to the county of Buckingham.

It is obvious from the interrupted distribution of these 4 existing species, namely, 1 in Europe, 1 in southeastern North America and 2 in eastern Asia, strikingly shown on the accompanying sketch map, that these existing species are the isolated remnants of a distribution which in late geologic time must have covered the intervening areas and embraced practically the whole Northern Hemisphere. This supposition derived from a study of the present ranges of the 4 existing species will subsequently be shown to be somewhat less rather than the whole story which geologic history elucidates.

With the exploration of antipodean lands during the last century about a dozen forms of beech-like trees and shrubs were discovered in New Zealand, Australia, Tasmania, Chile and Terra del Fuego. Some of these were found to only attain the stature of shrubs, many of them were evergreen and all had tiny leaves. They differ from the northern beeches in their partial lack of deciduous habits, their smaller leaves and in their flowers being solitary or grouped in clusters of three. For a long time these southern forms were referred to the genus Fagus, which was divided into two sections—a section Eufagus for the well known species of the north temperate zone and a section Nothofagus for their antipodean congeners. The latter have since been raised to generic rank, quite rightly it seems to me, although their close relationships and community of origin with the true beeches is clearly demonstrable. The curiously segregated ranges of these existing forms is shown on the accompanying sketch map.

Granting that these two lines are offshoots of a common stock the question of its original home at once suggests itself, along with the query as to whether in some past time members of the 2 genera flourished side by side either in the north or the south temperate zone. These questions can only be answered by an appeal to the fossil record, a book with unfortunately many missing chapters, especially those relating to the great land mass of Asia.

The oldest known fossil forms are a species (*Fagus prisca* Ettingshausen) from the early Upper Cretaceous (Cenomanian) of Saxony and three species in the Dakota sandstone of the western United States of almost exactly the same age as the Saxon species. Their essentially contemporaneous appearance in Europe and America argues that they were immigrants into both regions from some third area. Only two alternatives are probable. Either their ancestors came from the Arctic region and spread southward simultaneously into Europe and America or else they originated in Asia and spread westward into Europe and eastward into America across the land bridge which closed Behring Sea at about this time. If the Arctic was the original home of the beech its remains should occur in either the Cenomanian or later Cretaceous floras of Greenland where it has not been found although it is present in that region in the Tertiary. Furthermore if it had originated in the north it should have been a member of that migratory wave of vegetation that swept southward along the east coast of North America at about the dawn of the Upper Cretaceous. Our east coast Cretaceous contains a very large flora found in deposits of this age from Marthas Vineyard to Alabama and this flora had a great many elements in common with the Greenland Cretaceous flora. No traces of Cretaceous beeches have, however, been discovered along the Atlantic coast.

If, on the other hand, Fagus originated in the Asiatic region it would have had an almost latitudinal pathway with broad and uniform land surfaces both westward to Europe and eastward to western North America, the latter region almost entirely cut off from eastern North America by an epicontinental sea. The presence of petrified beech wood in the Cretaceous of Japan, of Germany and in the Eocene of the Caucasus, as well as leaves in the Cretaceous of Vancouver Island and in the Eocene of Alaska and the early Tertiary of Australia would similarly accord with this hypothesis of its center of radiation better than any other.

The Eocene records also embrace various North American and European forms which offer no difficulties on such a theory, nor do the numerous succeeding Oligocene and Miocene species of the northern hemisphere. The antipodean records, of which there are a considerable number, seem at first thought to offer greater difficulties. In deposits the age of which is unfortunately somewhat uncertain but which are either Eocene or Oligocene, 4 species of Fagus are found in southern South America—three in Chile and 3 in Terra del Fuego and a fifth is found on the edge of the Antarctic continent in Graham Land. They are, in all of these localities, associated with an abundant display of Nothofagus, no less than 10 species from Chile, Patagonia, Terra del Fuego and Graham Land having been described by Engelhardt and Dusen. The Tertiary species of Fagus in the Australian region are likewise associated with four or five species of Nothofagus. Another species is found in Tasmania and there are several in the outlying region of New Zealand, one of the latter being common to eastern Australia.

It would be an attractive hypothesis to consider Fagus as of northern origin and Nothofagus as having originated independently on the broad bosom of the Antarctic continent, from whence it spread northward into southern South America on the one hand, Tasmania and eastern Australia on the other, and to New Zealand by a third route from the south northward. Such a theory would be in accord with many recent discussions of geographical distribution. It would almost certainly be suggested by plant geographers who lacked any knowledge of antecedent floras by the peculiar distribution of the existing species of Nothofagus, namely, a dozen very similar species about equally distributed between southern South America (Chile and Terra del Fuego), South Australia and Tasmania, and New Zealand.

This attractive hypothesis is, I believe, entirely erroneous, and for the following reasons: It would entirely fail to account for the distribution of Fagus, which is clearly of northern origin and yet is associated with Nothofagus in the Tertiary of South America, Graham Land and Australia. Moreover what appears to be true species of Nothofagus occur in the Oligocene of Greece (*Fagus pygmaea* Unger and *Fagus chamaephegos* Unger). If on the other hand Nothofagus was of Holarctic origin it would reach these antipodean lands along with Fagus. A number of elements of the Dakota sandstone flora (Upper Cretaceous) are found in the later Cretaceous of Argentina, showing that migration from North America into southern South America was not only possible but actually took place during the Upper Cretaceous and all lines of evidence--bathymetric, tectonic, petrographic and paleontologic, indicate that South America was in direct connection with Antarctica. The Australian species would have reached Australia, Fagus and Nothofagus together or in successive migrations either from southeastern Asia or from Antarctica over the then existing land connections.

New Zealand offers more difficulties but there is really a vast amount of paleobotanical and botanical evidence (the latter discussed by Alfred Russell Wallace in his "Island Life") indicating a common origin for the Australian and New Zealand floras. There may have been a direct interchange of floral elements by

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FIG. 26. SOME FOSSIL LEAVES AND FRUITS OF THE BEECH (NATURAL SIZE)

1. *Fagus cretacea* Newberry from the Upper Cretaceous of Kansas.
2. *Fagus feroniae* Unger from the Miocene of Bohemia.
3. *Fagus horrida* Ludwig. Bur from the Miocene of Germany.
4. *Fagus lambertensis* Berry from the Pliocene of Alabama.
5. *Fagus intermedia* Ettingshausen. Nut from the Eocene of England.

6–8. *Fagus ferruginea* Aiton. Bur, nut and leaf from the Pleistocene of North Carolina.

FIG. 26

way of the since sunken lands indicated by the topography of the ocean bottom and by the coral islands and tectonic (structural) lines across Polynesia.

It seems probable, however, that Australia and New Zealand were never actually connected in later geological times, that is to say, since the higher plants were evolved. Otherwise New Zealand should contain some traces of the animals, such as the marsupials, and plants such as the Eucalyptus or gums that particularly characterize the life of Australia. New Zealand has, however, been shown to have been much more extensive in former than at the present time, and it seems probable that it received its beeches from the Antarctic continent during one of these times of extension rather than by a land bridge between New Zealand and Australia.

If Fagus or even Nothofagus were of southern origin, and I think that it will be conceded by botanists familiar with the two genera that they are the immediate descendants of a common stock, it would be contrary to the general rule of past distribution of the ancestors of our existing flora which in every case that has been investigated show former cosmopolitanism in the great land mass of the northern hemisphere and a simultaneous or subsequent migration into southern lands. This statement is notably true of the coniferous genera Araucaria and Dammara. It is likewise true of the great antipodean families Proteaceae and Myrtaceae, and many other and no less striking instances could be enumerated.

It would seem that Nothofagus was more primitive than Fagus, or at least that it is more like the original stock from which both took their origin. This stock was probably evergreen in habit, small in size and with relatively reduced leaves. If this supposition is justified it might be considered as furnishing another argument for the northern origin and southward migration of the original stock, for the natural place to look for existing forms most like their remote ancestors has been considered by some students of distribution as being farthest away from the original center of radiation—nearer this center they would tend to have been replaced by successively later and later evolved forms.

The actual details of the past history of the beeches were of course infinitely more complicated than I have sketched them. All of the new species did not originate successively in one area and radiate from it regularly in all directions. Each continental area must have been a local center of evolution and radiation after the stock had once reached it, and doubtless there were interchanges between one and another parts in progress during the whole of the long ages of the Tertiary period. Nevertheless the foregoing sketch shorn of its unknown and confusing complexities emphasizes the major features of beech evolution and migration.

It remains for me to consider the recorded occurrences of beeches during past time somewhat more fully than I have done in the preceding paragraphs. The Cretaceous species have already been enumerated in the paragraphs discussing the probability of Asia having been the original home of Fagus and Nothofagus. The Eocene species are nine or ten in number and include records from Europe, Greenland, Alaska and the western United States. The Oligocene species number about 14 and the records include eastern and southwestern Asia, probably Australia, all the countries of Europe where plants of this age are represented, eastern North America, Graham Land, Chile and Terra del Fuego. The Miocene species number about 30. Fagus at this time was practically cosmopolitan, being represented throughout Europe and North America, particularly in the west in the Rocky mountain province (Colorado) and along the Pacific coast (California) where it has now long been extinct. It was present in Iceland and Spitzbergen, in Australia, and at several points in eastern Asia. The Pliocene species number over a score and include several that foreshadow forms that are present in our recent floras. The records include Japan and most Pliocene plant localities in Europe. In the United States where Pliocene deposits other than those of strictly marine origin (and consequently lacking fossil plants) are very rare, an extinct species of Fagus is found in Alabama along the Gulf coast of that period.

Beech forests seem to have flourished in undiminished vigor over most of the northern hemisphere up to the advent of the glacial period, although their continuous range had already been interrupted by the formation of mountain ranges like those of the western United States or those of central Asia which by their interference with the climatic equilibrium caused the development of vast stretches of arid or semi-arid country like that of the present day in central and southwestern Asia and in our own western and southwestern states.

The Pleistocene records of the beech include the remains of wood, of an abundance of leaves as well as of nuts and husks, the latter almost always present in buried swamp deposits. These records embrace an extinct species in Japan, remains of the still existing *Fagus japonica*, and other leaves in that country which are distinguished with difficulty from the European beech. The latter, *Fagus sylvatica*, occurs in England, Germany and southern Europe at this time and is often associated with traces of Neolithic man. The American beech, variously denominated (*e.g.*, *Fagus ferruginea* Aiton, *Fagus americana* Sweet, *Fagus atropunicea* (Marsh) Sudworth, and *Fagus grandifolia* Ehrhart), is widespread in Pleistocene deposits. It is found in the Port Kennedy bone cave in Pennsylvania; in the bluffs of the Mississippi in western Kentucky; in the high river terraces of West Virginia, and in buried swamp deposits in Maryland, Virginia, North Carolina and Alabama.

In the foregoing brief sketch I have refrained from saying much about the utility of the beeches or of the surpassing beauty of their light smooth bark and glossy symmetrical foliage. Beech woods are the common heritage of the Anglo-Saxon race and are intimately associated with our ancestors during the time that they were slowly emerging from barbarism. Ages later they furnished the best fuel for the open hearth heating and cooking of our more immediate ancestors and along with the oaks furnished the mast for the swine that roamed the forests of the feudal barons.

The mist of tradition and history that clothes the beech should inevitably awaken some of the thrill corresponding to that awakened by a visit to some scene of ancient romance or tradition such as Kenilworth Castle, Palestine or the scenes of classic Greece or imperial Rome.

CHAPTER XIII

The Oak and Chestnut

The family to which the oak and the chestnut belong is now called the Fagaceae and includes the beech as well as various other tree types not familiar to the residents of the United States. The beech has been discussed in a separate chapter, and the present chapter will be devoted to the oak and chestnut after some mention is made of these other genera. The first of these is one called Castanopsis which has about 30 existing forms with evergreen leaves and found from the Himalayas and tropical India to Hong Kong, and represented on our Pacific coast. Castanopsis is intermediate between the true oaks and the chestnut, and its presence on both shores of the Pacific indicates that its ancestors must have flourished in the intermediate country and over the land bridge connecting North America and Asia in the Behring Sea region at some past time when the climate of these northern lands was more genial than it is today. Pasania is a second genus of existing oak-like plants with over 100 species in the southeastern Asiatic region, and like Castanopsis, it is represented on our Pacific coast by a single form which ranges from southwestern Oregon to southern California, separated from its 100 Oriental congeners by the whole breadth of the Pacific ocean. This western form is the so-called Tanbark oak, the *Quercus densifolia* of Hooker and Arnott.

There seems to be no doubt but that all of these and the other members of the oak family are the diversified descendants of a common Cretaceous stock. This ancestral stock is represented by the extinct genus Dryophyllum which is first recognized in the Upper Cretaceous at which time it was not only abundant and varied but widespread. Its leaves were of the chestnut, entire or holly oak type, and possessed a characteristic arrangement of the veins which usually enables them to be readily recognized and distinguished from those of the oak, chestnut or beech. They were especially abundant among the sand dunes that at that time bordered the Upper Cretaceous sea in northern Europe (Aix-la-Chapelle, Bohemia and Silesia). They were also abundant around the shores of the late Upper Cretaceous sea in the Mississippi valley where one of them has been given the significant Latin name of *protofagus*, and may actually represent the starting point of the beech line of descent. Dryophyllum also occurs in beds of Upper Cretaceous age in western Greenland, and there are several species recorded from deposits of this age in Montana, Wyoming and Colorado. They have even been recorded from Australia, but these last records are not regarded as authentic. Dryophyllum is even more abundant in the early Eocene than it was in the late Cretaceous. Here in America there are 5 abundant and very characteristic forms in the early Eocene of the Gulf states. There are 3 recorded from Colorado, 1 from Wyoming, 1 from the Yellowstone Park, California and British Columbia. Another is common in the late Eocene of Alaska and Sachalin Island at the opposite ends of the land bridge of which the central planking has since worn away to form Behring straits. In the early Eocene of Europe, which many geologists call the Paleocene, there are abundant leaves of 4 species of Dryophyllum in Belgium, 3 in France and another in Italy. By Oligocene times only 3 doubtful forms are known in France and Italy. It is true that 6 have been recorded from the late Tertiary of Indo-China, but the name Dryophyllum is used for these in the sense that it represents doubtful members of the Fagaceae, and not in a strict botanical sense.

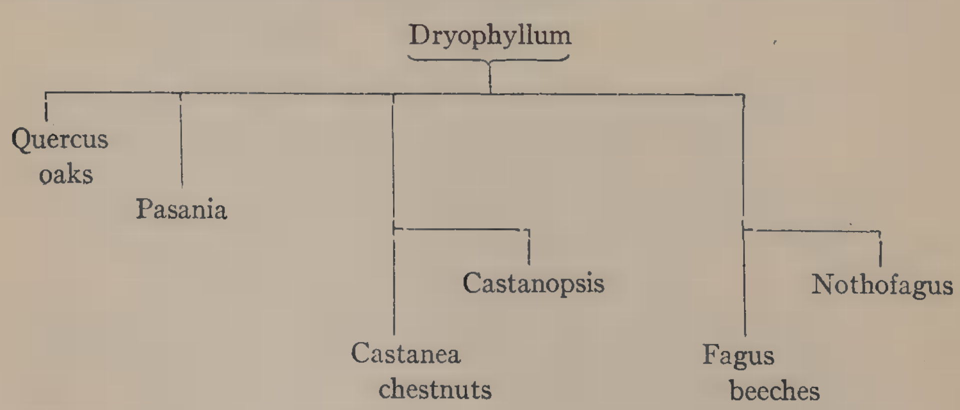

Diagram Showing the Interrelationships of the Oaks, Chestnuts and Beeches

The relation of the various modern genera to one another and to the ancestral Dryophyllum stock is shown in the accompanying diagram. Space does not permit of a detailed discussion of most of these genera even were such a treatment desirable, which it is not, since Pasania and Castanopsis are unfamiliar to most of my readers and are sort of alien immigrants from Asia that have survived on our Pacific coast.

THE OAK

"Jove's own tree,
That holds the woods in awful sovereignty."

—VIRGIL, *Georgics.*

The oak has always been an object of veneration or of sentimental tradition by all of the seafaring nations of history with the possible exception of the Phoenicians and the Norsemen. By the Greeks it was believed to have been the first tree, and it was sacred to Zeus. An oak had sheltered his cradle on Mount Lycaeus and he was believed to haunt the sacred oak at Dodona. The oak has also frequently been the object of worship of the various tree worshipping cults of the Old World—the very name Druid is said to have come from the root deru, the Celtic for oak.

We read in the Old Testament that Jehovah appeared to Abraham beneath the oak tree at Mamre in Hebron, and in later days the natives built altars to the supposed Abraham's oak (terebinth) which were eventually destroyed by order of the religious Constantine, who caused a church to be erected to replace them. That the earlier Hebrews were frequently tree worshippers is further indicated in the story of Gideon: And it was under an oak which was in Ophrah that the angel of the Lord came to Gideon and told him that it was he who was to save Israel from the Midianites.

In later days there was a great oak at Geismar in Hesse dedicated to Jupiter and this was felled by order of Bonifacius, and a chapel to Saint Peter was constructed of its timber. At Kildare in Ireland, the name being derived from the Gaelic cilldara or church of the oak, tradition has it that Saint Bridget built her church under an oak tree. The oak and the mistletoe associated with it in

Britain were a part of the druidical cult, and in the more modern days it was believed that the spirit of the oak took refuge in the mistletoe during the winter when the tree was leafless. The association of the mistletoe with Christmas grew out of the former belief and the custom of bringing the mistletoe into the house in order that the tree spirit might bring fertility to the homesteaders.

Fig. 27. Sketch Map Showing the Existing Distribution of Oaks

There are historic oaks in almost every region where oak trees of outstanding size and longevity are to be found. Among these may be mentioned Charlemagne's oak in the forest of Fontainbleau; the Abbott's oak at Woburn Abbey where Henry VIII hung the Abbott in 1537; the oak in the New Forest against which the arrow is said to have glanced that killed William Rufus; the royal oak at Boscobel in which Charles II hid after the disastrous battle of Worcester; the William Wallace oak at Torwood; Alfred's oak at Oxford; the Charter oak, that bulwark of liberty at Hartford, Connecticut, and the Wye oak on the eastern shore of Maryland.

The oak is especially esteemed by the Anglo-Saxon race not only as the monarch of the forest which turned into ships should forever preserve English liberty, but more particularly as a fit symbol of the sturdy Anglo-Saxon character, that might yield to adversity but which was not to be uprooted or changed by passing storms. A like recognition of the sturdy oak in still earlier days would seem to have been the inspiration for the use of oak leaves as a civic crown by the Romans, who also dedicated the tree to Æsculapius, probably because of its healthy longevity.

Not only did maritime folk early come to appreciate oak planking, but the more lowly keepers of the swine likewise had their reasons for appreciating the bounty of the oak, in fact the Greek choiros, a pig, is in allusion to oak mast, and acorns were believed to have been the staple food of humanity in those far distant days before Demeter had introduced grain upon the earth. We find that the British forests are enumerated in the Doomsday Book by the number of hogs they could fatten. Our Latin name for the oak tribe, *Quercus*, is said to have been derived from the Celtic *quer* or fine and *cuez* or tree, so that it will come as something of a shock to learn of the tiny oaks only a few inches high and with spreading underground stems like the *Quercus minima* of Florida, or to learn of the vast oak forests in Mexico and Central America with their strange undergrowth of small palms, tree ferns and tropical climbers.

Although the oak may be the monarch of the forest in the temperate climes of the Northern Hemisphere it is by no means confined to those regions but is well represented in most tropical countries except the uplands of Africa and South America where oaks have apparently never reached farther south than the mountains of Colombia. There are a number of oaks in the West Indies, and over 300 different kinds are recorded from Central America. Both shores of the Mediterranean as well as the Caribbean have their oaks and there are several species in tropical Asia and the East Indies as far as New Guinea.

Although so abundant at the present time the oaks represent a very old type of tree, this would be inferred from their present distribution even though nothing were known of their geological history. Considerable of this ancestral history is known, however, but not in enough detail to do more than sketch its more general outlines. Nor is the information about the existing oaks complete enough to aid greatly in an attempt to outline the past migrations and evolution of the various forms. DeCandolle's monograph of the existing oaks published in 1864 enumerated 281 species. Since that date much has been learned about oaks in general and much more about the maze of species inhabiting the uplands of Mexico and Central America. In a recent publication Trelease recognizes 354 species in America alone so that there must be about 500 existing species in the present floras of the world.

Both Saporta and Ettingshausen have sought to untangle the web of distribution and the geological history of the oaks, but it must be confessed with rather indifferent success. Explanation must still wait upon lagging information, and the present attempt must be considered one of generalities rather than of details. A great many fossil leaves have been described as oaks, but a large number of these have no claim to such a relationship. The problem of identification of oak-like leaves, particularly in the mixed floras of the Upper Cretaceous and Eocene periods is most difficult of solution. When the botanist compares these fossil leaves with only those of the familiar temperate trees he is frequently misled. For example, supposed oaks in the lower Eocene floras of our southern states have been found to represent an entirely different family of plants, the Dilleniaceae, at present not found in the United States. Similarly several oaks were described from Pliocene deposits in the state of Bahia, Brazil, which if authentic would represent a remarkable extension of their known range. I have not seen the actual specimens upon which Baron Ettingshausen based these determinations, but I have examined large collections from the same outcrop from which his specimens came, and these represent an entirely different floral assemblage without any traces of oaks, which, furthermore would be entirely out of place in such an assemblage.

In our latitudes the oaks are almost entirely trees which, as a rule, grow slowly and are long lived and agressive trees. Naturally among a multitude of forms there is a great diversity of individual adaptations. Thus our white oak, *Quercus alba*, is especially

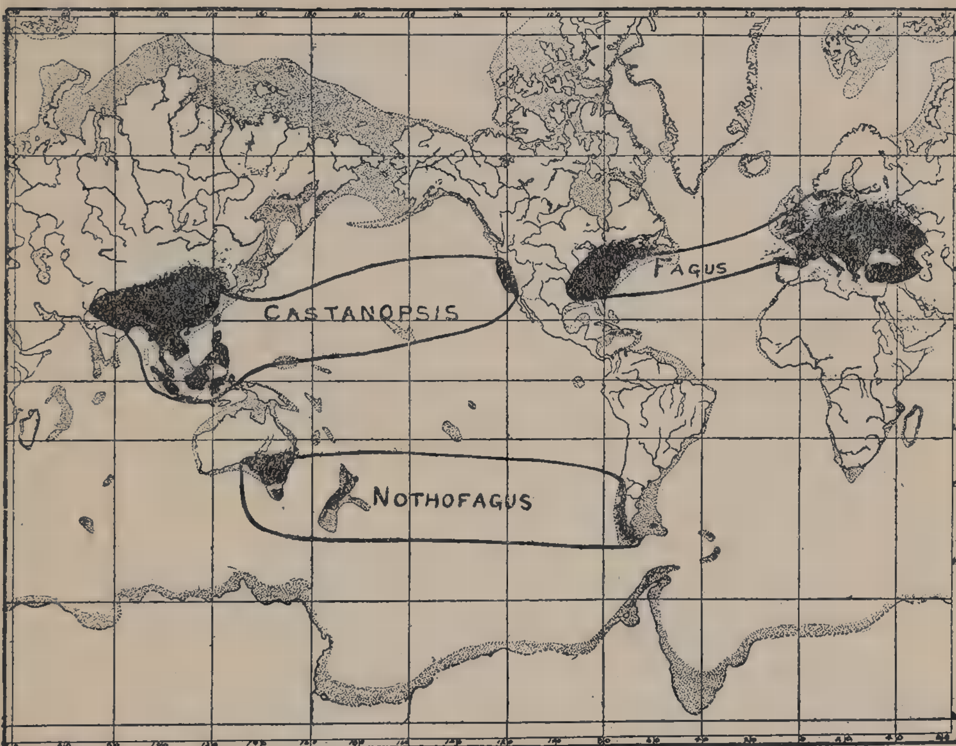

FIG. 28. SKETCH MAP SHOWING EXISTING DISTRIBUTION OF THE BEECHES, FAGUS AND NOTHOFAGUS, AND OF CASTANOPSIS

sensitive to excess supplies of ground water, whereas the swamp white oak, *Quercus lyrata*, the willow oak, *Quercus phellos*, and the various water oaks are extremely tolerant of water and often live in swamps and similar environments where the surface may be flooded for part of the year, and where it is always very wet.

The oaks are mostly massive trees with straight trunks, furrowed bark, and large powerful branches. Some, like the white oaks, mature their acorns in a single season, and others, like the black and red oaks require two years to mature their fruit. The pollen bearing flowers are minute and are borne singly on thread-like pendulous stalks in tassels from the twigs of the previous year. The seed bearing flowers are separate from those which produce the pollen and are also minute, being borne singly or in clusters from the bases of the young growing leaves of the spring. The pollen is brought to the ovulate flowers through the agency of the wind, and the mature acorns are disseminated by being carried by streams, to a slight extent being blown about by winds, and largely through the agency of mammals such as squirrels, or birds. On the whole they spread much more slowly than do the seeds of trees which have winged fruits like so many of our forest trees.

There is but slight need to take the space to eulogize the virtues of oak timber, which have been recognized for ages. The different species exhibit great differences, however, which lumber dealers are somewhat prone to overlook. Governments once maintained reserves of live oak timber for ship building purposes as today they maintain oil reserves. Cheap oak furniture consumes large quantities of the wood at all times, and the better grades vary with the fashions for flemish, golden, antique and other classes of finish or period furniture. Much oak goes into the better grades of flooring and interior finish, and this inventory merely hints at the variety of uses and the great annual consumption of oak wood for these and for tanning, milling, vehicle and other purposes.

The oaks are characterized by the sub-epidermal development of cork in their stems, and this tendency becomes excessive and the basis of an industry in the case of the cork oak, *Quercus suber* and its varieties. This tree of southern Europe and northern Africa has been utilized for at least the last two thousand years exactly as it is at the present time. Camillus is said to have worn a cork life preserver when he swam the Tiber during the siege of Rome by the Gauls. The gall oak, *Quercus infectoria*, like all the other oaks produces, but more abundantly, the tumors due to insect injuries, and known as galls, and these have entered extensively into the manufacture of black ink—less largely in recent chemical years. The tree is a native of Asia Minor and Syria, Aleppo being the chief exporting point.

Oak wood is distinguished by a feature that it shares with the beech, in that in both there are large compound rays running radially through the wood in addition to the small secondary rays, and it is these large rays that give the so-called silver grain to oak wood.

The oaks appear to have diverged from the ancestral Dryophyllum stock at the dawn of the Upper Cretaceous, or perhaps in the closing days of the Lower Cretaceous. Some hundreds of kinds of fossil oak leaves have been described, but a considerable number of these, and especially those from the earlier rocks are more or less open to suspicion regarding their proper identification. Cretaceous oaks have been described from both Australia and New Zealand, and Tertiary oaks from Australia and Tasmania by Ettingshausen, but that acute botanist was obsessed with the absolute cosmopolitanism of the Tertiary floras, and most, if not all, of his oak determinations are not to be relied upon. I do not deny the possibility that oaks may have formed a part of that ancient flora which appears to have spread southeastward from Asia during Cretaceous times, but the proof of this must await more convincing evidence than has as yet come to light.

Similarly, only 4 of the 14 species of oaks that Heer described from the Cretaceous rocks of western Greenland appear to be true oaks. A large number, 20 in all, of equally dubious oaks have been described from the Dakota sandstone of our western states—this sandstone representing the initial deposits of the advancing Upper Cretaceous sea in that region. Next in point of numbers are the 16 species of supposed oaks described from somewhat later Upper Cretaceous deposits in Westphalia. Other Cretaceous oaks have been recorded from Silesia, Prussia, Saxony and Bohemia in Europe; from Alaska and Vancouver Island on this continent; and from all sections of the United States where rocks of this age are known, to a much larger extent in the West than in the Atlantic Coastal Plain. No characteristic fruits have been found with these early oak-like leaves, which, if they are true oaks, belong to the entire holly, and chestnut oak types, and may really represent varieties of Dryophyllum.

There are many oaks described from the Eocene period, some undoubted in their identity, and represented by fruits as well as leaves. They occur in the basal Eocene of Belgium, and in the present plains country bordering the Rocky Mountains, which, however had not yet been elevated at the time that they flourished. Later in the Eocene we find oaks especially abundant and widespread in far northern lands, at that time marked by milder temperatures than prevail at the present time, a time when temperate floras pushed toward the poles and tropical floras invaded the temperate zones. Fifteen different oaks, nearly all authentic and of the chestnut or holly oak type are recorded from the late Eocene deposits of western Greenland: 6 are recorded from Alaska: 3 from Sachalin Island: 4 or 5 from British Columbia: 1 from Iceland: and 5 from Spitzbergen.

Oligocene times, largely unrepresented by plant bearing beds in North America, show numerous oaks in Russia, Germany, France and Italy. Oaks are exceedingly abundant everywhere throughout the northern hemisphere during Miocene times, especially in the humid forested Mediterranean countries and those of our Pacific coast region, in both of which many noble oak forests must have delighted ancestral squirrels and extinct members of the swine family with their bounty. Thus 33 Miocene oaks have been recorded from Italy alone, 20 from France, 15 from Switzerland, 12 from Hungary and Croatia, 13 from Styria, 10 from Baden, 9 from Bohemia, 7 from Spain and Greece. In this country the records include Virginia on the East coast, Oregon and California on the West coast, the two last with more than 10 species each. Nevada, Idaho and the Yellowstone Park all furnish their Miocene oaks, and the forested lake shores of the Miocene mountain basin of Florissant in the Colorado Rockies furnish us with a dozen species of oaks along with numerous other plant and insect types preserved in contemporaneous showers of volcanic ashes.

Pliocene times carry on the Miocene forests which were slowly changing. Over 30 oaks have been described from deposits of this age in Italy, and France had nearly as many. Southern Spain has furnished a dozen species, and others are scattered through Germany, Styria, Slavonia and Asia Minor, to the Altai Mountains of central Asia, and to Japan and Indo-China—the two last regions each furnishing 6 species. In this country Pliocene plant bearing deposits are much rarer, but 2 oaks have been recorded from New Jersey. Four, including an ancestral live oak, are found in Alabama, and a form like the modern *Quercus chrysolepis* has been described from California.

Many oaks have been recorded from the Pleistocene, found in deposits of Inter- or Post-Glacial age. Naturally these are largely representatives of still existing species. Of between 20 and 30 of the Pleistocene forms recorded, only 3 or 4 are extinct, and several of these such as pseudoalba or predigitata are but doubtfully extinct. With the exception of 3 oaks from the interesting Interglacial deposits of the Don valley near Toronto the bulk of the American records have come from the Coastal Plain in New Jersey, Maryland, Virginia, North Carolina, Florida, Alabama, Mississippi, Tennessee and Kentucky. Oaks occur also in the Pleistocene terraces near Morgantown, West Virginia, and in cave deposits in Pennsylvania.

There is an early Pleistocene oak found in the same deposits that yielded the bones of the Ape man, Pithecanthropus, on the Island of Java, and several still existing European oaks have been discovered in the Pleistocene of Denmark, Germany, France, Italy and Hungary.

Opinions differ regarding the relationships of these numerous fossil and living oaks. Ettingshausen saw in the Tertiary holly oak, *Quercus palaeo-ilex*, a synthetic type from which many of the existing forms might have been derived, and Trelease regards our existing western *Quercus chrysolepsis* as representative of a similar synthetic type. The latter author sees no evidence of close relationship between American and European Tertiary species, but thinks that there was an entirely independent evolution in both hemispheres. This is inherently improbable, and although similarities in foliar characters which can be pointed out are necessarily inconclusive, so many other genera show beyond question that there was a close filiation between the forms of the different northern continents, that it seems that the oaks could not be an exception to this general history, although it is very doubtful if there was any possibility of an interchange of species between the Old and New Worlds after late Eocene or Oligocene times.

THE CHESTNUT

The scientific name of the genus to which the chestnut belongs is Castanea, derived from the town of Castane in Thessaly, once famous for its chestnuts. The common name is said to be derived from the fact that the nuts are borne in an enclosed box or chest. Five existing species are recognized. The most familiar of these is the common European Spanish, or sweet chestnut as distinct from the horse-chestnut, which belongs to a totally different family of trees. This so-called Spanish chestnut, so named because most of the commercial supplies were formerly shipped from Spain, is often called the Italian chestnut in this country for the same reason. It is a magnificent tree, indigenous in Mediterranean countries from Portugal to Persia. Rumor places its home in the Pontus region and goes on to relate that the Emperor Tiberius introduced it into Italy from Asia Minor and that it spread from thence over southern Europe. Since it occurs fossil in France and Spain before the Pleistocene glaciation, and is found in the Interglacial deposits of Italy before the men of the Old Stone Age are known to have arrived in that country, the traditions mentioned above are conclusively disproved.

It is a most imposing and stately tree, attaining a very great size, and many large trees are on record. The most celebrated of these is the Castagno di cento cavalli, or tree under which 100 horsemen once took refuge, growing on the slopes of Mount Etna, and which, according to the measurements of Count Borch made in 1780, had a circumference of 190 feet. The Tortworth chestnut, said to have been a boundary tree in the time of King John, was still standing in 1788. At 5 feet from the ground it is said to have been 50 feet in circumference, although the tree is not a native of Britain. Much attention has been given to its culture in Europe and many varieties have consequently originated. The very large nuts, otherwise like those of our American tree, are a staple article of food in south Europe and the Levant, particularly among the poorer classes, being eaten raw, boiled or roasted. The nuts are

FIG. 29. SKETCH MAP SHOWING EXISTING RANGE (SOLID BLACK) AND THE FOSSIL OCCURRENCES (SOLID CIRCLES) OF THE CHESTNUT

also dried and made into flour, and there is a considerable export trade in them from Spain and Italy. Botanists formerly called the tree *Castanea vesca* from the Latin vescor, i.e., to eat, but the accepted modern name is *Castanea vulgaris*, or common chestnut. It was formerly confused with the Japanese *Castanea japonica*, of limited distribution in eastern Asia, and with the common

American chestnut or *Castanea americana,* now known as *Castanea dentata,* from the shape of its leaves. We have two additional chestnuts in southeastern North America—the Chinquapin or *Castanea pumila,* which ranges from southern Pennsylvania to northern Florida and eastern Texas, and the shrubby *Castanea nana* of the southern States.

FIG. 30. SKETCH MAP SHOWING DISTRIBUTION OF THE EXISTING GENUS PASANIA AND THE EXTINCT GENUS DRYOPHYLLUM

Our common and better known American tree, which ranges from southern Maine to Michigan and in the Appalachian uplands to Alabama and Mississippi, has never been cultivated like its European relative except for ornamental planting in grounds and parks. In recent years the chestnut blight has been sweeping its range, and the rising generation will scarcely know its beauty or the excellence of its fruit, which in flavor greatly surpasses that of the Old World tree. It seems probable, however, that the shoots from old stumps or present day seedlings will grow into trees with more or less immunity to the blight, and that the species will not become entirely extinct.

The wood of all of the chestnuts is coarse grained, and not to be compared with the better kinds of oak. In an old English work on trees we read "The chestnut is of little value for timber." The wood is light and soft and liable to check and warp. It contains much tannin and is consequently very durable in contact with the soil, and was hence much used for posts, cross ties, etc. The blight has caused large quantities to be cut and used as fuel. Burned in the grate it crackles and throws sparks, but is very cheery and satisfactory if screened.

Normally the tree reached a height of about 100 feet, and a trunk diameter of 3 or 4 feet, and occasionally of 10 to 12 feet. It is said by Sargent to reach its largest size in the Great Smoky Mountain region of western North Carolina and eastern Tennessee. The leaves are similar to those of some of the oaks, but preserve the ancestral Dryophyllum form much better than most of the living members of the family. They are also not so varied in the past as were the oaks, which is natural enough since the latter are still a more varied and vigorous stock, and one which has repeatedly passed through periods of evolutionary activity in the past.

A species of chestnut has been described from the Upper Cretaceous of Saxony, but it is probably a Dryophyllum, as are several of the supposed chestnuts from the Eocene, notably those recorded from western Greenland. There are, however, several undoubted chestnuts found in the Eocene in North America, France and Italy. Six or 8 have been described but there remains great uncertainty regarding their specific limits. The Oligocene has furnished the remains of 4 species in southern Europe. Thirteen nominal species have been recorded from Miocene deposits. The leaves, and in some cases the fruits, have been found fossil in beds of this age in France, Germany, Italy, Silesia, Styria, Croatia, Carinthia, Austria, Hungary, Transylvania, and Galicia in Europe.

In Japan in Asia; and in Colorado, Yellowstone Park, and Oregon in this country. The Pliocene records comprise the remains of 11 nominal species, found in Spain, France, Germany, Italy, Styria and Slavonia in Europe: in Asia Minor, Japan and Indo-China in Asia: and in New Jersey in this country.

The modern species represent the survivors from these Pliocene forms which did not succumb to the rigors of the Pleistocene glaciations. The European chestnut is found in the Interglacial deposits in France and Italy, and our American chinquapin has been found fossil in deposits of Pleistocene age in West Virginia, Kentucky and Tennessee.

Some of the more interesting forms of leaves of fossil and recent oaks are shown on the accompanying plate, and the small sketch maps summarize, not only the distribution of the oaks and chestnuts, but of the other genera as well, of this interesting and most important family of trees.

Fig. 31. Some Recent and Extinct Oak Leaves (About ½ Natural Size)

1. *Dryophyllum curticellense* Sap. & Marion. from the Paleocene of Belgium.
2. *Dryophyllum levalense* Marty, from the same horizon and region.
3–5. *Quercus chrysolepis* Lieb. a living synthetic type.
6. *Quercus serrata* Thunb., a living Oriental type.
7, 8. *Quercus ilex* Linné, an Old World synthetic type.
9. *Quercus oligodonta* Saporta, from the Miocene of southeastern France.
10. *Quercus armata* Saporta, same locality and horizon.
11. *Quercus conferta* Kit., a living species.
12. *Quercus ursina* Knowlton, a Miocene black oak from Oregon.
13. *Quercus imbricaria* Michx., a living entire leafed form.
14. *Quercus ilicifolia* Wagenh., a living species.
15. *Quercus Chapmanifolia* Berry, A Pliocene oak from Alabama.
16. *Quercus concinna* Wagenh. A living species.
17. *Quercus lobbii* Hook, f., a modern Asiatic form.

FIG. 31

CHAPTER XIV

The Elm, Planer and Hackberry

The elm family is known scientifically as the Ulmaceae, the name being derived from the Latin *Ulmus*, which was the classical name of the European elm, said to have been derived from the Celtic elm. Like so many other tree families the elm family offers much of interest to students of geographical distribution and its bearing upon geological history. Strange as it may seem to those who know only our familiar elms of the shaded malls and streets of our New England towns, the elm family is a largely tropical group, although the elms themselves are inhabitants of the Temperate Zone except for their occurrence in the mountains of tropical Asia.

The family contains about 15 genera and considerably over 150 species, of which less than one half belong to the elms and hackberries, which, with the single unique planer tree of our southeastern States, are the only members of the family native in the United States. To the botanist the problem of the absence of elms and hackberries and the presence of 3 other genera in Africa is difficult to explain, as is the absence of elms and true hackberries in South America where there are four other genera of the family represented. A similar unsolved problem is the range of the genus Solenostigma from the Mascarene Islands to Polynesia and its absence in Africa, or the presence of Zelkova in Asia Minor and the Caucasus and its reappearance in northeastern China and Japan; or why the hackberries range from the Atlantic to the Pacific in the United States when the equally ancient elms are not found in our west. Many facts pointing toward the solution of these problems have been derived from the study of fossil plants, but unfortunately no traces of many of the genera of the elm family have as yet been found in the rocks. For example a genus like Trema found at the present time in Africa, Asia, Australia and South America evidently had a long geological history since it could not attain such a distribution in the world of today, but absolutely nothing is known of its geological history.

The family splits sharply into two groups: those in which the fruit is dry and winged, as in the elms, and is distributed by the wind; and the other in which the fruit is more or less pulpy, or a drupe, with a bony stone, and is distributed by birds and mammals, as in the hackberry—the flesh being the attraction, and the stone with its contained seed passing uninjured through their alimentary tract, and discharged properly fertilized, often at a great distance from the parent tree. The winged fruits of the common elm, as everyone knows, mature in the spring and are immediately shed, usually sprouting the same season, whereas the hackberry fruits ripen in the autumn and do not sprout until the following season.

All three of the types of trees to which this chapter is devoted have their chief utility as shade trees, although one of the hackberries is useful in many other ways when planted in our semi arid plains country, and some are extensively lumbered in some regions. Their chief blessing may be said then to be largely aesthetic. One cannot observe a row of elms without being impressed with the beauty of trees and how poor the world would be without them, and if it is true, as some botanists assert, that the herbaceous plants are more efficient than trees and will as time goes on gradually replace the forests, we can rejoice that this process will require millions of years. I suspect that if we lived in an arid region we would venerate the trees as the Arab does the palm; certainly I know nothing so attractive as forests after one has spent a few months in a desert. The wood of both the elm and the hackberry is marked by wavy or zigzag lines of minute pores when viewed in cross sections of the trunk, a character not seen in the wood of any other of our forest trees.

THE ELMS

Elms are widely distributed throughout the North Temperate Zone, except in western North America. They extend southward as far as Mexico in the New, and to the Sikkim Himalayas in the Old World, both of these occurrences at the southern limit of range being probably due to their southward spread caused by the less genial conditions that prevailed during the glacial period in the northern lands, for although the genus may have been originally of tropical ancestry that far off event was long antecedent to Pleistocene times.

The common European elm, *Ulmus campestris*, is a doubtful native of England, and is said to have been introduced by the Romans. This is rendered probable by the fact that it rarely perfects its seeds there. Before the employment of cast iron its wood was in much demand for water pipes, since it is remarkably durable under constant conditions of either wetness or dryness, although decaying readily upon exposure to weather. Its inner bark was formerly much used for mats and ropes, and also in medicine, although it contains much less mucilage than our familiar slippery elm.

Few trees are more imposing or more graceful when planted in avenues. Francis I is said to have inaugurated this practise in France, and it subsequently became a sort of English tradition, especially in New England. The Long Walk at Windsor is bordered by elms, and magnificent examples are to be found in all the older towns of New England. The Concord Elm is one of the New England elms celebrated in colonial history, and there was a fine old elm on Boston Common measuring 22 feet in circumference which was destroyed by a storm in 1876.

The Scotch or Wych elm, *Ulmus montana*, is indigenous in Britain, and is the common elm in Scotland. It is a much smaller as well as a hardier tree than *Ulmus campestris*, and carries the northern limit of the elms northward to latitude 67° in Europe, or 4 degrees beyond the range of the common European elm. Its twigs were formerly much used for divining purposes. The highly ornamental weeping elm is a horticultural variety of this species.

We have 6 native elms in North America, the white or American elm, *Ulmus americana*, being the largest, and fully the equal of the European elm in both size and gracefulness, and like it, much planted as a shade tree in our northern States, and more rarely in western and northern Europe. It grows naturally from southern

Newfoundland and the Great Lakes to the foothills of the Rockies, and southward to Florida, being smaller toward its southern limits and confined to stream banks in the prairie States.

The rock or cork elm, *Ulmus racemosa*, is a northern form with a corky bark, of our northern states and southern Canada; and the Wahoo or winged elm, *Ulmus alata*, is a similar corky species of our southern states, in which it is frequently planted as a shade tree. The red or slippery elm, *Ulmus fulva*, is familiar to every rural boy of our eastern states because of its thick fragrant inner bark, which is very mucilaginous and affords delightful chewing in the spring time when the sap is flowing. It is used to some extent in medicine as a demulcent for inflammatory affections.

Our two other American elms—the cedar elm, *Ulmus crassifolia*, and the red elm, *Ulmus serotina*, differ from the others in flowering in the autumn instead of the spring, a habit correlated with their southern range. They are both fair sized trees occasionally planted as shade trees in Texas, Alabama and Georgia, and with restricted natural ranges in that general region. They will be unfamiliar to most of my readers.

A large number of fossil elms have been described and a few of these have been reproduced in the accompanying figures. It is not always possible to distinguish with certainty between elms and hornbeams or iron-wood when the leaves only are preserved as fossils. There is no positive evidence of the presence of elms in the forests of Upper Cretaceous times and elms are thus somewhat later in appearing in the geological record than are the ancestors of the related planer tree, or than are the ancestors of many of our other forest trees. The name *Ulmus* has been applied to fossils from the Upper Cretaceous rocks of western Canada, but these are not recognized as true elms. That ancestral elms were already in existence somewhere during Upper Cretaceous time is rendered almost certain by their abundance and wide distribution in the rocks of the early Tertiary, or Eocene.

Twenty-eight Eocene elms have been described. Several of these are from the earliest deposits of that time, often called Paleocene, and the reason that we think that the ancestral stock went back much farther than the geological records indicate is the presence of several elms in the basal Eocene of such widely separated regions as France and Colorado. Presumptively these ancient elms reached these localities from a third and more northern area. None are known, however, from the Upper Cretaceous plant beds of western Greenland where so many ancestral forms have been found, so that we cannot be sure whether the ancestral elms spread to France across an Upper Cretaceous North Atlantic land bridge or whether Asia was their original home and that they spread from that continent southwestward into western Europe and southeastward across the Behring Sea land bridge into the western land mass of North America which was separated at that time from eastern North America by an inland sea.

Later in Eocene time, with the spreading of the seas and the opening up of the Arctic to a free oceanic circulation from low latitudes, the elms, along with so many of our temperate forest types, spread into the far northern lands, and late Eocene elms are recorded from Colorado, Wyoming, Montana and Oregon northward through British Columbia, where seven species have been found, to Alaska, and across the north Pacific in beds of this

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FIG. 32. SOME RECENT AND FOSSIL ELMS AND HACKBERRIES (ABOUT ½ NATURAL SIZE)

1. *Ulmus montana* Sm., the Witch Elm, leaf. 2. Fruit.
3. *Ulmus fulva* Michx., the Slippery Elm, leaf. 4. Fruit.
5. *Ulmus alata* Michx., the Winged Elm, leaf. 6. Fruit.
7. *Ulmus plurinervia* Unger, a Miocene elm leaf. 8. Fruit.
9. *Ulmus bicornis* Unger, a fossil elm fruit.
10. *Ulmus Bronnii* Unger, a Miocene elm fruit. 11. A leaf.
12. *Ulmus longifolia* Velen., a Miocene fruit.
13. *Ulmus prisca* Unger, another Miocene fruit.
14. *Ulmus Braunii* Heer, a Miocene leaf.
15. *Celtis australis* L., fruit. 16. Leaf.
17. *Celtis japonica* Pr., leaf.
18. *Celtis Hyperionis* Unger, a Miocene stone.
19. *Celtis Japeti* Unger, a Miocene leaf.
20. *Celtis occidentalis* L. The American Hackberry, leaves and fruit.
21. *Celtis Bernhardtii* Klotzsch, a leaf.

FIG. 32

same age on Sachalin Island. They were also present at that time in Grinnell Land, Iceland and Spitzbergen.

As usual with all tree histories the Oligocene records show a falling off in abundance and variety of elms, only 4 being known from rocks of that age and these being confined to the European area, where they are found in France, Italy, Germany and Styria. If the Oligocene record is poor that of the succeeding Miocene rocks fully make up for this paucity of records for the closing days of the older Tertiary, for we know over 30 Miocene species of elms, and they were very abundant at many localities, particularly in Europe. Elms must have been a prominent element in the Miocene forests of Europe for their remains occur in rocks of that age in the following countries: France, Switzerland, Italy, Germany, Bohemia, Silesia, Styria, Carinthia, Croatia, Galicia, Austria, Hungary, Transylvania and the Caucasus. In Asia 3 species have been found in the late Miocene of Japan. In North America they occur on both the east and west coasts and in the interior, being known from Maryland, Virginia, Florida, Mississippi, Colorado, Oregon and California. They were not uncommon at that time in the basin in which lay the Miocene Lake Florissant in the Colorado Rockies, and their occurrence in the early Miocene deposits of Florida and Mississippi is especially interesting because there they were associated with breadfruit, palms, and other warm climate types of trees.

The Miocene probably witnessed the maximum distribution of the elms, for at that time they flourished in regions from which they are absent in modern times. During the succeeding Pliocene about a score of species of elms contributed to the geological record. They were especially abundant in southern Europe, in Spain, France, Italy, Germany, Styria and Slavonia. They were represented in the Pliocene deposits of Asia Minor, and the far east had its species in Japan. American records are as usual for the Pliocene, scanty, but two elms of that age are known from southern New Jersey.

Pleistocene climatic changes and the glaciation of that time undoubtedly played their parts in bringing about the modern distribution of the elms, but we are ignorant of the details during that dramatic period of earth history. Eight different species of elm have been found in Pleistocene deposits. Most of these represent species that still exist, but supposed extinct forms have been described from England and Maryland. The common European elm, *Ulmus campestris*, has been found fossil in France, Italy and Crimea. Our common American elm, *Ulmus americana*, occurs in the Pleistocene in Maryland and in interglacial deposits of Ontario. Our southern winged elm or wahoo, *Ulmus alata*, has been found fossil in North Carolina, Alabama and Kentucky; and the northern cork or rock elm, *Ulmus racemosa*, is present in the Pleistocene river terraces near Morgantown, West Virginia, and in the interglacial beds of the Don Valley near Toronto.

THE PLANER TREE

The planer tree or water elm belongs to a genus known as Planera and named in honor of Johann Jacob Planer, a German physician and botanist of the eighteenth century. Specifically the single living species is known as aquatica in allusion to its most common habitat in wet swamps. It is a small tree, with a short trunk rarely if ever reaching 2 feet in diameter, with slender spreading branches forming a low broad head, and light soft wood of no particular value. It is found at the present time from North Carolina southward to and along the Gulf Coast as far as the Trinity River in Texas, and reaches its largest size in the swamps of Louisiana and southern Arkansas. It is the sole living representative of the genus and it is probably becoming gradually more restricted in range since it formerly reached farther northward, being found in Maryland and Kentucky during the late Pleistocene. Its leaves are distinguishable with difficulty from those of some of the elms, and considerable uncertainty pertains to the determination of some of the earlier species.

Four species of these trees have been recorded from the Upper Cretaceous, and all of these come from the Western Hemisphere where they are found in Greenland, and in what is now the Atlantic Coastal Plain from Marthas Vineyard, New Jersey and North

Carolina. Five Eocene species have been described, and with the exception of 1 from Mississippi and 2 from Wyoming and North Dakota, these all belong to the middle and upper part of the Eocene. Two were found in the Green River basin deposits and the balance occur in those temperate forests which ranged so far to the northward during the late Eocene, and these last records of ancestral water elms include Greenland, Iceland, Alaska, Manchuria and Sachalin Island.

A single Oligocene form is known from Italy and Saxony. Two nominal Miocene species had a very wide range and have been found in beds of that age all over southern Europe from France to Greece, in Japan, and in Virginia, Colorado and Oregon. The water elms were evidently not yet reduced in numbers or range in the later days of the Tertiary, or Pliocene time, for we find 3 forms represented in France, Italy, Germany, Styria, and Slavonia; in New Jersey on our east coast; and in the Altai Mountains of central Asia. Then came the Pleistocene with its glaciations which seems to have effectually exterminated these trees in Asia, unless indeed their geologic record on that continent represent wrong identifications of what were really fossil leaves of some species of the allied genus Zelkova. A single form appears to have survived into the Pleistocene of Italy, but there are none in modern Europe. North American Pleistocene records of these trees include Maryland, North Carolina, Kentucky and Alabama.

THE HACKBERRIES

The hackberries as delimited in recent American botanical practice comprise a small group of large or medium sized trees, and shrubs, of ancient origin, and represented at the present time in both the eastern and the western United States, and in eastern Asia. The question whether the closely allied forms of lower latitudes should be referred to the same genus is a disputed one. They are evidently very near of kin, and if all are grouped under the generic name of Celtis, the scientific designation of the group to which the hackberries belong, and derived from a name that Pliny used for an African lotus-tree, then this genus has between 80 and

100 existing species and is common in the Indo-Malayan region, in the islands of Oceanica, in Africa, and in tropical and sub-tropical America southward to the northern Argentine.

The North American forms to which alone our attention will be confined number about 9, although the leaves of these trees differ so much in size, texture and character of the marginal teeth; and the berries vary so much in color and size, that a number of varieties have been described, and there is some uncertainty as to just how many species are represented.

The most widespread of our American forms is the hackberry or sugarberry, *Celtis occidentalis*, sometimes called the nettle tree from the resemblance of its leaves to those of the nettle. It varies in size according to its environment from a large tree 130 feet tall and with a trunk 3 feet in diameter, and free of branches for 70 or 80 feet above the ground, to a small tree or shrub toward its western limit of range. It is found from the St. Lawrence River near Montreal and Massachusetts Bay to Nebraska, Idaho and eastern Washington and Oregon to Puget Sound. Southward it extends down the Florida peninsula to Biscayne Bay and Cape Romano, and to eastern Texas.

Its cherry-like fruits have a sweet thin dry pulp covering the stone, and are greedily eaten by birds, which thus disseminate the seeds far and wide. Flood waters also occasionally serve the same purpose. The wood is rather heavy and brittle, and of slight commercial importance. It is more or less lumbered in the east where the trees reach a large size, and is sawed into second class timber. It makes excellent fuel, and poles when these are peeled, and is highly recommended by the Forest Service for planting in the semi-arid regions of our west. Although it naturally grows more slowly under conditions of adversity it has great hardiness and will live on almost sterile soils and produce seed where almost any other tree would die, although it cannot, on the other hand endure swampy soils. It is an excellent shade tree and is widely planted in our western cities, and also for wind breaks in the prairie states. Its value is naturally much enhanced in those regions where trees are scarce.

Our southern hackberry, *Celtis mississippiensis*, which is the only other familiar form here in America, is a somewhat smaller tree, rarely over 75 feet in height, with a short trunk 2 or 3 feet in diameter, spreading branches and a broad graceful head. Its leaves usually have entire instead of toothed margins, and the fruit stones are pitted instead of smooth as in the other form. The southern hackberry ranges from southern Virginia to southern Illinois and Missouri, and southward to Florida and Texas.

The hackberry line is not certainly known earlier than Eocene times. It has been recorded from the Upper Cretaceous of Europe, but the leaves so named belong in all probability to the unfamiliar and unrelated genus Zizyphus. Two forms of hackberry are recorded from the early Eocene of Wyoming, and there was a late Eocene species in Georgia. None are known from as early a horizon as this in Europe, showing how imperfectly its geological history is known. The Oligocene had furnished three forms in France and Italy and one represented by fruits in the western United States. The Miocene record is more full, and comprises traces of 9 different species widely scattered in central and southern Europe, and present at that time in both Colorado and Wyoming.

There were 4 Pliocene hackberries in Europe and Asia, but none have as yet been discovered in the limited Pliocene plant beds of North America. The Pliocene hackberry of France and Germany appears to have been directly ancestral to an existing species found from the Caucasus to Upper India, and a similar close affinity is shown to this same form by the Pliocene hackberry found fossil in Japan. Pliocene species are also known from Slavonia and Indo-China.

The rigors of Pleistocene times apparently killed off the hackberries in all except the extreme southeastern part of Europe, although a fossil species of that age has been recorded from Hungary. A doubtfully extinct species has been described from the Pleistocene of Maryland. The common hackberry has been found fossil in Virginia, and beautifully preserved and characteristic stones of our southern hackberry have been found in the wind blown Pleistocene deposits known as loess in Mississippi.

CHAPTER XV

The Platanus or Buttonball

The plane-trees, sycamores, and buttonball or buttonwood trees, comprise the family Platanaceae and well repay consideration. Not only are some of them among the most attractive, but they are the most massive among our deciduous trees, even if they are not the tallest. Pliny tells us that "no tree whatsoever which so well defends us from the heat of the sun in summer," and Evelyn writes of it in the following language: "the incomparable and shady Platanus, that so beautiful and precious tree which we read the Romans brought out of the Levant." These writers referred to the Oriental species, and the earlier botanists like Willdenow denied that the plane tree was indigenous in North America. Our plane is equal in every respect to the Old World tree although it is said to be less hardy in artificial plantings, consequently the Oriental tree is common in our city parks. The two are scarcely distinguishable but the native tree has solitary buttonballs or fruits whereas the oriental tree has several on a single stalk.

They are a widely scattered but waning type in these modern days, for the family consists of the single genus Platanus with only 6 or 7 species of southwestern Asia, Eastern and western North America, Mexico and Central America. The members of this small group are very uniform in general appearance, with large deciduous leaves, minute flowers in closely packed pendulous heads that remain attached during the winter, during which season the pappose fruits are widely distributed by the winds. The leafstalks are enlarged at the base to enclose the winter buds; and the bark is very thin, smooth, and pale green or whitish. The wood is likewise rather uniform, in all being light brownish or reddish in color with wide rays. It splits poorly and in general is of secondary commercial importance.

The known ancestral history of these trees extends back into the dim past a staggering number of thousands or even millions of years. A still flourishing forest giant with a height of upwards of 170 feet and a trunk diameter of 10 or 11 feet, which are the dimensions of some individuals of our American sycamore (*Platanus occidentalis* L.), has survived more changes in human history than almost any royal or ducal line. Columbus might have seen a still surviving one as a young tree had he penetrated inland along the river bottoms of our southern states. The family history is surpassingly more majestic for it extends back to the days when even the ape-man was a distant promise and the reptilian tribe of animals were the lords of creation. The gigantic uncouth dinosaurs of the late Cretaceous, so many of which have been unearthed and are now mounted in our larger museums, carry us a long way back and yet we know from the records, that when the breath of life left their massive bulks some of the leaves that fell around them were those of plane trees not very different from the leaves that strew the ground in our parks in October.

These trees have interests for the forester, the lumberman, the votary of culture and the botanist. For the latter they have an especial interest because of their affinity with the figs (another group of great antiquity) and their disputed position in the current schemes of classification.

A brief consideration of the Cretaceous records of Platanus sheds a significant light on the place of origin of the genus. Excluding the Laramie formation, since its records are confused in the literature with those of the basal Eocene, I have collected the following references to the existence of Platanus during the Cretaceous: The oldest occurrences are two species in the Raritan formation of the New Jersey region and two different species from the lower beds of the Tuscaloosa formation of the Alabama region. Very slightly younger are the strata of the Dakota Group extending from Minnesota and Colorado to Texas from which Lesquereux has described ten species and varieties. About the same age as the latter is the Magothy formation of our Northern Atlantic coastal plain with one species and the Atane beds of West Greenland with another. The somewhat younger Patoot beds of West Greenland furnish one species, there is another in the Ripley formation of Eastern

Alabama and a third in the Montana Group of Utah. These American records total 16 forms. The only other Cretaceous records known to me are the not certain identification of 2 Dakota Group forms from the Upper Cretaceous of Argentina, 1 certainly not a *Platanus*, and 3 supposed species from the Cenomanian of Bohemia described by Velenovsky and Marik. The latter I regard as referable to the probably allied genus Credneria of Zenker.

Regarding the authenticity of the botanical determination of these various species it is probable that some of the records are worthless, but enough remain which are based upon an abundance of absolutely characteristic leaves, in some cases accompanied by typical fruits, to render it certain that in Middle Cretaceous times ancestral plane trees were an abundant element in the flora of North America, and that later in the Cretaceous they had spread to South America and the Arctic region. They may have continued across the latter region into Europe although the records are not entirely convincing as regard the Cretaceous but are more ample in support of such a migration in the Tertiary.

These early ancestors had somewhat elongated rhomboidal leaves, with irregularly and remotely toothed margins, decurrent on the petiole, which was conspicuously enlarged at the base. There was a tendency, not especially pronounced, toward palmate trilobation. The floral axes were already shortened and aggregated and the fruiting heads were racemose as is indicated by the predominancy of this habit in the existing species and its frequent occurrence in forms like *Platanus occidentalis* that normally have but one fruiting head to a peduncle. These ancestral leaf characters are deduced from the form of the earliest species and from the substantial agreement between them and the leaves of modern seedlings and adventitive shoots from old stumps both of which are supposed to exhibit more or less reversionary characters. Several of these are figured in the present connection.

Reacting to the genial influences of the Cretaceous climate these early forms soon broadened their leaves, which also became lobate, so that *Platanus Kümmeli* Berry of the Magothy Formation is scarcely distinguishable from the leaves of the existing species, especially *Platanus orientalis*. Its leaves are exceedingly abundant and the clays in places are packed with the remains of its fruits—true midcretaceous "buttonballs." From that remote age to the present time Platanus leaves have all shown a very strong generic likeness so that they are relatively easy of determination.

A quarter of a century ago Professor Ward wrote a paper on the paleontologic history of the genus Platanus[1] in which he advocated the probable origin of the modern stipules from basilar leaf lobes. This suggestion was based on the basal lobes of several early Tertiary species and the occasional occurrence of comparable lobes in the modern *Platanus occidentalis*. This suggestion while interesting has not met with a ready acceptance. At the time that Ward wrote much less was known of the paleontologic history of the genus, especially its earlier manifestations, than is known today. At the present time the major outlines of this history can be sketched in with a good deal of certainty.

With the dawn of the Eocene, Platanus is abundant in North America, its original home. It would seem that the Eocene witnessed the greatest specific differentiation of the genus for no less than sixteen different species have been desciibed. North America is still the home of the majority of these but the genus had undoubtedly spread into Asia and it is exceedingly common in the Arctic regions in the so-called Arctic Miocene which is really much older than Miocene. From these far northern and now boreal lands Platanus has been recorded in Siberia, Greenland, Iceland and Spitzbergen. At this period it appears to have been too warm in low latitudes, for Platanus is absent from the Eocene floras of southeastern North America where the remains of tropical strand floras are found, and from the south European Eocene. The abundant American species occur for the most part in the low hilly country which marks the site of the present Rocky Mountains. From some of these basins, which at that time enjoyed a

[1] Ward. Proc. U. S. Natl. Mus., 11: 1888, pp. 39–42, pls. 17–22.

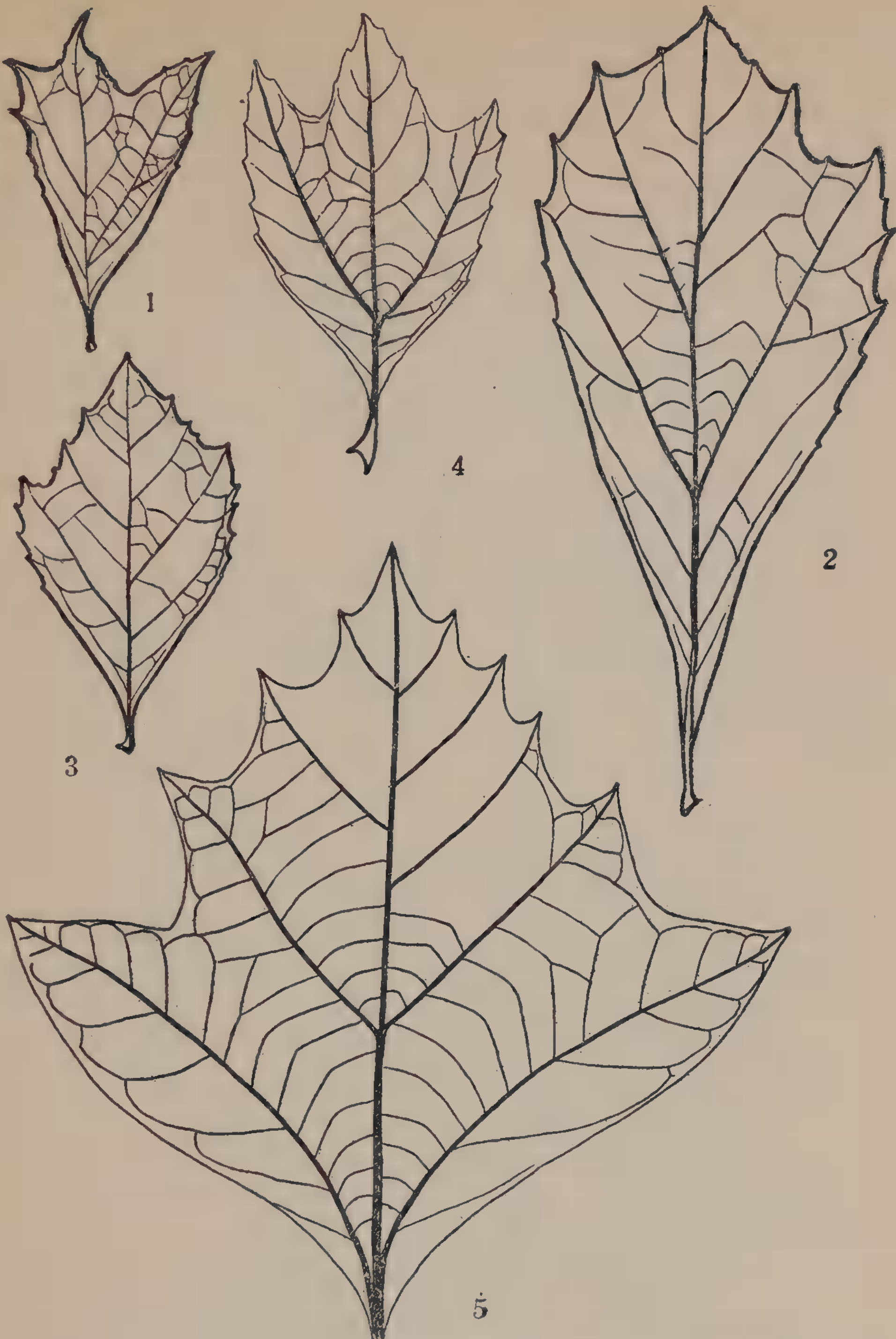

FIG. 33. SOME ANCESTRAL FORMS OF BUTTONBALL LEAVES (ABOUT $\frac{2}{3}$ NATURAL SIZE)

1, 2. Leaves of adventitive twigs from old stumps of the existing *Platanus occidentalis* Linn.

3. A leaf of a seedling of the species.

4. *Platanus shirleyensis* Berry, an Upper Cretaceous Platanus from Alabama.

5. A non-lobate leaf of *Platanus Kümmeli* Berry from the Upper Cretaceous of New Jersey.

humid climate and supported a rich fauna and flora, plane-tree leaves nearly two feet in diameter have been collected. The most southern Eocene record in the European area thus far discovered is in deposits interbedded with the basaltic lava flows of this period on the Isle of Mull from which staminate catkins, fruit and leaves have been described as *Platanus hebridicus*.

The Oligocene period which succeeds the Eocene was a period of land emergence and dry hot climates. Consequently the localities where plane trees may be presumed to have flourished have been regions where their remains failed to become preserved. North America is especially poor in Oligocene plant remains of all kinds and no Oligocene species of Platanus have been discovered although they must have been abundant since they again appear in the North American fossil record after the close of the Oligocene. Two or three species of Platanus of Oligocene age have, however, been discovered in European plant beds.

The Oligocene period was followed by the Miocene, a period during the early part of which the Oligocene elevation culminated and subsidence set in. This was accompanied by a striking climatic change, at least in the eastern United States. In our Southern States the Oligocene faunas and floras were such as flourish today under the equator. The succeeding Miocene deposits which overlie them in northern Florida and elsewhere contain leaves of trees of the temperate zone and the remains of a marine fauna which had advanced from the New Jersey-Maryland region as the tropical fauna was driven southward. North America does not contain very many Miocene plant beds but nevertheless the remains of plane trees have been collected from Oregon and California on the Pacific coast, from the Yellowstone Park, and from Virginia on the Atlantic Coast. In Europe where Miocene plant beds are more frequent the leaves of Platanus are abundant and widely distributed although they belong to but few species—five have been described. One of these, *Platanus aceroides*, first described by Goeppert in 1852, is the dominant Miocene form of the whole Northern Hemisphere. Its European records include Baden, Switzerland, Silesia, Italy and many localities in Austria

Hungary—a region remarkably rich in plant bearing deposits of Tertiary age.

Succeeding the Miocene are the deposits of the Pliocene lakes, rivers and seas. The Pliocene is the youngest period of the Tertiary age. North America was of much the same geographical extent as it is today and fossil plants are almost entirely unknown; consequently, although the plane trees were unquestionably present they have left no records. Europe on the other hand was a region of great geographical change and mountain-making. The chief of these changes centered about the Mediterranean Sea, the center of the classical world. At one time its waters withdrew westward to Italy leaving behind a chain of lakes. A wide grassy plain occupied the present Aegean region, another broad land bridge stretched across from Sicily to the site where Carthage was subsequently founded on the African coast, and a third united Spain with Morocco. At another time the Mediterranean waters extended over a vast area in southeastern Europe. The climate was mild and humid and some of the finest forests that Europe has ever known clothed its shores. Pliocene remains of Platanus have been collected in Italy along the foothills of the rising Apennines, from France, Spain, Styria, and Slavonia.

The Tertiary was succeeded by the Quaternary, the fourth age of the older cosmogonists who divided the rocks into primary, secondary, tertiary and quaternary. The latter includes the Pleistocene, and the Recent period in which we are now living. The Pleistocene is marked by climatic changes which brought about the extensive glaciation of the ice age, that most profound factor in the distribution of modern animals and plants. The most interesting Pleistocene deposits in the eyes of the botanist are those of old forest beds and peat bogs. These show that the plane tree was still present in central Europe, although today it is not a native in that region except as it is planted. American records show that our modern sycamore was already in existence with habits much like it has at the present time. Its leaves and fruits have been unearthed in the clays of river terraces around Morgantown, West Virginia; in the sediments that filled the bone cave at Port Kennedy, Pennsylvania, once the lair of various Pleistocene wild animals; and in the buried river swamps of North Carolina and Alabama. During an Interglacial period it spread northward to southern Canada and left its leaves in the clays of the Don Valley near Toronto.

I have written several similar brief sketches of the geologic history of different American forest trees and hope to add similar accounts of others from time to time. My object is not purely cultural. I hope that my readers will become awake to the records of the ages preserved in the structure and habits of our commoner forest trees. This fruiting habit acquired perhaps in the Eocene three millions of years ago, this anatomical feature of the wood acquired perhaps in the Upper Cretaceous—the changing environment of the successive ages that moulded each type until it is what we see it today. Let imagination play over the world history enacted in the shadows of these trees—the building of the Rockies, the evolution of the mammals and of primitive man. If the building of the tower of Babel, the hanging gardens of Babylon, or the pyramids, are awe-inspiring, what shall we say of the slow formation of the Himalayas, during which faunas came and went while the sycamore line flourished on and on. Beside the sycamore, oak or pine, the Rosetti stone or Elgin marbles are things of yesterday. Why should we not venerate our forest trees as we do man-built temples of classic days? When we are confronted by a sycamore that witnessed De Soto crossing the Tombigbee shall we not hesitate at the wanton destruction of what should mean so much to us?

CHAPTER XVI

The Magnolia and Tulip-Tree

Both of these familiar trees belong to the magnolia family, and although we are not here concerned with the other members of this family they exhibit much that is of interest to the student of geographical distribution and I do not think that any family of trees better illustrates the main outlines of the general history of a large number of tree types.

The magnolia family at the present time contains 2 genera which are confined to the southeastern Asiatic region (Kadsura, Michelia), and one that is limited to the island of New Caledonia (Zygogynum). The other 5 genera which round out the family, namely: Magnolia, Liriodendron, Schizandra, Illicium, and Drimys, are each divided between the Orient and the Occident. All of these except Liriodendron have more than a single species in both regions. Magnolia and Liriodendron are the most northern, Schizandra and Illicium are more southerly and overlap part of the range of the preceding two genera, Taulauma is tropical, and Drimys goes farthest southward in both hemispheres and does not reach the North Temperate Zone at all, extending southward to Australia and New Zealand in the Orient, and to southern Chile in the Occident, and showing moreover a most primitive type of wood that is entirely without the larger ducts or pores that are so characteristic of all but a very few of the higher plants.

No family is more obviously of northern origin, none is better represented in the forests floras of Upper Cretaceous times throughout the northern lands, or better exhibits the southward extension so characteristic of many other types as the pressure of plant populations behind them and the availability of suitable land routes to the southward permitted. Drimys, the most primitive in its anatomy, is today found farthest from its original home. Unfortunately the geological history of this genus is practically

FIG. 34. SKETCH MAP SHOWING THE FOSSIL OCCURRENCES OF THE MAGNOLIA

FIG. 35. SKETCH MAP SHOWING THE DISTRIBUTION OF THE DIFFERENT GENERA OF THE MAGNOLIA FAMILY

unknown but the fact that the species are distinct in each region, i.e., in Australia, New Caledonia, New Zealand and America, indicates that they were very ancient immigrants into those regions before the present geography had come into existence.

These items regarding the family seem to me to be of sufficient general interest to warrant mentioning them in an introduction to the two types in the family that are the subject of this chapter, and I have shown the modern distribution of the family, as outlined above, on the accompanying sketch map (figure 35).

THE MAGNOLIA

I expect that to most of us magnolia means the large pinkish flowered exotics of our lawns and parks which have been so generally planted in recent years; or perhaps the word suggests the fragrant yellowish white blossoms of the swamp magnolia of our eastern States which are sometimes peddled by street vendors in the cities of our Atlantic seaboard. It we come from the rural south, or have visited some of the old towns, such as Augusta, Georgia, we will be acquainted with the tall tree with shiny evergreen leaves which is just "magnolia" and without which the door yard of any southern mansion was incomplete. This last is a large and handsome tree, and was formerly frequently planted in the yards of the older and more pretentious houses as far northward as Baltimore and Philadelphia.

There are about a score of existing magnolias, the name itself being in honor of Pierre Magnol, professor of botany at Montpellier, who died in 1715. Of these about one-third are natives in southeastern North America, and the balance occur from the Himalayas eastward in southeastern Asia. Several of these Asiatic forms put forth their large blossoms before they unfold their leaves, and it is these that are much used for ornamental plantings throughout the Temperate Zone.

All of the magnolias have rather large showy blossoms, and the leaves vary a great deal from species to species in both their form and consistency. Our large leaved cucumber-tree, *Magnolia macrophylla*, has the distinction of having the largest entire leaves of any of our trees. They are light green in color and oblong in form and are often 30 inches long and 9 or 10 inches wide. This tree is not common and occurs as scattered individuals, haunting moist ravines where the soil is deep and rich, in the region between North Carolina and Alabama. Our umbrella-tree or elkwood, *Magnolia tripetala*, an Appalachian species found scattered from Pennsylvania to Alabama, also has large leaves, sometimes 20 inches long and 10 inches wide. Both of these and others of our native species, have frequently been cultivated as ornamental trees, both in this country and Europe, and are hardy as far northward as the southern New England coastal region.

The only one of our native species whose natural range extends that far northward is the sweet bay or swamp magnolia, a bush or slender tree of deep swamps, which post glacial climatic changes have left stranded in Essex County, Massachusetts, and on Long Island, and which ranges southward to peninsular Florida and eastern Texas.

The magnolias contribute to the higher things of life rather than to the utilities, and invariably suggest wayfarers from the orient rather than the staid natives of the Temperate Zone. Not all of them have blossoms that are especially beautiful and they turn to a yellowish brown rather rapidly when picked, and nothing is more dismal than one of the Asiatic forms that has been touched by a late spring frost, but when favored by the weather nothing in these climes is more gorgeous. Some of the flowers are of sufficient consistency that in exceptional cases they have been covered by sediments before they decayed and thus preserved as fossils, and several instances of this sort have been recorded. The peculiar cone-like fruits have also, and more frequently been preserved as fossils.

The fossil record of the magnolias is a long and extensive one and worthy of a more complete exposition than I can give it here. From the sediments laid down in the far off days of the Upper Cretaceous the leaves of no less than 23 species of magnolia have been described, and although some of these determinations may be legitimately questioned, others seem to be authentic. Several of these early magnolias were widely distributed, especially a group of forms found in western Greenland which ranged southward in what is now the Atlantic Coastal Plain from Marthas Vineyard to Texas.

A second Upper Cretaceous display of, in part identical forms, of magnolias is now found in the Dakota sandstone of Kansas and Nebraska—the Dakota sandstone representing the shoreward sands spread over the western interior of North America by the advancing sea of the Upper Cretaceous, which swept northward at that time from the Gulf of Mexico almost or quite to the Arctic Ocean. A Cretaceous magnolia has been recorded from western Canada, a second from Vancouver Island, and a later Cretaceous form has been found in Wyoming and Tennessee. In the Old World there was an early Upper Cretaceous species in Portugal, and three additional and slightly later forms have been found in Bohemia and Moravia.

The Eocene magnolias number about a score of species, all different from their Upper Cretaceous ancestors, and thus hinting at the long time interval that we know intervened between the marine deposits of these two geological periods, when the present land areas of the globe were elevated and the seas were restricted which fact led the early geologists to draw the boundary between the Mesozoic and the Cenozoic at this horizon. The Eocene magnolias have an equally wide distribution as those of the Cretaceous. They occur in both the basal or Paleocene, and in the upper Eocene of North America and Europe—the far northern records of their former existence, to be enumerated presently, belonging in the second category. These Eocene records include Greenland, Spitzbergen, Alaska, Sachalin Island and western Canada on the north and Oregon, California, Wyoming, Colorado, New Mexico, Mississippi, Tennessee, Louisiana, France, Germany, Bohemia and Croatia on the south. Beside the remains of leaves both flower parts and characteristic fruits have been found in the rocks of this age.

During Oligocene times which succeeded those of the Eocene, 8 different magnolias, all from the Old World, have been described. They were apparently most abundant during that time in Italy, but occurred also in France and Russia. As I have had occasion to state so many times in these sketches of tree ancestors our American plant records are especially deficient for the Oligocene and Pliocene so that the fact that I am unable to enumerate any Oligocene magnolias from North America does not mean that none existed for we are quite sure that they did, it simply means that the book of history whose pages are the rocks has the Oligocene chapter torn out of the American record.

Sixteen Miocene species of Magnolia have been recorded. These records include both Europe and North America, and the magnolias were about as abundant then as now although their range had not yet become as restricted as it is today. Miocene Asia probably had its magnolias as in modern times, but whereas magnolias were abundant in Miocene Europe none of these survived the Pleistocene glaciation.

The closing days of the Tertiary period, or Pliocene times, have furnished 11 magnolias, found in North America, Europe, and eastern Asia (Japan). In North America these Pliocene magnolias occurred in what is now the Atlantic Coastal Plain—the Pacific coastal region and western interior regions being at that time much as they are in modern times, both geographically and climatically. In Europe most of the Pliocene records are from countries bordering the Mediterranean, that is, Spain, France, and Italy, but magnolias were still present in the late Pliocene in both Holland and Germany. These last were apparently exterminated by the Pleistocene glaciation, thus leaving Europe without any native magnolias in the modern period. Two forms of Magnolia were described many years ago from the Tertiary of Australia, but these are not regarded as authentic representatives, and have been entirely ignored in the present discussion.

Pleistocene magnolias are restricted to the remains of the existing sweet bay, *Magnolia virginiana*, found in deposits of that age in southern Florida. The accompanying sketch map shows the localities from which fossil magnolias have been described and shows how much more extensive was their range in the past as compared with what it is today.

THE TULIP-TREE

The tulip-tree is one of the largest and the most valuable of our eastern trees, a favorite in private parks, and increasingly planted in suburbs throughout the eastern states and in central and western Europe. It is otherwise unknown in the latter continent, although it was not at all uncommon there for thousands of years previous to the Ice Age and before the advent of man in that region.

Until recently our common tulip-tree, or yellow poplar as it is often called, especially by lumbermen, although it is entirely unrelated to the true poplars, was thought to be the sole living representative of the genus Liriodendron—the name is from the Greek and signifies the tree with lily-like flowers, a singularly appropriate etymology. A few years ago a very similar tree was discovered in China, whose flora shares so much with that of eastern North America. It is so like its American relative that there was some question whether or not it really differed at all. Technically it was christened as the Chinese variety of the American tree, but subsequently it has quite generally been given species rank, so that these two—*Liriodendron chinensis* in the Orient and *Liriodendron tulipifera* in the Occident, on the opposite sides of the Northern Hemisphere, represent the last survivors of an ancient race. They hold their titles in fee simple from the Upper Cretaceous, but now much reduced in their territories as compared with their far flung range in the past over North America, Asia, Europe and the Arctic. Time was once when the sun never set on the tulip-tree, but the old days will never come back for our trees—humanity has largely replaced them.

Our American tulip-tree, *Liriodendron tulipifera*, has a tall straight columnar trunk with deeply furrowed bark, and relatively small branches which are not thrown out nearer than 80 to 100 feet of the ground. The tree frequently reaches a height of 200 feet and a trunk diameter of from 8 to 12 feet. It reaches its largest size in the deep rich soil of the lower Ohio valley. There is an immense old tulip-tree at Annapolis named for General Lafayette, and one old colonial manor in southern Maryland has a long entrance drive bordered with old giants of this species.

The tulip-tree is extensively lumbered, not only because of its size and the extent of clear wood that it yields, but because, although not strong, the wood is soft and easily worked, and there is a very large demand for it for interior finish, boat building, shingles, woodenware, etc.

It and its relative, the magnolia, are practically our only forest trees with large flowers, those of the tulip-tree being cup-shaped,

Fig. 36. Sketch Map Showing Existing Range (irregular black areas) and Fossil Occurrences (solid circles) of the Tulip-tree

about 2 inches in length and breadth, slightly fragrant, with 3 large petaloid sepals and 6 orange yellow petals marked with green. Inside are the numerous large stamens and a central mass of pistils which mature to form a dry cone-like fruit about 3 inches long, and made up of spirally arranged, overlapping, stiffly winged fruits, which the winters winds gradually detach and whirl against our window panes.

The flowers do not appear until after the leaves are out in the spring, and as the trees are tall they are not as familiar as they deserve to be. Some people never see them for they are hard to come at, are short stalked, and rather perishable even when it is possible to pick them. The tulip-tree leaves are dark green and unique in form and very handsome. Normally they are somewhat fiddle-shaped, like 7 of figure 37 or 10 of figure 38, notched at the tip with two or three sinuous pointed lobes on each side. They are long stalked and at the base of the stalk there are a pair of large lighter green oval leaflets of the sort that botanists call stipules. These serve as bud scales and protect the tiny leaflets during the winter. The peculiar arrangement of the leaves in these laterally compressed buds, where they are recurved or bent down so that their forked tip lies at the base of the future stalk, is the reason why they have the notched tip so unlike the majority of leaves.

The tulip-trees are undoubtedly derived from distant ancestors with pointed lanceolate leaves like those of the magnolias, and we as yet have no clue to the manner in which they came to adopt this peculiar arrangement of being tucked away in the buds flexed and folded one within the other and facing first one side and then the other, for the leaves are alternate in their arrangement. Most tree buds, either of leaf or flower, have a number of bud scales for their protection and these are generally resinous (the source of bees wax) or furry, and often of large size as in the walnuts and horse-chestnuts. To a certain extent in the magnolias and especially in the tulip-tree this function of protection is assumed by the basal leaflets or stipules. Theoretically we believe that all bud scales are modified leaves or leaf segments, but in nearly all trees the bud scales have been so modified or specialized that their history can not be readily deciphered, as it can in this family.

A good many years ago I spent much time collecting the leaves of the tulip-tree for purposes of comparison with the fossil forms, and the subject is such an interesting one that I have devoted a plate to some of the curious shaped leaves of our recent species that illustrate the origin of the stipules and that show how the life history of a modern form tends to repeat the life history of its ancestral line. Starting with figure 9 the reader will note an incipient lobe on either side of the base of an otherwise normally shaped leaf. The larger of these two basal lobes, that on the right, has a peculiar arrangement of the veins very similar to the arrangement found in a modern stipule. The next stage may be illustrated by figure 4 in which these basal lobes have become separate leaflets, like stipules but at the top instead of at the base of the leaf-stalk. Or this second stage may be illustrated by figure 3 where the leaf-stalk has not yet become elongated and where on one side it is winged, much like the condition preserved in the Upper Cretaceous form known as *Liriodendron alatum* (shown in figure 4 on the plate of fossil leaves) and on the other side the wing is separating from the rest of the blade in the direction of an affair that looks like a modern stipule. By the elongation of the leaf-stalk of a form like that shown in figure 3, a form like figure 1 would be approximated, figure 2 shows a succeeding stage, and it needs but to separate the stipules from the leaf-stalk of a form like that shown in figure 2 to get the normal condition of the modern leaves such as is shown in figure 7.

That the bud scales of the large blossoms have a similar origin is shown by the frequent presence of a midrib or of a vestigial base of a leaf-stalk between the scales and this is frequently elongated as in figure 8 with an awn-like thickened tip. About as frequently this elongation will expand into a tiny ovate leaf like that shown in figure 6, and not rarely a larger and more normal shaped leaf like that shown in figure 5 will be present. These may be compared with the figures of the corresponding occurrences in magnolia. Much the same sort of a history can be observed in the buttonball (Platanus), and it would seem that these extraordinary specimens of tulip-tree leaves illustrate the manner of origin of the stipules during Upper Cretaceous times.

The geological record of the tulip-tree is remarkable in several ways, especially in the great variety and wide range of the Upper Cretaceous forms. The oldest known are those of the Atlantic border in New Jersey. This in itself is interesting because much

Fig. 37. Some Singular Atavistic Leaves of the Existing Tulip-tree (About $\frac{1}{3}$ Natural Size)

of North America and the Arctic archipelago to the northward had been a land area for many millions of years previous to their marginal flooding by the Upper Cretaceous sea. This fact is more significant than it may seem at first sight. The latest marine submergence of the Appalachian province, using that term in a very broad way had been the dwindling sea of the Carboniferous. This area and that lying north of it to the pole itself was a land area during all of Permian, Triassic, Jurassic and Lower Cretaceous times. When this land first emerged from the Carboniferous sea it was clothed with a strange vegetation made up of entirely extinct types, such as the seed-ferns, Calamites, lepidodendrons and sigillarias. During the interval between the Carboniferous and the Upper Cretaceous the foregoing types had become entirely extinct and the flowering plants had been evolved and had rapidly spread toward that dominance in the plant world which they occupy at the present time, which position they had reached as early as Eocene time. This holds a still greater interest for the human race, since practically all plant foods utilized by man, and the plant foods utilized by the animals upon which man depends for meat (except fishes) are derived from the flowering plants, and it is no exaggeration to say that fixed abodes and agriculture which were the basis of civilization itself were conditioned upon the evolution

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FIG. 38. FOSSIL LEAVES OF THE TULIP-TREE (ABOUT $\frac{1}{3}$ NATURAL SIZE)

1. *Liriodendron meeki* Heer from the Upper Cretaceous of Alabama.
2. *Liriodendron quercifolium* Newberry from the Upper Cretaceous of New Jersey (Raritan formation).
3. *Liriodendron morganensis* Berry from the Upper Cretaceous of New Jersey (Magothy formation).
4. *Liriodendron alatum* Newberry from the Upper Cretaceous of Colorado (Vermejo formation).
5. *Liriodendron acuminatum* Lesquereux from the Dakota sandstone of Kansas.
6. *Liriodendron procaccinii* Unger from the Pliocene of France.
7. The same from the Pliocene of Italy.
8. *Liriodendron islandicum* Saporta & Marion from the Eocene of Iceland.
9. *Liriodendron gardneri* Saporta from the Eocene of England.
10. *Liriodendron tulipifera* Linnaeus from the Pleistocene of North Carolina.

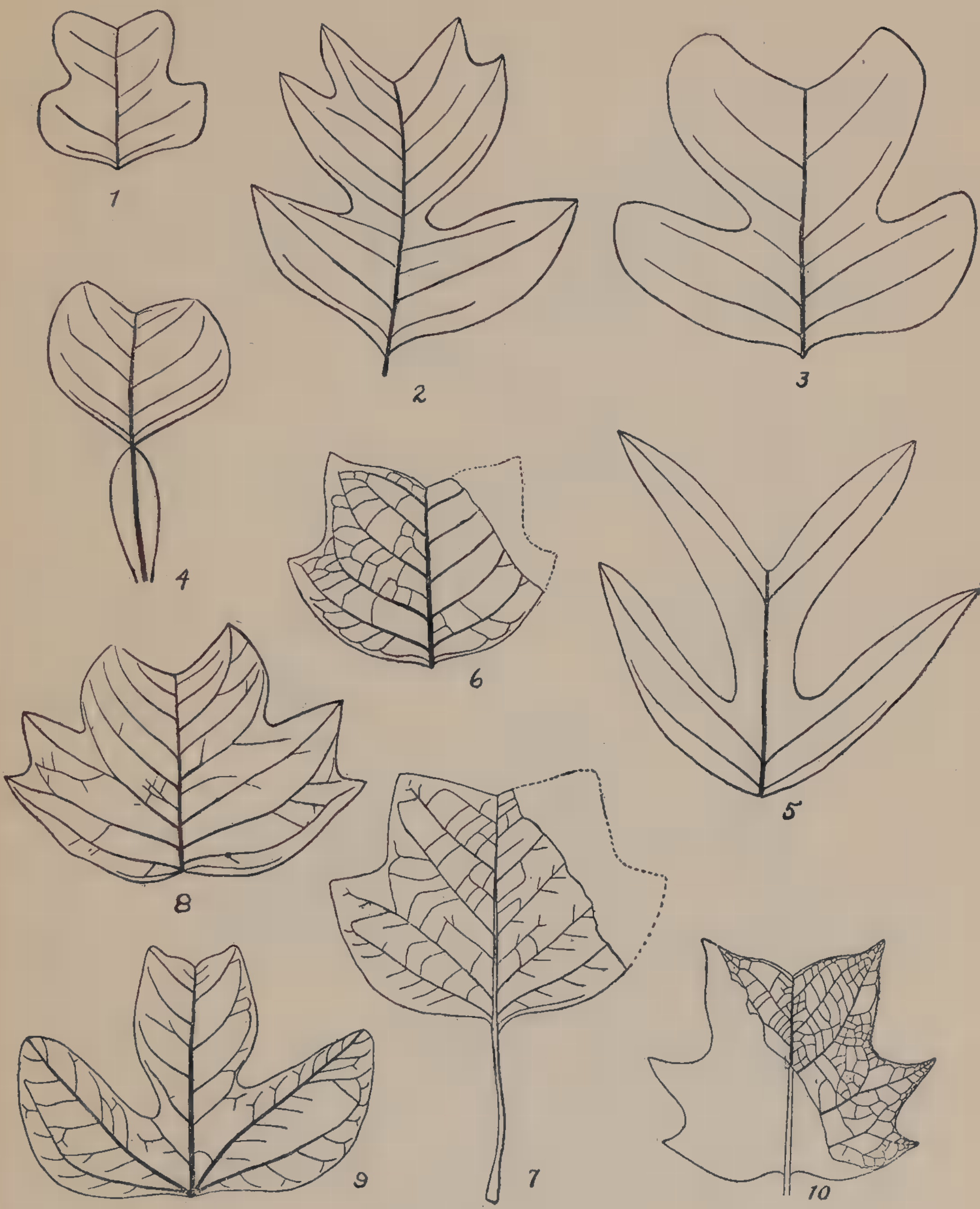

FIG. 38

of the flowering plants. It was then this evolution during the Mesozoic that made possible the evolution of the mammals during the Tertiary, so this far off happening of Mesozoic time might well be considered as the primary stimulus to that chain of events that resulted in humanity and humanity's civilization.

The remains of tulip-trees were also a prominent element in the forests that clothed the shores of the Upper Cretaceous sea that about the same time spread northward from the Gulf of Mexico up the Mississippi Valley and over the present prairie States. In the shore sands of this advancing sea, which geologists call the Dakota sandstone, a variety of tulip-tree leaves were preserved. Some students have argued that since the leaves of the modern tree are variable this variety of Cretaceous leaves may represent a single variable species, but this is not believed to have been the case.

There are at least 9 different kinds of tulip-tree leaves in the Dakota sandstone ranging in appearance from the small *Liriodendron meekii* (fig. 1) to the enormous obtusely-lobed *Liriodendron giganteum* with leaves 7 inches in diameter, and the greatly pointed-lobed *Liriodendron quercifolium* (fig. 2). Some of these forms have been found from Texas to Iowa, Kansas and Nebraska, and 7 of them are confined to the Dakota sandstone. A similar display has been found in the Upper Cretaceous deposits of the Atlantic Coastal Plain from Long Island to Alabama and Arkansas. There is 1 recorded from Long Island, 3 from New Jersey, 2 from North Carolina, 1 from Alabama, and 2 from Arkansas. One of these known as *Liriodendron meekii* is found in western Greenland, Nebraska, in Saxony, and it has even been recorded from Argentina, although this last record is not properly authenticated.

At the time that these tulip-trees were flourishing in Greenland, southeastern North America and in the western interior, other forms were present on our Pacific coast, two different forms having been discovered in the Upper Cretaceous rocks of Vancouver Island. Somewhat later in Cretaceous time a second species occurred in Saxony, and toward the close of the Cretaceous two additional American species appear in the record—one in western Tennessee and Wyoming, and the second the remarkable *Liriodendron alatum* (fig. 4) with its winged leaf-stalks, which is found in Colorado and Utah.

Cretaceous times were brought to a close by widespread land emergence and this emergent condition prevailed for a very long period of time, in fact at no subsequent stage of the earth's history was there anything approaching the degree of submergence attained during the Cretaceous. Finally there was a period of renewed submergence which ushered in the Tertiary. This early Tertiary renewal of sea expansion resulted in such a disposition of the land and water that extensive mediterranean seas had free connections with the Arctic not only from the Atlantic and Pacific oceans, but also across Asia, and this resulted in mild and comparatively uniform climates. The fossil floras of that time show a poleward expansion of the equatorial floras of that time, so that in southeastern North America we find few temperate types and no tulip-trees. They are found, however, in British Columbia, Greenland, Iceland, and England during the later Eocene. The Oligocene records which follow those of the Eocene have furnished no representatives of the tulip-tree, but well marked Miocene forms, representing two or three species are found in Italy, Switzerland, and Bohemia. None have been discovered in the Miocene or Pliocene floras of North America, but neither of these, and especially that of the Pliocene is at all well known.

There were at least three species still surviving in Europe during Pliocene time and immediately preceding the Glacial period (figs. 6, 7). These were found in Italy, France and Holland, and their remains comprise both leaves and characteristic fruits in the last two areas. Those from Holland cannot be distinguished from the still existing American tulip-tree, which adds another item to the long array of facts which show that the similarities in the existing floras of North America and eastern Asia and the dissimilarities shown with the flora of Europe, are due very largely to the havoc wrought on the last continent by the intense glaciations combined with the peculiar geography and topography of transverse mountain chains and mediterranean seas which largely prevented the southward retreat of the forests. Another link in the chain of distribution is the presence of fossil leaves like those of the existing species in the Pliocene of the Altai mountains, north of Tibet in central Asia. The extremely slight differences between *Liriodendron tulipifera* of southeastern North America and *Liriodendron chinensis* of southwestern China probably date from Pliocene time. Finally in Pleistocene time we find the fossil fruits and leaves of the existing American form in Maryland, North Carolina and Alabama.

CHAPTER XVII

The Sweet or Red Gum and Witch Hazel

The sweet gum belongs to a family, often called the witch hazel family (Hamamelidaceae), whose present geographical distribution is of remarkable interest. The family comprises 19 genera in all and about 50 living species, and no less than 9 of these genera are monotypic, that is to say, they are each represented by but a single existing species.

Monotypic genera are either geologically old or else very modern, that is, their single species may have been recently evolved or it may represent the last remaining descendant of a long and now extinct line, and it is usually possible to get some idea as to which of these categories we are dealing with by a consideration of the present geographical distribution of the different members of a plant family. In the case of this family 12 of the 19 genera are confined to Asia, 1 is prevailingly Australian, 3 are African and 3 are confined to Asia and southeastern North America.

Both the sweet gum and the witch hazel belong to this last category, their present range being shown approximately on the accompanying sketch map (fig. 39). It is obvious that a distribution such as this indicates that the family to which they belong had an extended geological history and that the particular genera once flourished in regions that connect the present discontinuous occurrences. The only alternative is to suppose that the present disconnected areas of distribution represent special creations—which is absurd, or to suppose that the same genus originated independently on different continents, which is almost equally absurd. The details of the geological history of the witch hazel family are for the most part unknown because of the imperfection of the geological record.

THE SWEET OR RED GUM

No part of the Temperate Zone can compare with southeastern North America in the brilliancy of autumnal foliar display and a considerable part of this is due to the sweet gum, whose leaves assume a variety of shades ranging from rich yellow through carmine to wine red.

Although the modern sweet gum rivals the red maple or the dogwood in the brilliancy of the autumnal tints of its star-shaped leaves, it was considered practically worthless as a wood until within the past few years, owing chiefly to its tendency to warp and twist. It was formerly left standing in logging operations and when land was cleared for agricultural purposes, the sweet gum was girdled and left to rot. But times and opinions change and the demand for the wood has increased rapidly since about the year 1900.

Not only does the heartwood make a most attractive interior finish, especially for panels, doors and woodwork in its natural color—abroad it is often called satin walnut—but it takes stain so well that it is often made into mahogany, oak and walnut furniture. Sapwood and the common grades go into boxes, cheap furniture, flooring, staves, etc. There is a large export trade in the heartwood, possibly as much as 50 per cent of the supply going to England, France and Germany, where its beauty for interior finishing was recognized earlier than it was in this country.

The sweet gum occasionally grows to a height of 150 feet and a diameter of 5 feet. Such dimensions are, however, unusual and the average diameter of large trees is perhaps 30 to 36 inches, indicating a normal age of from 150 to 350 years, the size being dependent on the habitat. The trees of the rich bottoms of the south Atlantic Coastal Plain grow much faster than those of the lower Ohio valley. The stem is straight and columnar and until the height growth is attained the high trunk and conical crown make it resemble a conifer. After reaching its height growth it branches freely and the crown becomes rounded and spreading. Its deeply furrowed bark and cork winged twigs are familiar to every explorer of swamps in our southern states.

The earliest popular name, sweet gum, doubtless originated from the local use for chewing of the sweetish gum obtained from the tree. The later name, red gum, refers to the reddish brown color of the heartwood and its use has become increasingly common since the decorative qualities and commercial possibilities of the wood have come to be appreciated. It might be stated parenthetically that the red gum is not related to the black, cotton and tupelo gums so common in similar situations throughout the southeastern United States, which belong to the genus *Nyssa* and are related to the dogwood.

FIG. 39. SKETCH MAP SHOWING PRESENT RANGE (BLACK AREAS) AND FOSSIL OCCURRENCES OF THE SWEET GUM (SOLID BLACK CIRCLES)

The red gum belongs to the genus Liquidambar, a name derived from the latin for amber colored gum in allusion to the balsamic exudation or gum which it yields. The tree is a native from southwestern Connecticut to southeastern Missouri and southward to peninsular Florida and eastern Texas. It reappears in a closely related form known as the variety *mexicana* in the uplands of central and southern Mexico and the highlands of Guatemala.

While its range is extensive and its habitat varied it reaches the largest size and commercial possibilities in the rich bottom lands of mixed hardwoods in the maritime districts or coastal plain of our southern States from the valley of the Great Pedee in South Carolina to the valley of the Trinity River in Texas, and northward along the bottoms of the Mississippi, Arkansas, Tennessee and Ohio. In the more northern part of its range it inhabits swamp borders and low wet swales.

There are at least three additional existing species of Liquidambar—one *Liquidambar macrophylla* Oersted, found in the mountains of Central America, while the other two are Asiatic. *Liquidambar formosana* Hance is found on the Island of Formosa and in southern China, and the other separated from it by the whole breadth of the Asiatic continent, is found in a limited area in the mountains of southwestern Asia Minor. The last was named *Liquidambar orientalis* by Miller and is the source of the liquid storax of commerce.

This disconnected distribution of the existing species of Liquidambar, which can be better appreciated by a glance at the accompanying map, figure 39, is a sure indication of an ancient lineage and a former occupation of the intervening areas where it is now extinct. If the sweet gum stood alone in having such a remarkable range its interest would seem much greater, but since the days of Asa Gray's American Association address we have become accustomed to many similar ties across the departed ages that formerly connected and now explain the near kin found in Asia and North America, exemplified also by the magnolia, sassafras, coffee-bean and tulip-tree.

Turning to the fossil record we find that about 20 extinct species of Liquidambar have been described. The oldest of these, *Liquidambar integrifolius*, described by Lesquereux from the Upper Cretaceous Dakota sandstone of Kansas and subsequently identified from Canada, Texas and South America, cannot be looked upon as the Abraham of the race of gums for unfortunately for our story its coriaceous and entire-margined leaves are not those of a Liquidambar but probably represent a species of Sterculia—a tropical genus of trees that was very common in Upper Cretaceous times throughout the Northern Hemisphere. The same comment applies to an early Eocene form described from France by Watelet, a student of the fossil floras of the Paris basin.

The oldest known authentic form is found in the upper Eocene in Greenland, Alaska and Oregon. This hints at the Arctic region as the original home of the genus—a not improbable hypothesis, although one for which the evidence is not conclusive, since the vast and almost unknown expanse of Asia cannot be left out of the reckoning. What is more remarkable is the fact that these ancestral gums of three or more million years ago and all of their numerous descendants are so like the sweet gums of today. They had the same palmately lobed and variable leaves with finely toothed margins, and this resemblance extends even to the consistency of the leaves. Today in our southern rivers the sweet gum leaves are the first to decay when they fall in the water and similarly, in the Pleistocene river deposits the gum leaves are rarer and nearer dissolution than the leaves of their associates. Judging by their usually fragmentary condition in the older rocks this characteristic was as true then as now.

Let us emphasize then the first landmark in the history of the sweet gum, namely, that the oldest known authentic species occurs in the late Eocene of the far North and on our Pacific coast in Oregon and Alaska.

Following the Eocene is the period of earth history known as the Oligocene, and it is a striking commentary on the imperfection of the geological record that the only known Oligocene species of gum is recorded from Italy. This is not quite as bad as it seems when it is recalled that we know nothing of the Oligocene history of Asia and that in North America the Oligocene was a time of continental mountain basin and plains deposits throughout the west and of tropical marine deposits along the southern coasts, in neither of which are to be found many traces of the terrestrial vegetation of that time.

The Oligocene was followed by Miocene times and these fortunately are not so chary with their evidence. About 9 species of sweet gum are recorded from Miocene rocks, most of them surprisingly like the modern gum. There are species from Japan on the east and from southwestern Asiatic Russia on the west. The European records are innumerable and widely distributed and the American records include Oregon and Colorado. If the reader will turn to the accompanying plate the resemblance of these ancient flowers, fruits and leaves to those of today will be at once apparent. These figures are taken for the most part from the wealth of remains preserved in the tiny Miocene Lake of Oeningen on the Swiss border of Baden, and the leaves show the same variation of three, four, five, or more lobed forms such as can be matched today in any Southern swamp.

The Miocene was followed by the Pliocene and the gums were still cosmopolitan in the Northern Hemisphere so that it is easy to see why their distribution is what we find it to be at the present time. Pliocene gums have been found at very many localities throughout central and southern Europe as well as on our Atlantic coast. I have reproduced a worn gum ball collected from the Pliocene deposits along the Main River in Germany on the accompanying plate, and the fruits found in the late Pliocene of Holland are indistinguishable from those of the existing species of Asia Minor.

The Pliocene was followed by the Pleistocene or Glacial time and the gums found fossil in this comparatively recent geological period include traces of the existing Formosa and south China species, which then still flourished in Japan, and the abundant leaves and fruits of the existing red gum which have been found in West Virginia, North Carolina and Alabama. A leaf and fruit from the Pleistocene swamp deposits along the Neuse River in North Carolina are shown on the plate.

That the gums which were so abundant throughout Europe in the late Tertiary should have been entirely exterminated by the glacial conditions while they survived in North America and Asia seems strange but is readily understood when it is recalled that high mountains and seas from the Pyrenees to the Caucasus made it impossible for the gums to escape southward to more genial climes and to return to the northward again when the cold stages

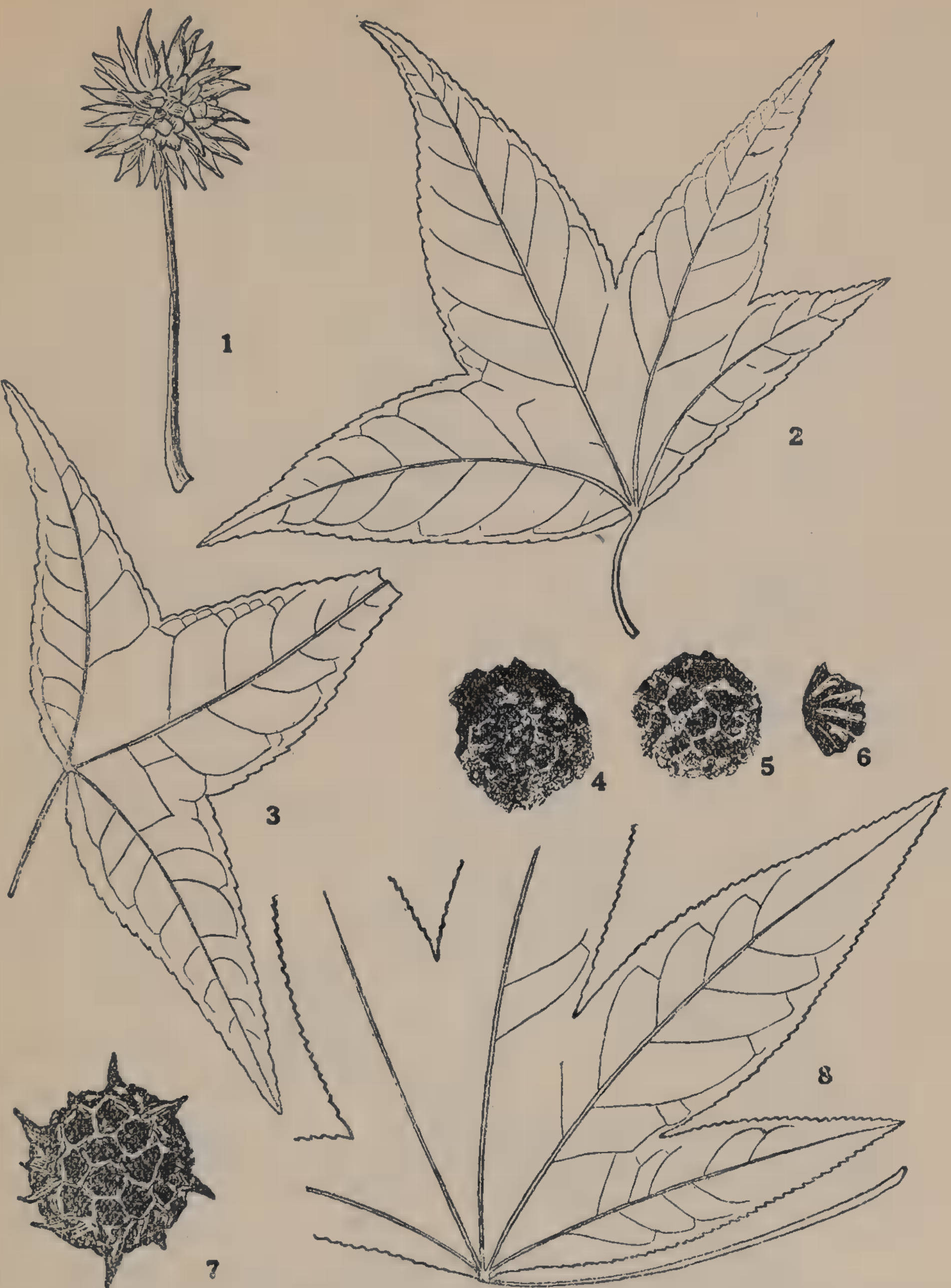

FIG. 40. SOME FOSSIL LEAVES AND FRUITS OF THE SWEET GUM (ABOUT $\frac{2}{3}$ NATURAL SIZE)

1, 2, 3. Variously lobed leaves and fruit of *Liquidambar europaeum* Al. Br., from the late Miocene of Baden.

4, 5, 6. Fruits of *Liquidambar pliocaenicum* Geyler from the upper Pliocene Brown Coal of Germany.

7, 8. Fruit and leaf of *Liquidambar styraciflua* Linn., from the Pleistocene of North Carolina.

were past, as was possible in both Asia and North America. The gum was only one of the many forest trees of the European Tertiary that met this fate. The witch hazel, tulip-tree, hickory, walnut, magnolia, and many others shared the same misfortune. By way of contrast with the present distribution of the sweet gum the accompanying map shows the Tertiary occurrences, thus illustrating something of the past history as it has just been related.

The record of the sweet gum ancestry does not go back so far nor is it as detailed as that of many of our forest trees, but it does cover several million years and all of the continents of the Northern Hemisphere, and it is surely impressive when we recall that while we have collected the gum balls, as the fruits are commonly called, admired the shape of the leaves and their autumnal tints, it remained for the twentieth century to discover the beauty of the wood and utilize it for interior finishing.

THE WITCH HAZEL

The witch hazel is closely related to the sweet gum but is sharply contrasted with it in size, in leaf habit, in flowers and fruits. It is small and elfish of stature, with zig-zag branches, coarse prominently veined simple leaves, bilocular woody capsules with large bony seeds, and fringe-like bright yellow flowers. Blooming in the winter it is a favorite topic for discussion whether the witch hazel is the last flower of fall or the first flower of spring. The persistence of the fruit of the previous season until the flowering time comes around again has suggested the scientific name of the genus Hamamelis, derived from the greek words ἅμα, with, and μῆλον, fruit.

The witch hazel is an altogether different plant from the Old Saxon witch or wych hazel, a name applied to the common European hazel nut which was Thor's tree and a magic tree as well. Opinions differ as to the origin of the fact that the twigs were long reputed to have magic properties as divining rods—not, however, for the discovery of witches, but to locate water, oil or precious minerals. Others see the origin of the name in the once considered mysterious bombardment of seeds from the persistent fruits. When the yellow pennants of the witch hazel are uncoiled and the November woods are tinged with a yellow halo by the millions of crinkly petals, last seasons woody capsules are opened and loaded and ready to bombard the loiterer in the woods with their doubled barrelled load of hard bony seeds. With the contraction of the walls of the capsule in drying the seeds are suddenly and forcibly expelled a distance of a score of feet or more.

There are three existing species of witch hazel and their distribution confirms the story learned from that of the sweet gum. Our North American form ranges from the maritime provinces of Canada westward up the St. Lawrence Valley through southern Ontario to Wisconsin and eastern Nebraska, and southward to northern Florida and eastern Texas. It thus extends much farther north than the sweet gum and unlike the latter it reaches its largest size on the slopes of the higher Alleghanies in the Carolinas. The wood is too small to be of any particular use. The witch hazel is, however, often cultivated as an ornamental plant in our northern States and in northern and western Europe, because of its odd habit of blooming in the fall and winter, a habit shared by the oriental species. The bark and leaves are slightly astringent and although without any known essential properties are largely used in homeopathic practice, and the extract made by distilling the bark in dilute alcohol is extensively sold as a toilet water.

The two other existing species of witch hazel are Asiatic—one, *Hammelia japonica* S. & Z. being found in the mountains of Japan (Kiusiu and Nippon) and southern China (Kiangsi and Hupeh). Thus all the witch hazels are essentially small mountain trees or shrubs and not bottom dwellers like the sweet gum.

Although we are sure, from their present distribution, that the witch hazels of today are the relics of an ancient line, we know little of their geological history. In the mid-Cretaceous of North America a number of leaves have been found which have been described under the name of Hamamelites (Saporta). Some of these are very like witch hazel leaves but whether they are veritable witch hazels or represent some other members of this family it is impossible to determine conclusively. Other related forms occur in the early Eocene of Belgium, France and Montana. A petrified wood that is closely related to if it is not true witch hazel wood (Hamamelidoxylon) has been described from the mid-Cretaceous of France and flowers (Hamamelidanthium) are preserved in the Baltic amber (Lower Oligocene). Finally unmistakable witch hazel leaves occur in the Pliocene of the Auvergne (Cantal) so that we know that the witch hazel was present in Europe in pre-glacial times although it became entirely extinct on that continent during the period of glaciation.

CHAPTER XVIII

LOCUST, COFFEE-BEAN AND RED-BUD

A consideration of the locust[1] and its allies introduces us to one of the largest alliances of flowering plants, popularly known as the Leguminosæ, and now divided by botanists into four families. These are the acacia or mimosa family (Mimosaceæ), the senna family (Caesalpiniaceæ), the krameria family (Krameriaceæ), and the pea or bean family (Papilionaceæ). Among these there is a well marked floral progression from the first, with its regular flowers, to the last, with its butterfly-like blossoms. The first two families are very old geologically and are largely arborescent forms of the Tropical Zone, many species of which have been found fossil in the Tertiary deposits of our southern States. The last two families, on the other hand, are mainly herbaceous forms dwelling outside the tropics, and both have probably attained their maximum of variation in the Temperate Zone since the inauguration of the Pleistocene glaciation.

A large number of leguminous plants furnish most important food or forage crops (peas, beans, lentil, peanut, tamarind, alfalfa, clover, etc.) or are utilized in medicine (senna, licorice, etc.) or other arts (indigo, logwood, gum tragacanth, gum arabic, copaiba gum, etc.). The habit of many of the Leguminosæ of abstracting nitrogen from the air by means of root bacteria makes them of especial interest in these days of the rapid exhaustion of natural nitrates. Many tropical Leguminosæ are important timber trees (brazil wood, iron wood, violet wood, etc.) but outside of local uses the world's markets know but a few and these are found in the cabinet maker's rather than in the lumber trade, and scarcely any awaken a concept in the popular mind unless it be rosewood

[1] This is not the locust tree of southern Europe, which is the carob, *Cecratonia siliqua*, a member of the Caesalpiniaceæ.

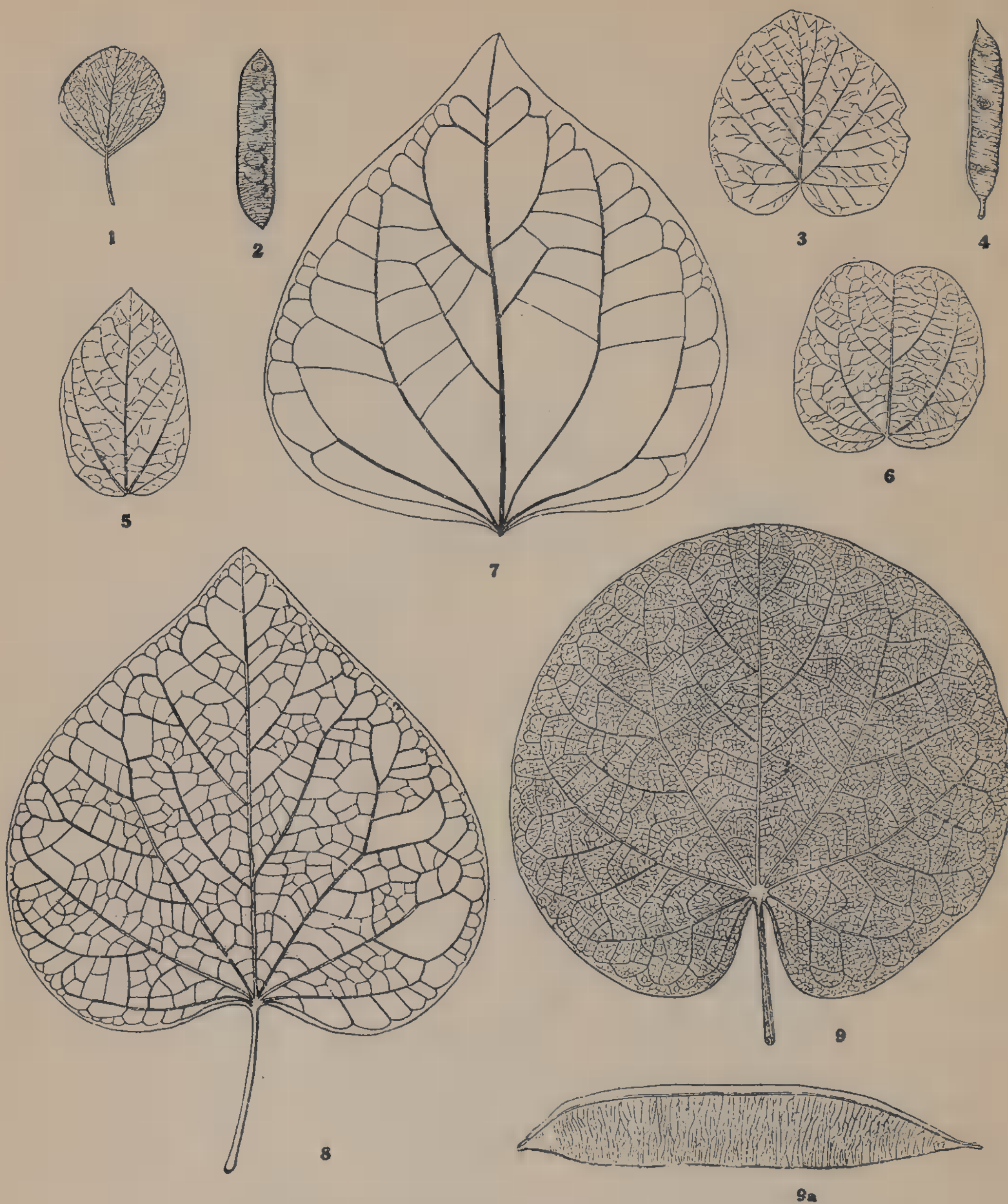

Fig. 41. Some Fossil Leaves and Pods of the Red bud (About ½ Natural Size)

1, 2. Leaf and pod of *Cercis antiqua* Sap. from the Oligocene of France.

3, 4. Leaf and pod of *Cercis virgiliana* Mass. from the upper Miocene of Italy.

5, 6. Leaves of *Cercis tournoueri* Sap. from the upper Oligocene of France.

7. Leaf of *Cercis wilcoxiana* Berry from the lower Eocene of Tennessee.

8. Leaf of *Cercis canadensis* Linn. from the Pleistocene of North Carolina.

9, 9a. Leaf and pod of *Cercis siliquastrum* Linn. from the Pleistocene of France.

(Dalbergia), a tree of the pea family which furnishes such an incomparably handsome cabinet wood.

There are about 500 genera and 10,000 existing species of Leguminosæ, of which only 17 genera with about 32 species attain to the stature of trees within the limits of the United States, and the bulk of these are confined either to the subtropical coastal belt of Florida or to the arid southwest. The only tree forms that are widely familiar in the eastern States are the Judas-tree or red-bud (Cercis), the Kentucky coffee tree (Gymnocladus), and the honey locust (Gleditsia) of the family Caesalpiniaceæ and the locust (Robinia) of the family Papilionaceæ, so that our attention in the present chapter will be confined to these four trees.

THE LOCUST (ROBINIA)

The black locust, often called the yellow locust because of its yellowish brown heart wood and yellowish white sapwood, is the type of the genus Robinia, so named by Linnaeus in honor of Jean and Vespasian Robin who introduced it into Europe at the end of the sixteenth century, at which time the former was in charge of the Garden of the Louvre. The specific name which Linnaeus gave this species, *pseudacacia*, commemorates in latinized form the common European name of false acacia by which this North American tree has usually been known abroad.

Its natural range extends from Pennsylvania to Georgia and westward to Iowa but it has been extensively naturalized on our western prairies as well as on the plains of Hungary. Perhaps no American tree was so extensively planted in Europe, and our colonists also, in the period immediately following the Revolution, valued it highly both for its timber and for its beneficial effect upon soils. In Revolutionary France May 6 was consecrated to the locust.

It is a medium sized tree and, while it sometimes reaches a height of 90 feet and a trunk diameter of 4 feet, the average tree branches early and tops irregularly and is not over 50 or 60 feet tall and about 20 inches in trunk diameter. The leaves, in common with nearly all the other members of the leguminous alliance, are what are known as compound, that is they consist of many separate leaflets. There are, in the locust, from 7 to 9 opposite pairs of elliptical slightly stalked leaflets and an odd one at the end terminates the slender stalk of the leaf, which is from 8 to 14 inches in length. At the base of the leaf-stalk a pair of short subulate stipules or accessory leaflets soon become transformed into straight or slightly recurved spines which persist for many years, often becoming an inch or more in length.

The flower clusters, which appear after the leaves toward the end of May, convert the tree into a creamy white bower of incense, since they are filled with fragrant nectar. The fruit, which ripens late in the autumn, is a red-brown pod, 3 to 4 inches long and ½ an inch wide with 4 to 8 smooth brown seeds, which are shed from the opened pods during the winter or early spring before the pods let go their hold on the parent tree. The locust is one of our most prolific trees in sending out sprouts from the roots, hence a tree will spread rapidly and is difficult to eradicate. It grows rapidly when young and thrives in the fertile soils of the Appalachian Mountain valleys, but will also make a good growth on sandy or rocky soils.

The wood is heavy, exceedingly hard and strong, and very durable in contact with ground or air, hence it is highly valued for fence posts and rails, cross arms and insulator pins for telephone

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Fig. 42. Some Fossil Locusts and Coffee Beans (About ⅔ Natural Size)

1, 2, 3. Leaflets and pod of the existing *Robinia pseudacacia* Linn.

4. *Robinia hesperidum* Unger from the upper Miocene of Croatia.

5. A probable locust leaflet from the Upper Cretaceous of South Carolina.

6, 7, 8. Leaf and pods of *Robinia regeli* Heer from the upper Miocene of Baden.

9. Another locust pod from the upper Miocene of Baden.

10. A leaflet of the existing *Gymnocladus dioecus* Koch.

11. *Gymnocladus casei* Berry from the Miocene of Oklahoma.

12. A leaflet of a Miocene honey locust, *Gleditsia allemannica* Heer, from Baden.

13. A leaflet of the existing honey locust.

14, 15, 16. A thorn, leaf and pod of a honey locust, *Gleditsia Wesseli* Weber from the lower Miocene of Germany.

Fig. 42

and telegraph lines, carriage hubs and similar turnery, tree nails, etc. It is also valued for fuel and construction purposes, but does not enter largely into the general lumber industry because of the scattered supply and its special uses.

A tree that has been cultivated for so long a time has naturally given rise to numerous horticultural varieties of the parks and gardens. There are also 6 or 7 additional species of Robinia, all confined to North America and very similar to the preceding except that they are smaller trees or even shrubs. The only one of these that is generally known is the clammy locust, *Robinia viscosa* Vent., which may be readily distinguished by the lack of fragrance of its blossoms. It is a native of the mountains from southwestern Virginia to Georgia, but has been extensively planted in all temperate countries where the climate is not prohibitive and has become extensively naturalized east of the Mississippi as far north as Massachusetts.

The rose acacia, *Robinia hispida* Linn. of the southern Appalachians, a shrub with pink or purple non-fragrant blossoms; and the New Mexican locust, *Robinia neo-mexicana* Gray, a shrub or small tree of the mountain valleys of Colorado, New Mexico, Arizona, and southern Utah, with handsome blossoms, are both favorites outside their natural limits for ornamental planting in both this country and western Europe.

The geological history of the locust is beset with difficulties, the leaflets usually becoming detached before fossilization and both leaflets and pods being often impossible to differentiate from other and unrelated leguminous leaflets and pods. This difficulty of distinguishing between the fossil leaflets of the various genera of Leguminosæ has led paleobotanists to establish a purely formgenus known as Leguminosites for leaflets of this sort that cannot be identified with certainty beyond that they are leguminous. Large numbers of species of Leguminosites ranging in age from the Upper Cretaceous through the Tertiary are known. Among these are several that might well represent an Upper Cretaceous locust, but such an identity is not conclusive. Certain pods from the top of the Cretaceous in Colorado have been referred to Robinia but since this genus has not been recognized with certainty in the succeeding Eocene deposits either in this country or elsewhere, these too must be considered questionable. Two species of locust have been recognized in the Oligocene of Europe—one in France and the other in Italy. It is in the Miocene, however, that the locust becomes widespread and exceedingly common. At least a dozen different species have been recognized from European deposits of this age and one of these from the late Miocene of central France is so similar to the existing locust of North America that its describer is disposed to consider the two as identical. This form continued to exist in the European area in Pliocene times. A well marked locust has also been found in the deposits of the lake-basin at Florissant, Colorado, but no other North American Miocene form has been discovered.

In addition to the very modern looking Pliocene form already mentioned a second was common at this time along the Mediterranean coast of southern Europe from Spain to Slavonia. There is no evidence that the locust survived the first glaciation in Europe but in North America we find the modern species in the Interglacial deposits of the Don Valley in Ontario some distance north of its existing range, and it is also found in the late Pleistocene of Maryland.

THE HONEY LOCUST (GLEDITSIA)

The black locust is sometimes called the honey locust in New England because of its fragrant nectar-bearing blossoms. The true honey locust is, however, quite another tree and belongs to the family Caesalpiniaceæ, Robinia belonging to the family Papilionaceæ.

The honey locust belongs to the genus Gleditsia, sometimes spelled Gleditschia since it was named by Linnaeus in 1753 in honor of J. T. Gleditsch, a German botanist. Gleditsia contains 5 or 6 species natives of eastern North America and Asia, and 3 of these are found in the United States. One, *Gleditsia texana*, Sargent, is confined to the Brazos River Valley in Texas; a second, the water locust *Gleditsia aquatica* Marsh, is found in our southern

States; and the true honey locust, *Gleditsia triacanthos* Linnaeus, a tall graceful tree, ranges from Ontario and western New York to Georgia, Kansas and Texas.

The honey locust is a large tree 75 to 140 feet in height and with a trunk 2 or 3 and occasionally as much as 6 feet in diameter. It is exceedingly graceful in habit with its slender spreading and somewhat pendulous branches forming a broad open head. This together with its tiny leaflets gives it more the appearance of so many of the tropical species of Leguminosæ rather than of a tree of the Temperate Zone, and it is consequently a general favorite as an ornamental and shade tree in all countries with a suitable climate.

The leaves are sometimes slender stalks with 9 to 14 pairs of oblong-ovate leaflets which are never over $1\frac{1}{2}$ inches long and $\frac{1}{2}$ inch wide, and which usually have a slightly, but not apparent, crenulate margin. More usually the leafstalk bears from 4 to 7 pairs of branches each with 8 to 12 pairs of leaflets, which are generally under an inch in length and $\frac{1}{2}$ inch in width. Such leaves in which there is on odd terminal unpaired leaflet on the main stalk or the branches is termed even pinnate. Sometimes, however, the honey locust leaves do have such an odd terminal leaflet, and frequently either the basal or the terminal part of the leaf stalk will lack subordinate leaflet bearing branches and have in their place somewhat larger leaflets on the main stalk with the leaflet bearing branches in the middle part of the leaf stalk. The stipules are small and are soon shed and do not develop into spines as in the black locust. Nevertheless the honey locust is plentifully supplied with thorns. These are large and much branched and are not superficial (epidermal) like the spines of the black locust but are true abortive branches and cannot be readily detached except by cutting.

The flowers appear in the late spring after the leaves. They are not especially conspicuous being greenish-white in color, but are exceedingly fragrant and abundantly nectar-bearing. They are not irregular like a pea blossom as are those of the black locust, but regular and polygamous, i.e., some are pollen-bearing and some seed-bearing. The pods are large and flattened, bright brown or purplish in color when mature, and are always more or less curved and twisted as they contract in drying during the autumn. They are from 5 to 18 inches long and about 1½ inches wide. The space between the seeds is filled with a sweet succulent pulp, hence the name honey shucks, and the pods do not split open when the seeds are ripe. The wood is much like that of the black locust and is used for similar purposes.

The water locust is a much smaller tree, with leaves much like those of the honey locust but with somewhat larger leaflets, which are thicker and a darker green. The pods, however, are not much longer than wide with only one or two seeds and without a succulent pulp. The water locust is an inhabitant of river bottoms and swamps and attains its maximum size in the bottom swamps and along stream banks in Louisiana and Arkansas.

No representatives of the honey locust can be recognized with certainty in either the Upper Cretaceous or the Eocene, although there are a number of leguminous leaflets found in the rocks of both of these periods that might well represent its ancestors, in fact a genus called Gleditsiophyllum found in both the Upper Cretaceous and the Eocene of North America is suggestively like the honey locust.

A supposed species is recorded from the Oligocene of Europe and there are a number of undoubted Miocene species. Seven or eight have been described, one occurring on the east coast of Asia and the others all confined to Europe, where they are known from Greece and Hungary to France. They are especially abundant in the Miocene woods of Switzerland in the days before the formation of the Alps had been completed. Pliocene records are wanting in both this country and Europe. The modern species appears in the early Pleistocene of Kentucky and an extinct species is recorded from the Interglacial deposits of the Don Valley in Ontario.

THE KENTUCKY COFFEE-TREE (GYMNOCLADUS)

Gymnocladus is one of those rather numerous and unrelated genera that at the present time is native only in southeastern North America and southeastern Asia, and like the Tulip-tree and the Sassafras it has a single species in each region, scarcely distinguishable from one another, while the ancestral stock has become extinct in the intervening areas. Our American tree is commonly known as the Kentucky coffee-tree or coffee bean, since its seeds were sometimes used as a substitute for coffee, especially during pioneer and Revolutionary times. It is also called the stump tree in certain localities because the leafstalks are often shed after the leaflets and their large size makes it appear that the tree is shedding its twigs. The fresh green pulp of the unripe pods is still used in homœopathic practice and the pulp surrounding the seeds of the Chinese species is detersive and is widely used in its native land as a substitute for soap.

The Kentucky coffee-tree is a large stately tree from 75 to 110 feet tall with a trunk from 2 to 3 feet in diameter, which, however generally forks to form three or four main stems within 10 or 15 feet of the ground. The leaves are large, particularly on vigorous saplings and may measure 3 feet in length by 2 feet in width. They have a stout leafstalk, a terminal branch and from 2 to 4 pairs of lateral branches, each bearing from 6 to 14 pairs of subsessile ovate leaflets, pink at first and turning to a bronzy green at maturity. The stipules, which in Robinia become spines, are foliaceous and are soon shed. Nor does the coffee-tree develop thorns like its close ally the honey locust. The flower clusters are large but scarcely conspicuous except in the young trees. The flowers, while sometimes mixed usually have the pollen bearing ones in separate and larger clusters than the seed bearing ones. The pods are large and hard, dark reddish brown in color, and are sometimes as much as 10 inches long and 2 inches wide. They remain unopened throughout the winter and contain numerous very hard globular seeds, about the size of small marbles, imbedded in the sweet pulp. The wood is strong and coarse grained, heavy but not hard. Like locust wood it resists decay and is occasionally utilized for fence posts, rails, ties and construction, and rarely for cabinet work. The shortness of the butts and the scattered growth usually render the tree immune from the lumberman.

The coffee-tree prefers rich soil and occurs sporadically but nowhere in abundance from central New York and western Pennsylvania through southern Ontario and southern Michigan to the valley of the Minnesota and southward to middle Tennessee and southwestern Arkansas. It penetrates the prairie country along the bottoms of the larger streams in eastern Kansas, Nebraska and Oklahoma. It is frequently planted in parks in the eastern United States and in western Europe.

The geological history of this tree is unfortunately almost entirely unknown. As it occurs at the present time in both Asia and North America it must have been present during the Tertiary in the intervening region, as I have already remarked. This implies its presence in not only the Arctic region but in northwestern North America and very probably in Europe. Its former presence on the last continent has not been definitely proven, however. Saporta, many years ago described leaflets and pods from the basal Miocene of France as *Gymnocladus macrocarpa*, but these are usually regarded as more properly referable to some other leguminous genus. Squinabol named a pod from the Oligocene of Italy *Gymnocladus novalensis* but this too is of doubtful identity. An undoubted fossil form has been found in North America. This is *Gymnocladus casei* and it comes from the late Miocene of the "panhandle" region of Oklahoma. It was much like the modern coffee-tree and is of interest chiefly in showing that at that time the western range of the genus was not as restricted as it is today.

There are also fossil leaflets that appear to represent a European coffee-tree found in deposits in central France, the Auvergne, of late Miocene age.

THE JUDAS-TREE (CERCIS)

Unlike the great majority of leguminous genera the different species of Cercis have simple leaves. These are cordate-orbicular in form, glossy green, palmately 5 to 7 veined and arranged in a two-ranked manner on the long shoots. The pods are small and compressed, lustrously red purple in color, and fall in the late autumn or early winter. There are 5 or 6 existing species of Cercis although the majority of my readers will be familiar with only the European Judas-tree or its very similar American relative. In addition to these two well known ornamental trees there is a third species in Texas, another on the Pacific coast of North America and two or three more in southwestern, central, and eastern Asia. Thus Cercis is another genus whose distribution suggests the same thoughts as did the distribution of Gymnocladus. But in the case of the former more links in the chain have remained until modern times and its distribution today suggests what may have been and probably was the distribution of Gymnocladus in Miocene times.

The European Judas-tree, *Cercis siliquastrum* is a native of the south of France, the Spanish peninsula, Italy, Greece and Asia Minor. It is a handsome low tree with a flat spreading head, much utilized in ornamental plantings throughout Europe. Its profuse purplish-pink flowers appear before the leaves. They have an agreeable acid taste and are sometimes mixed with salads or made into fritters.

When originally described the Judas-tree was the tree of Judea, from its supposed origin in Palestine. This name gradually became transposed into Judas-tree and tradition accounted for the latter name by the fact that it was this tree on which Judas Iscariot hanged himself. The tree was frequently figured by the herbalists, and one, Castor Durante, gives a woodcut showing Judas hanging from the branches thus illustrating the popular tradition.

The American tree, *Cercis canadensis*, is much like its European relative in every way and like the latter it is commonly known as the Judas-tree, particularly in ornamental plantings, for which it is extensively used not only throughout our northeastern states but also in western Europe. In its natural surroundings it is perhaps more often known as the red-bud, and is one of the striking objects of the early almost leafless spring woods, its masses of purplish-pink blossoms close to the branches, contrasting with the white of the opening dogwood and forming splashes of bloom in the gray woods. In the latter half of March the traveller through Virginia and the Carolinas can scarcely distinguish from the train window between the blooming peaches and the red-buds of the door-yards.

Our Judas-tree grows naturally from the valley of the Delaware and southern Ontario to Tampa Bay, northern Alabama, Mississippi and Texas, and extends westward along the bottoms of the large streams into the eastern border of the prairie states. It is said that the blossoms are sometimes eaten, although I have never observed this custom. In the days before the prevalence of aniline dyes the branches were sometimes used for giving wool a nankeen color.

The members of this genus are too small for lumbering and the wood has no special uses that I know of, consequently we are not likely to be deprived of the striking beauty of the Judas-tree as we probably should if the wood could be used for bobbins or lead pencils or boxes.

Fortunately in the case of the Judas-tree a considerable beginning has been made in tracing its geological history, although the inevitable gaps in this history have not all been closed. The oldest known forms come from the lower Eocene and all of these, three in number, are North American, occurring in Tennessee, Mississippi, Montana and Dakota—the last being in a region now one of prairies and bad lands far removed from the habitat of any of the existing forms and showing how the ancestral Judas-trees were enabled to migrate across North America in the more humid days that preceded the development of the prairie type of country. A middle Eocene species occurs at Bournemouth on the south coast of England and an upper Eocene form has recently been described, associated with a large and warm climate flora, in Hesse, Germany. By succeeding Oligocene times the Judas-tree had appeared at additional localities in Europe where a very characteristic form is found in southeastern France in the lower Oligocene and a second French species occurs at a somewhat later stage of the Oligocene.

We are without information as to whether Cercis came down from the north into both North America and Europe or whether America was its original home and it spread across the land bridge in the region of Behring Sea into Asia and thence into Europe. Personally I favor the interpretation that the vast and paleobotanically almost unknown continent of Asia was the original home of the genus from which it spread westward into Europe and eastward across the Behring land bridge into North America. If this is the true story then this migration must have taken place during Upper Cretaceous times even though we have not yet found Cercis in the abundant Upper Cretaceous floras, for it is present in the lower Eocene of our Gulf States and in the middle Eocene of the south of England and a journey from Asia would have required a very long time.

The Miocene was pre-eminently the period of hardwood forests, and the ancestral Judas-trees seem to have reached the zenith of their differentiation and their most extensive range during these ages that succeeded the Oligocene. Although Asia remains an unknown area we have a glimpse of a small species preserved in the volcanic ash beds of the Florissant lake basin in the heart of the Colorado Rockies, and a second species in Nevada. No less than 5 species are already known from Miocene Europe, where they are represented as fossils by both leaves and pods. It is especially interesting to note that one of these from the late Miocene of Italy and another closely related form of the same age in France are directly ancestral to the existing European Judas-tree, while a second French species (*Cercis ameliae* Saporta) from the older Miocene of France seems to have been the ancestor of the existing *Cercis japonica* Siebold of eastern Asia. There is little direct evidence of the Judas-tree during the succeeding Pliocene times. Since it occurs both before and after the Pliocene in North America it must have been present at that time. In Europe a single Pliocene species is known from France.

As practically everyone knows, the Pleistocene, which succeeded the Pliocene, was a time of continental ice sheets or glaciers, which played havoc with the floras and faunas, particularly in Europe because of the combination of high mountains and seas along its southern border which effectually barred the ebb and flow of life that took place in Asia and North America with the advance and retreat of the successive ice sheets. During the maximum extent of the ice only a fraction of the Northern Hemisphere was covered and Asia was largely ice-free. The southern limit of the ice in Europe, where the center of accumulation and dispersal was the Scandinavian region, was the German plain. Here in North America the easternmost or Labradoran center of accumulation and dispersal extended its ice fields only as far south as Staten Island on the Atlantic coast, so that there was plenty of room south of the ice for a vast forest and game preserve for the subsequent repopulation of the more northern region.

There were at least four periods of glaciation which were separated by long intervals during which the ice disappeared except in the far North, and it is in the deposits formed during these Interglacial periods that we find the fossil remains of the Judas-tree. Both the American and the European Judas-tree were already in existence. The former has been found in North Carolina and in the Don River Valley in Ontario. The latter is rather common throughout France as far north as the site of Paris, and at a number of localities in Italy. Both the American and the European Judas-trees frequently depart from the normal orbicular or cordate shape of the leaf, widening them and developing an emarginate apex. This may be an atavistic trait, since several of the ancestral forms appear to have normally had leaves of this shape.

CHAPTER XIX

Sumach and Holly

The sumach and holly families belong to the large natural order of plants called the Sapindales which includes a score of families and over three thousand existing species. Here belong the box, horsechestnuts and maples, as well as hosts of unfamiliar forms of other climes. On the whole this order does not contribute as many trees to our temperate forests as it does to those of equatorial regions.

THE SUMACH

The sumach, of which there are many kinds, belongs to a family known botanically as the Anacardiaceae. This family contains a great variety of highly interesting plants such as the oriental mangos, now cultivated in all tropical countries, and often facetiously considered the basis of rebellion in the Antilles since the insurrectos could live entirely on mangos when they were in season. It includes also the interesting cashew-nuts, the spondias or hog-plums, pistacia nuts, and many others of the greatest importance.

In the modern world the sumach family is divided into over 50 genera and nearly 500 species. All are trees or shrubs with pithy branches, and a resinous milky juice that is toxic, alternately arranged simple or palmate or pinnate leaves, and drupaceous fruits. They make their greatest display in the tropical and subtropical regions of both hemispheres, and are especially abundant in the Malayasian region.

The genus to which the familiar sumach belongs is known as Rhus which was the classical name of the south European sumach. Rhus is by far the largest genus of the family, and the only one to occur in the temperate regions of both the Northern and Southern Hemispheres. It contains over 100 existing species, just about the same number as have been found fossil. They are found in all temperate regions of the globe and are perhaps most abundantly represented in South Africa. In North America they are to be found from Canada to southern Mexico, and from the Atlantic to the Pacific. Of the 17 North American forms 5 attain to the stature of small trees.

Their wood is too small and has too large a pith to be of any commercial value, although the shoots were sometimes used as spouts in tapping the sugar maple. Several of the forms are handsome ornamental shrubs with beautiful foliage and scarlet fruit clusters. The acrid poisonous juice of the Chinese sumach, *Rhus vernicifera*, furnishes the black varnish used in China and Japan in the manufacture of lacquer. Other species are sometimes used for their contained tannin or for the wax that is obtained from their fruits.

Our native American forms show a considerable range of variations. Some have feather-like leaves, others like the common poison-ivy have their leaflets in threes, and a small Californian tree, *Rhus integrifolia*, commonly known as the mahogany, frequently has simple holly-like leaves. One shrubby eastern form is known as the fragrant or sweet scented sumach, and another found in our western States is often known as the skunk-bush because of its vile odor.

The largest as well as one of the handsomest sumachs is the staghorn sumach, *Rhus hirta*, which occasionally reaches a height of 40 feet. It ranges from New Brunswick to Minnesota and southward to Georgia, Alabama and Mississippi and is sometimes planted as an ornamental tree in this country and commonly used for that purpose in central and northern Europe. It has pinnate leaves, 10 to 24 inches long of 11 to 31 lanceolate falcate, toothed margined leaflets, borne on a velvety pinkish stalk, and of a fine shade of green which becomes darker and more opaque with age. The flowers are greenish and inconspicuous, but the fruits, which are in thick clusters, are bright crimson and very striking.

Very similar to the preceding but rarely over 20 feet tall is the upland or scarlet sumach, *Rhus glabra*, sometimes called the smooth sumach in contrast with the staghorn since it lacks the pubescence of the latter. It is found from Nova Scotia to British Columbia and southward to Arizona and Florida. The foliage is much like that of the staghorn, as are its scarlet fruits. It is a hardy shrub and has great possibilities for ornamental plantings which seem to be but little appreciated.

At least two of our sumachs have an evil reputation. These are the rather uncommon shrub or small tree of swampy situations in our eastern States known as the poison-sumach, *Rhus vernix*. It is also sometimes called poison-elder, poison-ash, or poison-dogwood, although the ash is the only one of these to which it shows any particular resemblance. Its small clustered fruits are white, and its leaves consist of from 7 to 13 smooth entire leaflets, and are very poisonous to most persons. Its restriction to out of the way swampy situations renders it less familiar than its relative the ubiquitous poison-ivy, which almost everyone has become acquainted with to their sorrow, although its poisonous effects vary greatly with the season and with individuals, many, including the writer being entirely immune, while others are affected with great severity.

The poison-ivy, or poison-oak as it is sometimes called, represents two closely related botanical species—*Rhus radicans*, which ranges from Nova Scotia to British Columbia and southward to Florida, Arkansas and Utah; and *Rhus toxicodendron* of our southern States. They are both hardy agressive woody vines of thickets or fence rows or stone walls, occasionally assuming an erect or bushy form. They grow to great lengths, climbing by numerous aerial rootlets, and I have seen stems of old plants in New England that were 5 inches in diameter. The leaves consist of three leaflets, which may have their margins entire or toothed, and which are of a shiny lurid green color The fruits, like those of the poison sumach, are white, so that if the uninitiated will avoid swamp bushes or vines with clusters of hard white fruits and with trifoliate or pinnate leaves, they will save themselves any subsequent unpleasantness.

The last of our American species to be mentioned by name is the dwarf, black, or mountain sumach, *Rhus copallina*, which is a shrub or small tree found from Maine and southern Ontario to Florida and Texas. It is neither handsome nor especially useful, and often looks very frowsy because of its susceptibility to insect and fungous infection. Its individual leaves are not unattractive and the plant is interesting as an illustration of quiet and persistent aggressiveness. Inhabiting dry soils, its underground stems penetrate for yards in every direction, often growing to considerable size, and sending up new plants from the nodes. Many a New England pasture has been ruined by it, and it cannot be eradicated until every vital spark beneath the sod has been uprooted. The fruit is not handsome, and the leaves, usually of entire leaflets, pinnately arranged, have the stem margins winged between the leaflets, making it readily recognizable. Both the leaves and the bark contain large amounts of tannin and they are sometimes systematically collected and used in tanning.

The geological history of the sumachs goes back to the far off days of the dinosaurs, and ten or a dozen widely scattered species have been found in the rocks of the Upper Cretaceous period. At the beginning of Upper Cretaceous time there was a sumach in Saxony, and two in Kansas and Texas, this wide distribution showing that still earlier species await discovery. No sumachs have been described from the Upper Cretaceous of western Greenland where so many ancestral trees have been found, although it is probable that some of the fossil leaves found in that region and identified as myricas may represent sumachs instead. Somewhat later in the Upper Cretaceous additional species of sumach occurred in South Carolina, Long Island, Wyoming, Bohemia and Italy.

About 13 forms are known from the Eocene. In the earlier part of that dawning Tertiary time sumachs occurred in Dakota, Colorado, Wyoming and Yellowstone Park. In later Eocene time they are known from Colorado, from central Europe, and in northern lands in Alaska, Greenland and Iceland. Four different forms have been found in the upper Eocene rocks of Greenland, which is presumptive evidence that they already existed in that region in antecedent Upper Cretaceous times.

The number of species of sumach was doubled during succeeding Oligocene times. As is the case with so many tree histories, the

Oligocene records are all European, and include France, Tyrol, Italy and Prussia, the last found in the celebrated Baltic amber deposits. Two-thirds of the known Oligocene sumachs have been found in France, and the bulk of these along with a most interesting and varied fauna and flora, come from the gypsiferous clays of southeastern France. At the time these clays were being formed and these fossil plants and animals were living the region was one of retreating seas and coastal evaporating lagoons in which hosts of fishes perished and were fossilized, along with insects, and terrestrial animals and plants. There is considerable of an African flavor to this life with which the fossil sumachs are in accord. In most of the tree histories the reader will note a falling off in the number of forms during Oligocene time due to the climatic conditions which were rather warm and dry and which were more favorable for plants of what are now exotic types rather than of the familiar temperate trees, but the sumachs are an exception to this general condition having been particularly adapted to the climate of the Oligocene.

During succeeding Miocene times the sumachs reached their maximum development and probably were more abundant and widespread than they are at present, although only about 70 Miocene species are actually known. They were especially abundant about the shores of the Mediterranean in the latter half of the Miocene. Four of these Miocene sumachs were survivors from Oligocene times. In Europe these Miocene sumachs have been recorded from southern Spain to eastern Greece, and they were especially varied in France, Styria and Croatia. Every European region with Miocene plant beds has its species of sumach. In North America Miocene sumachs have been found in Maryland and Virginia on the Atlantic coast, and in Oregon and California on the Pacific coast. Seven different forms are known from California. In the interior they have been found in Idaho, Nevada and Colorado. In the deposits of the celebrated fossil lake at Florissant in the Colorado Rockies, 7 different sumachs have been found entombed, and this vista furnished by the life of this tiny lake basin suggests that similar assemblages must have been present during Miocene times in many other basins in that great mountain system where their relics failed of preservation or have not yet been discovered.

Sumach history shrinks greatly during the closing days of the Tertiary period, the Pliocene forms being but 5 or 6 in number, and 3 of these were survivors from the Miocene. The Pliocene records are all European and include species in Spain, France, Prussia, Italy and Slavonia. A rich forest flora has been found in numerous Pliocene plant beds, especially in the countries bordering the Pliocene Mediterranean, so that it is difficult to think otherwise than that this scarcity of the sumachs was real and not merely an apparent feature of Pliocene times. The only Pleistocene records of the sumach that I know of are 3 different forms much like still existing species and found in China and Japan, regions that are still plentifully supplied with these plants.

THE HOLLY

> "But when the bare and wintry woods we see,
> What then so cheerful as the holly-tree."
>
> —Southey.

Holly inevitably reminds us of the hearty eating and deep drinking of the Anglo-Saxon Christmas tide, with roaring yule logs, when roast pig with a sprig of holly through its heart had not yet been replaced by the turkey, for North America had not yet been discovered. Like so many of our customs, the use of holly at Christmas is of great antiquity, mayhap a survival of the practises of the Roman Saturnalia, or perhaps not going back farther than the respectably ancient Teutonic custom of using the holly along with other evergreens as a refuge for the sylvan spirits during the inclemency of winter.

When our European ancestors settled America they found here an evergreen holly practically indistinguishable from their familiar European tree, and its use in wreaths and other Christmas decorations has grown so enormously in this country in recent years as to seriously threaten the continued existence of the tree. In some localities it is considered unlucky to bring the holly indoors before Christmas eve, and there are many superstitions connected with it, especially in the rural parts of Europe. Lonicerus mentions a German belief that consecrated twigs of the holly hung over a door would afford protection against lightning; and holly used to decorate churches in rural England is deemed to bring good luck throughout the year to those fortunate enough to secure a sprig, especially if it had berries on it.

The holly belongs to the botanical genus Ilex, the name being the classical name of the evergreen oak of southern Europe which has leaves very much like those of the Christmas holly. Thus both the Latin name of the genus, and the vernacular name refer to the evergreen holly of Europe which is the only species inhabiting that continent in the world of today. However, there are a great many other species of holly found in different parts of the world. Over 170 kinds have been distinguished by botanists, and some of these are found in all tropical and temperate parts of the world except western North America, Australia, New Zealand and New Guinea.

They are all shrubs or trees, with alternately arranged, entire or toothed, rather coriaceous leaves; small inconspicuous flowers; and drupaceous fruits, often bright colored, and enclosing several small stones. The greatest number of these modern hollys are found in northern South America. The only surviving form in Europe is *Ilex aquifolium* which has dark green, shining, leathery, evergreen leaves, often with spiny margins, especially on young trees. An old border proverb defines a story teller as one that "lees never but when the hollen in green," a most felicitous apellation for a habitual liar.

The European tree is usually small but is said to reach a height of 60 to 70 feet in Surrey, and Loudon mentions one tree that was 80 feet tall. It will grow on any soil that is not too wet, and is common in France, especially in Brittany. There are numerous varieties much used in plantings and for hedges, the latter a practice not followed in America. Evelyn's holly hedge in Deptford was 400 feet long.

This European tree is the holly per se, or hulver; the aquifolium of Theophrastus and other classical writers, whence its modern scientific specific name. It was the holen or holegn of the Anglo-

Saxons, whence the term holm, applied to regions where holly was prevalent, in which forms the history of its occurrence is preserved in many Teutonic place names. The wood, like that of its closely allied American relative, is even grained and hard, almost white in color, and is used in inlaying and turning, and as a substitute for ebony in handles. It was also used to some extent in wood engraving. The red berries are greedily eaten by birds who thus distribute the seeds uninjured, but they induce violent illness in man, which is no hardship since they are not at all palatable.

Our American evergreen holly, in every respect like its European cousin, is known as *Ilex opaca.* It is found naturally from the coast of Massachusetts southward near the coast to peninsular Florida, and in the Mississippi Valley from southern Indiana to the Gulf of Mexico. It is frequently cultivated as an ornamental plant, as is also its European relative in this country. It reaches a height of from 40 to 50 feet with a trunk diameter of 2 or 3 feet, and exceptionally it may be 4 feet in diameter, but large trees are usually remote from civilization. Dealers in Christmas greens have seriously restricted its range in recent years by destructive cutting and mutilation. Doubtless were large trees accessible in any quantity lumbering would complete the tragedy, for the wood is highly prized for cabinet work, turnery and interior finish.

In addition to the Christmas holly of our seaboard states, we have a dozen other species of holly in the United States, collectively ranging from Nova Scotia to Florida and Texas. About half of these have evergreen leaves and the others thinner and deciduous leaves. All are more often shrubs than small trees and many are not even called holly locally, as, for example the Ink or gall-berry, *Ilex glabra,* of the eastern States; or the black-alder or fever-bush, *Ilex verticillata;* or the dahoon, *Ilex cassine;* or the yaupon, *Ilex vomitoria.*

The plants of Ilex contain a bitter principle known as ilicin, and possess tonic properties, and perhaps the most useful species is *Ilex paraguariensis* which furnishes the mate or Paraguay tea, a delightful beverage, the basis of a very considerable industry, and, if sanguine advocates are to be believed, one that is destined to win a world wide approval.

Considerable is known of the ancestral history of the hollys, over 100 different forms having been discovered in the rocks, and even this large number is quite rightly considered to represent but a fraction of the hollys that have existed during the past history of the earth. They appear first near the base of the Upper Cretaceous, some 14 different species having been described from the rocks of that age. Half of these Cretaceous forms have been found in Kansas in the geological formation known as the Dakota sandstone. This sandstone represents the mantle of shore sands spread by the advancing Cretaceous sea that advanced from the Gulf of Mexico and which eventually submerged much of the interior region of North America.

Thus the earliest known hollys were trees of sandy coastal shores. Almost as old as these Kansas hollys is a holly found in what are known as the Atane beds of western Greenland. Two additional forms have been found in the later Cretaceous of Greenland, and several occurred along our Cretaceous Atlantic coast from Marthas Vineyard, New Jersey, Maryland and Alabama. A single European Upper Cretaceous species has been found in Bohemia, and a late Cretaceous form is recorded from Colorado.

During Eocene times fifteen different hollys were in existence. A third of these are from rocks of early Eocene age in Dakota, Texas, Louisiana and Mississippi, and one is recorded from beds of the same age exposed on the south coast of England. Later in the Eocene several hollys occurred in Wyoming and Oregon; and toward the close of the Eocene five different forms occurred in Greenland and one in Alaska.

All of the 19 Oligocene hollys are from European localities. They were apparently most abundant at that time on the Mediterranean coast of France in the same deposits that have furnished so many sumachs, but they are also found in Italy, Germany, the Tyrol, Bohemia and Styria. Four of these survived into the succeeding Miocene times, and very many new forms made their appearance. In all some 50 different hollys are known from the rocks of Miocene age. Miocene hollys were especially abundant in Europe. France alone had 11 different kinds. Most European countries from Belgium to Greece had their Miocene hollys, in all about 40 as compared with the single existing European species. In the Miocene of Asia the holly has been found in Siberia, Manchuria and Japan. In South America it was present in Colombia on the north and in southern Chile on the south. In North America, although there are few Miocene plant beds, hollys have been discovered in Maryland, Colorado and California. In the often mentioned lake beds at Florissant in the Colorado Rockies, the remains of seven different hollys have been found.

In the closing days of the Tertiary, or Pliocene times, the number of species of holly shrank to 12, of which 5 were survivors from the Miocene, but as we know practically nothing of the Pliocene hollys that lived at that time in most of North America and Asia, or in tropical lands, this shrinkage was probably more apparent than real. Pliocene hollys are known in Europe from Spain, France, Italy and Germany. In Asia there were two in Asia Minor and one in Japan. In North America 2 Pliocene hollys are known and both of these were discovered in New Jersey.

Following the Pliocene came the glaciation of the Pleistocene. That its influence on the forests was real and not imaginary is shown by the fact that only a single holly has survived in Europe and this one was already present in the Pliocene of France, and it occurs also in interglacial beds in north Germany. There was a Pleistocene holly, now extinct, on the island of Madeira. All of the other known Pleistocene hollys were North American, although this fact is merely a reflection of the imperfection of the Pleistocene record and our ignorance of it in most parts of the world. These American hollys include undetermined species found in Kentucky: the remains of our Christmas holly, *Ilex opaca*, in the river terraces of Maryland, North Carolina and Alabama: the fruits of the ink or gall-berry, *Ilex glabra*, in the celebrated fossiliferous deposits at Vero, Florida, associated with human and other vertebrate remains: the so-called black-alder, *Ilex verticillata*, associated with marine shells of cold water marine animals in the so-called Leda clays of Maine: and the leaves of the dahoon, *Ilex cassine* in Virginia.

CHAPTER XX

The Maple

The maple family, or Aceraceae as it is called, belongs to an order of plants known as the Sapindales, which is named from its largest family, the soapberry family, a large group of mostly tropical plants. In all there are 20 plant families grouped in this order, containing over three thousand existing species. The maple is one of the smaller but important families of the order Sapindales. It comprises trees, and in a few instances shrubs, with well marked characters of wood, leaf, and flower, especially the winged fruits or keys (technically samaras) which are familiar to all.

Usually the maples are segregated into 3 genera, although there is a great variation in usage in this respect. These 3 genera are: Dipteronia, with a single species in China; Negundo, or box-elder, sometimes included with the true maples; and Acer, the maple, with upwards of 100 existing species, mostly both beautiful and useful widely distributed throughout the Northern Hemisphere, extending across the equator to the mountains of Java, and reaching toward South America in the uplands of Central America. The name Acer is the classical name of the European maple.

It will probably come as a surprise to most of my readers to learn that maple, and particularly the sugar maple, has a strength and stiffness of wood considerably greater than that of the white oak, and that this heavy tough narrow ringed wood, which takes a high polish, is one of our most valuable timbers. Lumbermen have been cutting it at the rate of over a billion board feet annually. A large part of this production comes from the States of Michigan, Wisconsin, Pennsylvania, New York and West Virginia, and the supply is being rapidly depleted. Although available commercial supplies will not last for many years the tree is in no danger of extinction for it is a strong vigorous agressive tree, well able to hold its own on fertile fairly well drained land.

Although slow growing and not often reaching its maximum height of 129 feet and trunk diameter of 4 feet, it producesan abundance of amply winged seeds, of which a large number sprout, even in the shade, and tend to crowd out their elders, and when once established they successfully resist the encroachment of other trees. Few trees are seen as frequently in woodlots from New England to Ohio and the Potomac as the sugar maple.

In an early volume of the *Transactions of the American Philosophical Society*, over a century old, we read the estimate that 6000 maple trees were destroyed in clearing the average New York or Pennsylvania farm. Rusk, in his letter to Thomas Jefferson, just alluded to, suggested that at least a third of these trees should not be destroyed, but should be preserved as a source of sugar. But who but the few can look forward a hundred years. The land had to be cleared, and much superfluous maple along with many other valuable trees vanished up the chimneys—maple back logs were in such demand that they were once shipped regularly to Boston. Much maple went into charcoal for forging, and much was consumed by the makers of potash.

The strength and fine grain of the wood caused it to be valued for rifle stocks, saddle trees, spinning wheels and reels, dishes and trenchers. The Iroquois made paddles and spoons of it, and Withers, in his *Border Chronicles*, relates how in 1777 they unsuccessfully attempted to make cannon of maple logs. In these modern days maple is much used for flooring, still more goes into the manufacture of shoe lasts, and an even greater amount is consumed by furniture manufacturers, especially the pathological varieties known as curly, wavy, and birdseye maple. Sugar maple stands first in the list of woods used in Illinois in the manufacture of agricultural implements, and it also goes into wooden ware, and into a thousand miscellaneous uses.

Voorhees states that the Massachusetts Indians taught the Plymouth colonists the value of maple ashes in the raising of crops, and the maple stands at the head of the list of woods used for this purpose. The colonists early exported ashes, of which those of the maple were considered the best to England. Potash and pearlash are still exported from Canada, but the amount is trifling, almost as is the number of households that still hold to the once universal custom of making their own soap.

The Indians, from Canada to Dakota and southward to the Carolinas, made maple sugar, and the first settlers learned and improved upon their art. It is difficult to estimate the quantity that is consumed locally or sold at the present time, since most of it is adulterated by the producers, and real maple sugar and syrup have come to be regarded as Roman luxuries where formerly they were little used by anyone who could afford cane sugar.

The other species of maple are less important commercially and are usually not reported by name in statistics, or distinguished by lumbermen, but they are all similar in their characteristics, and the foregoing somewhat lengthy enumeration of the utilitarian virtues of the sugar maple must suffice for our purpose.

The maples are widely distributed in North America, their collective ranges extending from the valley of the St. Lawrence southward to Florida and Texas, and westward to Alaska northward to latitude 55°, southward along the Pacific coast to southern California, and in the mountain States to eastern New Mexico and Arizona, and northern Mexico. The bulk of the American forms are found in the deciduous forest region of southeastern North America, and similarly, the bulk of the more numerous Old World species are found in the valleys of southeastern Asia.

Many of our native species are used as shade trees, for which they are admirable, although slow growing. Several European forms are also widely planted, both in their native lands and in this country, and several of the smaller, more delicately lobed and red leaved oriental species are much used in ornamental plantings for parks and lawns, although none have the handsome flame colored shades that are common swamp maple displays in the Fall of the year. There are so many maples that a detailed discussion of their individual features and occurrences would be tiresome.

It is, however, very interesting to observe the results of the segregation caused by the Glacial period on the Tertiary circumpolar forests. Few maples were actually exterminated by the severi-

FIG. 43. SOME FOSSIL MAPLE LEAVES AND FRUITS (ABOUT ⅓ NATURAL SIZE)

1. *Acer caudatum* Heer from the Upper Cretaceous of Greenland.

2. *Acer osmonti* Knowlton from the late Eocene of Oregon.

3. *Acer Santagatae* Massalongo from the Pliocene of Italy.

4 to 8. *Acer trilobatum* Al. Braun from the Tortonian or Upper Miocene of Baden.

9. *Acer brachyphyllum* Heer from the late Eocene of Spitzbergen.

10. *Acer jurenaky* Stur from the Sarmatian or late Miocene of Hungary.

11. *Acer pliocaenicum* Saporta from the Pliocene of France. The ancestor of the existing *Acer polymorphum* (*palmatum*) of Europe.

12. *Acer narbonnense* Saporta from the Oligocene (Chattian) of France.

ties of Pleistocene times but their ranges were broken up in an astonishing way. In North America they survived in our eastern forests, in the Rockies, and in the Pacific coastal region. Few were left in Europe except in the lands bordering the Mediterranean. Many survived in eastern Asia and many more have since been evolved there, so that at the present time about two-thirds of the existing maples find their home in the last named region. Moreover glaciation resulted in the seeming pranks of distribution whereby our familiar eastern moosewood or whistlewood, *Acer pennsylvanicum*, belongs to a section of the genus whose ten other species are all confined to the Chinese-Japanese area. Similarly our Rocky Mountain sugar maple, *Acer grandidentatum* belongs to a section whose 8 other species are all Old World and mostly Mediterranean: our mountain maple, *Acer spicatum*, and broad-leafed maple, *Acer macrophyllum*, belong to a section whose score of additional species are all inhabitants of the Old World: the Negundos or box-elders, of which there are 3 closely related existing forms have 1 in the East, 1 on the Pacific coast, and the third in Central America.

Even the foregoing brief statement should convince the most incredulous that we cannot understand the present day distribution of any of our trees without some knowledge of their past history, and when this history approaches the completeness that we hopefully look forward to, it will be possible to explain much that still remains obscure. We can predict *a priori* that when closely related forms are remote from one another today that their ancestors occupied intermediate regions, and already the above mentioned break in the distribution of the box-elders is partially bridged by Tertiary forms in the country between.

The geological history of the ancestral maples is based upon the fossil remains of the leaves and fruits. Fortunately maple leaves have always had a rather characteristic form, not exactly like the leaves of any other trees, and the earliest ones differ from the modern ones in only minor particulars such as having elongated median lobes just as the young leaves of seedlings do at the present time. The winged fruits or maple keys (samaras) are also and apparently always have been characteristic. The leaves are superficially like those of some of the grapes or of the genus Cissus and its allies, but are usually readily recognizable, and if the winged fruits of the maple are at all well preserved in the rocks it is usually not difficult to distinguish them from the winged seeds of the conifers, or from the somewhat similar winged fruits of certain tropical genera belonging to the soapberry and banisteria families.

A very large number of fossil maples have been described, many more than are present in the living flora. The oldest of these come from the Upper Cretaceous of western Greenland and western Canada. Additional Upper Cretaceous species have been recorded in Saxony and along our middle Atlantic coast but these are not certainly identified.

At the beginning of the Tertiary, however, in Eocene times, maples were present in force. Over a score of different kinds have been described from the fossil remains of beautifully preserved fruits as well as the leaves. The maples had certainly reached western Europe early in the Eocene, for a characteristc maple key has been found in the celebrated travertine deposits of Sezanne east of Paris. In America early Eocene maples have been found in Yellowstone Park, Wyoming, Colorado, New Mexico and Dakota. In the later Eocene, coincident with the northward spread of the temperate forests of the globe, maples were abundant and had penetrated northward to Alaska, where 3 forms have been discovered; to Greenland where 5 different species have been recorded; to Spitzbergen and Iceland. In beds of the same age 3 different maples have been found on the island of Sachalin north of Japan; and in British Columbia, Oregon and Wyoming.

In the succeeding Oligocene times the known maples became reduced to 11 different forms, all of which, like so many other tree types during that time, are confined to European localities. Six of these are from various Oligocene horizons in France, 2 are from Germany, and Italy, Bohemia, and Russia have each furnished a single form.

The greatest display of fossil maples throughout the Northern Hemisphere occurs in deposits which were formed during the Miocene. Nearly 100 different kinds of leaves and fruits have been described and figured by paleobotanists, and although it is not certain that all of these numerous forms are true botanical species and not variables of a fewer number of true species, the actual number of true species was probably greater than exist in the modern world.

Of these numerous forms 1 or 2 are survivors from the Oligocene of Europe, and it is in the Miocene deposits that the greatest number have been found. For example, in the celebrated little fossil lake at Oeningen on the Swiss border of Baden, these late Miocene lake beds have yielded 14 different kinds of maple and some of these are exceedingly abundant in the shales. The lake waters must have been filled with the keys from the surrounding slopes when the maples shed their fruits in the Spring. In the similar Miocene Rocky Mountain lake at Florissant, Colorado, where the muds were exceedingly fine grained and consisted largely of volcanic ashes from the contemporaneous volcanos at Leadville and nearby localities, 6 different maples have been discovered.

From various horizons in the Miocene of France a score of different maples have been unearthed, and as many more are recorded from Italian localities. Evidently the country bordering the expanded Mediterranean sea of Miocene time was unusually well forested, and the maples were a prominent element in those forests. Other European localities of Miocene age where maples have been found are Bohemia, where they were abundant; Styria; Switzerland; Croatia; Germany; Carniola; Carinthia; Transylvania; Hungary; Bosnia and Greece. In Asia Miocene maples have been found in Siberia, in the Altai mountains, and in Japan.

Athough apparently not as abundant in North America at that time, we know much less about the plant life of this continent in late Tertiary times, especially the Miocene and Pliocene of the central and eastern parts of the continent. Ten different Miocene maples have been discovered in Oregon and the surface of the Miocene history in that region has scarcely been scratched. Four maples are known from the Miocene of California, where also much still awaits discovery. One is known from Yellowstone Park, and one from British Columbia.

The leaves and fruits of extinct kinds of maples are less abundant in the succeeding deposits of Pliocene age than they are in Miocene deposits, but they were still a prominent element in the forests of that time, about forty different species having been already determined. Twelve of these, all Mediterranean forms in Spain, France, Germany, Austria, Styria, Slavonia and Asia Minor, were survivors from the Miocene. Pliocene maples are most abundant and varied in France, where 12 different species have been found. Italy ranks second with 10 species. No Pliocene maples have been discovered in North America, although maples were undoubtedly present in both the eastern and western parts of the continent at that time. In Asia Pliocene maples have been foundin Indo-China, Manchuria Japan, and in the Altai region of the central part of that continent. These are mostly forms of Japanese and Chinese affinities, where the descendants of these late Tertiary species now live, and several of the fossil forms are undoubtedly the direct ancestors of the latter.

A quite considerable variety of maples have been found in the Pleistocene deposits of North America and Europe, and as might be expected, most of these are forms which still exist in modern times. The stately sycamore maple of Europe, *Acer pseudoplatanus*, was already present in Pliocene times in France and in the Pleistocene it has been found in France, Italy, Luxembourg and Hungary. The existing *Acer campestre* is found in the Pleistocene of Germany, France, and Italy. There is a third form in Germany and 2 additional in Italy.

The records of Pleistocene maples in North America extend from Ontario and Massachusetts to Alabama and Florida. The sugar or rock maple, *Acer saccharum*, is found fossil in southern Ontario and New England: the silver or white maple, *Acer saccharinum*, has been found in Alabama: and the red or swamp maple, *Acer rubrum*, occurs in the Pleistocene of Alabama and Florida. There are still other, not exactly named fossil maples in Virginia and Maryland, and a supposed extinct species has been described from the interglacial deposits of the Don valley near Toronto, Canada.

Several of the fossil maples mentioned in these pages and represented by both leaves and fruits, and from widely scattered regions, are shown in reduced size on the accompanying plate. Surely botanists and tree lovers should not keep their attention so closely focussed on the woods and flowers of the living world as to lose sight of the dead world beneath their feet, which needs but understanding to make live again in all its ages old glory and impressiveness. The Pharoahs have long since been mummies. From the standpoint of human history the Chaldeans and Assyrians belong to an ancient world, and yet the maples along with most of our forest trees are of a lineage so much more ancient as to scarcely be intelligible or believable. Practically all of our forest trees go back farther than we can trace the warm blooded animals that furnished the stock out of which humanity arose in the late Tertiary, at about the time that the most luxuriant and widespread forests of the world were shrinking before those climatic changes that ushered in the glacial period and shattered their unbroken and far flung distribution.

CHAPTER XXI

The Ash

"Venus of the woods."
—Gilpin.

I imagine that few of my readers unless they be professional botanists realize that our familiar ash of southeastern North America is a member of the olive family, or Oleaceae as it is known scientifically. This family of plants which was named originally after the Mediterranean olive—now extensively cultivated in California—contains a number of other particularly well known plants both native and introduced from the old world that have long been highly prized for ornamental planting. Among these the commonest are the lilac, privet, syringa, forsythia and jasmine. The devil-wood (Osmanthus) of our Gulf States, sometimes called the American olive, is also a member of this family.

The two principal areas of distribution of the existing ashes are southeastern North America and southeastern Asia, although they are by no means wanting in Europe or in the forested region of our Pacific coast. There are about the same number of species of ash in China as there are in North America, but ours are usually the larger trees and furnish more valuable wood. In addition to the ash there are two other members of the olive family that are common to China and our southeastern states. These are the fringe-tree (Chionanthus) and the devil-wood (Osmanthus)—the flowers of the latter being utilized for scenting tea in China.

Obviously the ash, fringe-tree, and devil-wood did not originate simultaneously or at different times independently in Asia and North America, so that there must have been a time in the past when the lands lying between these remote areas were traversed by the ancestors of the living forms that now inhabit them. On a subsequent page we shall see that this is clearly indicated in the case of the geological history of the ash, and the presence of a fossil devil-wood (Osmanthus) in the early Eocene of western Tennessee indicates that this genus also is an ancient one that formerly migrated between Asia and North America at a time when climates were more suitable for such a migration than they are at the present time, a time when a land bridge united the two continents across the present Behring Sea region.

The ashes have handsome, usually compound leaves consisting of a greater or less number of separate leaflets arranged in a pinnate manner on a central stipe. Their leaves are thus similar to those of the walnuts and hickories, but may readily be distinguished by their opposite arrangement on the branches—the walnut and hickory leaves being arranged in an alternate manner.

The generic name Fraxinus for the ash genus is derived from the classical name of the European ash, and the common name doubtless refers to the ashy color of its branches. Ash flowers are not conspicuous but the winged fruits, technically known as samaras, are borne in panicles and are familiar to all that tramp the fall woods, each fruit resembling a tiny canoe paddle.

Ruskin with his characteristic unbalanced enthusiasm said that there is no lovlier tree in the world than the common ash. Fully appreciative of the beauty of the ash I must say that I have seen many more lovely trees. The more practical Evelyn says of the common ash of England: "In peace and war it is a wood in the highest request." Toughness and strength go along with elegance and this is reflected in the Norse legend that Yggdrasil (the ash) was the tree which upheld the heavens and that out of it Odin made the first man—a hint of the early tree worship cult among the Norsemen. It is shown also in the old English custom of passing children through ash woods or through a split ash tree as a cure for the rickets.

The wood is tough, straight grained and that of some of the species is a most valuable timber. In Britain ash lumber ranks next to that of the oak in importance. In this country ash is one of the leading commercial hardwoods and the annual cut which amounts to about $10,000,000 in value probably exceeds the annual growth increase in the supply, so that soon we will be obliged to bestir ourselves and do intensive cultivation or see the important industries that use ash lumber pinched by scarcity and consequent higher prices or obliged to use inferior substitutes.

Ash timber has such special uses that it is too valuable to be used for ordinary construction purposes. These uses all depend on its straightness of grain, elasticity, strength, hardness, and the characteristic of wearing smooth with use. Among these special uses the making of handles, which the layman might think unimportant, utilizes about 22 per cent of the total cut with a value of about $2,000,000 annually. Next in importance has been the use of ash for butter tub staves and other dairy supplies, which consumes over 20 per cent of the annual cut. Vehicle manufacturers take about 15 per cent, while planing mills use large amounts and the manufacturers of boat oars consume about a quarter of a million dollars worth of ash lumber every year.

Next to spruce, ash is the most important wood used in aeroplane construction. It enters into frames, outriggers, skids, rudders and propellers. As recently as 1914 this use amounted to a trifling percentage of the total annual cut but during the war and at the present time this percentage must be much larger although I do not have the figures. Ash, chiefly black ash, enters largely into bent frame parts, as well as slats and splints for basketry. The early settlers of New England learned from the Indians of the region who had long practised it the art of making baskets of ash splints and strips that lasted a lifetime.

The production of Chinese or insect white wax (Peh-la) is, next to agriculture or silkworm culture (sericulture), the most important industry in certain parts of China (Szechuan). This wax is deposited by a scale insect of a species of ash (*Fraxinus chinensis*). The insects are bred on a privet (*Ligustrum lucidum*) another member of the family which does not grow in the immediate vicinity of the ash plantations, so that the eggs must be carried rapidly by coolies a distance of over 150 miles from privet to ash. This Chinese wax is highly valued by the Chinese and since it does not melt until a temperature is reached around 180° it makes exceedingly valuable candles, but because of its price it is usually used merely for the outer coating of candles. It is also used for coating pills, polishing jade, soapstone and delicate furniture, or as a size to give a lustre to cloth. Perhaps its most extensive use is for glossing the higher grade papers of native manufacture.

A somewhat remotely comparable product is obtained from the Manna-ash (*Fraxinus ornus*) of Mediterranean Europe. This product is the manna of commerce, and is not a true wax, but a secretion whose chief constituent is mannite or manna sugar. It is obtained in commercial quantities entirely from Sicily, and unlike the Chinese wax it is not due to the activity of scale insects, but is obtained by making incisions in the bark. It is thus not related to the manna of the scriptures, which last was due to the punctures of scale insects working on Tamarix trees.

There are upwards of 50 existing species of ash and they are widely distributed throughout the temperate regions of Eurasia and North America, extending into the Tropics in both the Eastern (Java) and the Western (Cuba) Hemispheres. Their generalized limits of distribution together with the known fossil occurrence of the ash are shown on the accompanying sketch-map. The American species number from 18 to 24 according to the varying conceptions of different students as to what constitutes a species. Three of these (*Fraxinus breggii*, *F. cuspidata* and *F. dipetala*) are shrubby forms of the southwest. The three important commercial species are the white ash (*Fraxinus americana*), the green ash (*Fraxinus lanceolata*) and the black ash (*Fraxinus nigra*). The lumber trade, however, may only recognize white or dark ash, or more often simply ash, and all or some of the other species that are cut go to swell these categories.

The white ashes, which include the species *F. americana*, *F. texensis* and *F. biltmoreana* are upland forms. The green ashes, which include a large number of less important species than the important *Fraxinus lanceolata* (namely *F. darlingtonii*, *F. michauxii*, *F. profunda*, *F. berlandieriana*, *F. pennsylvanica*, *F. oregona*, *F. velutina*, *F. toumeyi*, and *F. coriacea*), are broadly speaking bottom land dwellers. The water ashes, *Fraxinus caroliniana* and *F. pauciflora* are swamp trees: while the black ashes, *Fraxinus quad-*

rangulata, *F. anomala* and *F. nigra* are trees of what might be called unfavorable situations such as dry hills and cold swamps. The shrubby species are chaparral and upland forms of the arid southwest.

The geographical extent of the different existing species seems to be determined very largely by the lightness and durability of the seeds and their quickness of germination combined with the frequency of seed years, that is to say the factors are largely those of seed dispersal. In accordance with this dictum it has been found that the so-called green ashes are the most aggressive and widely distributed; the white ashes are but little less so; while the water ashes and the black ashes seem to be the least fitted for maintaining their present range.

Not all of the trees called by the name of ash are related to the true ashes—thus the poison-ash of our eastern States is a species of sumach (Rhus); the bitter ash of the West Indies is a species of Simaruba; the Cape Ash of South Africa is a species of Ekebergia; the prickly ash of our eastern States is a Xanthoxylon; and the familiarly cultivated rowan or mountain-ash of America and Europe are related species of the genus Sorbus and belong to the rose family (Rosaceae), in fact none of these that I have enumerated belong to the same family as the true ash.

The earliest known fossils that have been referred to the ash are leaves, whose identity is not conclusive, from what have been called the Patoot beds in western Greenland. These deposits are of late Upper Cretaceous age and are underlain in that region by the older deposits known as the Atane beds which also contain numerous plants including walnuts, magnolias, persimmons, poplars, and other species of ancestral trees, but no traces of the ash. The correctness of the identification of these Patoot species of ash is really one of slight importance for the deposits in which they are found are immediately overlain by a series of lignitic shales and basalts of early Tertiary age and an abundant fossil flora has been found in these shales including undoubted remains of the ash. We know this since these same sort of leaves are found in the Eocene of the United States associated with characteristic ash fruits.

The history of the ash is hence known to go back at least as far as the dawn of the Tertiary period, an interval of several million years, to a time antedating the five toed ancestral horses, or for that matter any of the lines leading to the higher mammalia.

About a dozen Eocene species of ash are known. They are found from Greenland to Louisiana, and from Alaska to Oregon, Colorado and Wyoming. Their remains include leaves and characteristic fruits or ash-paddles, Eocene species of both of which are much like their modern relatives. All of these Eocene forms that have thus far been discovered are either North American or Arctic American—none having as yet been found in the abundant Eocene floras of Europe, and Asia being practically unknown. Undoubtedly there were Eocene ashes in northeastern Asia for we find there many of the forms found at that time on this side of Behring strait in Alaska. We may tentatively assume that the ash originated at some time during the late Cretaceous on the North American mainland or in the region north of it. Very little is known of the geologic history of plants in the vast region of Asia, as already remarked, but if the ash had originated on the latter continent it should have spread to Europe, where Eocene plant beds are so common, about as quickly as it did to North America. This fact and the large number of American Eocene species fortify the conclusion that the early ash was an American product.

However, the ash was well on its way toward Europe for during the succeeding Oligocene the leaves and fruits are found at a large number of localities on that continent, from the amber beds on the shores of the Baltic to the gypsum beds along the shores of the Gulf of Lyons. Ten different forms of Oligocene ash are known and these are all European, since Asia remains unknown and in North America the deposits of Oligocene age are largely marine marls or limestones along the continental borders or flood plain and channel deposits in the interior in which fossil plants seem to be rarely found. Two fruits of Oligocene ashes from Europe are shown on the accompanying plate.

Passing to Miocene times, which succeeded those of the Oligocene, we find Fraxinus, like most of the other tree genera, to have been widespread, diversified and common, and probably more abundant than at the present time—their geographical range was certainly more extensive then than now. Over 30 different ashes are known from Miocene deposits. They are found in North America in Oregon on the west coast and in Virginia on the east coast. A hint at their probable abundance at this time in the Rocky Mountain region is given to us by the lake deposits at Florissant, Colorado, where the fortunate preservation of the sediments of this tiny lake basin furnish an unparalleled picture of the insect and plant life of Miocene times in that region.

No less than seven species of ash have been discovered in these Florissant beds, thus indicating that the ash was much more abundant and diversified at that time than would otherwise have been suspected from a consideration of the rather infrequent Miocene plant beds of other parts of North America. Fraxinus is present in all of the more important Miocene plant bearing deposits throughout Europe, and it appears to have been especially abundant in late Miocene times along the shores of the Mediterranean and in the uplands of central France, southern Germany, and in the various crown-lands of the Austrian monarchy. An ash leaf from the Miocene of Virginia is much like that of our modern species.

Ashes seem to have declined in variety during the succeeding Pliocene times, and the few species that have been discovered all show a near approach in their characters to those of the existing species. Thus in Spain, France and Italy fossil leaves are found in the Pliocene deposits that are indistinguishable from those of the existing Manna-ash (*Fraxinus ornus*) of southern Europe, whose range at that time like that of the so-called Hipparion fauna, was much greater than at present, for its leaves have been found in the Pliocene deposits of the Altai mountains of central Asia. Similarly modern looking ash leaves are found in the Pliocene deposits along our Gulf coast in what has been called the Citronelle formation.

During the succeeding Pleistocene times, marked by continental ice sheets, the ashes that have been found fossil are all still existing species, and include at least two European and two American forms. These all occur either far to the southward of the ice sheets, as for example *Fraxinus ornus* in Italy, or in Interglacial deposits, as for example *Fraxinus excelsior* in France and Germany. In this country our white ash, *Fraxinus americana*, is found in the early Pleistocene of western Kentucky and the late Pleistocene of Maryland; the existing blue ash (*Fraxinus quadrangulata*) of the Mississippi valley was present and pushed northward as far as the Don Valley in Canada during an Interglacial period when the climate for a time was somewhat warmer than it is at the present time in the same latitude.

CHAPTER XXII

The Linden or Basswood

"A summer home of murmurous wings,
And all around the large lime feathers low."
—Tennyson.

The family Tiliaceae to which the Linden belongs comprises about 35 genera and upwards of 400 existing species. These are chiefly tropical, and they are massed in two general regions—one around the Indian Ocean and the other in northern South America. The number of genera that have known fossil representatives is unfortunately limited to ancestral forms of the linden (*Tilia*), to the genus *Grewiopsis* which is ancestral to the existing oriental species of *Grewia*, and to the genus *Triumfetta* which is found in the tropics of both hemispheres and abundant in the Antilles and tropical South America, with two fossil species in the lower Miocene of Chile: To *Apeibopsis* which is ancestral to the South American genus *Apeiba*, and to the South American genus *Luhea*. All of these indicate that in former times the geographical distribution of the various members of this family was very different from what it is at the present time.

The genus *Tilia*, which gives its name to the family, although belonging to a family that is essentially tropical, is itself confined to the North Temperate Zone, occurring on all of the great northern land masses, but now absent in western North America, in central Asia, and in the Himalayan region. All of the existing species are trees, all have similar simple alternate leaves with free stipules, all have similar flower clusters borne on a large leaf-like bract, and the fruits are nut-like, although some of the members of the family have capsular fruits.

The wood is pale in color and soft, but straight grained and easily worked. In America it is commonly known as whitewood, a name which it shares with the wood of the tulip-tree, Liriodendron, although the terms basswood and linn are also frequently applied to it. Pulp mills consume large amounts of timber annually and the lumber enters very largely into interior finish and planing mill products, cheap furniture, turnery and similar uses.

There are about a score of existing species, about equally divided between North America, Europe and Asia. Apparently all of these have very fragrant flowers, rich in nectar, and thus the source of large quantities of honey—the light colored honey known as bass-wood honey in our northeastern states. This utility, especially in the earlier days of the human race, has made the linden a favorite tree, and we find it mentioned by Theophrastus, Pliny, Virgil, Aristophanes and other early writers. The Romans knew it as Tilia and Virgil speaks of it particularly and mentions the quality of the yokes made from its wood. Americans know it best as basswood (bastwood). Lime is the favorite name in England, doubtless a modification of the old English lind. In our South it is often called linn. Linden is the favorite of the Germans and it is much mentioned in their folk poetry and early romances. The word occurs in *Beowulf*, and it was a leaf settling between his shoulders as he bathed beneath the linden that enabled Hagen to stab the otherwise invulnerable Siegfried.

Aside from the compact handsome form of the tree and the beauty of its foliage, I suspect that its association with bee keeping and the distillation of the oil from its flowers for use in perfumery, has something to do with widespread custom of planting both the American and the European form as shade trees, even though most of humanity is no longer fortunate enough to keep bees, and as a shade tree the linden is not very large and somewhat untidy.

The various species of linden in the United States go by the names of linden or basswood, less frequently the tree is termed bee-tree or linn, the last name being common in certain southern States, both the last two being essentially rural and the first two more especially urban. Very infrequently are these trees called limes in this country although the latter name is perhaps the one most commonly applied to them in Europe as a whole, where, as previously mentioned, it is probably derived as an altered form of the old English lind. The tree was introduced into England (Kent), some say by the Romans, which is not improbable. Others place the date of its introduction as late as 1590.

Some individual trees grow to a great size and corresponding old age. Ray mentions a European linden that was 48 feet in circumference, although this seems unusually large. The famous linden that gave the town of Neuenstadt in Württemberg the appellation of "Neuenstadt an der grossen Linden," was 9 feet in diameter. There is a record, how accurate it is hard to say, made in 1798 of a linden at Trous which was 51 feet in circumference, and which was said to have been already a celebrated tree in 1424. Its age was estimated at 580 years.

Many of our American streets are lined with lindens, more often the European than our native form, and most of our larger eastern cities have a Linden Avenue. Perhaps the two most famous avenues of lindens, however, are those at Trinity College, at Cambridge in old England, and "Unter den Linden" in Berlin. In the regions more remote from the work-a-day world where wood carving is not a lost art, linden wood is very largely used for this handicraft, and in backward countries like much of Russia, the bast or inner bark of the linden is used in the manufacture of cords, fish nets and similar articles. Bast mats made of this material are, or were before Russia emerged from the necessity of working, a regular article of commerce and largely exported. The American Indian independently discovered this use for the inner bark or bast of our species, and also utilized the easily worked wood for the making of utensils, Longfellow narrating that all of the bowls at Hiawathas wedding being of basswood, smoothly polished.

The somewhat generalized range of the existing species and the known fossil occurrences of the lindens are shown on the accompanying sketch-map of the world. The number of fossil species is inconsiderable, comprising not more than 30 known forms, which is really a small number when one reflects on the countless centuries that these trees have been represented in the forests of past geological times, and the vast areas that they have ranged over during those ages. As far as is known at the present time no lindens have been found in deposits as old as the Upper Cretaceous, and the linden line is therefore less ancient than that of the majority of our forest trees, unless possibly the unknown expanse of Asia has Cretaceous lindens hidden somewhere in its bosom.

The oldest known lindens are found in the Eocene or early Tertiary. In the rocks of this age 4 or 5 different species have been discovered and although this number is small the localities where they have been discovered point rather unmistakably to the region where the linden stock originated. None occur south of latitude 40° and two come from north of latitude 60°, one of the latter being found as far north as Spitzbergen. A linden was recorded by Heer from the upper Eocene of Grinnell Land within 10° of the North pole, but it seems rather to represent a hazel (Corylus). This species, in part apparently representing a linden is known as *Tilia Malmgreni* and a leaf of this far northern form is shown on the accompanying plate. It had typical broad leaves about the size of those of the existing European lime. It has been recorded from rocks which are probably late Eocene in age in both Spitzbergen and Iceland, where it is associated with volcanic rocks (basalts) that seem to have characterized the earlier Tertiary throughout the North Temperate and the Arctic regions. It affords perhaps the most striking illustration of the different climate and floral distribution that is disclosed by a review of the ancestors of any of our trees, and it is almost impossible for us to picture forests of broad leaved temperate trees covering the present perpetually ice clad wastes of the far North, and flourishing where the winter's night lasted for six months.

A second Eocene species occurs in the Kenai region of Alaska and a third on Sachalin Island off the Asiatic coast immediately north of Japan. A fourth has been found in the early Eocene of Montana. This Eocene distribution would seem to indicate that the linden stock originated somewhere in the far north, but whether actually in the Polar region or in northern North America or northern Asia it is impossible to say. The Montana species is somewhat older than the other known Eocene forms and this may mean that it is nearer than the others to the place of origin of the genus, or it may be due simply to accidents of preservation or of discovery since earlier forms in other areas may not have been preserved at all or may still be awaiting discovery in the rocks.

No Oligocene lindens are known and this must be ascribed to the reasons mentioned at the close of the preceding paragraph since in the succeeding Miocene times there was a great display of a varity of lindens. They are found at this time from the base to the top of the Miocene deposits of Europe, where plant beds of this age are much more abundant than they are in either North America or Asia. At least fourteen different Miocene species are known and their remains include several of the characteristic and curiously bracteate fruits which, when ripe, turn brown and serve the volplaning habit by which the distribution of the seeds is effected, as well as a variety of leaves.

The lindens are especially abundant and varied in the late Miocene of southern Europe along the shores of the expanding Mediterranean sea of that time, and in the Pyrenees, the foothills of the Apennines and in the mountains of Transylvania, Styria and Bohemia. The fruit of one of these late Miocene species found near Vienna in Austria and named *Tilia vindobonensis* from the old Roman name of Vienna is shown on the accompanying plate.

The Miocene records in North America are scanty but the genus was still represented in the Rocky Mountain region having been found in deposits of this age in the Yellowstone Park and in the lake basin at Florissant, Colorado, both of which localities are now separated by several hundreds of miles of treeless plains country from the westernmost outposts of the existing species in the river valleys of eastern Kansas and Nebraska.

The known Pliocene lindens, owing to the rarity of plant beds of this age in North America, are confined to Eurasia, although the genus was undoubtedly present in North America during the Pliocene since it is found in the deposits of the immediately preceding and succeeding times. There are four Pliocene forms recorded from Europe where they are found in variety and abundance in the Auvergne region of France, and in northern Italy. In

Asia the existing Japanese "ash," *Tilia cordata*, a typical linden, has been discovered in the Pliocene deposits of the Buchtorma Valley in the Altai region of the central part of that continent and is also probably the tree upon which the paleobotanist Nathorst bestowed the name of *Tilia distans* for specimens found in the late Tertiary at Mogi, Japan. Another linden fossil found at Mogi and not given a distinctive specific name is ancestral to the existing *Tilia mandschurica* now found on Nippon, and in Manchuria and the lower Amur region.

Although the Pleistocene records of the linden are not numerous nevertheless lindens are found in deposits of this age in both North America and Europe. Fruits of two different forms occur in Interglacial beds in Germany and Tilia wood is recorded from the lower Pleistocene of Holland. The leaves of the still existing basswood, which is the most widely ranging of our American lindens have been found in the Interglacial beds of the Don Valley near Toronto, and another form, or perhaps the same species under another name is found in the late Pleistocene terrace deposits of the Delaware River in southern New Jersey. Undoubtedly other of the existing species were already in existence and it would not be at all surprising if the southern basswood were discovered in the similar river terraces of our southern States.

CHAPTER XXIII

The Dogwood and Gum

The Cornel family, which is the vernacular name of the family to which the dogwood and gum belongs—the Cornaceae, as it is known scientifically, contains about 15 genera and a great many species or different kinds of shrubs and trees, widely distributed throughout the modern world and mostly unknown to all except the professional botanist.

THE DOGWOOD

The dogwoods, known scientifically as Cornus, derived from the Latin *cornu*, a horn, in allusion to the hardness of the wood, embrace 40 to 50 existing kinds of shrubs and small, economically unimportant hardwood trees. These are widely distributed throughout the three continents of the Northern Hemisphere, and cross the equator into South America. Here in North America we have 17 or 18 species, of which 4 attain to the stature of trees, and it depends whether you live on the Atlantic or Pacific coasts as to what the name dogwood calls to mind.

The dogwoods are chiefly moisture-loving plants, growing either in naturally moist soils, or in forests where shade and ground litter conserve the soil water. The often bright colored and sometimes exceedingly handsome fruits are eagerly eaten by birds and mammals with no injury to their contained seeds which are thus widely distributed. The flowers themselves are small, crowded together and inconspicuous, but are surrounded by from four to six large whitish or pinkish bracts that constitute the "flower" to the average person, and it is these showy bracts to which the beauty of the dogwood blossoms are due. Next spring when the dogwood whitens the woods and you bring some sprays indoors examine them carefully and you will see the small yellowish true flowers forming the central disk with the pinkish leaves or bracts surrounding them. The latter, in our eastern species, show the harder brownish apical notches that preserve the shape they had when they were merely leaves or scales protecting the bud before they grew out to form the showy bracts.

In the eastern United States the name dogwood refers primarily to the so-called flowering dogwood as contrasting it with some of the less conspicuous forms that lack the showy bracts. Its scientific name is *Cornus florida*, and it is commonly a small tree with slender spreading or upright branches, the flower heads with large bracts which are generally white but often pink or reddish, and notched at their tips. The fruits are in clusters, bright scarlet in color, and very beautiful.

The dogwood is usually an under tree of the forest and it is found from Massachusetts to Ontario, and eastern Kansas and southward to central Florida and Texas, reappearing on the uplands of northern Mexico where it was apparently left during the Pleistocene, or time immediately preceding the present, by the development of the arid country along the international boundary. The wood is close grained and heavy and much used for turnery, bearings, handles, and occasionally for engravers' blocks. It is never abundant enough to be classed as lumber.

The dogwood is frequently planted in parks and on private lawns in our eastern States, and forms a most attractive mass of color in both the vernal and autumnal seasons. Nothing is more beautiful than the rich woods of the Middle and South Atlantic States with dogwood interspersed with the leafless but brilliant red-bud or Judas-tree (Cercis). Two of our other native dogwoods which reach the stature of trees have inconspicuous blossoms and are little known. The fourth and only other showy species is the western dogwood, *Cornus nuttalli*. Like its eastern relative it flowers in the spring of the year, its button-like cluster of small greenish yellow flowers being surrounded by from four to six showy white or faintly pinkish petal-like bracts an inch or two in length. These, unlike those of the eastern flowering dogwood, are pointed and not indented at their tips. The berries are a shiny red and much like those of its eastern brother. The wood is lighter and less dense, and but little used.

The western dogwood is similarly an under tree, frequently of Douglas fir, redwood, or western hemlock, and reaches its largest size in the Douglas fir forests of the Puget Sound country, where it may reach a height of 100 feet and a diameter of 2 feet, but is usually from 40 to 60 feet tall and with a trunk diameter of from 8 to 12 inches. It probably reaches an age of from 150 to 250 years, is a vigorous annual seeder of persistent vitality, and is found from southern British Columbia near the coast, that is, the lower Fraser River and Vancouver Island region, through Washington, Oregon and California to the San Jacinto Mountains and the western slopes of the Sierra Nevadas.

The dogwoods all have rather characteristically shaped and veined leaves, and consequently considerable is known of their geological history. Over 50 fossil forms have been described, and the oldest known of these come from the Upper Cretaceous. A dozen different forms have been recorded from the rocks of that far off age, and the oldest of these occurred in western Greenland and in beds of approximately the same age along the Atlantic coast of North America of that time, when the coast was somewhat west of where it is today. Similar ancient dogwoods left their leaves in the initial sandy deposits that were laid down by the Upper Cretaceous sea that swept over our western plains country from the Gulf of Mexico.

Dogwood leaves continue to turn up throughout the Cretaceous in Colorado, Wyoming, Montana, Vancouver Island and Greenland, but none have thus far been found outside of North America except for a single form recorded from supposed Upper Cretaceous deposits in Spitzbergen. These facts suggest that America was near the place of origin of the dogwood tribe. At least dogwoods do not seem to have reached Europe until much later. What happened in Asia in those far off days can only be surmised, since we know scarcely anything of the later floral history of that vast area.

During the first stage of the succeeding Tertiary period—the Eocene, or dawn period of modern life—13 species of the dogwood have been discovered. The bulk of these are American, but there was a single form in France and 2 others are known from the late

Eocene of Sachalin Island on the east coast of Asia. In North America the Eocene records are numerous, and most abundant in the rocks of late Eocene age, and in our more northern States and still farther northward.

The southernmost record is New Mexico, the others include Colorado, Wyoming, Montana, California, Oregon and British Columbia. Eocene dogwoods are found in Greenland and Spitzbergen. One described from Wyoming is based upon a characteristic fossilized flower head with the enlarged bracts much like our existing flowering dogwood.

The Oligocene records of the dogwood drop to 3 species described from Italy, Prussia and Bohemia. This scanty record for those times is due partly to adverse conditions and partly to the carcitys of plant records of that age, particularly in North America. The record becomes more representative in the succeeding Miocene times for some 20 species of dogwood have been described from deposits of that age. These are mostly European and Miocene species which were widely scattered over Europe at that time from France to Austria and Hungary. In this country 1 form has been found in deposits supposed to be of Miocene age in the Yellowstone Park, and 2 others have been recorded from California.

In succeeding Pliocene times which brought the Tertiary period to a close the variety and abundance of dogwoods appears to have waned. I say appear, since the Pliocene records are so incomplete that the merely negative evidence may be of no value. Four different dogwoods are reported from Pliocene deposits and all of these are from Old World localities. This does not mean that the dogwood became extinct in North America during the Pliocene and reappeared in modern times—the mere fact that they could not have attained their present day distribution under existing climatic conditions is sufficient proof that this was not the case, but that our American Pliocene plant record is very incomplete.

The Old World Pliocene forms have been found in France, Spain and Italy in Europe, and in Japan. The dogwood was thus a member of the forest flora that at that time extended almost unbrokenly from Portugal eastward to Japan. Traces of this forest flora have been discovered at various scattered localities throughout that vast area, as have also the remains of a considerable representation of the terrestrial animal life commonly known as the Hipparion fauna from the abundance of the remains of extinct horses of that genus that have been found in it.

The Pleistocene or glacial period, which fills the interval in geological history between the Tertiary and the present has yielded the remains of dogwoods of 2 existing species in Europe, namely, *Cornus sanguinea* in England and Germany, and *Cornus mas* in Holland and Hungary. A single seed of an undetermined species of dogwood has been found in the Pleistocene deposits of New Jersey, and recently a second species based upon the seeds has been reported from a deposit of this age in the city of Washington. Doubtless a comprehensive study of American Pleistocene plant beds, which has never been made, would add much to the last stages of dogwood history.

THE GUMS

The various trees embraced under this name are better known to the professional botanist and lumberman than they are to the layman. They comprise the tupelo, cotton, and sour gum, and are not related to the sweet gum, Liquidambar, whose history has been sketched in an earlier chapter. The gums are referred to a genus known as Nyssa, the name of a water nymph, in allusion to the fact that most of the gums grow in wet soils, and one in particular is found in standing water in the sloughs or swamps of our southern States, in which situation it swells out its butt just like that of the bald cypress.

There are 6 or 7 existing species of gum, all of which are confined to southeastern North America except a single form which is found in southeastern Asia from the eastern Himalayas to the island of Java, thus furnishing another link in the chain of evidence that shows that these two regions are vast plant preserves where the glaciation of the Pleistocene was unable to destroy the Tertiary forest population that so largely perished in all other parts of the Northern Hemisphere at that time.

The gums all yield a tough wood which has an intricately contorted and twisted grain, and are hence not extensively utilized by man because of this difficulty of working it. The gum fruits are stone fruits with a thin oily acidulous flesh which is utilized and distributed by birds, and by mammals other than man. In the fall of the year such bears as are left in our southern States invade the somewhat drier swamps of this season in search of gum fruits. The stones are rather characteristic being bony and compressed, with longitudinal wings or ridges, and they have frequently been found fossil.

A large number of fossil forms of gums have been described. Leaves that are apparently those of extinct species have been found in Upper Cretaceous deposits in Wyoming, Nebraska, Kansas, and Alabama. During the early Tertiary gums are extraordinarily abundant with many different species. From the isolated and restricted lignite deposit at Brandon, Vermont, which has been mined sporadically when coal was scarce or prohibitive in price in that region, 18 different kinds of stones of gum fruits have been described.

It is worthy of comment that all of the Upper Cretaceous and Eocene gums are North American or Arctic, none being known from the numerous plant beds of Europe until Oligocene times. Besides the abundance of Eocene gum stones in New England, which we infer from their abundance in the tiny lignite deposit in Vermont, Eocene gums have been recorded from Montana, Wyoming, Colorado, New Mexico, Tennessee, Louisiana and Texas. In the far north they occurred at that time in Alaska, Greenland and Spitzbergen.

There are 8 known Oligocene forms of gum. The scene, in so far as the actual geological record is preserved had now shifted from the New to the Old World, but this is due entirely to the absence of Oligocene records in North America, and probably not at all to the absence of gums in the North American forests of those times, especially in eastern North America, although it is quite probable that by Oligocene time they may have become extinct or extremely limited by the drying of the climate brought about by the elevation of the western mountain ranges which cut off the moisture bearing winds from the Pacific.

Gum stones are almost as common in the brown coals of central Europe as in the Brandon lignites of an earlier day and the Oligocene records are principally those of southern England and Germany, showing for how many thousands of years the gums have been accustomed to a swampy habitat.

FIG. 44. SKETCH MAP SHOWING PRESENT DISTRIBUTION (ENCLOSED AREAS) AND FOSSIL OCCURRENCES OF THE TUPELO

The gums appear to wane in the later Tertiary, if their geological record as it is now known may be taken as a safe guide. Thus there are but 4 or 5 Miocene species. On the other hand these are widely distributed. An American Miocene form, again based on the fruit stones, is found in the coastal deposits of diatomaceous sediments in Virginia. In Europe the Miocene records include various localities in Germany and in the components of the now disrupted Austro-Hungarian empire (Styria, Carinthia, and Croatia). One of the gums found in the latter region is also recorded from Siberia.

The Miocene witnessed the last known gums in Europe, their extinction on that continent having apparently been due to climatic changes long anterior to the glacial period for none are known from European Pleistocene deposits which is a reasonable guerdon of their absence at that time for many of these Pliocene plant beds were swamp deposits. The known Pliocene or late Tertiary gums, 3 in number, are all North American, and very much like some of our existing American species, of which they were undoubtedly the ancestors. They come from New Jersey and southern Alabama. The Pleistocene gums are likewise North American and represent still existing species. They are known from New Jersey, Maryland, Virginia, North Carolina, Alabama, and Kentucky.

CHAPTER XXIV

SASSAFRAS, SPICE-BUSH AND BAY

The sassafras, spice-bush and bay belong to a family, the Lauraceae, that is mainly tropical in its modern distribution and which contains over 1000 species many of which are valuable timber trees in the tropics or yield camphor, cinnamon, alligator pears, and other less well known articles of commerce. Very few members of the family are found in the Temperate Zone and it is especially well represented at the present time in northern South America.

THE SASSAFRAS

None of our native trees surpass the sassafras in the personal interest that it arouses. Many of my readers are familiar with it and have noticed the sometimes mitten-like shape of some of its leaves, or know the fragrant root, but most of them I suspect think of the sassfras as a bush or small tree, and yet it frequently reaches a height of 125 feet and occasionally a trunk diameter of 7 feet. The sassafras is not uncommon in southern New England, and I have a tree on my place in eastern Connecticut some 90 feet tall and with a trunk a foot in diameter. This tree always calls up memories of the tropics for the dark green leaves are massed toward the ends of the branches in a way characteristic of many of its tropical relatives, and its whole appearance seems exotic, and suggestive of the Spanish Main rather than staid old New England. In lieu of gold or precious stones Captain John Smith sent the first ship back to old England loaded with sassafras, and this was, so far as I know the first and last incursion of the sassafras in any large way into the commerce of the world, although the Choctaw Indians are said to make a soup flavor from its leaves, and the aromatic principle, especially of the roots, furnishes a mild aromatic stimulant, and yields upon distillation oil of sassafras, sparingly used in perfumery and soapmaking.

Until a few years ago when two species were recognized in central China sassafras was known as a monotypic genus, that is to say, one with only single living species—for botanists, like most other people, have rarely paid any attention to other than living species.

The great systematist Linnaeus called the sassafras *Laurus sassafras* in allusion to a name of Spanish origin in Florida, and when the old and composite genus Laurus was dismembered, its scientific name became *Sassafras sassafras* which is in conformity

FIG. 45. SKETCH MAP SHOWING PRESENT DISTRIBUTION (SOLID BLACK) AND FOSSIL OCCURRENCES (CIRCLES) OF THE SASSAFRAS

with the rules which modern systematic botanists observe, although Nees who in 1831 established the genus Sassafras for its reception called our American tree *Sassafras officinale* in allusion to its place, if but a minor one, in the pharmacopeia.

The wood is soft, brittle and weak, but durable like that of most members of this large family. It is sometimes used for posts and rails where the tree is abundant, and some of its tropical relatives yield a very hard wood that is almost indestructible.

Our American sassafras ranges from Massachusetts westward to Iowa and Kansas and from Ontario and Michigan southward to Florida and Texas. Just why it, along with the two Chinese species should have remained a Temperate Zone type in contrast to the vast majority of its relatives is a mystery. To be sure its most ancient home was outside the Equatorial Zone, but this was also true, at least ancestrally, of many of its kin.

The ancestry of the sassafras has this remarkable feature—that the most ancient known forms are quite like some of those still existing as regards their leaves, showing both the two lobed mitten-like and the three lobed leaves with which we are familiar, but apparently without entire leaves. They are also remarkable in that they are found in somewhat older rocks than most of the flowering plants. Toward the close of Lower Cretaceous time, in the last or Albian stage, as geologists call it, of that period, several different kinds of sassafras have been found. One of these comes from western Europe (Portugal) and three from eastern North America (Maryland and Virginia).

It seems incredible that in those far off days of the age of dinosaurs trees so like their modern descendants should already have been in existence. That they occur on both shores of the Atlantic indicates a still more ancient ancestry, and an origin in a third region accessible to both Portugal and Maryland. That this was toward the north rather than in Asia seems probable from the records of Upper Cretaceous time, of not only the sassafras, but of many other plant types.

Leaves like those of the sassafras are often exceedingly abundant and varied in certain rocks of Upper Cretaceous age. Over a dozen species have been described, and their leaves are especially abundant in the shore deposits of the Upper Cretaceous sea that advanced over our western great plains country (the Dakota sandstone), and in the muds of the estuaries and lagoons that skirted the corresponding sea along our east coast at the time it commenced to encroach on the old land.

At least 3 different kinds of sassafras were present at that time in western Greenland and along our eastern coast from New

Fig. 46. Some Pliocene or Late Tertiary Sassafras Leaves from France and Italy (Slightly Reduced)

York to Alabama. In Europe they are known from Bohemia and Moravia, and they have been even recorded, but on somewhat doubtful authority, from Argentina. At no later time are they as varied as during the Upper Cretaceous.

During the Eocene 4 or 5 different forms of sassafras are known from widely scattered localities which include France, Germany, Greenland and British Columbia. In succeeding Oligocene time but 2 species are known and these are both from European localities, in fact the only items of record in the later geological history of the sassafras come from the records in the European rocks. As I have explained in connection with several other of our trees, this is largely due to the paucity of later Tertiary plant records in North America, especially in those regions where the sassafras existed during those times.

The Miocene records are of 6 or 7 species found in Spain, France, Italy, Baden, Styria and Bohemia. During the succeeding Pliocene times one of the Miocene species survived in Europe, and I have pictured several leaves of this form in order to emphasize how like the modern sassafras leaves they were, and the further fact of the many modern North American and Asian types that lived in Europe during the Pliocene and until the coming of the Pleistocene glaciers. In fact a sassafras leaf has been found in France as late as the deposits of the third Interglacial stage of the Pleistocene, showing that it survived three Glacial periods on that continent and only succumbed finally during the fourth or final glaciation that came to a close only a few thousand years ago and after the men of the Old Stone Age had already been a long time in western Europe.

THE SPICE-BUSH

The spice-bush, or benjamin-bush as it is sometimes called should be familiar to all those who tramp the spring woods. Its clusters of fragrant bright yellow flowers borne close to the stems as in so many tropical trees and shrubs makes it a conspicuous object in the bare woods of early spring for it blooms long before its leaves come out, as early as March in our northern States and still earlier in the South. In 1922 I noticed it in blossom in Maryland in February and in 1923 it was out in January. We have 2 species in eastern North America—a more northern and a more southern one, their combined range being almost identical with that of the sassafras, and overlapping one another in the Carolinas. Technically they are referred to the genus Benzoin named because the fragrance of the spice-bush suggests that of benzoin gum. Both are species that frequent moist places in low woods or along streams. In some localities they go by the name of fever-bush or wild all-spice, the latter an appropriate name for the aromatic spicy odor of the blossoms, bark or crushed leaves. Later in the year when the ovate leaves have unfurled and before the small red plum-like fruits have ripened some search is required to recognize the spice-bush even in its favorite haunts.

In addition to our 2 eastern American forms which never reach proportions larger than bushes, there are 4 or 5 species of southeastern Asia which are trees and have trilobate, sassafras-like leaves, so that the spice-bush, like so many other of the types we have been considering, illustrates a past general distribution and a post-Pleistocene restriction to the southeastern parts of Asia and North America, paralleling in its history that of the sassafras, but much less fully known in the case of the former.

Eight different fossil species have been described and all of these are more like the existing Asiatic than they are like the existing American forms. The oldest known are 2 varieties found in the Upper Cretaceous of Kansas and Texas, contemporaneous with several of the sassafras forms of that time. There is an early Eocene form in France and a late Eocene form in western Greenland. Three Oligocene species are recorded from France, Italy and Germany.

In succeeding Miocene times, especially in the later days of the Miocene, 4 different species of Benzoin have been discovered. These are found in Spain, France, Switzerland, Italy, Baden, Prussia, Silesia and Croatia. Three of these lived on in Europe and left their fossil remains in the Pliocene of Spain and Italy. The Pleistocene glaciation, however, put an end to their long continued European residence, and apparently blotted them out in the whole region from Spain to China where formerly they presumably flourished in appropriate situations, leaving them only in eastern Asia and southeastern North America.

THE BAY

The term bay is in different regions the popular name of several different kinds of swamp plants. As used here it applies to the 3 forms of our southern States known as the red bay, swamp bay or Isabella-wood. They will be unfamiliar to most of my readers, and are introduced in order to give a glimpse into the history of a member of this great family of the Lauraceae which is essentially tropical rather than temperate in its modern development, although our bays range northward as far as southern Maryland. They are either trees or shrubs, those of the tropics being mostly trees, our boys being either, with ovate or lanceolate leathery leaves, small not especially conspicuous flowers, and globose berry-like fruits. Our American forms are dwellers in swamps and low stream bottoms where the climate does not fluctuate as in other situations but this habitat does not hold for the other members of the genus.

They are referred to a genus called Persea, which was the ancient name of some now unknown Oriental tree, although the existing Perseas are all Occidental except for a single survivor from bygone days that at present inhabits the Canary Islands. There are about 50 existing species of Persea, mostly trees of tropical America, some of which furnish the alligator pears or avocados that are now cultivated in many tropical countries. I have had but slight experience with the alligator pears usually to be seen on sale in our better fruit stores, but I can testify to the extreme daintiness and appetizing taste that they have when personally collected and properly seasoned with sugar and lime-juice.

The geological history of Persea is of interest since it is somewhat different from that of most of the trees discussed in this volume. The known fossil species are about as numerous as the still existing species, that is, about 50 different forms are known from the rocks. Six of these are recorded from the Upper Cretaceous in

Kansas, Vancouver Island, Marthas Vineyard, Long Island, Alabama, and Moravia.

We have records of 9 forms during the Eocene. Four of these are from the early Eocene of France, 1 comes from the Upper Eocene of Germany, 1 from the Upper Eocene of British Columbia, and 3 from the early Eocene of the United States. One of the last comes from Colorado and the other 2 were members of the warm flora that spread northward from equatorial America during that period of mild climate that characterized the later Eocene and which contained so many representatives of this family, including even the cinnamon and camphor trees which in existing floras are confined to the Old World.

The Oligocene forms of Persea are 6 in number and come from Italy and southern Germany. Succeeding Miocene rocks furnish many records, and include no less than 27 different species. They are known at that time from four different continental areas and occur in Indo-China, southern Chile, Peru, Colombia, Italy, Baden, France, Switzerland, Germany, Bohemia, Styria, Carniola, Croatia, Carinthia, Transylvania, Greece, New Jersey, Colorado, Yellowstone Park and California. As regards the general facies of the flora that of Pliocene time is essentially a continuation of that of the later Miocene without great change.

Eleven different forms of Persea have been discovered in Pliocene deposits and these Pliocene records include Spain, France, Italy, Asia Minor and Brazil. The still existing species which I have mentioned as surviving in the Canary Islands is found in beds of Pliocene age in France and Italy and in the volcanic beds of that age on the Lipari Islands. The Pleistocene records are confined to the presence of one of the living American forms which has been found in the deposits of that age in North Carolina and Alabama, and possibly a third occurrence in western Tennessee.

CHAPTER XXV

The Persimmon

The ebony family or Ebenaceae of the order Ebenales is comparatively large, with upwards of 300 different species distributed among 5 or 6 genera, more than half of them being referable to the genus Diospyros to which our common eastern form belongs. The name Diospyros is derived from the Greek and means God or life-giving or heavenly. Its selection for these particular plants required the same type of imagination which gave to our common clams the name Venus, and which saw the mythical shapes embodied in the constellations. Most of my readers are familiar with our common American persimmon or "Possom wood" and not a few will recall the extremely astringent taste of its unripe fruits. Many are also familiar with large edible persimmons of China and Japan which are now often cultivated in our extreme southern States. Persimmon wood is hard and strong and is used to a considerable extent in the manufacture of bobbins and similar articles. This quality of hardness and fineness of grain runs through the whole family and the bulk of the ebony of commerce is derived from various species of Diospyros. According to the writer of the Book of Ezekiel, ebony was one of the articles of merchandise of the Phoenicians and the ancients esteemed it even more than we do at the present time. Virgil and Pliny mention it as a product of India and Herodotus relates that it was one of the articles of tribute in the days of the Persian Empire. Naturally a wood which has been utilized for so long, a wood so fine-grained, hard, and heavy, and susceptible of such a high polish was thought to possess many mystic virtues. It was used for making scepters, images and drinking cups because of its supposed antagonism to poison. Pausanius relates that the ebony tree produced neither leaves or fruit, nor was ever seen exposed to the sun.

The species of Diospyros and indeed the entire family to which it belongs are, for the most part, confined to tropical and subtropical countries. The different species of persimmon or ebony are widely distributed and indigenous to all of the continents. At first sight, it seems singular that a tree whose near relatives are all tropical should be found ranging from Florida and Texas, northward to southern New England and to Iowa and Kansas in the west. It is clear that present climatic conditions altogether fail to explain such a range. Nor is it to be accounted for by the supposition that the persimmon has extended its range northward from the tropics during the few thousands of years which have intervened since the last glacial epoch. Like so many of our other American trees, the real explanation is to be sought in the records which are far older than those of post-glacial times. Fortunately the persimmon has left many such records of its former distribution extending back some millions of years previous to the advent of man on this earth.

Our common persimmon, scientifically known as *Diospyros virginiana*, makes a rather handsome shade tree with its large ovate glossy leaves, and can be purchased from a number of dealers. Its fruits were probably the first native fruits to be described, DeSoto publishing a laudatory account of them in 1557 in Portuguese. de Laet in his work on Virginia, published in 1558, describes the persimmon in that State. In Captain John Smith's narrative of the resources of the New World there is to be found a long discussion of the persimmon, and he says most aptly of the fruit: "If it be not ripe, it will draw a man's mouth awrie with much torment."

The tannic acid in the immature fruits and in some apparently mature fruits renders them very astringent with the result that their food value has been little recognized. It is a common saying that persimmons are not fit to eat until after frost, although freezing no more improves persimmons than it does other fruits. The real truth seems to be that the species includes many diverse strains, some with greater and some with lesser amounts of tannin, some ripening early and others not maturing until after the first frosts. Undoubtedly if some attention was given to the selection of the right varieties, to care of the trees, pruning and grafting of the finer sorts, a profitable industry could be built up, as there is no pleasanter fruit than some persimmons, and none except the date that has a greater food value.

We have a second species in the United States, less well known because of its more restricted range. This is the black persimmon or chapote, *Diospyros texana*, found in the river valleys from the Colorado River of Texas to the Neuvo Leon in Mexico. It is a fair sized, intricately branched tree, whose fruits of a black color are often said to be insipid. They lack the astringency so frequent in our common persimmon, and I have found them fully as appetizing as the large Japanese persimmons often grown in our southern States.

In that grand display of dicotyledonous genera which during the mid-Cretaceous replaced the old Mesozoic flora of ferns, cycads, and conifers and which appeared with such apparent suddenness at a number of points in the Northern Hemisphere, we find unmistakable evidence of the abundance and wide distribution of species of Diospyros. No less than 17 different forms have been described from the rocks of this age, and the localities where they have been found are scattered from Australia to Bohemia, Greenland, and Vancouver Island. A large majority of these species are American, and they seem to have been especially at home along the Cretaceous coast of the Atlantic and along the border of the Mediterranean Sea which extended northwestward from the Gulf of Mexico over much of our present Great Plains area. One of these species, well named *Diospyros primaeva* by Professor Heer in 1866, is especially widespread and abundant, being found not only in Iowa, Kansas, and Nebraska in the west but also from Texas eastward through Alabama and northward in South Carolina, North Carolina, Maryland, New Jersey, Long Island and Greenland, or, from latitude 33° to latitude 71° north. That these early persimmons were not very different from those of today is shown by their similar foliage, as may be seen from a comparison of the leaf of *Diospyros primaeva* shown in figure 1 alongside of a small leaf of our existing *Diospyros virginiana* (fig. 3). This resemblance is also shown by the fossilized remains of the calices of various species. One of these calices from another early upper Cretaceous species, recently described by the writer is *Diospyros vera* and found in what is known in the Potomac River valley, as the Raritan formation is also shown in figure 2. Apparently the habit of accrescence had not been fully formed but the calyx was persistent then as now and entirely like a modern calyx in appearance. It was four-parted as it usually is in existing persimmons but other fossil forms had a five-parted calyx like a good many present day tropical species. This feature is well shown in a large fossil calyx found recently in the upper Eocene of southwestern Texas (fig. 7).

In the Eocene period, which succeeded the Cretaceous, the records of the fossil occurrences of Diospyros, show that it was truly cosmopolitan. These records include about 20 species in Siberia, Alaska and Greenland on the north, Canada, various localities in Europe, as well as Colorado, Montana, Wyoming, Nevada, Oregon, Washington, and other western states and the Canal Zone on the South. In beds of supposed Eocene age in Panama many fruits of a persimmon have been discovered in a petrified condition in the andesitic tuffs. These fruits are about the size of cherries with a hard, very tanniferous and more or less fibrous flesh, and 8 to 10 varyingly developed seeds. So far as I know this is the only petrified persimmon fruit known. Two sections of these fruits are shown in figures 8 and 9. A leaf of one of the early Eocene forms from Montana is shown in figure 4. Unfortunately, we have no Eocene or later Tertiary records along the Atlantic coast of North America north of Panama since the preserved deposits are all largely of marine origin and contain no fossil plants. There is little doubt, however, that Diospyros continued to be an abundant element in the arborescent flora of this area.

The Eocene was succeeded by the geological period known as the Oligocene in the rocks of which age no fossil plants have thus far been discovered in this country. In Europe, where the Oligocene is marked by a warm temperate climate and by shallow lake and river deposits, the remains of Diospyros are very common.

The records include Greece, Germany, Italy, Austria, and France and embrace calices or leaves of at least 15 different species. Especially in southern France where the climate approached subtropical conditions, numerous varieties of the persimmon flourished along the borders of the shallow gulf which extended up the Rhone valley. In succeeding Miocene time, a period of luxuriant forests, species of persimmon are found throughout Europe. In America where the Miocene records are very incompletely preserved, the persimmon is recorded from Montana, Colorado,

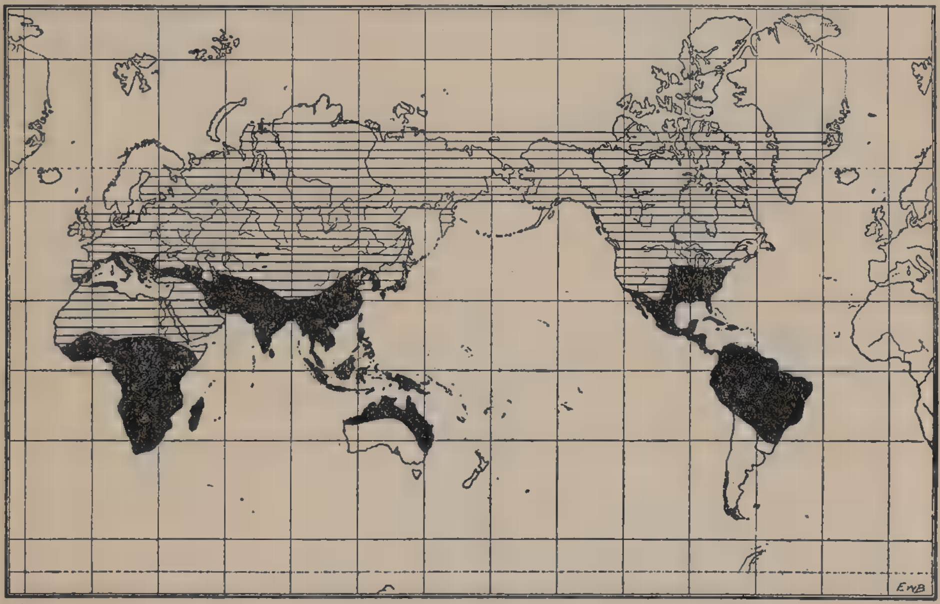

Fig. 47. Sketch Map of the World Showing the Distributional Areas of the Existing Species of Diospyros (solid black) and the More Extended Range of the Fossil Species (ruled lines)

California, and Oregon. The leaves of at least 2 species are preserved in the late Miocene upland lake basin of Florissant in the Rocky Mountains of Colorado. Specimens of Diospyros calices from the Miocene of Switzerland are shown in figures 5 and 6.

The Miocene period was followed by the Pliocene, a time during which the American deposits appear to have been unfavorable, either because of their character or location, for the preservation of fossil plants, since practically none have been discovered. In

Europe on the contrary, there were great fluctuations of the Mediterranean Sea which at one time covered most of southeastern Europe with its shallow waters. The climate was consequently equable and humid and the shores were well wooded, as is clearly indicated by the great abundance of fossil plants which were preserved. The persimmon continued to be an abundant element in these Pliocene floras, and no less than eight different species of Diospyros have been reported from deposits of this age. The localities include Italy, Spain, France and Austria, one of the French species being indistinguishable from our existing *Diospyros virginiana*. A fortunately preserved Pliocene deposit on the island of Java shows that then as now, Diospyros was a prominent element in the Malayan flora.

What happened at the close of the Pliocene, we can only conjecture, since we have no Pleistocene records of Diospyros. We know that their range was gradually restricted through cool northern climates, and by the gradual development of the plains type of country due to continental growth and to the elevation of mountain ranges which shut off the moisture laden winds. With the subsequent advance of the glaciers southward over Europe in Pleistocene time, and the glaciation in the mountains, Pyrenees, Alps, Carpathians and others, which with the Mediterranean Sea

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FIG. 48. SOME LEAVES AND FRUITS OF EXTINCT PERSIMMONS (ABOUT $\frac{3}{5}$ NATURAL SIZE)

1. Leaf of *Diospyros primaeva* Heer from the Upper Cretaceous of New Jersey.

2. Calyx of *Diospyros vera* Berry from the Upper Cretaceous of the District of Columbia.

3. Leaf-print of a small leaf on the existing *Diospyros virginiana* Linné.

4. Leaf of *Diospyros ficoidea* Lesquereaux from the early Eocene of Montana.

5, 6. Calices of *Diospyros brachysepala* Alex. Braun from the Miocene of Switzerland.

7. Calyx of *Diospyros miraflorianna* Berry from the upper Eocene of Southwest Texas.

8, 9. Transverse and longitudinal sections of the fruit of *Diospyros macdonaldi* Berry from the early Tertiary of the Panama Canal Zone.

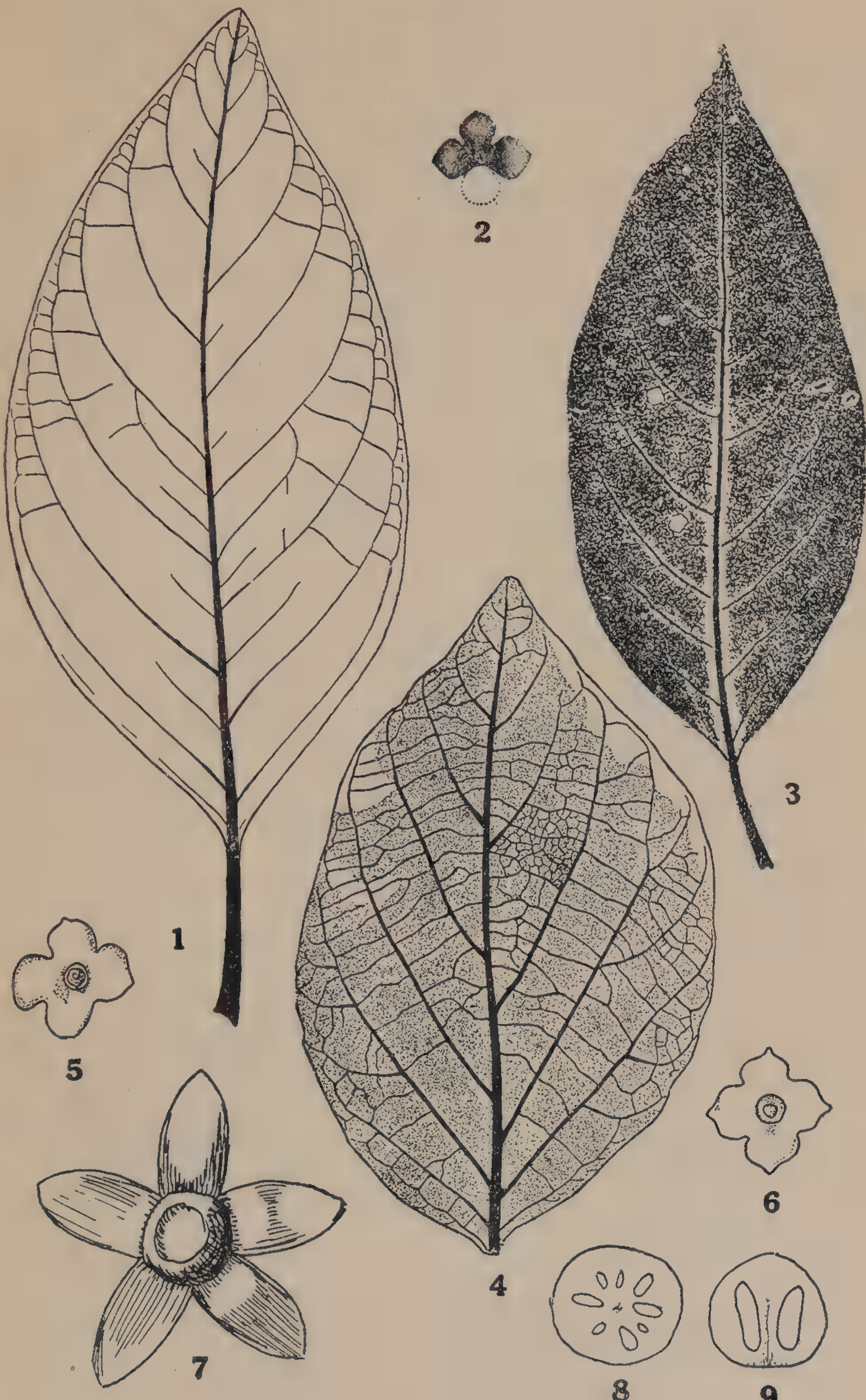

FIG. 48

shut off the retreat of the numerous Tertiary forms, Diospyros fared but ill on that continent and most of the species became exterminated. In America and Asia, a congenial habitat spread far to the southward of the ice-front and there were no dangerous mountain glaciers across their paths, consequently the persimmons were able to maintain themselves and to spread northward again in the wake of the ice sheet. In America, our common persimmon forsook temporarily its more northern haunts, although it is doubtful if its northern limit at any time was farther south than the Potomac River, since it is extremely probable that the extensive Pleistocene glaciation was due more to unbalanced precipitation than to any great degree of secular change in temperature.

Much more might be written concerning the geologic history of Diospyros and its migrations in the past, as well as something of the existing species,—their utility, beauty, and habits of life, but enough has been recorded here to show how immensely remote its forbears were and what an extensive territory its ancestors once occupied. In closing, let me repeat the cardinal fact first emphasized in Alfred Russel Wallace's work on distribution, that the present day geographical distribution of plants is almost entirely the end product of their distribution in antecedent geological ages and that there is the most complete dependence between their ancestral history and the geologic, geographic, and climatic history of the earth.

I have attempted to summarize the history of Diospyros in a graphic way on the accompanying small sketch map of the world. The solid black indicates the distributional areas of the existing species while the ruled lines indicate the larger areas over which Diospyros extended its range during its geological history. This range was probably more extensive even than is indicated since data are not available for plotting the complete record which will always remain more or less incomplete.

INDEX

Sans Tache

IN THE "elder days of art" each artist or craftsman enjoyed the privilege of independent creation. He carried through a process of manufacture from beginning to end. The scribe of the days before the printing press was such a craftsman. So was the printer in the days before the machine process. He stood or fell, as a craftsman, by the merit or demerit of his finished product.

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