Herbert H. Ross.
The DUNESLAND Heritage of IL.

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HERBERT H. ROSS

Circular 49
ILLINOIS NATURAL HISTORY SURVEY
in Cooperation With the
ILLINOIS STATE DEPARTMENT OF CONSERVATION

STATE OF ILLINOIS • DEPARTMENT OF REGISTRATION AND EDUCATION

NATURAL HISTORY SURVEY DIVISION

The DUNESLAND Heritage of Illinois

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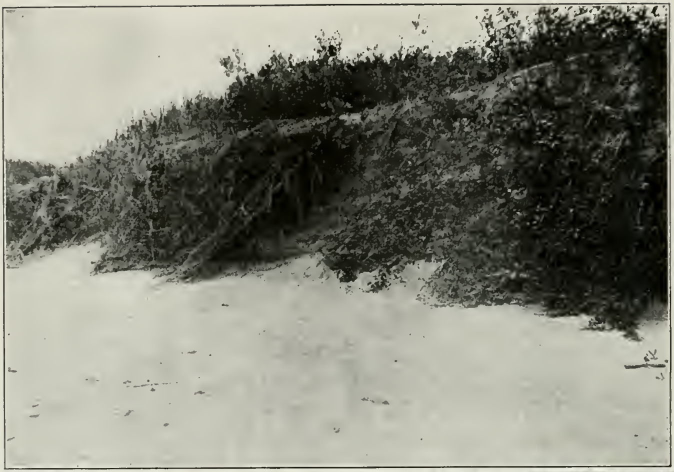
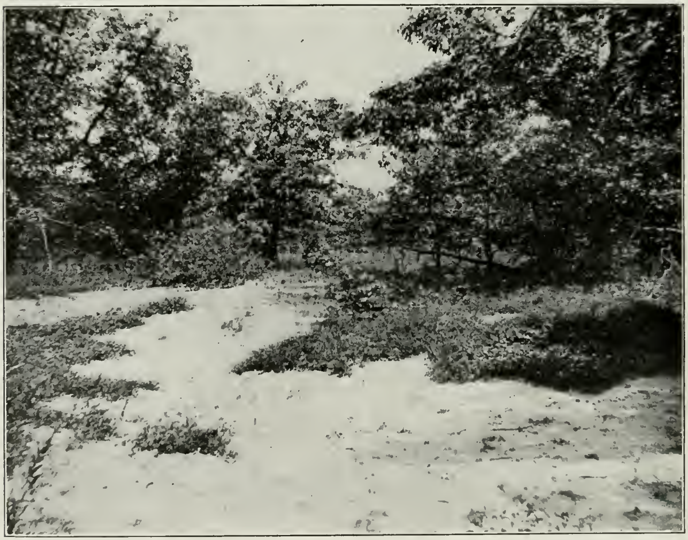




The Dunesland is never static. It is always changing. Above, Lake Michigan shore in the process of being cut away by storm-driven waves. Below, revegetation of a blowout in a Dunesland oak forest. These pictures, taken September 4 and July 19, 1909, are from *The Vegetation of the Beach Area in Northeastern Illinois and Southeastern Wisconsin*, written by Frank Caleb Gates and published in 1912 by one of the parent organizations of the Illinois Natural History Survey.

The DUNESLAND Heritage of Illinois

HERBERT H. ROSS

THE northeastern corner of Illinois contains a number of natural areas that are unlike the rest of the state but reminiscent of the country to the north. Perhaps the best known of these areas are the large lakes, such as Channel Lake and Fox Lake, which are readily seen from well-traveled highways. The shore margins and the marshes along these lakes contain a large number of plants and animals not common in other parts of Illinois. Less well known but of even greater interest to naturalists are two other kinds of areas. One kind includes the tamarack bogs, of which the best example is the Volo bog. The other kind includes the areas of sand deposits along the west shore of Lake Michigan. Many of these areas have

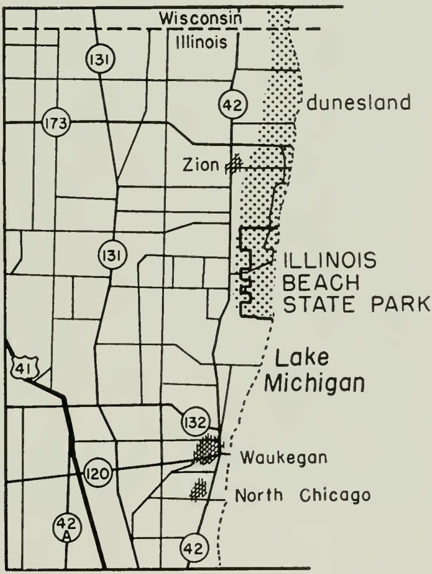


Fig. 1.—Outline map of northeastern Illinois. The Dunesland area is indicated by stippling.

been cultivated or they have been taken over for housing or industrial developments; we must rely on old collections of plant and animal specimens to document the unusual life that formerly occurred in them.

One area of sand deposits is still well preserved in its wild state. This is the strip of sand ridges and marshes extending from Waukegan northward along the shore of Lake Michigan into Wisconsin, fig. 1. Part of this unique area in Lake County, Illinois, forms Illinois Beach State Park. In the following account, the Illinois strip of Lake Michigan shore north of Waukegan, including Illinois Beach State Park, is called the Dunesland, the name given by the naturalists who have long been appreciative of this historic wilderness remnant.

Both the topography making up the Dunesland and the peculiar combination of plants and animals that constitute its life are the result of events dating back into remote stretches of time. Attempts to unravel this history make a fascinating study.

At first glance, much of the Dunesland, fig. 2, looks like an ordinary marsh or prairie such as those occurring alongside many miles of railroad tracks throughout Illinois. However, as soon as the particular kinds of plants and animals growing and living in the Dunesland area are identified, it is clear that this superficial resemblance is deceptive, because the Dunesland contains a remarkable biological assemblage found in no other part of Illinois.

Species unusual for Illinois are found in all parts of the Dunesland. The two native junipers, fig. 3, and bearberry, fig. 12, grow on the open sand ridges. The dwarf birch and the roundleaf dogwood occur along the edges of the swales. Several kinds of unusual orchids and gentians grow in the meadowlike marshy areas. Each of these plants is found in some other locality in Illinois, but nowhere else do all of them grow in such profusion on one small area. The unusual feature about all of these plants is that they are typically northern species. Most of them are common from the Atlantic to the Pacific coasts in more northerly regions of the United States and adjacent parts of Canada. The Illinois occurrence of each of these species represents the southernmost edge of its range in the central part of the continent.

The particular combination of plants found in the Dunesland does not occur in other prairies and marshes situated only a few miles west of Lake Michigan, where the climate is presumably almost identical with that in the Dunesland. This circumstance indicates that there is some other ingredient in addition to climate that is responsible for the peculiar combination of living things found in the

Dunesland. The other ingredient is sand, which makes up most of the soil along this stretch of land. In Illinois the bearberry, the junipers, and many of the marsh plants can prosper on almost pure sand better than the plants that live in the heavier soils farther from the lake. Thus, the combination of sand and a northerly climate has set the stage for the natural communities growing in the Dunesland.

Some of the sand ridges support a sparse growth of black oak. These oaks are a reminder that natural communities are always changing. If left to themselves, eventually all the sand ridges of the Dunesland would become black oak forests through a process called ecological succession. This type of change can be understood by considering the vegetation of the entire area in which we live.

Illinois lies near the western edge of the temperate deciduous forest, sometimes called the beech-maple forest. Eastward this forest

Fig. 2.—An expanse of Dunesland prairie dominated by bluestem grasses and supporting a wide variety of other herbs. The flowers in bloom are on spikes of blazing star, *Liatris*. Rows of black oak can be seen on some of the sand ridges in the background.

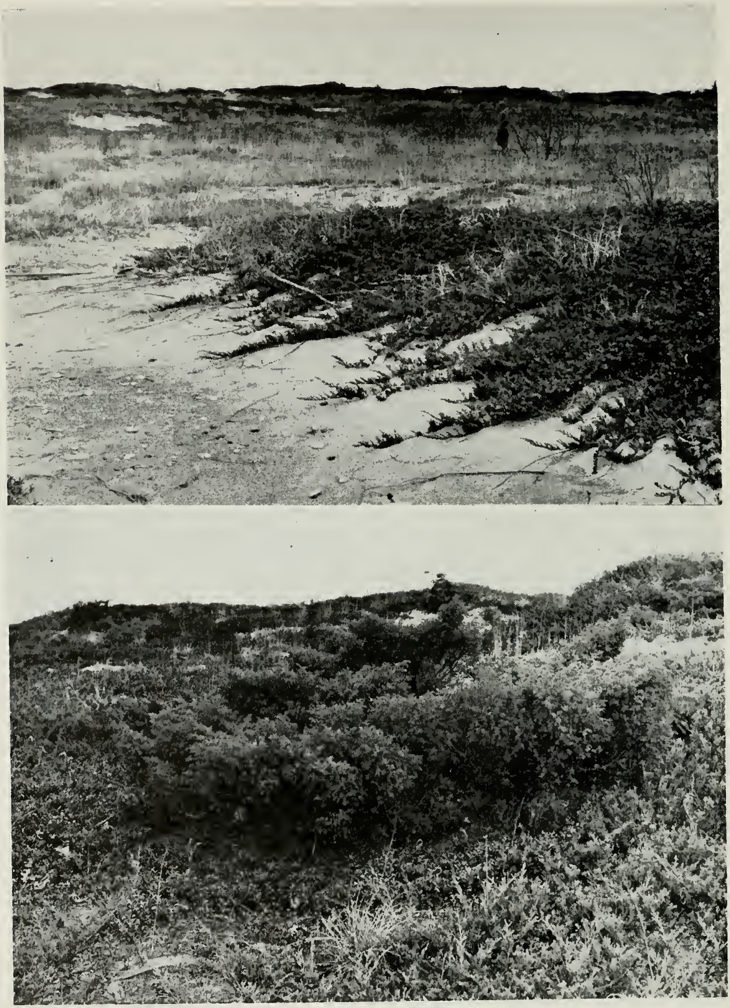


Fig. 3.—The two native junipers found in Illinois. Above, the creeping or Waukegan juniper, shown with new growth extending over and stabilizing bare sand. Below (center of picture), the common or upright juniper, which usually becomes established on sand already stabilized by the creeping juniper.

stretches to the Atlantic Ocean; westward it is replaced in a few hundred miles by the great central grasslands, fig. 4. Mature stands of the temperate deciduous forest consist of various mixtures of a wide variety of hardwood trees including different kinds of oak and hickory, hard maple, beech, and linden. When areas of this mature forest are disturbed in such a way that trees are no longer present, other natural plant communities grow up in their place. In most Illinois areas from which forest has been cleared, the land plowed and cultivated, and then left idle, the bare earth is colonized first by some of the annual grasses and other herbs, later by perennial plants

Fig. 4.—Principal areas of terrestrial biological zones or biomes of North America.

such as the bluestem grasses and goldenrod, and still later by shrubs and small trees such as the red haws. After perhaps hundreds of years, the deciduous hardwood trees may colonize the small tree communities, and eventually the forest may be re-established.

This Dunesland area that is of such great interest to us represents a set of these colonizing communities. It is no ordinary set.

The first pioneer plant community growing on newly created sand bars or ridges consists primarily of two annual plants, the wild mustard called *Cakile* and the cocklebur called *Xanthium*. This community is soon followed by one dominated by perennial plants, including (alone or in combination) the sand-binding grass called *Calamovilfa*, fig. 5, the dune willow and the sand cherry, fig. 6, the creeping juniper, and the upright juniper. After the dead roots and leaves of these plants have added a slight amount of humus to the soil or stabilized the shifting sand, the bearberry and some of the bunch grasses can grow on it. The roots and foliage of these plants add more humus to the soil, after which still other plants can grow on the area. This plant succession often results in extensive prairies dominated by little bluestem and big bluestem grasses, intermixed with a wide variety of other herbs, especially species of blazing star or *Liatris*. In this succession, the later sets of plants crowd out and replace the preceding sets. The process of adding humus to sand is slow, and some botanists estimate that it may take up to several hundred years to progress from bare sand to a black oak forest and over a thousand years more for a black oak forest on sandy soil to change gradually into a deciduous forest typical of the temperate zone.

The wet swales of the Dunesland, as well as the ridges, have a succession of plant communities, but they have components different from those on the ridges. Although the soil of these swales appears to be mucky, it is chiefly sand. The first pioneer communities on the swales are dominated by sedges, rushes, or marsh grasses. Next come shrubs, such as dwarf birch and roundleaf dogwood. Many of the older swales containing more humus are dominated by several kinds of marsh-inhabiting willows and by cottonwood. Finally, as these areas fill up or become better drained, plants of the deciduous forest gradually invade them, and a black oak forest emerges, fig. 7.

Looking at this process backwards gives rise to some intriguing questions. If this type of natural change called succession leads always from sand, meadow, and swale communities to forest, some other kind of process must have been operating in order to produce the areas of bare sand that resulted in the present Dunesland strip of sand. Investigation proves these processes to be those that bring

Fig. 5.—Sandy shore of Lake Michigan at Illinois Beach State Park, showing a bank of the sand-binding grass, *Calamovilfa*, on the right.

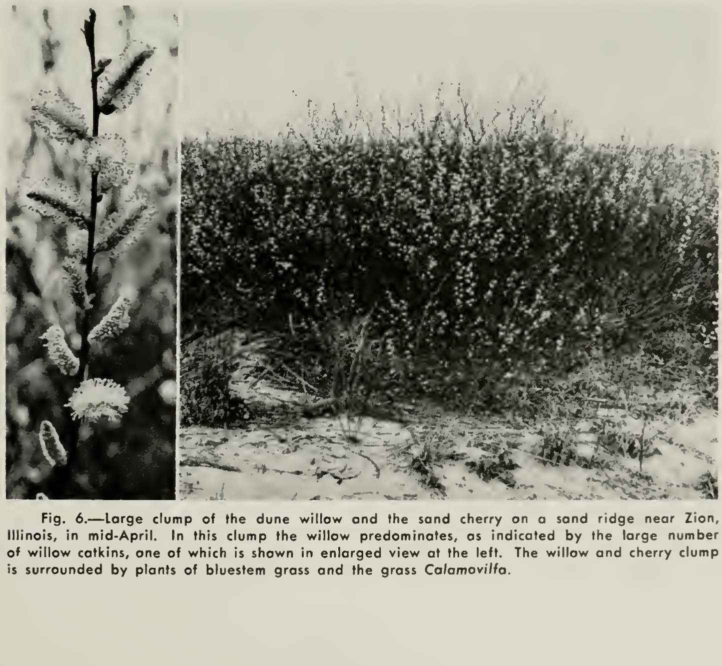


Fig. 6.—Large clump of the dune willow and the sand cherry on a sand ridge near Zion, Illinois, in mid-April. In this clump the willow predominates, as indicated by the large number of willow catkins, one of which is shown in enlarged view at the left. The willow and cherry clump is surrounded by plants of bluestem grass and the grass *Calamovilfa*.

about change in the physical form of the surface of the earth, processes that extend over tens of thousands and millions of years. To understand how the Dunesland area came into existence, we must therefore pry into the history of earth changes for many millions of years. When we do this, we discover that not only has the earth been

Fig. 7.—Marshy swales in the hollows and oak forest along the ridges in the mature part of the Dunesland. One line of trees at the left and another in the center of the picture represent thin strips of black oak; trees in the extreme background are the deciduous forest on a higher and older lake shore.

different in the past from what it is now, but that the kinds of life also were different. The present Dunesland plants and animals and the landscape on which they occur are thus the products of a long history of earth and life changes.

LEARNING ABOUT THE PAST

Civilized man was not present at the beginning of Dunesland history and therefore could not collect field notes and write books about it. For this reason we have to rely on special methods and techniques to unravel the past of the Dunesland. The special methods consist of (1) deducing the phylogenetic or family relationships of different kinds of organisms and (2) accumulating and analyzing data concerning the distribution of these organisms in relation to time and geographic area.

Evidence for unraveling this past falls into two categories. First is fossil evidence, comprising the field of investigation called paleontology. If fossils are sufficiently well preserved that we can identify them at least to family or genus, fig. 8, we can deduce many ecological facts about the time or place in which the fossilized organisms lived —such as whether it was aquatic or terrestrial, humid or dry. All our evidence indicates that, within rather broad limits, like things have lived under about the same climatic conditions for the greater

Fig. 8.—An insect fossil from an iron nodule or concretion found at Mazon Creek, Illinois; hind wing of an ancestral mayfly, *Lithoneura mirifica* Carpenter. Actual length of wing about one-half inch. This fossil represents an insect that lived during the Pennsylvanian period, about 250 million years ago. (Photograph courtesy of Illinois State Museum.)

part of their history. If a species has become adapted to different climatic conditions, almost invariably morphological changes of some kind have accompanied or followed the ecological change.

The second great accumulation of evidence used in unraveling this past comes from investigating the relationships and present geographic distribution of existing forms of life. This evidence comprises part of the field known as biogeography. If plant or animal groups are studied on a world basis, the relationships and present distribution give us indubitable evidence of at least some past movements of floras and faunas. A plant and an insect offer two dramatic examples of these movements.

The plant is the eastern skunk cabbage. At present, this plant is known only from the temperate deciduous forest of eastern North America and the temperate deciduous forest of China. Because skunk cabbage seeds are not spread easily (unlike others, such as dandelion seeds, which may be carried long distances by wind), it does not seem possible that the species was spread adventitiously from one area to the other. Instead, conditions in the intervening areas must at some time have been different from what they are now, different in a way that would permit the skunk cabbage to disperse across the area between China and eastern North America. The simplest conditions permitting such a dispersal are as follows: (1) at some time in the past, temperate climatic conditions favoring the skunk cabbage occurred farther north than they do today, so that the skunk cabbage occurred north to the Bering Straits area in either Asia or North America; (2) the Bering Straits area itself was above water, also temperate, and afforded a land connection over which the skunk cabbage could disperse; and (3) since that time, temperate climates of the Bering Straits area have been displaced by colder climates, the temperate climates have moved southward to at least their present positions, and the skunk cabbage has moved with the climatic conditions favorable to it.

The insect example is a little aquatic caddisfly called *Wormaldia mohri* (Ross), which is known only from the Great Smoky Mountains of Tennessee and North Carolina. Its only close relatives are Asiatic, and its sister species is now known only in Japan. Because these caddisflies can fly only short distances, the only logical conclusion to be drawn is that the common ancestor of the American and Japanese species had a range extending from eastern Asia into eastern North America.

From fossil evidence and evidence of relationships and dispersal of living organisms, we have been able to piece together a reliable picture of many historical facets of the plant and animal life in many parts of the world. When this picture is outlined for Illinois, it becomes obvious that we know much about some periods and little about others.

THE CALENDAR OF LIFE

In a history, it is difficult to know what to consider as the beginning. The areas now occupied by the Dunesland probably came into existence soon after the earth solidified four or five billion years ago. The life of the Dunesland traces back to the origin of life itself, which is estimated to be at least two billion years ago. A fairly continuous and well-preserved fossil record is known for about the last 600 million years of the earth's history, although parts of this record are fragmentary.

At various times during the period chronicled by the fossil record, certain marked changes have been noticed in the physical features and the life of the earth. On the basis of these changes,

Cenozoic Era—Modern life		
Quaternary Period		
Pleistocene Epoch	1	Includes the Ice Age
Tertiary Period		
Pliocene Epoch	13	
Miocene Epoch	25	Dominance of flowering plants; diversification of mammals
Oligocene Epoch	36	
Eocene Epoch	58	
Paleocene Epoch	63	
Mesozoic Era—Medieval life		
Cretaceous Period	135	Dominance of cycads, tree ferns, and conifers; era of dinosaurs; origin of mammals
Jurassic Period	181	
Triassic Period	230	
Paleozoic Era—Ancient life		
Permian Period	280	Evolution of modern insect orders
Pennsylvanian Period	310	The Carboniferous; first great tropical forests
Mississippian Period	345	
Devonian Period	405	Beginnings of land animals
Silurian Period	425	Predominance of marine invertebrates; rise of land plants
Ordovician Period	500	
Cambrian Period	600	

Geologic timetable. Names in the left column designate the various time periods for which there are relatively satisfactory fossil records. Each number in the middle column refers to the number of millions of years ago that a particular time period began. Comments in the right column indicate some of the notable events that occurred during the last 600 million years.

geologists have divided these 600 million years into a series of eras, periods, and epochs, which are listed in the accompanying table and are the principal time periods referred to in this account.

LANDSCAPES OF THE PAST

During the first half of the Paleozoic Era, the central and eastern parts of North America were covered by shallow continental seas (called epeiric seas), fig. 9. Many of the animals living in these seas had shells of calcium carbonate, and some of the very simple plants, especially algae, contained calcium carbonate. When these organisms died, their calcareous parts accumulated on the bottom of the seas, became compacted and rocklike, and now form the limestone beds that are quarried at Thornton, Joliet, and many other localities in Illinois.

Much later, during the Pennsylvanian period, most of the area that is now Illinois and a large area to the south and east, fig. 9, were covered by a luxuriant forest. Preserved remains of this forest form most of the coalfields of the state. This forest, very different from our present one, consisted chiefly of tree ferns, scale trees, and rush trees. Tree ferns no longer occur in Illinois, but some kinds still persist in the tropical areas of the world. The scale trees are repre-

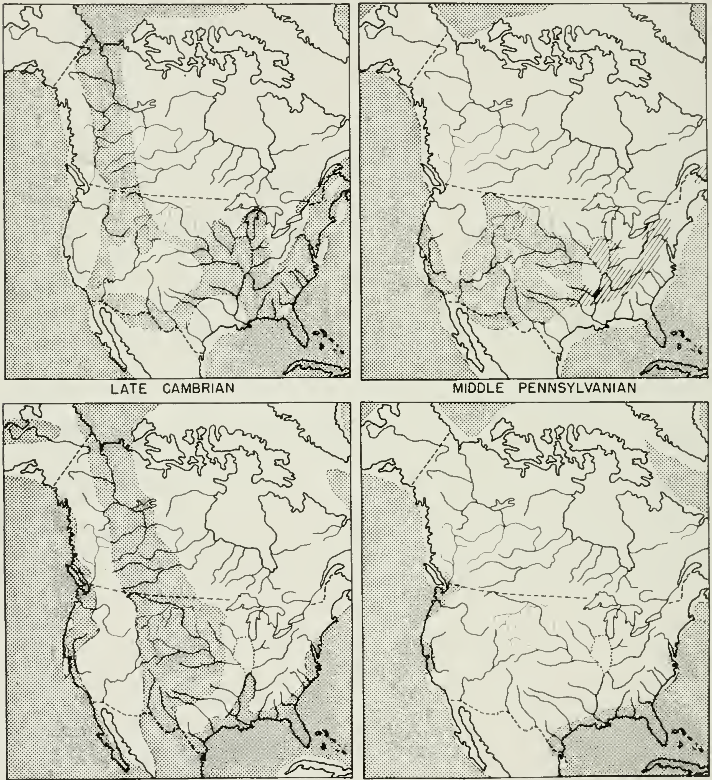


Fig. 9.—Maps of North America at various times in the past, showing the differences in the exposed land areas. In all four maps the stippled areas represent oceans; the white and striped parts represent land. Although these maps do not show all the known details, they present moderately accurate pictures of the geography of the various times. They do not by any means show all the changes that took place in the physiography. They are simply a set of samples showing the physiography at the following times: late Cambrian, about 500 million years ago; middle Pennsylvanian, about 290 million years ago (the striped area represents forests, many of which formed coal beds); late Cretaceous, about 70 million years ago; Eocene, about 50 million years ago. (Adapted from Dunbar 1960.)

sented only by the club mosses, not now known from the Dunesland but occurring in a few localities in Illinois. The rush trees are now represented only by the horsetails or scouring rushes, which belong to the genus *Equisetum*. Horsetails are widespread and abundant; they can be found along the railroad right-of-way through the Dunesland and are a diminutive reminder of ancient trees that once grew in the Pennsylvanian forest of the area. Most of the animals in this forest, including large amphibians, reptiles, and many kinds of insects, were different from those living now. Practically all of the

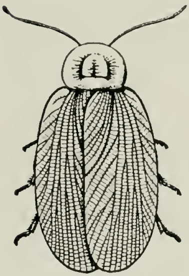
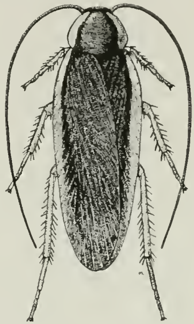


Fig. 10.—Cockroaches. Left, a fossil cockroach from Pennsylvanian times; right, a present-day cockroach, abundant today in Illinois woods.



insects known from these forests have long been extinct, but the native Illinois cockroaches of today are remarkably similar in external appearance to those found fossilized in the Pennsylvanian coal forests, fig. 10.

There is little direct evidence in Illinois concerning its terrestrial conditions from the Pennsylvanian period almost to the present. Fossil evidence from other areas, however, gives abundant evidence that during the Mesozoic Era many modern groups of living things evolved. Among the plants were the conifers and broadleaved or angiospermous trees. The Mesozoic is most famous for the dinosaurs that evolved, flourished, and became extinct during this era. Toward the latter part of the Mesozoic Era and certainly by the end of its last period, the Cretaceous, many groups well known to us today had already evolved, including primitive birds, primitive mammals, most of our groups of fishes, freshwater mussels, and a large assortment of modern insects.

Fossilized pollen from localities in Minnesota indicates that during the latter part of the Cretaceous Period the area that is now Illinois was probably covered by one of the first modern forests. The fossil pollen finds indicate that if modern man could have walked through one of those forests he might have thought himself in a forest of today. He would have found pines, witch hazel, oak, and sycamores very much like those of today. But mixed with them would have been a few strange plants. Analyses of various groups of insects indicate that he would have found many familiar insects, including termites, mosquitoes, caddisflies, bees, flies, beetles, and bugs. Whether these ancient Cretaceous forests were coniferous forests with a scattering of deciduous trees or the reverse we do not know.

There is no evidence of anything like the Great Lakes during the Cretaceous Period; at that time the present Lake Michigan area was probably part of a continuous forest. However, the area was not far from the ocean, which had inundated much of North America, as illustrated in fig. 9.

SETTING THE MODERN SCENE

The Cenozoic Era is divided into a relatively long period, called the Tertiary Period, and a short one, called the Quaternary, embracing chiefly the Ice Age and the time since then. Soon after the beginning of the Cenozoic, North America lost most of its continental seas, fig. 9. The general outlines of the continent have changed little since then. In an early, long epoch, the Eocene, the North American climates appear to have been warmer than those of today; in later epochs the climate of the northern and central portions became more temperate.

By the Oligocene Epoch, possibly 35 million years ago, at least the northern portion of Illinois was probably covered by a temperate deciduous forest that looked almost like that of the present. Fossil evidence indicates that this forest contained species of oak, hickory, linden, beech, sycamore, and many other trees that were remarkably similar to those living today. The temperate deciduous forests of that time differed in one important respect from those of today. They stretched in an unbroken band from the Atlantic coast of North America, across the continent, through Alaska, and across Eurasia to westernmost Europe. Thus, forest trees that may have originated in various areas of the northern land masses had an opportunity to disperse among the continents. The mixture of trees thus formed undoubtedly resulted in a temperate deciduous forest of greater complexity than had existed in any one place before.

At some time after this, chiefly in the Miocene Epoch, probably 20 million years ago, the crust of the earth underwent a period of activity that eventually resulted in a number of striking upheavals.

In Europe many new mountains arose or older ones were elevated to greater heights; in Asia the interior was elevated and the highest part of the Himalaya Mountains resulted from these tremendous movements; and in North America the entire central area was elevated and some of the mountain ranges were formed. These upheavals produced arid conditions and rain shadows that broke the previously continuous temperate deciduous forest into isolated areas. This temperate deciduous forest can exist only with a fairly high minimum of rainfall; hence, wherever the rain supply was reduced the hardwood trees disappeared and other kinds of vegetation took their place. The pattern of rainfall changes that accompanied the crustal unrest of the later Cenozoic Era restricted the deciduous forest to three large areas, one in western Europe, one in China, and one in eastern North America, plus small isolated remnants in central Eurasia and western North America. To the best of our knowledge, these areas of typical temperate deciduous forest have never been rejoined since they became separated 15 to 20 million years ago. Since the break-up of this world-wide temperate deciduous forest, each isolated segment has evolved in its own way.

A part of the evidence for the existence of this temperate deciduous forest, world-wide in extent, followed by a break-up into three large areas, is that each of many introduced European and Asiatic trees used for ornamentals is like, but not exactly like, one of our native American trees. The European and Siberian elms, for example, have close relatives here, as do also the European beech, sycamore or plane tree, hazel, linden, alder, maple, and others. The domestic fruit trees, such as apple, cherry, and walnut, all Old World in origin, are remarkably similar to many native North American trees. Each pair of such closely related species is evidence that the parental form of both species occurred across the whole band of the former world-wide forest; after the forest was broken up, the North American segment of each parental species evolved into one species and the European or Asiatic segment evolved into another. In some instances, the separated populations of a plant species did not change at all, as is true of the eastern skunk cabbage, whose populations in eastern North America are still exactly like those that survived in Asia. In other instances, the population in one place changed very little, but populations in other places changed a great deal. An example is the present-day eastern sycamore of North America, which is remarkably like fossils of the mid-Cenozoic transcontinental sycamore; some of the Eurasian populations of this widespread ancestor have since evolved into different species.

Varied elements of the eastern North American segment of the temperate deciduous forest have evolved into a great variety of different species. Examples of these are the trilliums and violets. The best-known examples of species multiplication are found in the insects. In genus after genus of these little creatures, species isolated long ago in the eastern deciduous forest have evolved into groups of 15 to 20 species, and in some instances into flocks of 300 to 400 species.

What may have been a relatively sparse assemblage of species 20 million years ago has evolved into a large and blossoming fauna and flora.

SHIFTING CLIMATES

There is good evidence that, as the Cenozoic Era proceeded, the climates became progressively cooler. Under these conditions the temperate deciduous forest gradually supplanted the more tropical forests in the area south of Illinois, and the northern coniferous forests may have extended farther south than they do now. Two or three million years ago the Dunesland area may have been covered by this coniferous forest. The new techniques for analyzing fossil pollen may some day give us evidence about this.

The most spectacular changes in living conditions here in Illinois were produced by the glaciers of the Pleistocene Epoch or Ice Age. In the Dunesland, evidence for these great glaciers is present in the form of pebbles scattered along the beach and mixed with the sand on the ridges. Very few of these pebbles are exactly alike. They are not composed of the limestone and sandstone which occur at the surface in Illinois; they are hard, granite-like (or granitic) pebbles. There are no Illinois outcrops from which these pebbles could have come. The question is, how did they get here? The most obvious answer is that they were carried to their present positions from the neighboring outcrops of granitic rocks, the closest of which are in central and northern Wisconsin and Michigan. More of these granitic outcrops occur even farther to the north and east. When the glaciers of the Ice Age overrode the northern countryside, they loosened, picked up, carried along with them, and broke into fragments these granitic rocks. When the glaciers melted away, they left the granitic fragments from which the Dunesland pebbles were formed.

The Ice Age glaciers must have been among the most awesome sights we can imagine. Starting from centers in Canada, immense glaciers formed and moved by their own weight over tremendous areas of North America, fig. 11. Four major ice sheets descended over portions of the continent, each one eventually melting away. The third of the four major ice sheets extended over Illinois as far south as Carbondale. During the fourth major ice advance, called the Wisconsinan, the tremendous Lake Michigan glacial lobe spread to central Illinois, after which its southern margin retreated and readvanced, retreated and readvanced, time after time until finally it melted away. The last ice thrust of this Lake Michigan lobe to enter Illinois occurred about 13 thousand years ago. A subsequent thrust 11 thousand years ago covered much of southeastern Wisconsin but did not quite reach Illinois.

Evidence from many sources indicates that the four major glacial periods were associated with four climatic periods. There is an indi-

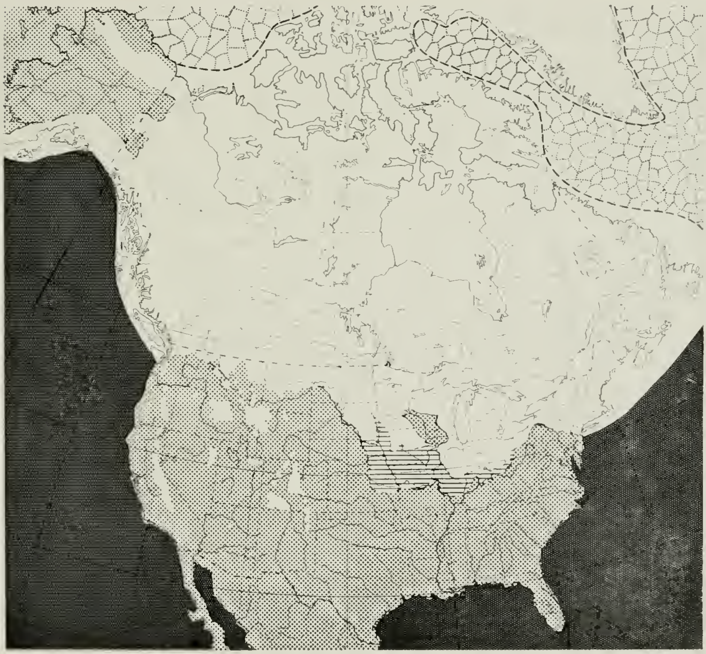


Fig. 11.—General outline of glacial events during the Pleistocene in North America. White, extent of the last major glacial period, the Wisconsinan; northern rhombic area, shelf ice; horizontal lines, southern extent of previous glaciations in the Midwest; stipple, areas thought never to have been glaciated.

cation that at the height of each glacial period the climate was cooler than it is today and that during the times when the glaciers were not present the climate was warmer than it is today. Great divergence of opinion exists as to how much cooler or how much warmer these climates were. Special differences of opinion exist as to how far south of the glaciers their cooling effects extended.

FORMATION OF THE DUNESLAND

There is no evidence that either Lake Michigan or the other four of the Great Lakes existed before the Ice Age. When ice moves, it flows somewhat like water, especially in that it moves into and along low places in the terrain. The thrusts of the great ice lobes presumably gouged out the basins of the Great Lakes. It can be inferred that some of these lake basins coincided with the valleys of streams along which the glaciers moved in their southward advance. After the southern parts of the glaciers melted away, these depressions filled with water and formed the Great Lakes. In the present basin of Lake Michigan and extending farther south was a much more extensive lake that geologists call Lake Chicago. Eventually, the level of Lake Chicago went down, leaving certain peculiarities of soil and terrain as evidence of its former presence. The flat, sandy area centering around Evergreen Park is part of the old basin of Lake Chicago, as are the series of sandy beach dunes in the neighborhood of Homewood and South Chicago.

Neither Lake Michigan nor its shores are static features; both have movement and change. Storm-driven waves eat away the sand and gravel along part of the shore; other waves may transport the sand and gravel and deposit them along the shoreline in other places. The Dunesland is one of these latter places.

The sand and gravel deposits along the lake shore form a series of beaches and bars caused primarily by changes in lake level combined with deposits of storm-driven sand. Formation of the high sand dunes along the southeastern shore of the lake, for example those at the Indiana Dunes State Park near Tremont, is due almost entirely to wind, which blows the sand over the beach and deposits it in ever-increasing windrows along the shore. The prevailing winds that blow across Lake Michigan are from the northwest, west, and southwest; hence, the dunes occur principally on the southeastern, eastern, and northeastern shores of the lake. Only low, narrow ridges and small dunes have been formed on the western shore, as at Illinois Beach State Park, fig. 3. The peculiar topography of the Dunesland thus was due first to the formation of Lake Michigan, then to the reworking of the shoreline by the waters of the lake and the wind, and finally to intermittent changes in lake levels.

RECOLONIZATION AFTER THE GLACIERS

What of the life of the Dunesland area during the period of the Ice Age? The ice sheets that shoved or carried boulders and pebbles from the north also overrode the life of the land. The area that is now the Dunesland was once covered by ice a mile thick, a mass eight and one-half times as high as Chicago's Board of Trade Building, including the statue on its top. All life beneath this sheet of ice was obliterated. Everything now living on the areas once covered by the ice has spread into them from other areas.

When we consider that practically the northern half of the North American continent was covered with a blanket of ice extending from coast to coast, the question naturally arises: What happened to the Arctic and Boreal forms of life that today are restricted to areas far north of Illinois, fig. 3? Fossil remains, especially pollen from peat bogs and other deposits, indicate that the northern, cold-adapted kinds of life moved south ahead of the ice front. The ice front moved probably only a few miles a year, and most species, with ranges several hundred miles across, could move with the changing climate ahead of the glaciers.

It seems possible that when the glaciers were at their maximum southward extension truly Arctic conditions prevailed for only a short distance in front of them, perhaps only a few miles in front of the ice itself. It is certain that a large proportion of the present northern species were able to persist somewhere if not everywhere along this band of cold conditions. Other Arctic and subarctic species persisted in the large unglaciated portion of Alaska. As the edges of the ice sheets melted back, the various aggregations of living things spread northward from the southern part of the continent and eastward from Alaska.

Any Dunesland sand beaches formed soon after the front margin of the last glacier retreated northward would probably have been populated by some of the Arctic poppies and the dwarf willows that today characterize the tundra far to the north. At a later time, when the surrounding countryside was probably predominantly spruce, fir, and pine forest, any new sand ridges and beaches in the Dunesland area would have been colonized by plants and animals typical of the successional stages of the northern coniferous forest.

Many small colonies of animals, especially insects, indicate that at some time during the last Ice Age climates that we might describe as "north woods" prevailed as far south as southern Illinois. Evidence for these climates comes mainly from small southern populations of primarily northern species of insects and other animals that, because of restricted flight or sedentary habits, cannot disperse across considerable distances having conditions unsuitable for the existence of the organisms. In spots such as cool ravines or spring-fed rocky recesses protected from the extremes of summer heat prevailing in

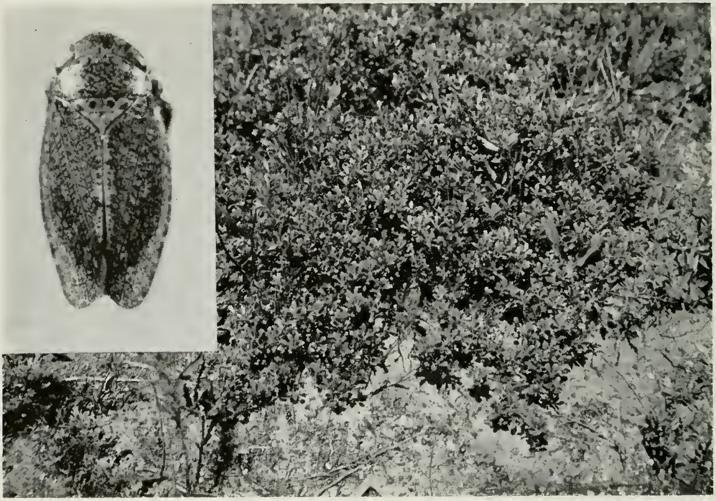


Fig. 12.—Clump of bearberry on sand ridge near Zion, Illinois. The insect at the left is the bearberry leafhopper, *Texananus cumulatus* (actual length about three-eighths inch).

the surrounding terrain, colonies of these northern species have persisted far south of their present continuous range to the north or northeast. A large number of these species are stoneflies and caddisflies whose young live in the spring-fed streams occurring in these habitats. A northern caddisfly and a northeastern stonefly of this type occur at Lusk Creek, near Eddyville, Pope County, in extreme southern Illinois. In the small stream at Rocky Branch, Clark County, in east-central Illinois, a peculiar relict stonefly persists. In the cold, spring-fed brooks in the Elgin Botanical Garden, in the city of Elgin, two kinds of stoneflies and four kinds of caddisflies persist 300 to 500 miles south or southwest of the main range of each species. These typically northern kinds of stoneflies and caddisflies are quite different from the other 50 kinds of stoneflies and nearly 200 kinds of caddisflies that abound in most Illinois streams and lakes. These isolated occurrences of northern species are bits of evidence that furnish clues in detecting movements of the life that once occurred in Illinois, but that now, except for these relict populations, has moved to the north.

As the ice dissipated and the climate became warmer, the coniferous forest and its associated plants and animals spread to the north or became restricted to the higher elevations in the eastern and western mountains of North America.

Temperate deciduous forest also spread northward. At the present time, there is a broad area of overlap nearly 500 miles wide in which the more southerly of the northern coniferous forest trees are intermingled with the northern extensions of some of the temperate deciduous forest trees. The main band of this intergrading area (technically called an ecotone) lies only a hundred miles north of northeastern Illinois. Evidence from several sources indicates that the temperate deciduous forest extended a few hundred miles farther north during a warm period several thousand years ago. Since then the Illinois climate became cooler, with the result that the temperate decidous forest again shifted southward and the coniferous forest moved to within a short distance of Illinois.

These ecotonal or intermingling areas do not form rigid boundaries. The situation is simply this: In the northern part of the ecotone, between the northern coniferous and the temperate deciduous forests, most of the life is typical of the coniferous forest, but with a few outposts of temperate deciduous elements occurring in local areas that favor them. Toward the southern edge of this intermediate area the opposite condition prevails—most of the life is typical of the temperate deciduous forest, but with a few colonies of species chiefly associated with the coniferous forest. Some species of plants and animals that are primarily northern in distribution occur even south of this ecotone, especially species that live in the successional stages which become established on bare areas. Among the plants, excellent examples of northern species whose ranges just barely include Illinois are sand cherry, dune willow, bearberry, dwarf birch, and the two gentians occurring in the dunes.

The birds contribute several members to the complement of northern species occurring in the Dunesland. In Illinois the piping plover nests only in these lakeshore areas; it nests chiefly northeast and northward to the Arctic. During its migrations this plover can be seen in all parts of Illinois. Not so some of the Arctic birds that occur in Illinois only in the Dunesland region. Several Arctic sandpipers, for example the purple sandpiper, and some of the northern terns nest far north of Illinois but spend the winter in the Zion region.

Many insect species that are chiefly northern still occur in the northeastern corner of Illinois. Perhaps the best known of these are the many species of sawflies, plant bugs, and moths that feed only on native tamarack and have been collected in Illinois only in the bogs at Volo and other bog areas in Lake County. Insect denizens of the Dunesland include many other examples of northern species not found in the bogs. These include a leafhopper and an aphid that live only on bearberry, figs. 12 and 13, another leafhopper and another aphid

Fig. 13.—Bearberry twigs infested with the bearberry aphid, *Tamalia coweni*. The aphids feed on the terminal leaves; their feeding causes the leaves to curl and swell and to form bean-shaped galls. Several galls are shown at the ends of twigs (one gall indicated by arrow). When fully developed, the galls are bright red and contrast sharply with the bright green of the normal bearberry leaves.

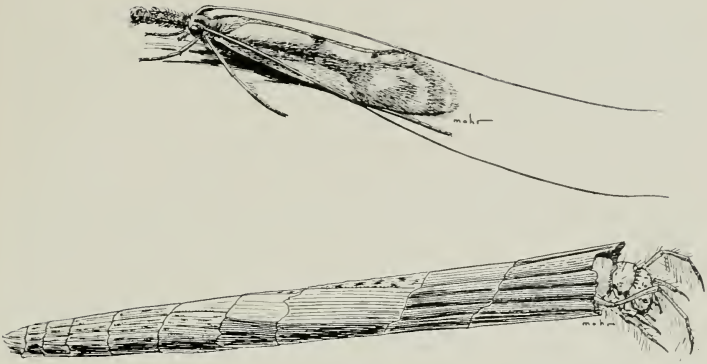


Fig. 14.—The caddisfly *Trianodes tarda* Milne, one of the species living in the Dead River. Above, adult insect. Below, tapering case made of bits of leaves; the front portion of the larva is shown protruding from the open end of the case. The larva drags its case with it when it crawls over submerged vegetation.

that live only on meadowsweet, a species of sawfly that lives only on horsetail, and a peculiar assemblage of northern caddisflies occurring in the Dead River. These caddisflies, fig. 14, are aquatic insects whose larvae make either portable cases or live in netlike retreats. When full grown, the larvae transform into pupae that live either in the

Fig. 15.—Dead River, Illinois Beach State Park. In this stretch of the river, case-making caddisfly larvae abound.

larval cases or in specially constructed cocoons in the water. When mature, the pupae escape, swim to the surface, and crawl up on plant stems; the adults emerge from the pupal skins. These insects abound in the waters of the Dead River, fig. 15; three species of them have been found in no other area in Illinois.

SPREAD OF TEMPERATE DECIDUOUS LIFE

Although the Dunesland life contains many northern species, the great bulk of it comprises species typical of the temperate deciduous forests. These species include several kinds of willows, grasses, sedges, the black oak, and many other plants. To this list belong also a large number of spiders, insects, and other animals, fig. 16. All these forms of life spread into the Dunesland from areas to the south; they probably arrived by a variety of routes and at different times. Some of the species may have spread into the Dunesland from

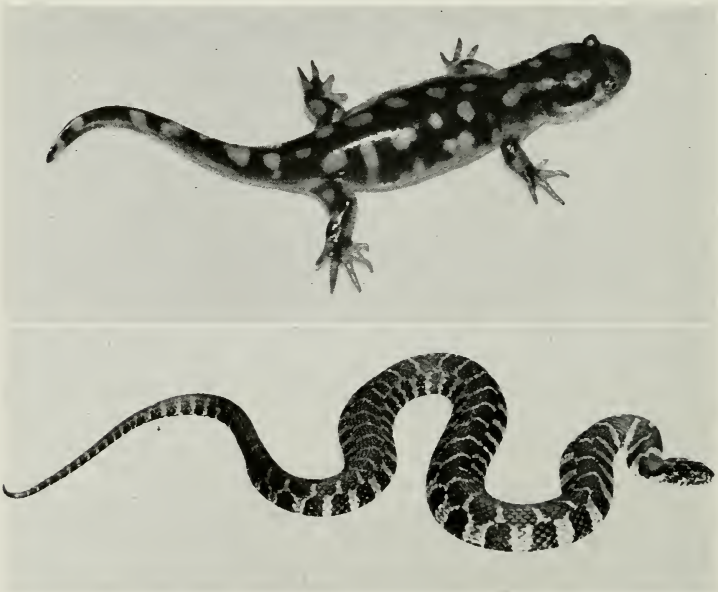


Fig. 16.—Two animals typical of the temperate deciduous forest biome; both occur in the Dunesland. Above, the eastern tiger salamander, *Ambystoma tigrinum tigrinum*. Below, the northern water snake, *Natrix sipedon sipedon*.

the southwest, others from the southeast. Some of the typical prairie forms, such as the leafhoppers on the prairie grasses, may have spread fairly directly from the south. There is some evidence that the many forms of life that inhabit the swales and the Dead River may also have arrived directly from the south. These could have spread northward via the ponds and lagoons left in central Illinois after retreat of the glaciers. Finding bits of evidence that will help to unravel these northward patterns of dispersal is a laborious but a highly intriguing occupation. A great deal remains to be done before we will have more than a general understanding of these patterns of northward spread following the glaciers.

EXTINCT LIFE

During this long history of Illinois life, many species of plants and animals were unable to survive and became extinct. It is thought that extinction of species may have been especially pronounced during the Ice Age, when the ranges of some animals changed geographically and in size. The best evidence we have for this statement concerns large mammals. Some of the extinct large animals that once ranged over Illinois were the giant ground sloth, the giant beaver (as large as a bear), the American mastodon, and two species of mammoths. Other extinct large mammals, which may have been rarer and less widely distributed in the Illinois area, were a musk-ox, a peccary, and the giant or royal bison. Too few remains of these animals have been found, however, to allow us to know exactly where these animals belonged in the scheme of natural communities then occurring in the area.

It is likely that many other kinds of life also became extinct during this period. This is suggested by our knowledge of certain insects. A small stonefly is now known only from the streams in Rocky Branch and one neighboring ravine and from a single stream near Ottawa, Ontario, Canada. Two distinctive caddisflies are now known only from one small spring in southern Illinois. It seems plausible to assume that these and a goodly number of other kinds of animals may have become as rare as these before man altered the environment. Following the same reasoning further, it is likely that still other species of which we have no record diminished in numbers and ultimately became extinct.

Although a large number of species may have become extinct, truly remarkable numbers of living things have persisted to the present. Illinois has probably 25,000 different kinds of plants and animals—about 2,500 species of plants, about 20,000 species of insects, and numerous species of other animals including protozoans, worms, fishes, birds, reptiles, and mammals.

THE DUNESLAND AS A HERITAGE

After the glaciers came man. Accounts of the first European travelers who explored North America indicate that pre-European man did not alter appreciably the landscape and vegetation of Illinois. The advent of European man, however, signaled a tremendous change. Native vegetation was cleared or plowed under and its place taken by farms, railroads, highways, cities, and factories. This conversion has progressed to the point that in Illinois we now have remarkably few relatively undisturbed areas that portray accurately what the native life actually was at the time European man arrived. Such pristine spots as still remain constitute a unique natural heritage for the people of Illinois. The Dunesland is certainly one of those unique remnants in which we have the opportunity to see the effects of great geological events on the distribution and perseverance of native plants and animals.

SCIENTIFIC EQUIVALENTS OF COMMON NAMES CITED

Animals

Aphid, bearberry	*Tamalia coweni* (Cockerell)
Beaver, giant	*Castoroides ohioensis* Foster
Bison, giant or royal	*Bison* species
Ground sloth, giant	*Megalonyx jeffersoni* Desmarest
Leafhopper, bearberry	*Texanus cumulatus* (Ball)
Mammoth	*Mammuthus* species
Mastodon, American	*Mammut americanus* (Kerr)
Musk-ox	*Symbos cavifrons* (Leidy)
Peccary	*Platygonus compressus* Le Conte
Plover, piping	*Charadrius melodus* Ord
Sandpiper, purple	*Erolia maritima* (Brünnich)
Tiger, salamander, eastern	*Ambystoma tigrinum tigrinum* (Green)
Water snake, northern	*Natrix sipedon sipedon* (Linnaeus)

Plants

Alder	*Alnus* species
Apple	*Malus* species
Bearberry	*Arctostaphylos uva-ursi* (Linnaeus) Sprengel
Beech	*Fagus grandifolia* Ehrhart
Birch, dwarf	*Betula pumila* Linnaeus
Bluestem	*Andropogon* species
Cherry	*Prunus* species
Cherry, sand	*Prunus pumila* Linnaeus
Cottonwood	*Populus* species
Dogwood, roundleaf	*Cornus rugosa* Lamarck
Fir	*Abies* species
Gentian	*Gentiana* species
Goldenrod	*Solidago* species
Hazel	*Corylus* species
Haw, red	*Crataegus* species
Hickory	*Carya* species
Juniper, creeping	*Juniperus horizontalis* Moench
Juniper, upright	*Juniperus communis* Linnaeus
Linden	*Tilia* species
Maple, hard	*Acer saccharum* Marshall
Meadowsweet	*Spiraea* species
Oak	*Quercus* species
Oak, black	*Quercus velutina* Lamarck
Pine	*Pinus* species
Poppy, Arctic	*Papaver alpinum* Linnaeus
Rush, scouring	*Equisetum* species
Skunk cabbage, eastern	*Symplocarpus foetidus* (Linnaeus) Nuttall
Spruce	*Picea* species
Sycamore	*Platanus* species
Tamarack	*Larix laricina* (Du Roi) K. Koch
Walnut	*Juglans* species
Willow, dune	*Salix adenophylla* Hooker
Witch hazel	*Hamamelis* species

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