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I hereby recommend that the thesis prepared under my supervision by Dorothy Inez Parker
entitled Affinities of the Flora of Indiana

be accepted as fulfilling this part of the requirements for the degree of Doctor of Philosophy

Approved by:

J. Lucy Braun
J. H. Harkness

AFFINITIES OF THE FLORA OF INDIANA

A dissertation submitted to the
Graduate School
of the University of Cincinnati

in partial fulfillment of the
requirements for the degree of

Doctor of Philosophy

1936

by

Dorothy Inez Parker
"

B.S. Butler University 1932

A.M. University of Cincinnati 1934

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AFFINITIES OF THE FLORA OF INDIANA

by

Dorothy Parker

Contents

I. Introduction.....	1
II. Sequence of Events.....	4
III. Present Composition of the Flora.....	16
A. Intraaneous species.....	19
B. Extraneous species and species at or near the limits of their ranges.....	21
1. Appalachian element.....	21
2. Southern element.....	28
3. Northern element.....	33
4. Prairie element.....	40
5. Coastal Plain element.....	44
IV. Summary.....	49
V. Literature Cited.....	50

AFFINITIES OF THE FLORA OF INDIANA

BY

Dorothy Parker

I. Introduction

The present distribution of plants in general, depends not alone upon modern environment but also upon past conditions. The present range of any species is the resultant of its range in the past and its opportunities for subsequent migration as determined by later environmental conditions.

The disjunct occurrence of a single species having a low migration capacity indicates that it formerly covered a more extensive area and now may be considered as a relic; on the other hand disjunct occurrences of a single mobile species sheds little light on its past history. Isolated colonies of several species are important in interpreting past conditions. It is beyond the limits of chance distribution to presume that a dozen or more species, normally growing together in a particular vegetation region should also be found together in a remote section beyond the normal limits of dispersal of any one of them.

A combination of evidence from successional tendencies and relic colonies indicates both the direction and the extent of plant migrations. The full extent may not be

indicated, because the isolated colonies may have disappeared completely from the more remote parts of their original range. In such cases isolated stations of single species give some idea of their original range. The further back in time plant migrations are traced, the fewer relic colonies may be expected and the more difficult it is to reconstruct migrations.

There are approximately 1500 species of native vascular plants growing in Indiana at the present time. About sixty percent of the present flora is widespread not only in Indiana but also in a large part of eastern United States. These species are not of primary importance in this study. The remaining forty percent of the flora is of greater interest because it is made up of plants that are now isolated from the mass distribution of their species or are at the limits of their ranges. The disjunct occurrence of these species indicates that they are either withdrawing from or advancing into our area.

The present distribution of each species that has been reported from Indiana was obtained from the Butler University file of maps of vascular plants which contains all of the records of distribution that have been published concerning the Indiana flora and from Mr. C.C. Deam's "Trees of Indiana" (31), "Shrubs of Indiana" (32), "Grasses of Indiana" (29) and from some of Mr. Deam's

unpublished records. The community relationships were determined from field work in 1934 and 1935, and from information obtained from several publications of Indiana ecological investigations.

Only well recognized species have been used in order to eliminate false records and confusing data. The species selected are by no means all of the examples that exist in this state but the numbers were thought to be sufficient to make the illustrations clear.

The writer wishes to express her thanks to Dr. Ray C. Friesner for the use of the Butler university file of distribution maps, and Dr. C.C. Deam for his kindness in furnishing his unpublished data of the distribution of many herbaceous plants. She is indebted to Dr. E. Lucy Braun for suggestions and aid during the course of this work.

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II. Sequence of Events

Previous to the Pleistocene glaciation, during the Tertiary time, a rich deciduous forest including beech, tulip tree, maple, walnut, magnolia, sweet gum, sycamore, oaks and other plants, extended far north of its present boundary. This mixed deciduous forest was more widely distributed then than it is today. During this period there were oscillations in the level of the land that resulted in erosion and base leveling. These actions of uplift and depression of the surface of the earth had a profound effect upon the Tertiary flora. Doubtless some species were exterminated in these readjustments: others found on the peneplain or in the more diversified southern Appalachian region suitable habitats where they have been able to persist to the present time or from which they have spread into other favorable territory.

During late Tertiary times climatic changes caused a retreat from the north of the warm climate species resulting in a separation into more or less well defined zones. Eventually the tundra formation became the dominant vegetation in the far north. To the south of this belt was an evergreen forest while the deciduous forest took up a more southerly position.

Then the ice age began. There were at least four well defined glacial advances in America; Nebraskan,

Kansan, Illinoian and Wisconsin. Illinoian and Wisconsin drifts form a mantle over seven-eighths of Indiana. Thus far evidence of other glaciation is lacking.

Slowly the ice accumulated and the glacier began to move southward into our territory. This movement was so slow that the temperate species were able to migrate, by propagules, to points far enough removed from the edge of the glacier to be beyond the direct influence of the ice. There probably resulted a zonal arrangement of tundra at or on the margin of the ice, a band of northern coniferous forest beyond the tundra, and the intraneous flora parallel to the coniferous vegetation and farthest removed from the ice. The flora of the unglaciated region was but little disturbed by the ice mass except at the margin where the narrow zones of northern vegetation bordered the ice.

At its maximum extent the Illinoian ice occupied all but a narrow wedge of the southern part of the state (Fig.1). However, every county but Crawford County had major streams by which the glacial waters were carried to the Ohio River, which resulted in valley trains of gravel, sand, silt, and clay from the glacier. Although this area was unglaciated, only Crawford County (designated by C in Fig.1) was therefore unaffected by glaciation. The unglaciated wedge was the only place available for plant occupancy at this time. Here was assembled the intraneous flora of the region plus

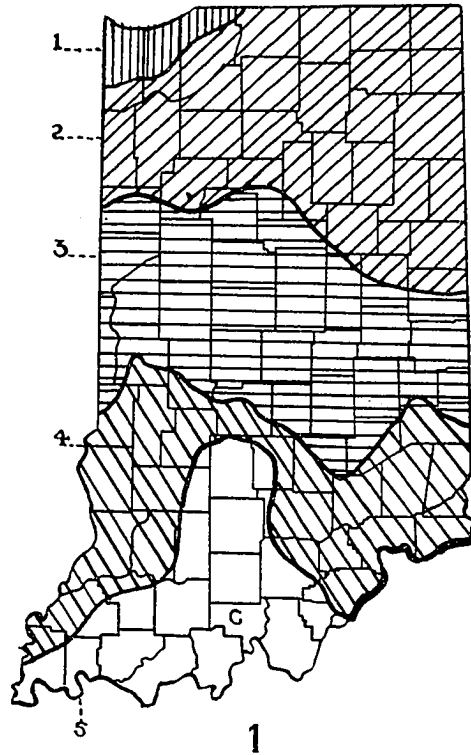
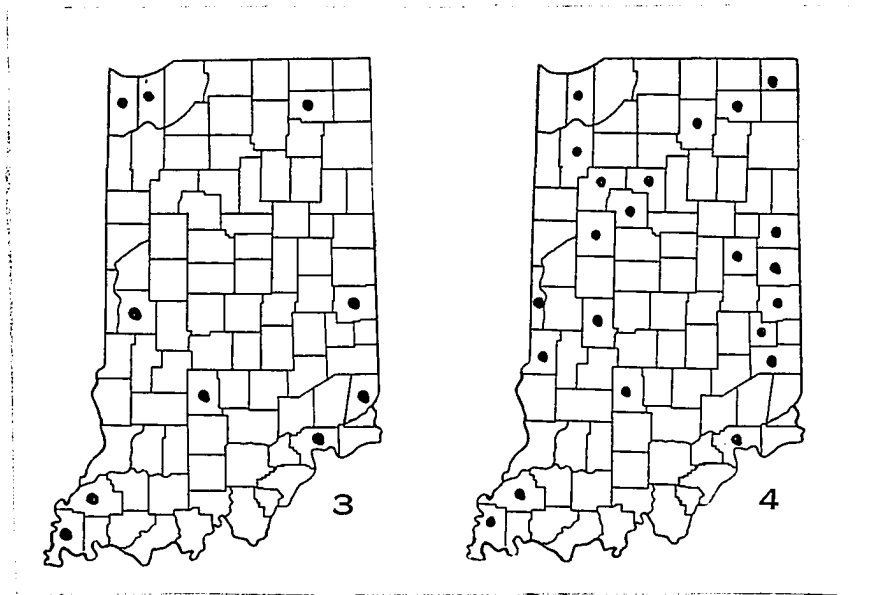


Fig. 1. Glacial Map of Indiana. (1) Lacustrine Plains.
(2) Late Wisconsin Drift. (3) Early Wisconsin Drift.
(4) Illinoian Drift. (5) Unglaciaded Area.

the northern plants that had been forced to migrate southward.

As the glacier retreated, the Illinoian drift was left, onto which plants migrated. The Illinoian drift sections that are now exposed in Indiana are almost separated by the unglaciated area (Fig.1). The drift varies in depth over this surface from practically nothing where it has been removed by subsequent erosion, to a depth of over one hundred feet. Much of this drift-covered portion is exceptionally flat, still exhibiting the characteristics of a featureless ground moraine. Plant migrations closely followed the melting of the ice. The tundra vegetation was able to keep pace with the retreating ice border. This was followed more slowly by plants which are now found in the northern coniferous forest. A few of these plants remain at the borders of Illinoian glaciation in Indiana (Fig.3 and 4). Eventually species of the southern deciduous forest doubtless invaded the territory. In addition to the northward migration of plants that had been restricted to the south of the ice, plants from the east and west were able to migrate into suitable habitats in the area affected by glaciation.



Figs. 3 and 4. Maps showing the distribution of northern relic species whose southern stations are along the margin of Illinoian glaciation : Fig.3 Viola cucullata; Fig. 4. Lilium canadense.

The advent of the Wisconsin glacier later caused another southward migration of plants. The southward extension of this glacier did not reach as far south in Indiana as did the Illinoian glacier. The intraneous flora and northern plants were crowded into the area south of the glacier as in the preceding glaciation. The Wisconsin glaciation consisted of a complex series of advances and recessions of different lobes of ice. There are several systems of moraines marking either halts of readvances of the ice border, with nearly plane-surfaced tracts between the moraines. The Wisconsin period has been divided into Early Wisconsin and Late

Wisconsin time. The portion of the state covered by Wisconsin drift contains two regional units, the Tipton Till Plain and the northern Moraine and Lake Region (Fig.2)¹

¹

The physiographic classification is that of Malott ('22) which follows that of Fenneman ('17) with some modification.

The Tipton Till Plain, including most of Early Wisconsin glaciated area and part of Late Wisconsin, is the largest physiographic division in the state, occupying nearly one-third of the entire area of the state. It is characteristically a slightly modified ground moraine plain that is very flat over wide areas. The drainage lines over extensive areas of the plain are mere channels without noticeable valley formation. The tributary streams on their approach to the great valleys developed by the Pleistocene waters are entrenched somewhat in accordance with the main valley. Such entrenchment is best developed by the streams which enter the Wabash valley. In Fountain, Montgomery and Parke counties considerable relief exists where the main streams have dissected the plain. Sugar Creek in southwestern Montgomery and northeastern Parke counties is deeply entrenched in and below the massive resistant sandstone, and sheer cliffs of one hundred feet or more are present.

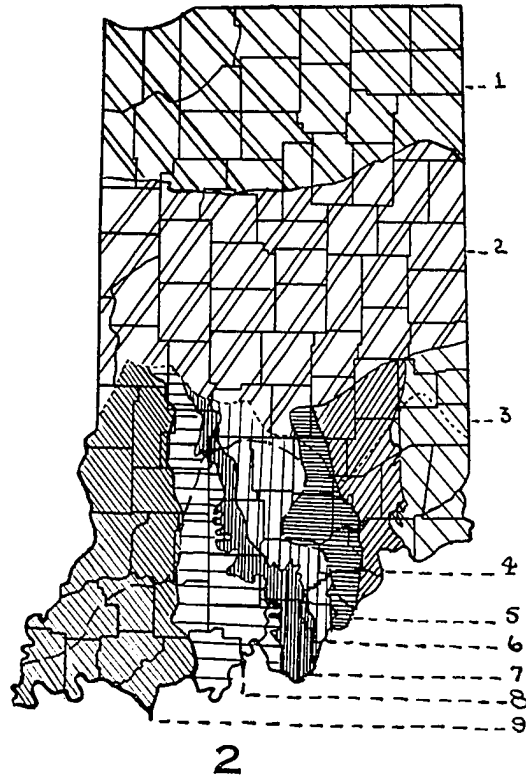


Fig. 2. Physiographic Map of Indiana showing Regional Units based chiefly on Topographic Conditions. After Malott('22).
 (1) Northern Moraine, (2) Tipton Till Plain,
 (3) Dearborn Upland, (4) Muscatatuck
 Regional Slope, (5) Scottsburg Lowland,
 (6) Norman Upland, (7) Mitchell Plain,
 (8) Crawford Upland, (9) Wabash Lowland.

The region north of the Tipton Till plain is the northern Moraine and Lake region which is a compound of massive, rugged moraines occupied by lakes and broad lacustrine plains.

The melting glacier left vast deposits of drift containing numerous lakes and wet areas, sand plains and many other diverse habitats favorable to occupation by many different ecological groups of plants. Some of the northern plants that had been forced southward left some individuals in isolated areas in suitable habitats in the Wisconsin glacial drift as the plants moved northward again.

Since glaciation, the climate has not always been the same as now. Evidence for changes in the climate have been demonstrated by Sears ('32, '35) in the study of bog pollen. By correlating studies of pollen deposits from southeastern Canada, Virginia, Iowa and Ohio, Sears has divided the post-glacial climate into the following periods: the oldest record is of a humid period followed by a period of undetermined climate, which was followed by dry, humid, dry and finally a humid period again. The term xerothermic period has been used to designate a period of mild and dry climate. The occurrence of a xerothermic period would have destroyed the balance that existed between forest and prairie vegetation with a consequent advance of the prairie vegetation eastward and a withdrawal of the mesophytic species from

this area. This prairie extension persisted as long as conditions remained suitable and acted as a barrier to the migration of mesophytic species. Hence, the northward migration of mesophytic species was prevented. At the same time the northward migration of mesophytic species could continue in the east. Thus some mesophytic species were able to move around the prairie lobe and entered northern Indiana from the east. There are examples to demonstrate that such migrations actually occurred (to be discussed later). With a return of humid conditions the mesophytic flora invaded the territory previously occupied by more xerophytic species and the xerophytic species were able to remain only as relics in isolated stations in habitats least favorable to the invading flora. Several shifts of prairie and forest communities must have occurred with the changes from humid to dry conditions.

The vegetational history of Indiana is closely related to the geological history and climatic changes that have occurred in the past. The present flora then is the result of the readjustments in distribution that have been made by plants both in the past and at present.

The flora of Indiana as a whole is that of a mesophytic deciduous forest in which widespread intraneous species prevail. Within the state are five areas with distinctly different floras (Fig. 5).

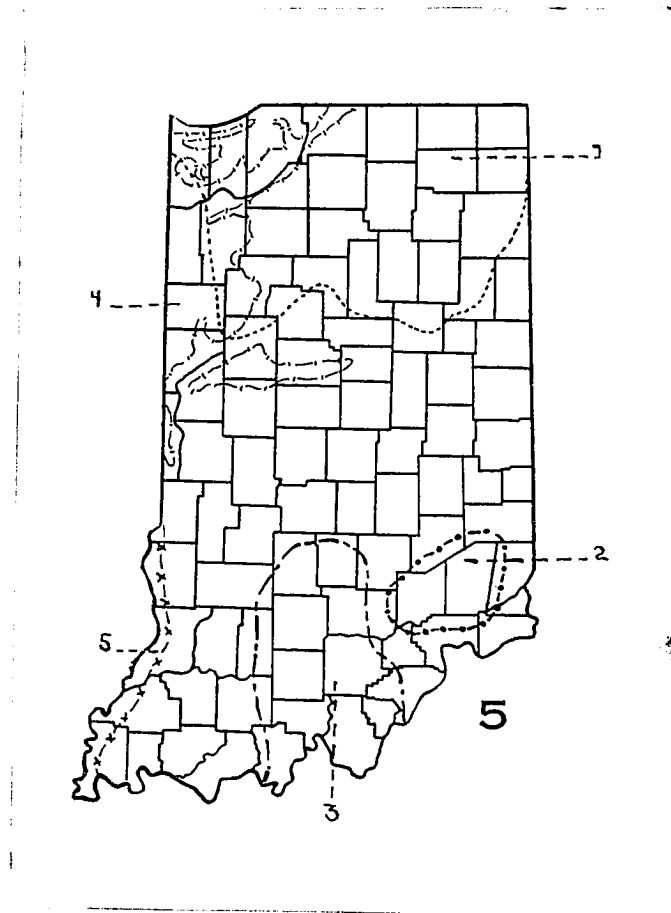


Fig.5. Map of Indiana showing the five areas having distinctly different floras: (1) "Lake" area, (2) "Flats" area, (3) "Knobs" area, (4) "Prairie" area (just the main extent has been mapped). After Transeau '35. (5) "Lower Wabash Valley" area.

1. The lake region is the northern portion of the state composed of the northern lake and moraine physiographic regional unit. Many northern plants are here and it is these that give the character to the region; coastal plain and prairie species are well represented; a few Allegheny species occur.

2. The flats are remnants of the old Tertiary peneplain and are covered with a mantle of Illinoian drift. This area is characterized by a swamp forest in which beech, sweet gum and pin oak are the more important species (comparable to the forest of the Illinoian Till Plain of southwestern Ohio, Braun '36). In addition to the intraneous flora there are some distinctly northern species, and some distinctly southern and Appalachian species that are at or near the limits of their ranges.

3. The knobs area lies in the unglaciated portion of southern Indiana in the highland region which includes the Crawford Upland, Mitchell Plain and the Norman Upland. This highland area is a portion of the Highland Rim (Fenneman '17) and is a northwestern extension from the Appalachian plateau of Kentucky. Here occur many southern and Allegheny species along with the intraneous flora. Northern species are lacking except the few glacial relics found near the glacial boundary.

4. The prairie area does not correspond to a physiographic area but consists of remnants of the prairie peninsula (Transeau '35) of post-Wisconsin age. As is to be expected prairie species are more numerous here than elsewhere in Indiana.

5. The Lower Wabash Valley area is a narrow strip of land bordering the Wabash River from the Ohio River northward to Vigo County. The distinctive floristic feature is the occurrence of Mississippi embayment species.

III. THE PRESENT COMPOSITION OF THE FLORA

Indiana, though situated in the deciduous forest, nevertheless occupies a position more or less transitional between the northern and southern forests, the prairies, the Appalachian forest, and the Mississippi embayment region. Consequently, its flora is made up not only of large numbers of plants characteristic of the deciduous forest as a whole, but also many species having affinities with other floristic regions. However, we are more concerned with how and when the species arrived in the state than arbitrarily deciding to which floristic region each belongs.

The flora of the state is made up of widespread intraneous species, species at or near the limits of their ranges, and extraneous species. The flora then is made up of the following elements:

- A. Intraneous species - general and widespread species.
- B. Extraneous species and species at or near the limits of their ranges.

- 1. Appalachian element - composed of three groups;
 - a. Allegheny species² - plants which reach their maximum distribution in the Appalachian physiographic province.

2

The term Allegheny element has been used widely in floristic literature and is retained because of that reason. It does not refer to the physiographic regional unit of that name but refers to species that are widespread in the Appalachian province.

- b. Appalachian-Ozark species - those which reach their maximum distribution in the southern Appalachian Upland and in the Ozark Plateau.
 - c. Ozark species - those which reach their maximum distribution in the Ozark Plateau and adjacent areas to the west and southwest.
2. Southern element - plants whose mass distribution is in the southern part of eastern United States.
 3. Northern element - plants that are characteristic of the northern part or boreal North America. This element is made up of two groups of plants:
 - a. Far northern species.
 - b. Species of the evergreen coniferous forest region.
 4. Prairie element - species that are characteristic of the grasslands of the western district of Interior Atlantic America.
 5. Coastal Plain element - which may be divided into three groups:
 - a. Species characteristic of the northern district of the Atlantic Coastal Plain, with inland stations around the Great Lakes.

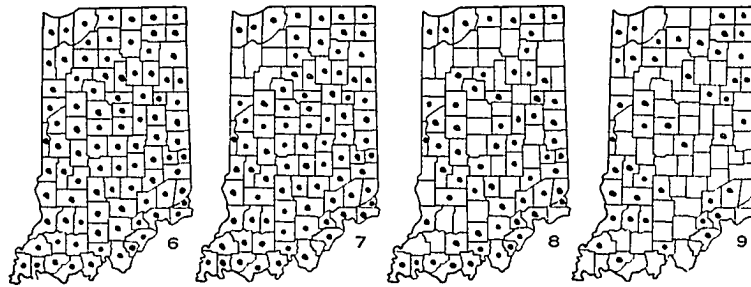
- b. Species characteristic of the Gulf Coastal Plain and Mississippi embayment district.
- c. Species found throughout the entire Coastal Plain province.

A. INTRANEOUS SPECIES

Within our area are many plants that are widespread in distribution. Although important in the vegetation of the state, these plants do not reveal the past conditions of vegetation and so are not important in a study of this type as are those of more limited distribution. Among the widespread species are Quercus alba Fig.6³, Acer Negundo, Carya cordiformis, Carya ovata, Juglans nigra, and Ulmus americana. There is another large group of species generally distributed over the state but not found in every county as are the preceding species. Among these are Fagus grandifolia (Fig.7), Prunus serotina, Sassafras variifolium, Acer saccharum, Cornus florida (Fig.8), Benzoin aestivale, Rosa palustris Marsh., Panicum huachucae, P. capillare, Leersia oryzoides (Fig.9), Agrostis perennans, Elymus virginicus.

 3

Nomenclature is that of the seventh edition of Gray's New Manual of Botany unless otherwise noted.



Figs. 6-9. Widespread species Generally distributed through Indiana. Fig.6 Quercus alba, Fig.7 Fagus grandifolia conspicuous by its absence in the prairie counties, Fig. 8 Cornus florida, Fig.9 Leersia oryzoides, its distribution being dependent upon the occurrence of wet habitats.

B. EXTRANEEOUS SPECIES AND SPECIES AT OR NEAR THE
LIMITS OF THEIR RANGES.

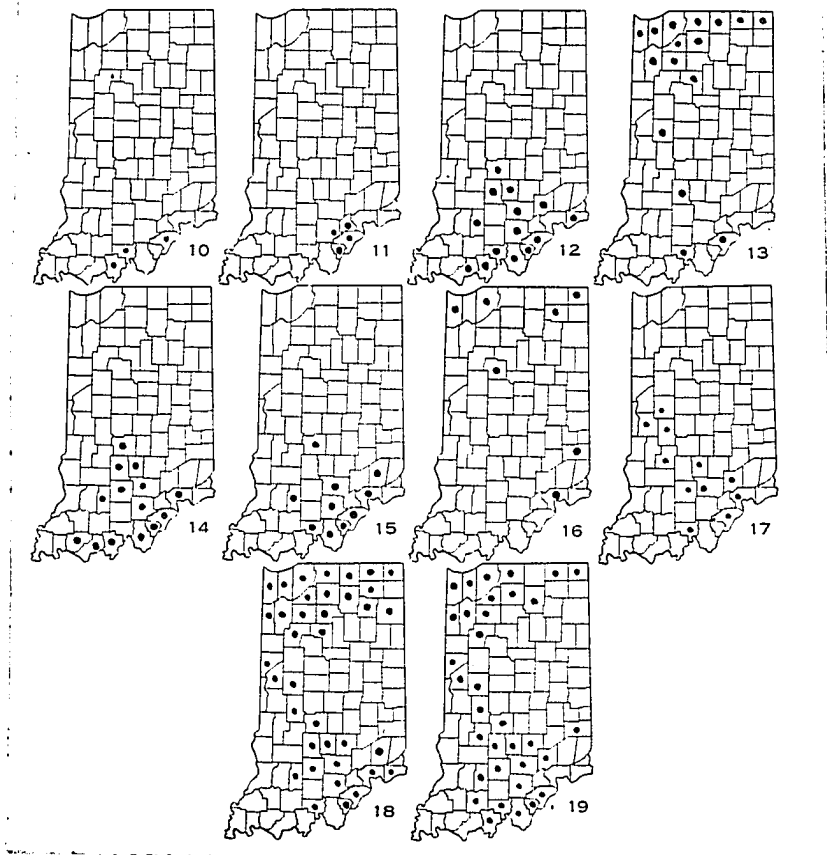
1. APPALACHIAN ELEMENT

There are several species found in the knobs area of Indiana that are at the northern limits of their present distribution and attain their maximum distribution in the Appalachian province.

The Appalachian province of Harshberger ('11) is divided into the Piedmont district (which is lacking in interest floristically as far as we are concerned), the Appalachian district, and the Ozark district. The southern part of the Appalachian province, the Ozark plateau and the knobs of Indiana have had a similar geological history. Each of these has been a land area standing above sea-level since the close of the Paleozoic era; each has been uplifted and peneplained; each has escaped glaciation. The rich Tertiary flora was fairly uniform and widespread over the land area.

In Indiana, the following Alleghenian plants appear to be relics of the Tertiary flora; Kalmia latifolia and Pinus virginiana (Figs. 10-11), with a very limited distribution in southern Indiana, and Vaccinium stamineum, Gaultheria procumbens, Quercus montana Will., Castanea

dentata, Viola rostrata and Tsuga canadensis (Figs. 12-17), all of which have spread more or less into glaciated territory.



Figs. 10-19. Alleghenian Plants in Indiana. Fig.10 Kalmia latifolia, Fig.11 Pinus virginiana, Fig.12 Vaccinium stamineum, Fig.13 Gaultheria procumbens, Fig. 14 Quercus montana, Fig.15 Castanea dentata, Fig. 16 Viola rostrata, Fig. 17 Tsuga canadensis, Fig. 18 Gaylussacia baccata, Fig. 19 Vaccinium vacillans. Three of these records, Castanea dentata in Ripley County; Viola rostrata in Franklin County; Gaylussacia baccata in Ripley County; and Rubus hispidus (Fig.82) in Ripley County are previously unpublished records.

Tsuga canadensis is generally considered as a glacial relic in Indiana (Clements '34, Daubenmire '31, Friesner and Potzger '34). However, there seems to be sufficient evidence to warrant a different interpretation.

The Cretaceous and Tertiary plants of North America listed by Knowlton ('98) indicate a rather uniform flora extending from the Arctic regions through America far to the south. Hemlock was a member of this flora. The glacial period restricted the distribution of this species to the south of the glacial border in the eastern part of the United States. There were (and still are) many suitable areas in the luxuriant Southern Appalachian forest where *Tsuga* persisted. There were fewer suitable habitats outside of this region and more competition with other species; however, it is found in a few areas. Hemlock has remained in southern unglaciated Indiana as a relic of the Tertiary forest. In Indiana hemlock is established on north-facing canyon rims where there is extreme drainage and consequently dry soil (Daubenmire '31). After its establishment, the presence of hemlock gives rise to a secondary set of conditions which tend to inhibit the seedlings of competing plants and thus the permanency of the hemlock community is secured. In all of its stations in Indiana *Tsuga* is found on the north-facing wall at the upper rim of canyons. It has persisted in these areas that are unfavorable to the intraneous flora.

The effects of glaciation were not pronounced more than a very short distance beyond the edge of the glacier. It is not necessary to call upon glacial migrations to explain the occurrence of hemlock in Crawford and Lawrence counties. It would have persisted here since Tertiary time. Likewise in the stations near the border of Illinoian glaciation it has been able to persist since Tertiary time and has migrated into the glacial territory only in the habitats where it can grow due to the lack of competition with other trees.

If this species is a glacial relic that followed the retreating glaciers northward and then became widespread in the Great Lakes region, why is not hemlock pollen found in bogs of central and northern Indiana? To date Houdek ('33) has been the only investigator to find hemlock pollen in Indiana bogs. He has found it only in very small percentages in the upper strata of peat from two bogs in the extreme northern part of Indiana, one in Porter County and the other in Steuben County. Hemlock is a prominent member of the Appalachian flora and since Pleistocene glaciation has spread north and northwest from that center into the Great Lakes-ST. Lawrence Valley region where it is now a dominant in the hemlock-White Pine-Hardwood forest of that region. This movement passed through Ohio and into Michigan but missed Indiana. The absence of pollen in the bottom of the bogs mentioned above, its scarcity in the upper part and its

absence in other Indiana peat bogs south of these two indicate that this species was not a member of the northern vegetation that retreated northward with the melting glacier but that it is a Tertiary relic in unglaciated southern Indiana from whence it has spread slightly into glaciated territory since glaciation. The occurrence of hemlock pollen in the extreme northern bogs was due to the spread of some individuals from southern Michigan or eastern Ohio. Hemlock does not grow in northern Indiana at the present time.

The lobe of prairie vegetation that stretched across the state in post-Pleistocene time acted as a very effective barrier to the Allegheny plants that might have been migrating northward from the knobs region so that they were restricted to the south of the prairie region. However, certain of the Allegheny plants occur not only in southern Indiana but also in the Lake region in the north. Gaylussacia baccata, Vaccinium vacillans (Figs. 18-19) and Gaultheria procumbens (Fig. 13) appear to have reached these northern stations by following a route from the unglaciated Allegheny plateau of eastern Ohio through the northern part of Ohio into northern Indiana.

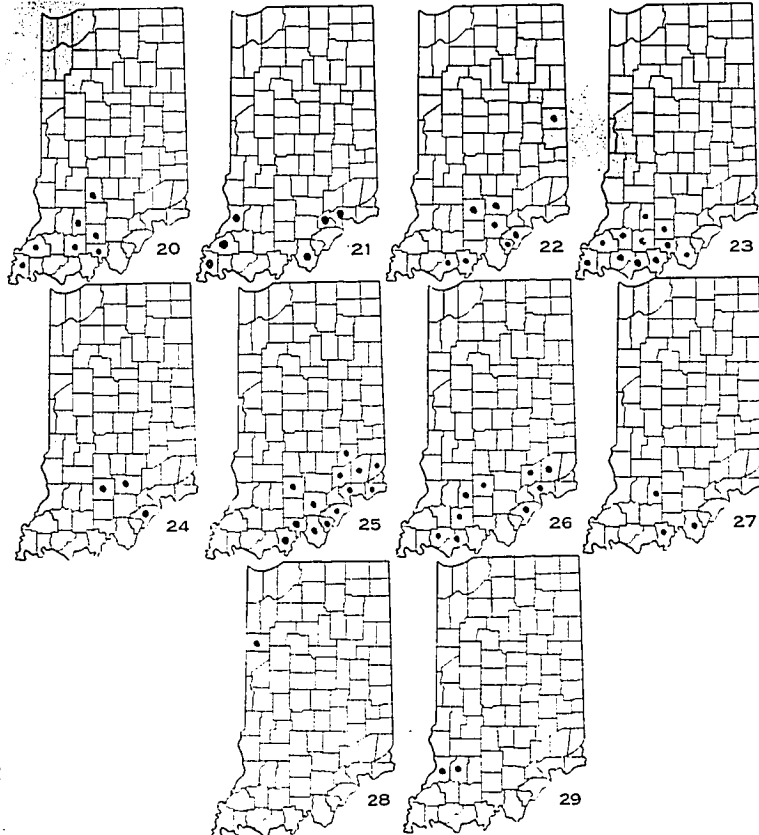
A second group of species found in southern Indiana occurs in the southern Appalachian Upland and the Ozark plateau (Steyermark '34). Among these are Asplenium

pinnatifidum, Agave virginica, Iris cristata, Ulmus alata,
Magnolia acuminata, Viburnum rufidulum, Habenaria peramoena,
Vaccinium arboreum (Figs. 20-27) and Robinia Pseudo-Acacia.

The last is now found as an escape in all parts of the state but was doubtless native along the Ohio River at least in the southeastern part of the state. There is an interesting account of Robinia found in the book of "Western Travels" by David Thomas published in 1819. "After a traverse of three or four miles we came to Rising Sun, Indiana..... On leaving the river, we ascended the hills, the soil of which is very fertile, and the vegetation uncommonly fine. We had gazed at the majestic beech of this country, three feet in diameter, with branches of great size; we had seen the honey locust, the black walnut and the horse chestnut (called sweet buckeye) of equal magnitude; and here we saw, with surprise, the black locust almost a rival in stature; with grape vines like cables, hanging from tops of trees in every direction....." Cladrastis lutea, another Appalachian-Ozark species grows natively in Brown County. Deam says (in a letter of February 1936) that its habitat there leads him to believe that it will be found elsewhere in Indiana.

A third group of species are members of the group which Steyermark ('34) considers as having originated in the Ozark plateau and adjacent area to the west and southwest. Thus, it is not surprising that only two of this group get into our area. These species are Carex austrina (Small) Mack

and Pentstemon tubiflorus (Figs.28-29). Carex has been reported from only Benton County, and the Pentstemon has been reported from both Daviess and Knox counties.



Figs. 20-27. Southern Appalachian and Ozark Species occurring in Indiana. Fig.20 Asplenium pinnatifidum, Fig.21 Agave virginica, Fig.22 Iris cristata, Fig.23 Ulmus alata, Fig.24 Magnolia acuminata, Fig.25 Viburnum rufidulum, Fig.26 Habenaria peramoena, Fig.27 Vaccinium arboreum. Figs.28-29. Ozark species occurring in Indiana. Fig.28 Carex austrina, Fig.29 Pentstemon tubiflorus.

2. SOUTHERN ELEMENT.

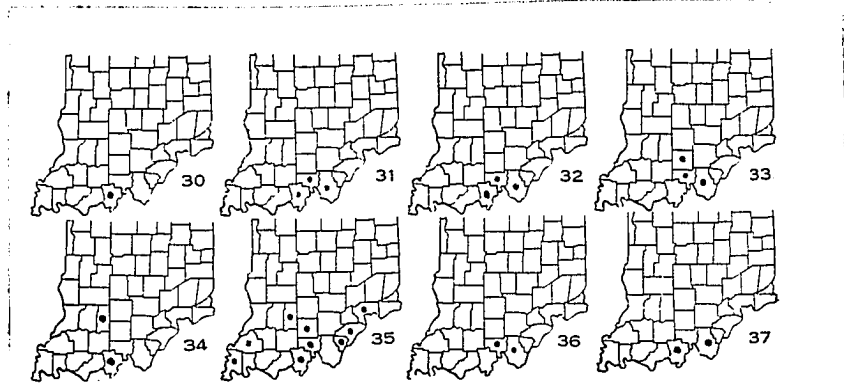
By the southern element is meant those plants that are characteristic of and are widespread in the southern portion of eastern United States and which have northern stations in Indiana. Their general ranges as given in the manuals are usually from Virginia to Indiana and Illinois or Nebraska, south to Florida and Texas or some comparable range. These southern plants show three different types of distribution in the state.

The first group of southern plants is made up of species that reach their maximum distribution in the south and in Indiana are restricted to the unglaciated territory of the southern part of the state. Bumelia lycioides (Fig.30) is considered one of the rarest shrubs of Indiana. It has been reported from only one station near a perpendicular cliff along the Ohio River in Perry County. Smilax Bona-nox (Fig.31) has been reported from open woodlands along the bluffs of the Ohio River from Perry, Crawford and Harrison counties. Rhamnus caroliniana (Fig.32) occurs in Harrison, Crawford and Perry counties near the Ohio and Blue rivers where it is locally frequent on wooded slopes from the base to the top of the ridges. Isoetes Engelmanni, Cheilanthes lanosa, Polypodium polypodioides, Hexalectris aphylla and Passiflora incarnata (Figs. 33-37) are other southern plants with a limited distribution in particular habitats in southern

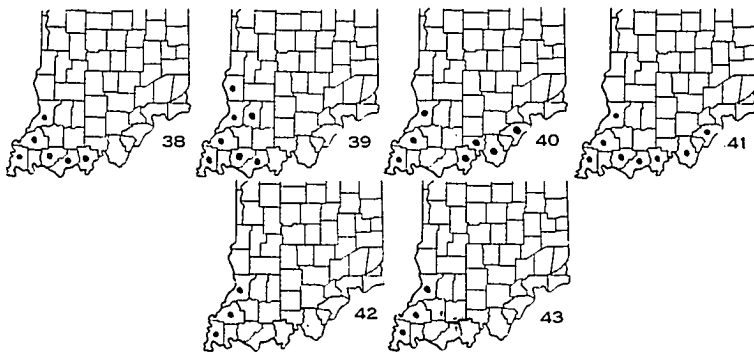
Indiana. Jussiaea decurrens has been reported from only Posey and Spencer counties and Spigelia marilandica in Posey County. This portion of the state was largely unaffected by glaciation, therefore it has been possible for these plants to live here undisturbed for a long period of time since this is the oldest land area in the state.

A second group of southern plants is composed of species that inhabit borders of streams and river bottoms in southern Indiana. They have moved into the glaciated region a short distance. Adelia acuminata, Quercus lyrata, Bignonia capreolata, Arundinaria macrosperma, Aristolochia tomentosa and Vitis palmata (Figs, 38-43), are found along the margins of the Ohio and Wabash rivers and their tributaries. This type of distribution has been attained by migration of the species into our area from the south where they found continuous suitable habitats along the margins of the Mississippi and Ohio rivers.

The last group of southern plants is made up of species that have extended their ranges beyond the unglaciated into the glaciated portion of the state. Some species such as Symphoricarpos orbiculatus, Diospyros virginiana and Hydrangea arborescens (Figs, 44-46) have made considerable advance and extend into the Wisconsin glaciated territory. Other species as Evonymus americanus, Aralia spinosa, Smilax glauca, Phoradendron flavescens, Ascyrum hyperidoides,

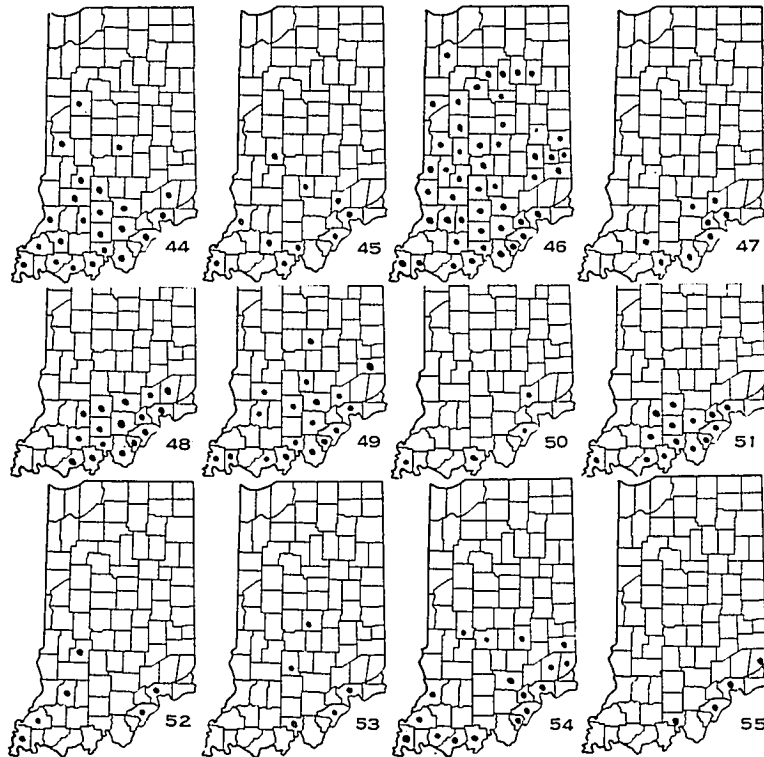


Figs. 30-37. Southern Species having a limited range of distribution in Indiana. Fig.30 Bumelia lycioides, Fig.31 Smilax Bona-nox, Fig.32 Rhamnus caroliniana, Fig.33 Isoetes Engelmanni, Fig.34 Cheilanthes lanosa, Fig. 35 Polypodium polypodioides, Fig.36 Hexalectris aphylla, Fig. 37 Passiflora incarnata.



Figs. 38-43. Southern Species that have crossed the glacial border in Indiana. Fig.38 Adelia acuminata Fig.39 Quercus lyrata, Fig.40 Bignonia capreolata, Fig. 41 Arundinaria macrosperma, Fig.42 Aristolochia tomentosa, Fig. 43 Vitis palmata.

Asclepias perennis, Salvia lyrata and Liquidambar Styraciflua (Figs. 47-54), have extended their ranges into the Illinoian drift area but their ranges are terminated at or near the Wisconsin glacial boundary. On the other hand Aesculus octandra (Fig. 55) is found only in Dearborn, Jefferson, Clark, and Crawford counties and in no place more than a mile from the river, hence it is found but a very short distance within the limits of Illinoian glaciation.



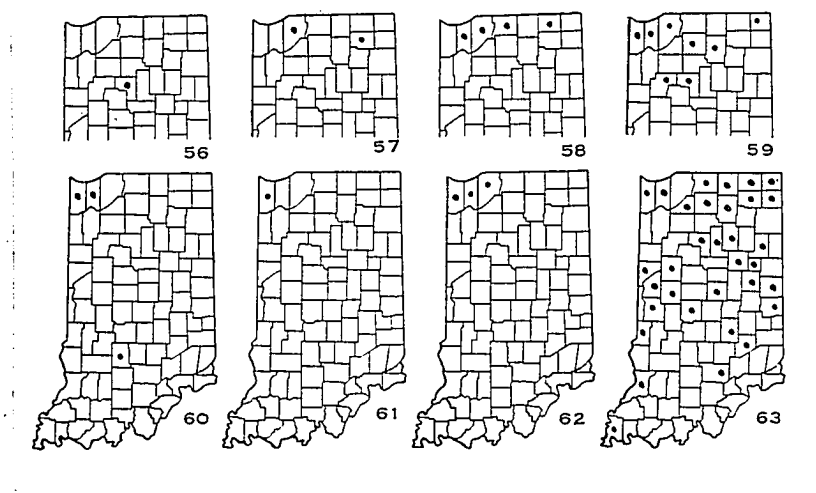
Figs. 44-54. Southern Species that have extended their ranges some distance within the glacial boundary. Fig.44 Symphoricarpos orbiculatus, Fig.45 Diospyros virginiana, FIG.46 Hydrangea arborescens, Fig.47 Evonymus americanus, Fig.48 Aralia spinosa, Fig. 49 Smilax glauca, Fig.50 Phoradendron flavescens, Fig. 51 Ascyrum hyperidoides, Fig. 52 Asclepias perennis, Fig. 53 Salvia lyrata, Fig.54 Liquidambar Styraciflua, Fig.55 Aesculus octandra.

3. NORTHERN ELEMENT

As mentioned previously, the boreal relics of Indiana can be divided into two main groups; (a) far northern species, and (b) species of the northern evergreen coniferous forest region. The first of these can be further subdivided into circumboreal species and species confined to boreal North America.

Naturally the number of circumboreal plants that are in our region is few. Schizachne purpurascens (Torrey) Swallen (Fig. 56) has been reported from Cass County. It occurs in dry, moist, or rocky woods and open places in North America from Labrador to Alaska, south in the United States to Pennsylvania, Kentucky, Indiana, South Dakota and Montana and in the mountains from British Columbia to New Mexico; Siberia and Japan. This grass becomes rare in the southern part of its distribution. Galla palustris (Fig. 57) inhabits cold bogs from Nova Scotia to New Jersey, west to northern Indiana, Minnesota and northward; also in Eurasia. This plant has become quite rare in Indiana due to its destruction by man and now occurs in only two counties in extreme northern Indiana. Vaccinium Oxycoccus (Fig. 58) is circumboreal in its general distribution and occurs infrequently in northern Indiana in bogs. Campanula rotundifolia (Fig. 59) likewise is circumboreal in its distribution with a

few southern stations in northern Indiana. Pyrola secunda (Fig. 60) also is circumboreal and has been reported from the extreme northwestern counties and from Monroe County. This last station was at old Lake Flatwoods in the northwestern part of the county which was formed by the melting ice of the Illinoian glacier. In recent years the swampy remains of this glacial lake have been drained and the woods have been cleared, hence this plant, along with others, has disappeared.



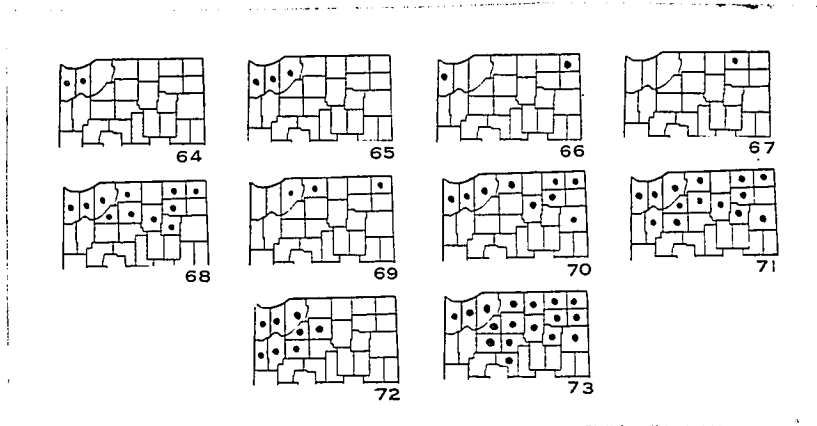
FIGS. 56-60. Circumboreal Species occurring in Indiana. Fig. 56 Schizachne purpurascens, Fig. 57 Calla palustris, Fig. 58 Vaccinium Oxycoccus, Fig. 59 Campanula rotundifolia, Fig. 60 Pyrola secunda. Figs. 61-63. North American Boreal species occurring in Indiana. Fig. 61 Shepherdia canadensis, Fig. 62 Arctostaphylos Uva-ursi var. coactilis, Fig. 63 Caltha palustris.

Some of the far northern plants found in Indiana are confined to boreal North America. Among these are Shepherdia canadensis (Fig.61) found only in Lake County; Arctostaphylos Uva-ursi var. coactilis Fernald (Fig.62) (a variety of the species found in Eurasia) is found on rocks and bare hills in the far north of America and as far south as Virginia, Illinois, Colorado and northern California. With one exception it is, in Indiana, confined to the dunes near Lake Michigan. It is found in open places on the crests and slopes of dunes. It has already become quite scarce in Lake and LaPorte counties, but is still frequent in most parts of Porter County (Deam '32). Corydalis sempervirens ranges in the north from Nova Scotia to Alaska and occurs in Lake, Newton, Pulaski and Stäke counties. Caltha palustris (Fig.63) is more widespread than these others and occurs as far south as the glacial border.

Present disjunct stations of plants of the conifer forest region now separated from the mass of the species and the remains of tamarack in deposits of glacial age (Coulter and Thompson'86) are evidence that boreal vegetation actually occurred in southern Indiana.

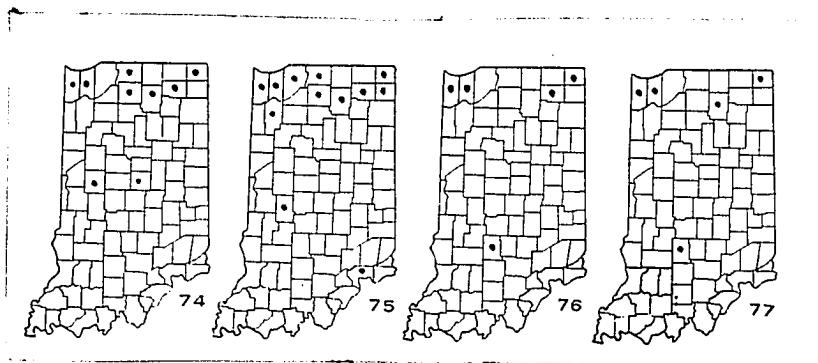
Numerous members of the northern forest are found in the state. One group of these species is now found only in the extreme northern portion of the state. Among these are Thuja occidentalis, Pinus Banksiana, Glyceria borealis, Poa

leptocoma Trinius, Salix candida, Sorbus subvestita Greene,
Rhamnus alnifolia, Betula pumila, Myrica asplenifolia and
Larix laricina (Figs. 64-73).



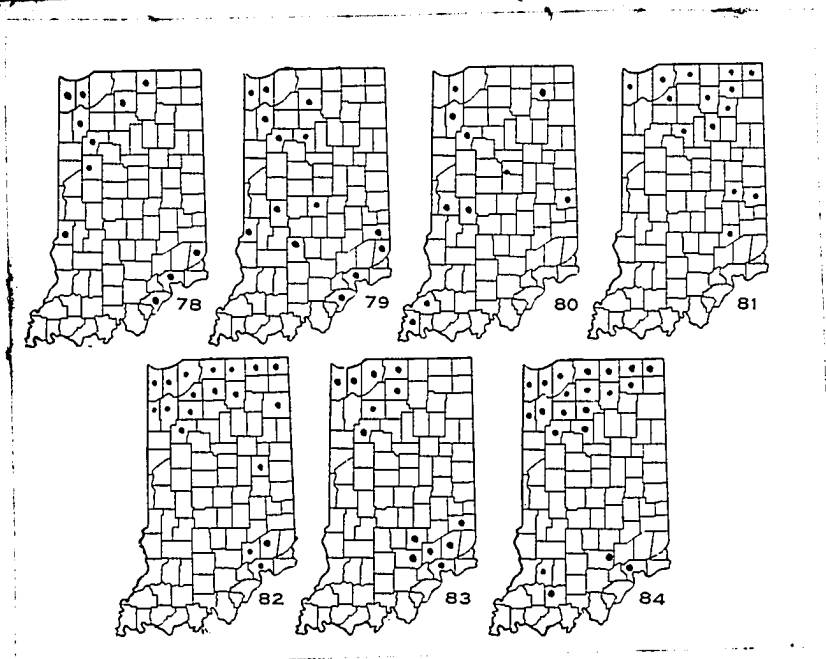
Figs. 64-73. Species of the Northern Evergreen Coniferous Forest Region now found only in the extreme northern part of Indiana. Fig.64 Thuja occidentalis, Fig.65 Pinus Banksiana, Fig.66 Glyceria borealis, Fig.67 Poa leptocoma, Fig.68 Salix candida, Fig.69 Sorbus subvestita, Fig. 70 Rhamnus alnifolia, Fig.71 Betula pumila, Fig.72 Myrica asplenifolia, Fig.73 Larix laricina.

A second group of species of the northern evergreen forest region is made up of those having several northern Indiana stations with disjunct occurrences at or near the glacial boundary. Among these are Cypridium hirsutum Mill., Maianthemum canadense, Pyrola americana and Pyrola elliptica (Figs. 74-77). The occurrence of the Pyrolas in Monroe County was in the old Lake Flatwoods area.



Figs. 74-77. Species of the Northern Evergreen Coniferous forest region found in northern Indiana with disjunct stations near the glacial border. Fig. 74 Cypridium hirsutum, Fig. 75 Maianthemum canadense, Fig. 76 Pyrola americana, Fig. 77. Pyrola elliptica.

A third group of the northern evergreen forest is found in northern Indiana and in scattered suitable habitats as far south as the margin of Illinoian glaciation. Among these are Viola lanceolata (Fig.78), V. cucullata (Fig.3), Houstonia caerulea (Fig. 79), Symplocarpus foetidus (Fig. 80), Lilium canadense (Fig.4), Potentilla fruticosa, Rubus hispidus, Vitis labrusca, and Spiraea tomentosa (Figs. 81-84).



Figs. 78-84. Species of the Evergreen Coniferous Forest Region found in northern Indiana and in scattered suitable habitats as far south as the margin of Illinoian glaciation. Fig.78 Viola lanceolata, Fig.79 Houstonia caerulea, Fig.80 Symplocarpus foetidus, Fig.81 Potentilla fruticosa, Fig.82 Rubus hispidus, Fig.83 Vitis labrusca, Fig. 84 Spiraea tomentosa. (Note the localization of the last three in the flats.)

With the changes to drier climatic conditions during post-Wisconsin time, the prairie barrier extended across the state and separated the northern plants near the glacial border from the ones in the northern part of the state, hence many of this group tend to be somewhat localized in the southern part of the drift areas, particularly in the southeastern Illinoian flats where numerous suitable habitats are found. Comparable distributions of these species are seen in Ohio (Braun, Rhodora '35).

4. PRAIRIE ELEMENT

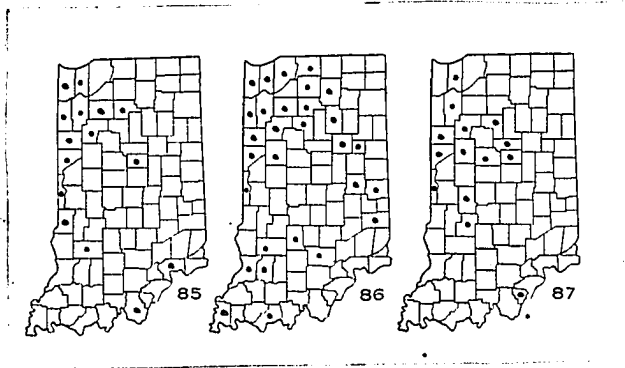
At present the prairie communities of Indiana are restricted largely to the western portion of the central and northern part of the state with small isolated communities to the east and northeast. Many species of the prairie flora have a wide range of distribution and occur far beyond the limits of the grassland formation. Single occurrences of these species of wide range would have little significance. However, the former more widespread extent of grassland is indicated by communities which appear in habitats comparable to those in the western prairies and in which the species bear the same relationships to each other (as to relative importance and dominance) as they do in the prairie region.

As the Wisconsin glacier melted, the present Great Lakes were formed. At first they were more extensive and stood at higher levels. Lake Chicago, the predecessor to Lake Michigan, extended far south of the present lake. As new outlets were formed, the lake gradually retreated toward the north. The newly formed sandy beaches and shores were available not only to the species migrating from the south, but were suitable and available to the prairie species of the west and also to the Coastal Plain species of the east. The post-Wisconsin eastward shift of the prairie margin formed a peninsula of this vegetation reaching southern Michigan and central Ohio (Transeau '35).

With the return of more humid climatic conditions, the deciduous forest invaded this peninsula. Gradually the forest replaced the prairie vegetation at the margins of the peninsula except in the more extreme habitats. It is these places that prairie communities are still found and it is these relics that indicate the former extent of the prairie migrations.

The prairie communities are of two types, wet and dry, i.e., they correspond to the lowland prairies dominated by the big bluestem grass, and the upland prairies dominated by the little bluestem grass, as described by Weaver and Fitzpatrick '35. Of the twenty most important forbs of the wet prairie species (having a 10% or higher occurrence as a society of the first class in the lowland prairies), the greatest number are of wide distribution. They occur not only in the prairie region but range far east, some of them appearing locally in the forest region as well. Among these are Galium tinctorium, Fragaria virginiana, Steironema ciliatum, Aster salicifolius, Anemone canadensis, Solidago altissima, Phlox pilosa, Helianthus grosseserratus, Zizia aurea, Teucrium canadense, Viola papilionacea, Pycnanthemum virginianum, P. flexuosum, Veronica virginica, Asclepias verticillata and Cicuta maculata.

Only three of these twenty important forbs of the wet prairies are at or near their eastern limits of distribution in Indiana. Among these are Silphium laciniatum, S. integrifolium, and Asclepias Sullivantii (Figs. 85-87).

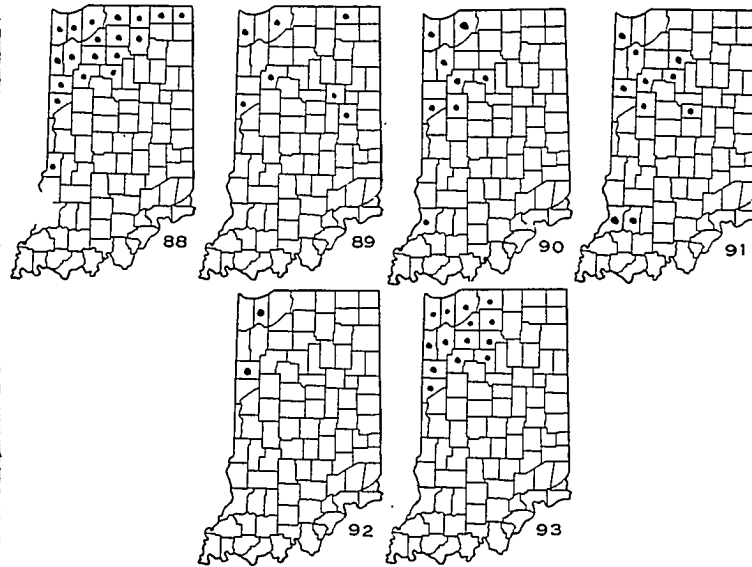


Figs. 85-87. Three of the most important forbs of the wet prairies of central United States reach the eastern limits of their distribution in or near Indiana. Fig. 85 Bilphium laciniatum, Fig. 86 Silphium integrifolium, Fig. 87 Asclepias Sullivantii.

The grasses of both wet and dry prairies are quite widespread, in some cases ranging as far south as Mexico and South America.

The nineteen most important forbs of the dry prairies (having from 10-74% occurrence as a society of the first class in the upland prairies), have a more limited distribution than the wet prairie species. A few are widespread and are found as far east as the Atlantic coast in suitable habitats. These are Aster multiflorus, Erigeron ramosus, Euphorbia corollata, Solidago rigida and Liatris scariosa. However, a larger percentages of the most important forbs of the dry prairies are at or near their eastern limits of distribution in Indiana. These species are Amorpha canescens, Helianthus rigidus (Cass) Desf., Petalostemum candidus,

P. purpureum, Brauneria pallida and Coreopsis palmata (Figs. 88-93). The remainder of the nineteen most important dry prairie forbs reach their eastern limit of distribution to the west of Indiana and so do not enter our flora.



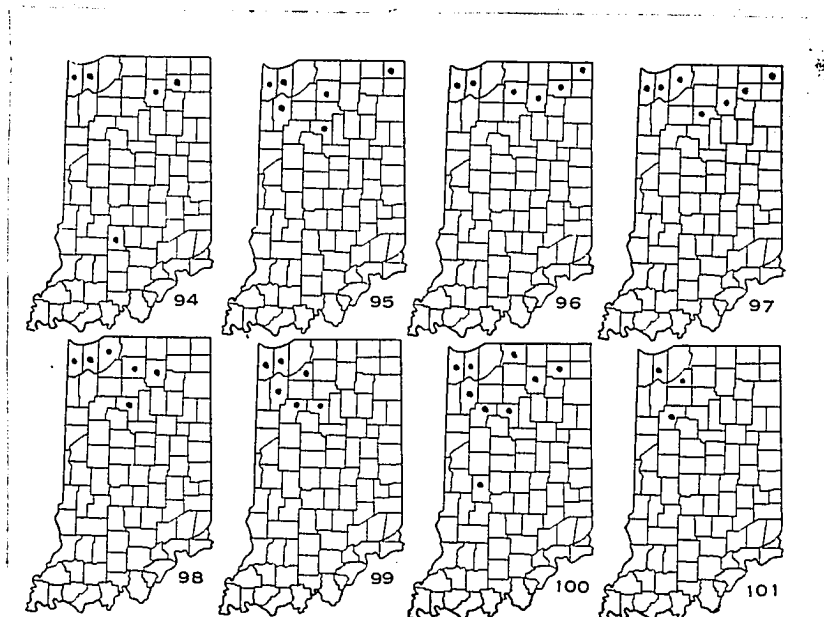
Figs. 88-93. Six of the most important forbs of the dry prairies reach the eastern limits of their distribution in or near Indiana. Fig. 88 Amorpha canescens, Fig. 89 Helianthus rigidus, Fig. 90 Petalostemum candidum, Fig. 91 P. purpureum, Fig. 92 Brauneria pallida, Fig. 93 Coreopsis palmata.

5. COASTAL PLAIN ELEMENT

The Coastal Plain species which occur in Indiana are found either in the lake region or in the Lower Wabash and Ohio River valleys or in both regions.

The distribution of these coastal plain species within Indiana and their general distribution outside of the state show that they have had three possible routes along which they could migrate; (1) by way of the old Mohawk-Hudson outlet of the glacial Great Lakes, (2) by way of the Ottawa connective (another outlet of the Glacial Great Lakes); (3) by way of the Mississippi embayment. Some arrived, perhaps more or less simultaneously, by way of the Mohawk-Hudson outlet and the Mississippi embayment. As the Wisconsin ice sheet melted away from what is now the lake region, sand barrens, swales and lagoons were far more extensive than at present. These conditions afforded a more or less continuous suitable habitat for the coastal plain plants from the Atlantic Coastal Plain to our region, by way of the Mohawk-Hudson connective and the Ottawa connective (Peattie '22).

A considerable number of coastal plain species more or less scattered over the southern part of Indiana appear to have arrived by way of the Mohawk-Hudson outlet of the glacial Great Lakes. Among these are Bartonia virginica, Polygala cruciata, Utricularia gibba, Hydrocotyle umbellata, Xyris flexuosa, Sisyrinchium atlanticum, Lupinus perennis



Figs.94-101. Atlantic Coastal Plain species occurring in northern Indiana. Fig.94 Bartonia virginica, Fig.95 Polygala cruciata, Fig. 96 Utricularia gibba, Fig.97 Hydrocotyle umbellata, Fig.98 Xyris flexuosa, Fig.99 Sisyrinchium atlanticum, Fig.100 Lupinus perennis, Fig. 101 Viola primulifolia.

and Viola primulifolia (Figs. 94-101). The disjunct occurrence of Bartonia virginica in Monroe County is explained by Potzger ('34) as a chance distribution effected by birds since this station is in a newly formed bog and it could not be a relic of glaciation.

On the basis of its distribution, it seems probable that Ammophila breviligulata Fernald (Fig. 102) has entered the state by way of the Ottawa connective. It is found at the head of Lake Michigan. Outside of the state it is found on sandy shores along the Atlantic coast from Newfoundland to North Carolina and inland along the St. Lawrence river system to the Great Lakes. Peattie ('22) lists it as occurring on the shores of Lake Ontario, in the region of Lake Erie, Saginaw Bay (Lake Huron), Detroit and St. Clair rivers, Lake St. Clair and Port Huron. It is not found in the Hudson-Mohawk Valley or the Finger Lakes region.

Certain species in Indiana are limited to the lower Ohio and Wabash valleys. These are represented by Gleditsia aquatica, Taxodium distichum, Ilex decidua, Celtis mississippiensis and Crotalaria sagittalis (Figs. 103-107). These species are conspicuous members of the flora of the coastal plain region that extends up the Mississippi Valley to southern Illinois. This Mississippi embayment region is an alluvial plain and is continuous with the alluvial plain of the Ohio River and Lower Wabash River in southwestern

Indiana. Thus there is a continuous suitable habitat for these coastal plain species into southern Indiana.

A fourth group of coastal plain species is found in the lake region in northern Indiana and southern Indiana along stream margins and in the valleys. Among these are Linum striatum, Styrax americana, Phloxia virginica, Peltandra virginica, Rotala ramosior and Fimbristylis autumnalis (Figs. 108-113). The last two species have comparable distributions in Ohio. The distribution of these species in northern Indiana and northern Ohio has been achieved by migration along the Mohawk-Hudson connective, while the distribution in southern Indiana and in southern Ohio can be explained by migration along the stream margins of the Mississippi and Ohio river systems from the southern coastal plain. Peltandra being present in northern and southern Indiana and only in northern Ohio adds weight to this explanation.

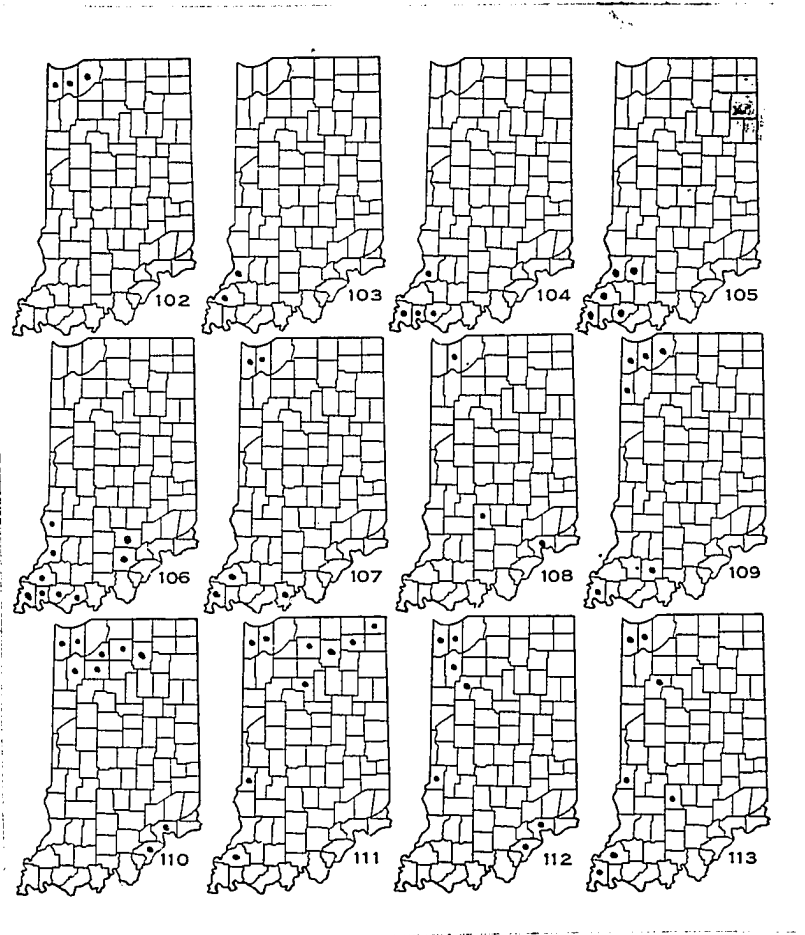


Fig. 102 Ammophila breviligulata, of the north Atlantic Coastal Plain and Great Lakes region. Figs. 103-107. Mississippi embayment species reaching their northern limits of distribution in Indiana. Fig.103 Gleditsia aquatica, Fig.104 Taxodium distichum, Fig.105 Ilex decidua, Fig. 106 Celtis mississippiensis, Fig. 107 Crotalaria sagittalis, Figs. 108-113. Coastal Plain species found in the Lake region in northern Indiana, and along stream margins and valleys in southern Indiana. Fig. 108 Linum striatum, Fig.109 Styrax americana, Fig.110 Rhexia virginica, Fig. 111 Peltandra virginica, Fig.112 Rotala ramosior, Fig.113 Fimbristylis autumnalis.

IV. SUMMARY

Approximately sixty percent of the flora of Indiana is intraneous, the remaining forty percent is composed of extraneous species and species that are at or near the limits of their ranges. This forty percent is divided into five main groups that have affinities with five distinct floristic regions: Appalachian, Southern, Northern, Prairie and Coastal Plain. In general the Appalachian species represent relics of the Tertiary flora and are found, in the main, in the unglaciated knobs region of the state; a few have spread into glaciated territory. The southern species reach the northern limits of their ranges in Indiana. The northern species are relics of glacial migrations. The prairie species are remnants of the post-Wisconsin prairie peninsula. In general, the Coastal Plain species are relatively recent entrants in the flora of the state. Certain Mississippi embayment species are at the limits of their ranges. Such diversity in the flora can not be explained on the basis of present conditions, therefore geological history and climatic changes have been called upon in order to trace the vegetational history of the state.

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