THE VEGETATION OF TRUMBULL COUNTY, OHIO[1]

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In this paper an attempt is made to describe the original forest vegetation of Trumbull County, Ohio. The distribution of generalized vegetation types is indicated by a map. These types are described and an analysis of their successional relationships is based on a study of existing remnants, secondary successions and historical records of the original vegetation.

Investigations of this kind are not only of historical value, but it is also recognized that the natural vegetation of a region is an expression of the total effect of a complex of environmental factors, and its use as a practical "indicator" of environment is increasing.

THE REGIONAL BACKGROUND

Trumbull County is located in northeastern Ohio, adjacent to Pennsylvania. It lies midway between the glacial boundary and Lake Erie, and a single county lies between it and the lake. It is approximately twenty-five miles square. Its subdivisions and principal streams are shown in the accompanying map (Figure 1).

The elevation above sea level ranges from 800 to 1260 feet. Within this range altitude is of much less significance in relation to vegetation than relative local relief. Application of this concept of "relative relief," developed by Smith (1935), clearly demonstrates two distinct types of topography in the county. With the exception of a small portion in the extreme northwestern corner, the area north and west of the Defiance moraine, which extends through the towns of Southington, Champion, Bazetta, Johnston and Gustavus (Cushing, Leverett and Van Horn, 1931), is level to gently rolling, while the dissected plateau in the eastern and southeastern parts of the county varies from rolling to decidedly hilly and broken. In this region underlying rocks through their influence on topography may have an indirect influence on vegetation. The rugged topography of the eastern and southeastern portions of the county is related to the more resistant character of some of the rocks of the Pennsylvanian system.

Over much of the old valley in the western part of the county and upon the broad divides, natural drainage has not yet become well established. This is due to the location of the county upon the divide between the Great Lakes and the Ohio River, the reversal of drainage brought about by the glacier, and the comparatively short time which has elapsed since glaciation.

With the exception of small areas where the bedrock lies at or near the surface, or where muck or peat deposits have formed, the soils are of glacial origin. Over nine-tenths of the soils of Trumbull County originally were in need of internal drainage for agricultural use. Surface drainage varies to a much greater extent. In this region vegetation types correlated with soil types are also correlated with topographic features. When mapped soil types are an expression of topography and drainage they are useful indicators of vegetation.

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[1]Papers from the Department of Botany, The Ohio State University, No. 447. A more detailed account is contained in a thesis presented to the Graduate School of The Ohio State University for the Master of Science degree, 1937. The advice of Dr. H. C. Sampson and Dr. E. N. Transeau is gratefully acknowledged.

As might be expected, this region has greater climatic similarity to northwestern Pennsylvania and western New York than to central and western Ohio. Northeastern Ohio has, on the average, later spring frosts and earlier autumn frosts than the rest of the state, a slightly lower average temperature, precipitation more uniformly distributed and more of it in the form of snow, and less frequent drought periods of significant duration.

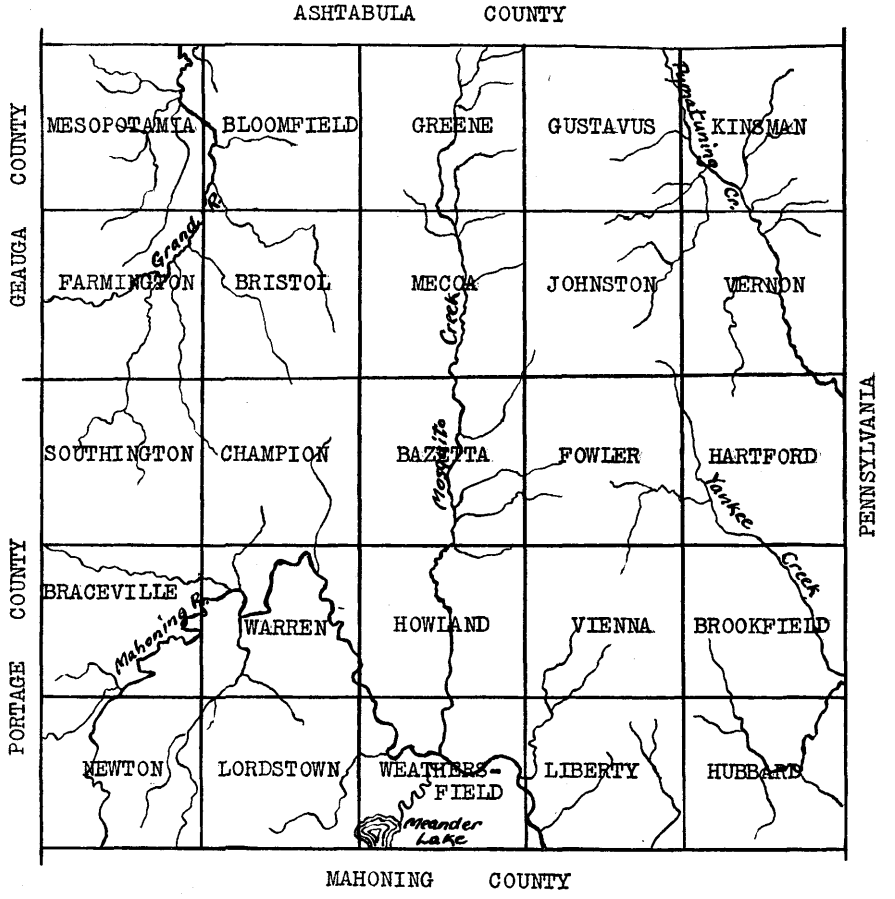

FIG. 1. The towns and principal streams of Trumbull County, Ohio.

METHODS

In an attempt to reconstruct an accurate picture of the original vegetation, the following sources of information were used: (1) historical records, including land survey notes, written descriptions by local historians, verbal accounts by old residents, timber buyers and sawmill operators, and herbarium records; and (2) field observations, including recording of present-day vegetation, analysis of least disturbed areas, observation of secondary successions on areas of known vegetational history as a basis for establishing indices to be used in further field work, and local correlation of vegetation types with topography and soils.

Trumbull County is a part of the Western Reserve included in the original land grant to Connecticut. In 1795 this area was sold to the Connecticut Land Com-

pany, which employed surveyors to divide the land into towns[2] five miles square. A part of their job was to describe the timber, the suitability of the land for agriculture and any apparent "mineral deposits" along these five mile traverses. Their descriptions provided the only basis for evaluation of the land, and considerable pains were taken with them. The traverses of present-day Trumbull County were completed in 1796 and 1797.

The nature of these survey notes is such that for our purposes they amount to transects of the vegetation at five mile intervals. They do not give a detailed picture, but the general features of the original vegetation stand out quite clearly. A thorough study leaves no doubt as to their reliability. Apparently the species were listed in approximate order of abundance. Usually a description was given for every mile, but in a few cases, where distinct changes occurred, there were as many as three descriptions to the mile. In other places the "timber" was described as "the same" for several miles. Lists of species, sometimes annotated, varied from one (e. g., *white oak*, on the south line of Newton) to several (e. g., *cherry, walnut, hardbeam, ash, beech, maple, oak, ironwood, elm, basswood, butternut, cucumber, boxwood*, in the mixed mesophytic area between Vernon and Kinsman and east of Pymatuning Creek).

In the present study field work formed the principal basis for mapping of forest types in all areas that had even a small percentage of wooded land. The various historical records were used as contributory evidence and seldom modified the final conclusions. In most cases history merely confirmed the evidence of the existing vegetation. In the urban and thickly settled suburban areas of Warren, Niles, Youngstown and Sharon, Pennsylvania, it was necessary to rely to a greater extent on historical records and generalization of types on the basis of remnants in adjacent and similar territory. The rural areas of the county practically all contain enough wooded land to enable one to reconstruct the original forest associations after he has acquired a knowledge of the secondary successions in the area. According to the United States Census of Agriculture (1935), 19 per cent of the farm land of the county is in woods. Probably the percentage of rural non-farm land in woods is higher. In using farm woods as a basis for judgment, it must be kept in mind that the sites left in woods are frequently either too wet or too rough for agriculture. Consequently these sites are often unfavorable for the development of the regional climax vegetation and these woods might be misleading without site evaluation.

VEGETATION TYPES

The following outline includes the types clearly recognizable in the original vegetation of the county. Further variants were probably extremely local in occurrence and are discussed under related types. In general, the types recognized by Sampson in northern Ohio (1927, 1930a) are followed. Associations are named for their dominants in order of abundance, the dominants named making up over half the stand. This rule is not, however, rigidly applied to transition types, which are sometimes identified by indicator species.

Arrangement of the series is roughly in order of decreasing drainage. The associations are grouped into generalized types for convenience in mapping. Local areas of historical interest showing little direct relationship to other present-day vegetation are classified separately as relict types.

Chestnut types.....Chestnut
Oak-chestnut

[2]The designation "town" is used here, as in New England, to refer to the subdivisions elsewhere called "townships." It is customary when referring to these units to use their names alone, without specifying "Town of ——" or "—— Township."

Upland oak types	Mixed oak
	Oak-hickory
	White oak
	Oak-maple
	Oak-maple-tulip
Mixed mesophytic type	
Beech-maple types	Maple-oak-beech
	Maple-beech
	Beech-maple
Transition types	Red oak
	Wet beech
	Mixed
	Swamp oaks
Swamp forest types	Elm-ash-red maple
	Pin oak
	Black ash
	Sycamore-willow
Relict types	Hemlock
	White pine
	Bogs
	Treeless areas

In presenting the accompanying generalized map (Fig. 2), certain points should be mentioned. The similarity of the secondary forests on much of the area originally occupied by the better drained transitional phases of the swamp forest, and the lack of detailed historical information for the entire area, have made it advisable to map together all areas too wet for the beech-sugar maple community. Local spots occupied by almost pure stands of beech, too poorly drained for sugar maple, thus occur within areas generalized as swamp forest.

Gradual transitions from one type to another in certain parts of the county, notably in Southington, Gustavus and Vienna, have made the boundaries arbitrary. Certain areas of rolling topography, especially in Southington and south of the Mahoning River, exhibit extreme local variation. All such problem areas are mapped as their predominant type, on the basis of available information. It is also probable that mixed mesophytic forests were much more extensive than indicated in the southeastern part of the county. However they are shown only where direct information was available.

It is intended by these criticisms to define the value and recognize the limitations of the accompanying map. It shows generalized types graphically and as accurately as possible.

Chestnut Types

Chestnut was originally a dominant in local types which did not occupy more than 3 per cent of the area of the county. The most extensive stands occurred in the eastern tier of towns and in the northwestern corner of the county. Sites occupied by chestnut were of two major types: (1) overdrained sites, usually ridges, associated with sandstone outcrops; (2) sandy second terrace soils, particularly along Mosquito Creek in the north central part of the county.

Chestnut was an important component of the mixed mesophytic forests in the eastern and northeastern towns. Areas so mapped probably included small spots on which chestnut was a dominant species. It was also locally present in the beech-maple stands in the northwestern and northeastern towns.

Characteristic tree species of the oak-chestnut association included the following:

DOMINANTS

Black oak	*Quercus velutina* Lam.
Chestnut	*Castanea dentata* (Marsh.) Borkh.
Chestnut oak (locally)	*Quercus montana* Willd.
Red oak	*Quercus borealis* Michx. var. *maxima* (Marsh.) Ashe
White oak	*Quercus alba* L.

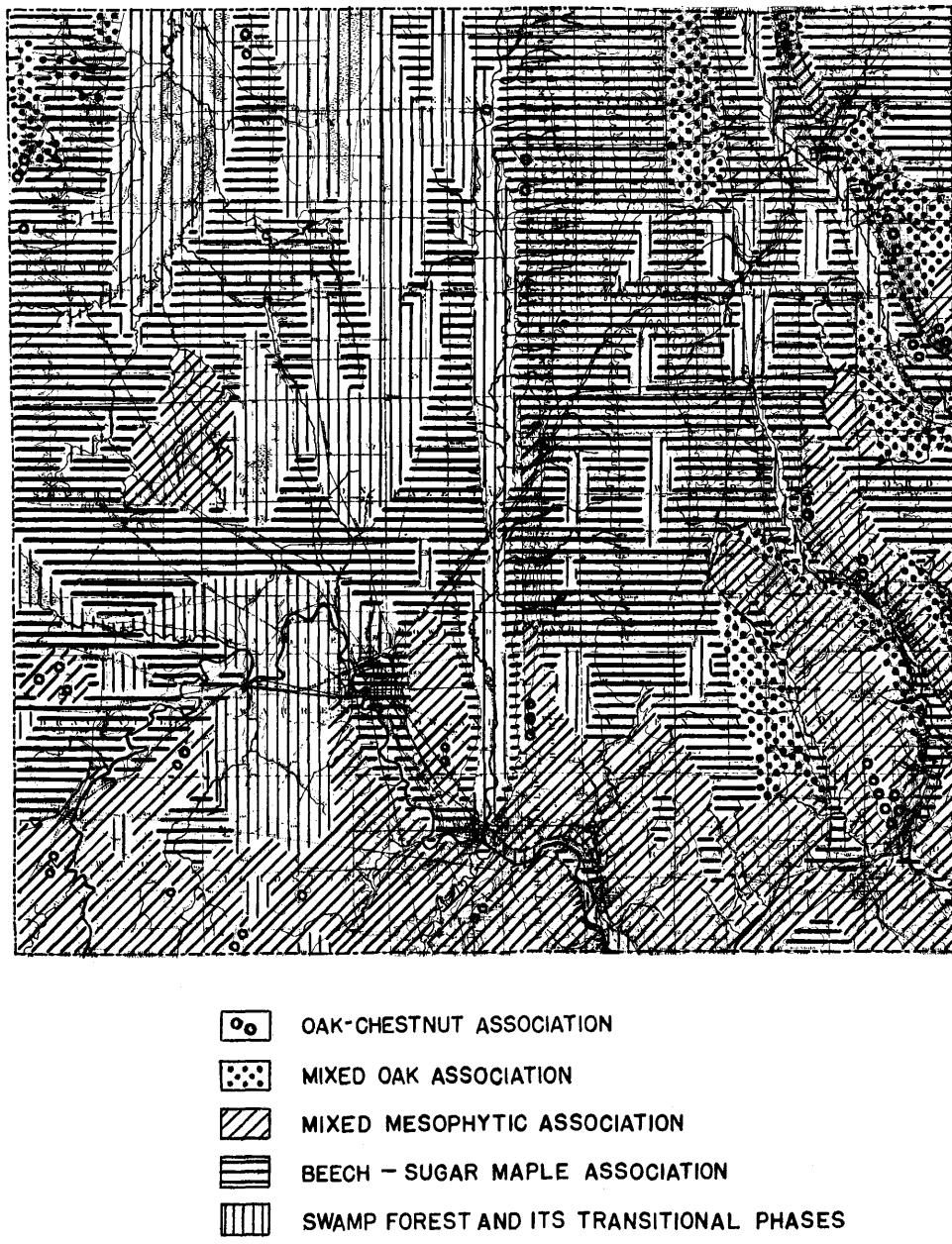

FIG. 2. Generalized map of vegetation types of Trumbull County, Ohio.

ASSOCIATED SPECIES

Sassafras	*Sassafras variifolium* (Salisb.) Ktze.
Red maple	*Acer rubrum* L.
Tulip tree	*Liriodendron Tulipifera* L.
Ironwood	*Ostrya virginiana* (Mill.) K. Koch
Flowering dogwood	*Cornus florida* L.
Juneberry	*Amelanchier canadensis* (L.) Medic.
Wild cherry	*Prunus serotina* Ehrh.
White ash	*Fraxinus americana* L.
Pignut hickory	*Carya glabra* (Mill.) Sweet

Upland Oak Types

The upland oak types originally occupied between 25 and 30 per cent of the area of the county, and were only exceeded in area by beech-maple. With the notable exception of the white oak area in midwestern Trumbull County, they were principally located on the rolling topography to the south and southeast.

Considerable local variation occurred in these types. North and east slopes were much more mesic than those facing south and west. In fact, typical mixed mesophytic stands were probably of local occurrence throughout the area. However only stands of significant size or areas where the type was predominant were so mapped. Local stands of upland oaks in areas dominated by more mesophytic associations were found on the southwest-facing slopes above Pymatuning Creek in Kinsman and Yankee Creek in Hartford.

The most extensive oak type was the mixed oak association, which corresponds with Type 49: *White Oak—Black Oak—Red Oak*, of the Committee on Forest Types, Society of American Foresters (Hawley et al, 1931).[3]

DOMINANTS

White oak	*Quercus alba* L.
Black oak	*Quercus velutina* Lam.
Red oak	*Quercus borealis* Michx. var. *maxima* (Marsh.) Ashe

ASSOCIATES

Red maple	*Acer rubrum* L.
Shagbark hickory	*Carya ovata* (Mill.) K. Koch
Sour gum	*Nyssa sylvatica* Marsh.
Wild cherry	*Prunus serotina* Ehrh.
Shingle oak	*Quercus imbricaria* Michx.
Sassafras	*Sassafras variifolium* (Salisb.) Ktze.
Pignut hickory	*Carya glabra* (Mill.) Sweet
Small-fruited hickory	*Carya ovalis* (Wang.) Sarg.
Linden	*Tilia americana* L.
Flowering dogwood	*Cornus florida* L.
Sugar maple	*Acer saccharum* Marsh.
White ash	*Fraxinus americana* L.
American elm	*Ulmus americana* L.
Slippery elm	*Ulmus fulva* Michx.
Juneberry	*Amelanchier canadensis* (L.) Medic.
Scarlet oak	*Quercus coccinea* Muench.
Chestnut	*Castanea dentata* (Marsh.) Borkh.
Butternut	*Juglans cinerea* L.
Tulip tree	*Liriodendron Tulipifera* L.

Black oak dominated the drier phase and red oak the wetter phase, while white oak was probably the most abundant species throughout the entire range of habitats covered by the association in Trumbull County. Shingle oak was restricted to the parts of the county where the oak types occurred, but it was also a component of the swamp forests within this range. Scarlet oak was restricted to the drier sites and even there was very infrequent.

[3]Types listed by this committee are subsequently referred to as S. A. F. types.

In the morainal region of Southington and parts of the towns south of the Mahoning River, local increase in the abundance of the hickories gave rise to an oak-hickory association. Land survey records indicate that this type was originally much more extensive than would be inferred from present day vegetation, particularly in the latter region.

Other local variants dominated by oaks occurred in these two regions and in the morainal area in Gustavus. The oak-maple association occurred locally in all three regions. Dominants were white oak, red oak and sugar maple. Sugar maple was sufficiently abundant for sugar making in these areas, but was exceeded in abundance by the oaks.

The oak-maple-tulip association is also known to have occurred locally, especially in Lordstown and Gustavus, and with the last mentioned association occupied the most mesic habitats dominated by oaks. In fact, the oak-maple-tulip association approached and graded into the mixed mesophytic association, being distinguished from it by the more pronounced dominance of the species named.

The white oak stands already mentioned occurred on the area of Mahoning silt loam (Conrey and Burrage, 1937) in Southington and adjoining towns. Here white oak was decidedly predominant, forming almost pure stands in many places. The type boundary was well defined on the east, but to the west there was a more gradual transition, grading through oak-maple and oak-maple-beech to beech-maple. The soil type has fair to good surface drainage, but a heavy subsoil makes internal drainage very poor, and the soil tends to bake and crack badly in dry weather.

Mixed Mesophytic Forests

In analyzing "the mixed mesophytic forest community in northeastern Ohio," Sampson (1930b) pointed out that it is a special type of transitional community occupying a position between dry sites covered by oak-chestnut and moist sites in which the complex of factors is favorable to the dominance of beech-maple, and is characterized by an increase in abundance of secondary species intermingled with the dominants of two or more associations.

The evidence obtained indicates that not less than 10 per cent of the area of the county was originally covered with forests of this type, principally in the eastern fourth and on the east-facing slopes of the extreme northwestern corner of the county. In Trumbull County this type is almost entirely restricted to slope habitats, as the internal drainage of the soil is seldom sufficient elsewhere. Slopes that are so steep that they are excessively drained, or so exposed that evaporation is excessive, are characterized by more xeric types, and the mixed mesophytic community is chiefly restricted to more protected situations such as "coves" or ravines, north and east-facing slopes and the more gradual west slopes. Both a good supply of water and good internal drainage (soil aeration) seem to be required.

As previously stated, the mixed mesophytic community occupies a position between oak and chestnut types on the one hand and beech-maple on the other. Although the dominant species of these associations occur in the mixed mesophytic community, other secondary species equal or exceed them in degree of dominance. Species typically showing increased abundance in this community are:

Cucumber tree	*Magnolia acuminata* L.
Tulip tree	*Liriodendron Tulipifera* L.
Red maple	*Acer rubrum* L.
White ash	*Fraxinus americana* L.
Sour gum	*Nyssa sylvatica* Marsh.
Linden	*Tilia americana* L.
Butternut	*Juglans cinerea* L.
Wild cherry	*Prunus serotina* Ehrh.
Slippery elm	*Ulmus fulva* Michx.
American elm	*Ulmus americana* L.

Other species characteristically present, but showing decidedly less dominance than in adjacent associations, are:

Chestnut	*Castanea dentata* (Marsh.) Borkh.
Red oak	*Quercus borealis* Michx. var. *maxima* (Marsh.) Ashe
Sugar maple	*Acer saccharum* Marsh.
White oak	*Quercus alba* L.
Black oak	*Quercus velutina* Lam.
Beech	*Fagus grandifolia* Ehrh.

As Sampson (1930b) pointed out, the invasion order of some of the species varies with the nature of the substratum, and local variation in the relative abundance of certain individual species commonly occurs. It is obvious that a great number of local variants may occur. This extreme local variation has given rise to the general name applied to the community since any binomial or trinomial term would only be locally applicable.

Occurring in parts of the county were certain rather local associations and variants which approached the mixed mesophytic in composition and ecological status. This is true of the oak-maple-tulip association previously mentioned as occurring in Gustavus and Lordstown. Both white and red oaks occurred in this association. Sugar maple was more abundant than red maple. Cucumber was absent or rare in both localities. Hickory was an important constituent in Lordstown. Both a drier phase—oak-chestnut-tulip—, and a wetter phase—maple-oak-beech—are known to have occurred locally in the morainal region of Gustavus. With the exceptions noted, these local variants differed very little in composition but are distinguished by differences in dominance.

The mixed mesophytic areas indicated in Mesopotamia contained a high proportion of red oak, tulip, chestnut and sugar maple. Cucumber was absent and white oak infrequent. These areas were closely associated with a maple-oak-beech association similar to that mentioned in Gustavus.

The transitional types in parts of Southington were of somewhat different composition. Rather than being mixed mesophytic in character they seemed to consist largely of the dominants of the adjoining oak and beech-maple types. They might properly be designated as oak-maple-hickory or oak-maple-beech. The large white oaks characteristically overtopped these forests and were more dominant from size than abundance. The hickories and walnuts showed local increases in abundance in these transition types but chestnut, tulip, cucumber and sour gum were either rare or absent.

Beech-Maple Types

A greater part of the area of Trumbull County was originally covered by beech-sugar maple forests than by any other type. Although extensive stands were largely restricted to the northern two-thirds of the county, they are believed to have occupied between 40 and 45 per cent of the total area.

This part of the county varies from undulating to gently rolling, with little stream dissection. Beech-maple typically and almost exclusively occupied slopes of from 40 to 100 feet per mile in this area. More poorly drained areas were occupied by various phases of the swamp forest formation and areas of greater gradient graded into mixed mesophytic and more xeric types.

In the more deeply dissected areas to the south and southeast, beech-maple types were restricted to certain local situations. Stands occurred on some rather level and undissected upland sites between streams in Hubbard, Liberty and Vienna. Occurrence of beech-maple types in stream valleys was probably more common, especially on second terraces. Local stands on such sites were apparently common in the southern third of the county, the most extensive being along the Mahoning River, Duck Creek and Little Yankee Creek. Local variation in the

direction of a pure sugar maple type was common on these terraces along the Mahoning River and its branches in the southwestern part of the county.

Most of the beech-maple forests of this area conformed to the generalized type listed as S. A. F. Type 57: *Beech-Sugar Maple* (Hawley et al, 1931) and described by Gordon (1932).

DOMINANTS

Beech	*Fagus grandifolia* Ehrh.
Sugar maple	*Acer saccharum* Marsh.

COMMONLY ASSOCIATED SPECIES

Red oak	*Quercus borealis* Michx. var. *maxima* (Marsh.) Ashe
White ash	*Fraxinus americana* L.
White oak	*Quercus alba* L.
Red maple	*Acer rubrum* L.
Wild cherry	*Prunus serotina* Ehrh.
Bitternut hickory	*Carya cordiformis* (Wang.) K. Koch
Shagbark hickory	*Carya ovata* (Mill.) K. Koch
Linden	*Tilia americana* L.
Tulip tree	*Liriodendron Tulipifera* L.
American elm	*Ulmus americana* L.
Slippery elm	*Ulmus fulva* Michx.
Ironwood	*Ostrya virginiana* (Mill.) K. Koch
Blue beech	*Carpinus caroliniana* Walt.

Variants occurring in Trumbull County were due to shifts in relative dominance with little change in species present. Over most of the area beech and maple were decidedly predominant, in some cases making up over 90 per cent of the total stand. The dense shade in these forests was an important factor in suppressing other species. On most of the sites beech exceeded maple in abundance, this dominance becoming greater on wetter soils. On some upland flats a "wet beech" type occurred in which beech was predominant and was associated with swamp forest species, with sugar maple entirely absent. Such areas are discussed and mapped as transitional types.

A maple-beech sub-type occurred in Mesopotamia and Gustavus on east slopes considerably steeper than those occupied by typical beech-maple, and was associated with a further variant which might be termed maple-oak-beech, in which red oak exceeds beech in abundance. These variants approach the mixed mesophytic community which is present in both these areas.

Swamp Forests

Prominent among the original forest types of Trumbull County were a number of associations belonging to the northern swamp forest formation. These forests probably occupied 20 to 25 per cent of the total county area, being only exceeded in area by the beech-maple and oak types. As pointed out by Sampson (1930a), these forests were perhaps unexcelled anywhere in the northern and central portions of the North American deciduous forest in the number of tree species represented. Variations in the relative requirements of these species and in the vegetational history of the areas on which they occur gave rise to a large number of more or less distinct phases within the region considered.

Swamp forests dominated those areas in the county characterized by level to gently undulating topography, heavy, highly acid soils and a very high water table during at least the greater part of the growing season. Both surface and internal drainage are very poor in this range of habitats. These habitats include (1) flood plains, and (2) pre-erosion post-glacial flats.

The alluvial or "first bottom" soils of the flood plains, subject to more or less frequent flooding, were almost entirely covered with swamp forests. The better drained second terrace soils had largely gone over to beech-maple types, but the extensive, flat, poorly drained terraces of the Grand River in Farmington and

Mesopotamia were still too wet for sugar maple. It is not unusual for an area of this valley floor two or three miles wide to be inundated following a heavy rain.

Upland areas bearing swamp forests in Trumbull County are practically uneroded—drainage is very poorly developed. The most extensive areas of this type lie in the broad pre-glacial valley occupying much of the western half of the county. The glacial deposits filling this valley are from 100 to 200 feet thick in many places. Run-off from the higher ground both to the east and the west does not pass through the area but is intercepted by Mosquito Creek on the east and the Grand River on the west. Although both these streams have fairly well developed branch streams toward their opposite sides, very few branches of significant size enter the broad flat between them. This situation is apparently due to a combination of several factors, including the comparatively short time since glaciation, the very level topography, and the impervious character of the glacial soils. Much smaller areas of similar character occur throughout the county on the upland flats between streams.

In his paper on succession in the swamp forest formation of northern Ohio, Sampson (1930a) recognizes the elm-ash-soft maple community as basic for the entire area, at the same time recognizing (1) "certain successional or transitional phases of the swamp forest that frequently developed previous to the invasion of beech, hard maple or white oak," and (2) "certain swamp forest communities in which some of the characteristic secondary species of the elm-ash-soft maple community became sufficiently abundant to be classed among the principal dominants." Elm, ash and soft maple frequently remained dominant in the transitional phases referred to, but degrees of improvement in drainage and soil aeration were attended by the entrance of certain characteristic species. Transition types in the following successional phases of the elm-ash-soft maple community listed by Sampson are recognized from, and named for such indicator species. They may be dominants but are not necessarily so.

(1) Elm-Black Ash-Soft Maple Association.
(2) Bur Oak-Big Shellbark Hickory Transition.
(3) Red Oak-Linden Transition.
(4) Tulip-Walnut Transition.

In the swamp forests of Trumbull County variants and successional phases in which the indicator species attained the rank of dominants were apparently more extensive than the elm-ash-soft maple community. Its best development was attained adjoining the willow-sycamore stream margin association on the flood plains of the larger streams, on lighter and less acid soils than those of the upland swamps. Silver maple (*Acer saccharinum* L.) was practically restricted to such habitats and, even there, was usually less abundant than red maple (*Acer rubrum* L.). Black ash (*Fraxinus nigra* L.) was frequently predominant in the wetter places, while white ash, occurring on the better drained portions, was often exceeded in abundance by the maples.

The upland swamp most nearly like the elm-ash-soft maple of flood plains correspond more closely in order of abundance with S. A. F. Type 26: *Black Ash—American Elm—Red Maple* (Hawley et al, 1931). This type occurred on soils wet the year round, highly acid and frequently mucky. Black ash was much more abundant on these upland areas than on flood plains, in places forming extensive pure stands, notably in Bloomfield and Champion. Silver maple was practically absent, while red maple was often more abundant than elm. Locally yellow birch was an important constituent.

Alder (*Alnus*), willow (*Salix*), and buttonbush (*Cephalanthus*) occurred locally on marshy areas associated with this type. Such marshes commonly occupied from a fraction of an acre to several acres. The willow swamps above beaver ponds in Champion, Johnston, Bloomfield and Southington were the most extensive areas of this sort of which we have record.

Entrance of bur oak (*Quercus macrocarpa* Michx.) and big shellbark hickory (*Carya laciniosa* (Michx. f.) Loud.) into the swamp forest indicates some improvement in drainage and soil aeration. Areas in which these species became common to abundant are known to have existed along the Grand River in Mesopotamia and Bloomfield, along Little Yankee Creek in Hubbard, and locally in Newton and Lordstown. The total area occupied by such forests was, however, quite small. This transitional phase was more commonly developed as a swamp oak type, with marked increase in abundance of pin oak (*Quercus palustris* Muench.) and swamp white oak (*Quercus bicolor* Willd.), and very little hickory present. Such a type characterized a large part of the Grand River flats and some of the heavy clay upland soils. American elm, red maple and sour gum were the most frequent and most abundant associates of the swamp oaks.

Stands of almost pure pin oak occurred as a local variant, representing the wettest phase of the swamp oak type. Such areas are known to have occurred in the original forests of Champion and Lordstown, and along Mosquito Creek in Howland, and pin oak has become more widespread and quite abundant in the secondary forests.

With slight improvement in drainage and aeration shagbark hickory and red oak enter both the big shellbark-bur oak transition and the swamp oak association, frequently in considerable abundance. Shagbark hickory is more abundant in these transitional phases of the swamp forest formation than in any other association occurring in Trumbull County. White ash seems to have attained its maximum abundance in this phase of the swamp forest, particularly in the southwest quarter of the county. Much of the swamp forest of the eastern half of the county has reached this stage in succession with red oak frequently sharing the rank of dominant with elm, white ash, and red maple, and such secondary species as shagbark hickory, bitternut hickory, sour gum and slippery elm attaining local prominence. While these successional phases correspond with Sampson's red oak-linden transition, it is of interest that linden is only very locally abundant in Trumbull County.

A fourth phase of the swamp forest, termed the tulip-walnut transition, is recognized in those situations in which these species along with butternut and cucumber tree also enter before invasion and dominance of beech, sugar maple or white oak. Perhaps the most typical development of this phase occurred locally on the terraces of the Mahoning River, Mosquito and Pymatuning Creeks, but the large pre-erosion flat in north central Trumbull County contains portions which have reached a corresponding phase of development. In general aspect much of this area was a mixed swamp forest, consisting of an intimate mosaic of intergrading transitional phases. The topography varies from level to gently undulating, and the slopes average only a few feet to the mile, but local variation in drainage was enough to bring about the development of a mosaic forest, with the previously described transitional phases locally represented. Within this area some "ridges" only a few feet higher than the surrounding territory were covered with white oak or beech, but by far the greater part of the area was dominated by swamp forest species. Sugar maple was very infrequent.

Some portions of this upland flat had developed the wet beech type. The wet beech flats differed from the beech-maple association in several respects. They were practically restricted to the upland flats west of Mosquito Creek, on heavy clay soils with the water table at or near the surface of the ground most of the growing season. Sugar maple was almost entirely absent, but beech made up as much as 80 per cent of the stand in many cases. The commonest associates were swamp forest species, such as red maple, shagbark hickory, elm, sour gum, red oak and pin oak, with cucumber tree locally frequent to common. On such areas beech invaded the swamp forests far in advance of sugar maple. Cucumber invaded these areas before tulip.

The root systems in such forests are very superficial and the existing remnants have suffered greatly from pasturing and recent droughts. In this swampy region, the beeches frequently have dead tops. These forests would fall into S. A. F. Type 58: *Beech. Pin Oak* is given as a variant of this type, but in this region pin oak is an index of a wetter site that is invaded by beech as the drainage improves.

A similar forest community was described by Hicks (1933) for Ashtabula County, the most extensive area occurring in the south central portion of that county, just north of the headwaters of Mosquito Creek. Sampson (1930a) mentions that "wet beech forests with elm, hickory and red maple as the principal secondary trees are sometimes found in Portage County." A similar community is described by Braun (1916) as the pre-erosion climax of the hydrarch succession in the Cincinnati region. Although the soils of that region differ in their origin from those of northeastern Ohio, those on the areas in question are alike in their heavy character, poor drainage and high acidity.

RELICT TYPES

Certain associations occurring very locally in Trumbull County have little direct relationship to present day vegetation and are best explained as remnants of types which occupied the region much more generally in past stages of its vegetational history. Such local areas are not only interesting because of their unique nature, but because of their indication of vegetational history.

Hemlock

Although extensive hemlock forests occurred on upland flats in Ashtabula County within ten miles of the north edge of Trumbull County (Hicks, 1933), this species was here restricted to gorges and protected stream banks. With the exception of two gorges in the extreme northwestern corner, it was found only on scattered sites in the eastern half of the county.

Only in the Mesopotamia gorges did the hemlock become abundant enough or occupy sufficient area to form well-defined forest types. The least exposed situations, particularly steep north-facing slopes, were covered with pure hemlock. More extensive was a hemlock-birch-beech association which graded through a beech-maple-hemlock transition into the beech-maple of the surrounding upland. This transitional stage was sometimes characterized by an abundance of red oak and the presence of chestnut, and then approached a local mixed mesophytic type.

The flora of the gorges was characterized by the following species not found on the surrounding upland:

Hemlock	*Tsuga canadensis* (L.) Carr.
Yellow birch	*Betula lutea* Michx. f.
Sweet birch	*Betula lenta* L.
Mountain maple	*Acer spicatum* Lam.
Red-berried elder	*Sambucus pubens* Michx.
American fly honeysuckle	*Lonicera canadensis* Marsh.
Bush honeysuckle	*Diervilla Lonicera* Mill.

White Pine

Insofar as known, only one area of white pine (*Pinus Strobus* L.) occurred in the primeval forest of Trumbull County. This stand originally occupied about 100 acres in the south central part of Kinsman, east of Pymatuning Creek. This area consisted of low gravel ridges with small bogs lying between them, the pines occupying both the bogs and the higher ground. According to reports of local residents, trees over four feet in diameter were present in the original stand. White oak and sugar maple were the most frequent associates of the pine on the low ridges, while the boggy portions characteristically included alder, yellow birch, winterberry (*Ilex verticillata* (L.) Gray) and high bush blueberry (*Vaccinium corymbosum* L.).

Bogs

The poorly drained upland flats of Trumbull County have been sites favorable to the maintenance of bog vegetation until recent times. Even today such characteristic bog species as sphagnum and high bush blueberry occur frequently in the wetter phases of the swamp forest.

Two bog areas dominated by tamarack (*Larix laricina* (Du Roi) Koch) are known to have been present in Trumbull County at the time of settlement. The larger of these was the famous "Bloomfield swamp" occupying the eastern third of Bloomfield. About one and one-half square miles of this area was covered with tamarack. It occurred in a pure stand, but was entirely surrounded by a zone of black ash, which graded outward into the mixed swamp forest characteristic of this flat upland.

Most of the tamarack was destroyed by fire in 1854, and periodic fires since then have altered the vegetation and destroyed the surface muck of a large part of the area. The swamp was drained about 20 years ago and a large part has been cleared and is being used for market gardening. A few tamaracks, the largest about 15 inches in diameter, remain on the area. The bulk of the accompanying vegetation consists of the following species:

Pin oak	*Quercus palustris* Muench.
Red maple	*Acer rubrum* L.
American elm	*Ulmus americana* L.
Yellow birch	*Betula lutea* Michx. f.
Quaking aspen	*Populus tremuloides* Michx.
Poison sumac	*Rhus vernix* L.
High bush blueberry	*Vaccinium corymbosum* L.
Toothed arrow wood	*Viburnum dentatum* L.
Winterberry	*Ilex verticillata* (L.) Gray
Alder	*Alnus incana* (L.) Muench.
Smooth sumac	*Rhus glabra* L.
Blackberry	*Rubus allegheniensis* Porter
Swamp dewberry	*Rubus hispidus* L.
Chokeberry	*Aronia melanocarpa* (Michx.) Ell.
Hardhack	*Spiraea tomentosa* L.
Meadowsweet	*Spiraea alba* Du Roi
Clematis	*Clematis virginiana* L.
Goldenrods	*Solidago* spp.
Asters	*Aster* spp.

A much smaller area of tamarack was encountered on the west edge of Braceville by the surveyors who ran the Trumbull-Portage county line. These trees were likewise destroyed by fire some time previous to 1900, and the area is at present covered with a pin oak swamp.

Evidence of bog shrub and bog meadow associations is not likely to be as well preserved. Destruction by fire, drainage and cultivation is almost complete. The following list of bog locations is based chiefly on historical evidence of the occurrence of cranberries.

(1) The portion of the Bloomfield bog south of the center road contained about 50 acres of sphagnum-cranberry bog meadow, surrounded by a zone of blueberries.

(2) A cranberry bog in the southeastern corner of Johnston is locally reported to have covered about 200 acres, and lay above a beaver dam.

(3) A bog in the northeastern quarter of Lordstown was mentioned in a local history. The area has been drained and the only remnant is a sedge meadow of 3 or 4 acres.

(4) A bog of about 30 acres was located in the northwest corner of Newton. The cranberries were eliminated by drainage during railroad construction.

Treeless Areas

Few areas in Trumbull County were naturally treeless. Since such areas were unusual and since they indicated the character and value of the land, they were recorded in the survey notes.

Sears (1926) has interpreted three of these areas as "prairies" in his map of the prairies of Ohio. The applicability of the term is very doubtful. The survey notes indicate that they were of two types: (1) "beaver meadows" and (2) "intervales."

Beaver dams gave rise to treeless areas by raising the water table and "drowning out" the trees. The ponded areas became sedge and *Calamagrostis* meadows or bogs. The Johnston cranberry bog and the treeless areas recorded in the west central part of the county were of this type. Beavers may also have been a factor in extending the area of the Bloomfield bog.

The term "intervales" seems to have been used to refer to sedge and grass meadows along streams. They seem to have occupied those portions of the flood plain where the water table was very high much of the time and soil aeration was consequently insufficient for trees. They were for the most part dominated by species of *Carex, Juncus, Glyceria,* and *Calamagrostis.*

SUCCESSFUL RELATIONSHIPS

With the development of modern plant ecology has come general recognition of the dynamic nature of vegetation. Vegetation in a changing environment is undergoing constant change. The most general vegetational changes result from shifts in climate, but local microclimatic situations and local edaphic factors, particularly soil texture and water relations, may offset or modify the effect of even a general change in climate. The result is a segregation of vegetation types—the development of a vegetation pattern.

Subsequent general changes in environment are likely to affect these local phases of the vegetation in different degree, and produce an even more complex picture. Any explanation of the relationships of the present vegetation types must therefore take into account the vegetational history of the region.

The post-Pleistocene vegetational history of this general area has been inferred on floristic grounds by Transeau (1903) and Gleason (1923) and on the basis of studies of fossil pollen by a number of workers, including Sears, who has summarized and interpreted these investigations (1932, 1935, 1938). Details of interpretation differ, but there is general agreement on the broad outline presented in the following paragraphs.

At the time of maximum glaciation a zonation of vegetation similar to our present continental zonation is believed to have existed south of the ice border. The narrow tundra zone nearest the ice margin was bordered by a northern coniferous forest, the most extensive southern development of which occurred at high altitudes. Between this boreal forest and the deciduous forest farther south occurred the northern types of mixed forests of conifers and hardwoods.

In our region the receding glacier was probably closely followed by tundra vegetation, followed in turn by spruce and fir on the better sites. With the development and extension of forest vegetation over most of the area during this and subsequent stages, the tundra vegetation became more and more restricted to shallow depressions and flat pond and stream margins too wet for trees. Edaphic conditions on some of these sites retarded succession to such a degree that these boreal bogs with their accompanying bog forest of tamarack persisted until destroyed by human agencies.

The boreal forests of spruce and fir seem to have been succeeded by mixed forests such as we now find in the St. Lawrence valley. Sears interprets the great abundance of pine at this point in the pollen profiles as indicative of change from

a humid to a dry climate. In central Ohio oak also comes in at this point. Following this pine-oak level a beech maximum occurs in Ohio and a hemlock maximum in southeastern Canada, indicating the recurrence of more humid conditions.

Such climatic shifts would result in a segregation of the various species on those sites most favorable for them, or on poorer sites more favorable for them than for other species.

The late post-glacial xerothermic period postulated by Gleason (1923) and supported by Sears' interpretation of the pollen profiles would help to account for the absence of northern conifers from the usual upland forests of the region today.

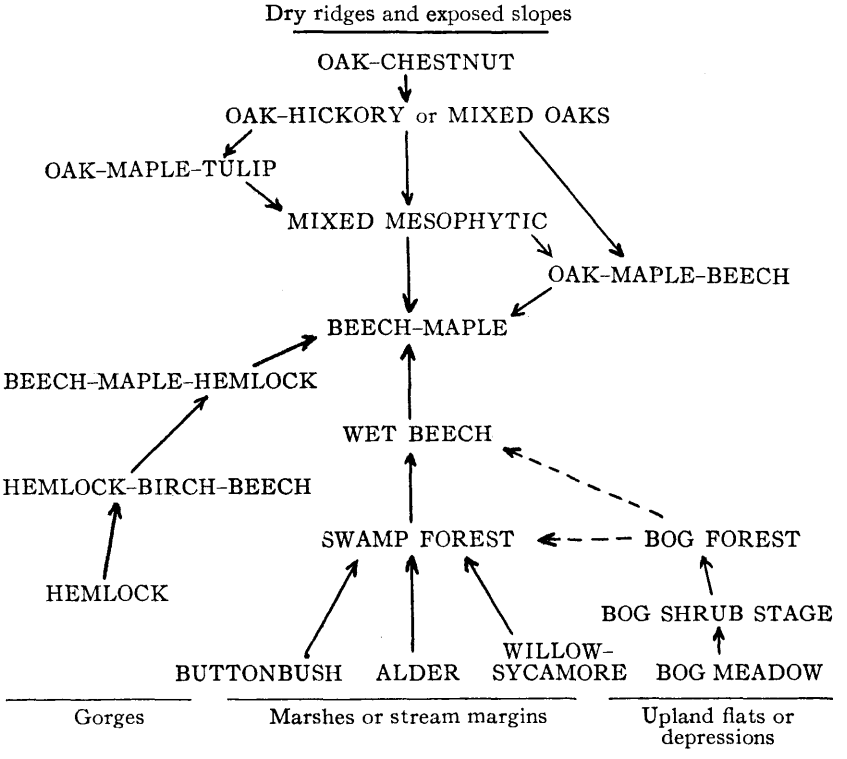

FIG. 3. Diagram showing inferred successional trends with improvement in soil moisture relations. The beech-maple climax occupies those sites on which a good soil moisture supply is combined with favorable soil aeration.

During such a climactic extreme the segregating effect of local environments would be quite pronounced. It seems logical that the more mesic forests of beech, maple and associated species already segregated out would be reduced in area, while more xeric species such as the oaks would show a marked increase both in abundance and in area dominated. Such a period would favor the development of oak forests like those in southeastern Trumbull County, although it is also possible that these slopes were covered with oaks at a much earlier time, such as the "cool, dry, pine-oak" period designated by Sears for central Ohio.

In addition to these historical successions, succession continues to occur as a result of modifications in drainage, topography and soils. The direction of change in any locality depends upon the nature of the changes in the habitat, and may be toward a more mesic or a more xeric type of vegetation. However the tendency

of these lines of succession to converge toward the regional climax association has been frequently observed, and may best be illustrated for this region by a chart (Fig. 3), which summarizes the present-day changes in the vegetation of this area which occur as soil moisture relations improve. The arrows indicate the direction of succession. The beech-maple climax occupies those sites on which a good soil moisture supply is combined with favorable soil aeration. It develops on areas with swamp and bog history as soon as drainage and consequent soil aeration improve enough to permit the entrance of its dominant species, and on areas formerly occupied by upland oak forests and related types as soon as the soil moisture supply becomes constant enough to permit their establishment. The climax status of the beech-maple association is largely due to the dense shade it produces and the shade-tolerance of its dominant species.

In the past century and a half white man has introduced a number of factors which have profoundly modified the natural vegetation. These factors include selective cutting, complete lumbering and clearing, and the pasturing, fire and artificial drainage incidental to agriculture. Successional trends in the secondary forests following such disturbance vary with the degree of modification of the habitat, but the usual effect of disturbance is a decrease in available moisture and consequently the oaks and hickories have generally increased in abundance in the secondary forests of the region.

SUMMARY

The major types of natural vegetation which covered this portion of the glaciated plateau region of northeastern Ohio may be summarized as follows:

1. The climax beech-maple association was the most extensive vegetation type occurring in the county, occupying almost half of the total area and attaining its best development on the undulating to gently rolling topography of the northern two-thirds and western parts of the county.

2. The most characteristic association of eastern and southeastern Trumbull County was a mixed oak type, which covered the steeper and more exposed slopes. Upland oak types originally occupied about one-fourth of the total county area.

3. The mixed mesophytic forest community, made up of a wide variety of species and occupying slopes having well aerated soil and continuous water supply, occupied at least one-tenth of the total county area, occurring locally in the eastern quarter and the extreme northwestern corner.

4. Forests in which chestnut was a dominant species covered only a small part of the area of the county, and were restricted to overdrained situations, characterized by thin soils over sandstone or gravel.

5. Swamp forests were most extensive in the western half of the county, particularly on the flats in the broad pre-glacial valley to the north. These forests included a number of local variants and transitional phases of the elm-ash-soft maple community which are associated with varying degrees of drainage and soil aeration.

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