AN ECOLOGICAL SURVEY OF DELAWARE COUNTY, OHIO.

A Thesis Presented for the Degree of
Master of Arts

by

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Approved by
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I. Introduction

Delaware County is unique both in position and topography, being very near the center of the State and dissected by four parallel streams, each peculiar to itself. On the west the Scioto River flows from north to south thru glacial flats and gravel pits in the north, to Columbus limestone in the south. Along the upper course of the Scioto the general level of the country is but little higher than the water in the runs and creeks. Here the river has not deeply eroded its bed, so that the appearance of this part is not unlike that of the marsh lands of Hardin and Marion Counties.

There is little doubt but that the geological history of this portion of the county thru the townships of Thompson, Badmin and parts of Scioto and Delaware is much differently written than that of the rocky slopes of the southern part.

The Olentangy has worn its channel thru the central part of this region in much the same manner as has the Scioto; with this exception: it encountered the high shale banks thru which it has been able to force a way, also thru the terminal moraine at Powell. The upper course known as the Whetstone has a much older appearance, denoting that there have been changes or upheavals during its history from youth to old age.

Alum Creek crosses the county east of the center where there are excellent outcrops of Ohio Shale; in the northern part near the Morrow County line, near Wilbourne, and again
at Cheshire are found sections of the black shale from forty to sixty feet in depth.

Big Walnut with its numerous branches, covers the eastern part of the county. In Porter Township at its source are found the high glacial drifts some of which are more than one thousand feet (1045) above sea level. It flows south-westerly until it leaves the county at the east side of Seneca Township, where it has encountered the Bedford Shale; here a fine example of weathered hills may be seen. The bluffs along the bank in the eroding shale have assumed a topography resembling the 'Bad Lands' of 'The Dakotas', the color being so conspicuous as to fasten upon them the name, 'Red Hills' (Stauffer).

There are four distinct rock forms outcropping in this region; the Scioto River having worn its valley down to the formation known as the Columbus limestone, presents a steep rock face in some places along the river and its tributaries, which furnish a very fine place for the growth of such trees as red cedar (Juniperus virginiana) and arbor vitae (Thuja occidentalis); on the Olentangy the Delaware limestone and the Olentangy shale give perhaps the widest range of associations. However there is so much similarity to the associations which are found along the Scioto, that one may hardly consider the difference.

Alum Creek lying about six miles to the east of the Olentangy presents the black shales known as 'Ohio Shales' which were the last formation of the Devonian Age in Ohio.
The writer has had occasion to carefully examine this formation for several miles along the outcrop at Salt Well Run, Dutton's Run or Slatelick, Longwell Run and Alum Creek in Brown and Berlin Townships where there is a distinct exposure. This shale when spread out and exposed to the weather breaks up into stiff dirt colored clay which slips down the side of the high banks to form terraces and alluvial fans at the bottom of the slopes.

This region has an area of 283,289 acres, embracing about 81,975 acres of tillable land; 104,649 acres of meadow and pasture land; 96,665 acres of woodland; this being taken from the Auditor's report several years ago. The area of the woodland has diminished somewhat since those figures were given.

The purpose of this report is to determine the location of the various plant associations together with the composition of each. No attempt will be made to list all of the plants which occur in this region, but only sufficient to identify the associations. The writer has spent a number of years living in different parts of this county, where many survey trips have been taken for the purpose of studying the different plant groups, so that whatever may be said of this is given first hand.

The writer wishes to express appreciation to Dr. Edgar N. Trueseau who has given many valuable suggestions and helps in the preparation of this survey. To Captain Henry of the State Auditor's office for helping in locating the records of the U.S. Govt. Survey. To Dr. Homer C Sampson whose paper
on The Prairies of Illinois has been very helpful in plan
and outline. To Mrs. V. T. Sheets for many helpful suggestions
and corrections. To the farmers and friends of Delaware County
who helped to locate some of the fine forests and who
allowed the writer to visit their farms in search
of valuable data.
Composition of The Associations.

The Mixed Mesophytic Forest Association: To all appearances this is the climax of all the forests found in this region.

The constituent species are: Fagus grandifolia, Acer saccharum, Quercus alba, Fraxinus americana, Ulmus americana, Ulmus fulva, Quercus rubra, Fraxinus nigra, Quercus cocinea, Quercus velutina, Cornus florida, Prunus serotina, Gleditsia triacanthos, Carya ovata, Acer saccharinum, Juglans nigra, Aesculus glabra, Sassafras officinale, Ostrya virginiana, Nyssa sylvatica, Populus deltoides, and Carpinus caroliniana.

With the above there are found many seedlings and shrubs such as: Cornus florida, Acer saccharum, Prunus serotina, Rubus occidentalis, Rhus toxicodendron, Asmina troloba, Psedera quinquefolia, Carya ovata, Pyramus obovatus, and Rubus nigro-baccus.

With the above are found a few characteristic herbs which are always present, such as: Viola papilionacea, Galium circosans, Desmodium nudiflorum, Agrimonia, parviflora, Circeea lutetiana, Hepatica triloba, Viola pubescence, Aspidium spinulosum, Adiantum pedatum, Impatiens fulva, Prunella vulgaris, Potentilla canadensis, Pilea pubilla, Actea alba, Smilacina racemosa, Prunanthes alba, Agrostis stolonifera, Jeffersonia diphylla, Saginaria canadensis, Podophyllum peltatum, Acalypha gracilens, Hydrophyllum macrophyllum, Geranium maculatum.
The mixed mesophytic forest of Delaware County is not entirely complete, for the writer has been unable to find the tulip trees (Liriodendron tulipifera) in this section anywhere. In the northern part of Marlborough Township there is a forest located on a till plain in a habitat which is favorable to the growth of tulip trees. However none are present.

Are tulip trees a remnant of pre-glacial times? Are they crowded out by a more hardy race of trees, or why are they absent? The writer is unable to say.

Maple Beech Association: This association seems to be the leading group in this region as far as numbers are concerned. It is found in nearly all townships of this county except those of the northwestern part, namely Radnor and part of Thompson, and here the beech is found only in rare cases, while the rock maple and soft maple are growing to good size.

Listed as follows: Acer saccharum, Fagus grandifolia, Acer saccharinum, Ostrya virginiana, Fraxinus americana, Carya ovata, Quercus alba, Cornus florida. Shrubs: Ostrya virginiana, Carya ovata, Cornus florida, Aesculus glabra, Prunus serotina, Rhus toxicodendron, Acer saccharum, Ulmus fulva, Fagus grandifolia, Quercus rubra, Herbs: Impatiens fulva, Agrostis alba, Agrostis stolonifera, Hydrophyllum macrophyllum, Circaea lutetiana, Prunella vulgaris, Smilacina racemosa, Desmodium nudiflorum, Viola papilionacea, Epifagus virginiana, Panax quinquefolium, Hepatica triloba, Agrimonia parviflora, Adiantum pedatum, Aspidium spiculatum, Aspidium marginale. Fine examples of this type of forest
may be seen at the Randolph Estate in Brown Township and in Delaware, Genoa, Orange, and Liberty Townships. The Beech-Maple Association is almost exactly the same except beech trees predominate. Maple trees are among the seedlings, with elm, ash, and oak coming in. This indicates that there is a higher moisture content in the soil. That is, there is more moisture held in the soil than is transpired.

The Pure Beech Association; This association is of rare occurrence, however the writer found several places where to all appearances there is a complete beech association. In each case there is an abundance of humus with a deep layer of leaves, covered by dense shade under which it is difficult for new plants to make headway. Surrounding these groups are armies of intruders ready to make in to the forest, so it is only a question of time until there will be no such thing as a pure beech forest.

Listed as follows; *Fagus grandifolia*, *Ostrya virginiana*, *Gormus florida*. Herbs; *Adiantum pedatum*, *Epifagus virginiana*, *Phegopteris polypodiacea*. Examples of this type of forest association are found in Brown, Genoa, and Liberty Townships.

The pure beech forest associations grade off into the beech-maple or go directly to the mixed mesophytic forest.

In the case of a beech forest there is always a tension line where the foreign plants are encroaching upon them. Some of the invaders were; Blue grass (*Poa pratensis*) and white top (*Erigeron annuus*). It seems that the beech woods of this county are doomed to be driven out by the mixed forest in every short time.
Oak-Hickory Forest Association: This association is found in all parts of the county where the slope has lowered the water table sufficiently for the development of this type of forest. The oak-hickory forest is found on the glacial deposits of Rainor and Porter Townships as it is found on the shale of Brown and Berlin Townships. However, this must be qualified by saying, that in all cases where this forest occurs, whether it be on shale, sandstone or limestone, there has been lain down at some time prior to its development a layer of glacial drift. In none of the conditions did the writer find this association unless the drift was of at least five or six feet to many more in depth. The shale outcrops along Alum Creek about one-half mile from what was one of the finest oak-hickory forests of the State; but the deposits here are found to be about thirteen feet in depth, consisting of a thin layer of soil over yellow clay. The soil held a generous amount of shale flakes and small concretions composed largely of iron.

On the limestone in the western part of the county are found several fine oak-hickory forests with the hickory not so large as those mentioned above. There are however a greater number of oaks in this than are found in close proximity to Alum Creek. Listed as follows; Trees, Quercus alba, Quercus cocinea, Quercus rubra, Carya ovata, Quercus velutina, Carya alba, Acer saccharum, Frazier americana, Fagus grandifolia, Acer negundo, Cornus florida, and Acer saccharinum. Shrubs, Cornus florida, Prunus serotina, Rubes occidentalis, Asclepias glabra, Juglans nigra, Frazier americana, Acer saccharinum,
Ulmus americana, Paeonia quinquefolia, Rubus nigrobaucus and
Rhus toxicodendron. Herbs, Viola palmata, Potentilla canadensis,
Carex sterilia, Haeuchera americana, Oxalis stricta, Pilea pumila,
Acalypha gracilens, Solidago canadensis, Agrostis alba, Lebelia
inflata, Polygonum arifelium, Viola papilionacea, Hedeoma pul-
egioides and Danthonia spicata.

Examples of this type of forest may be found in Brown,
Radnor, Kingston, Porter and Liberty Townships.

It has been difficult to locate a good example of this
kind of forest, for hickory lumber has been in so great demand
at high prices, that at present there is no well defined
oak-hickory forest in existence. Perhaps the best one at the
present time is located on the Joe Thomas farm about five
miles south of the village of Radnor. Here on a low gravel
deposit is a very good example of this type of woods in good
state of preservation, with oaks and hickories of good size.

Chestnut-Chestnut Oak Forest Association: This group
is found in one place only in this county and that is at
Rattlesnake Run about one mile east of Sunbury on the sand-
stone cliffs which are present at that place. Some writers
have said that chestnut trees are found only on sandstone by
reason of their habit of growth, but the writer has found
chestnut trees in two different locations in Ohio growing
upon the limestone ridges. On the limestone ledge of Erie
County there are chestnut trees growing and bearing fruit.
They also occur in Hancock County just above Big Spring Prairie
in the eastern part. So it seems that there are many variations
in the choice of trees and plants in selecting their habitats.
Moisture, soil, and proper climate with ability to secure a foothold seem to be the prominent factors in deciding where a tree shall grow.

Listed as follows: Trees, Quercus prinus, Quercus rubra, Quercus velutina, Quercus coccinea, Quercus xifengdui, Castanea dentata, Quercus alba, Tilia americana, Acer saccharum, Carpinus carolina, Ostrya virginiana, Fraxinus americana, Hiceoria glabra, Fagus grandifolia, Acer nigrum (Var. Saccharum) Shrubs, Rhus toxicodendron, Cornus florida, Cornus alternifolia, Passera quinquemolis, Celtis occidentalis, Juglans nigra, Juglans cinerea, Vitis cordifolia, Ribes cynosbati, Aesculus glabra, Benzoin benzoin, Evonymus obovatus, Fraximn americana, Carva cordiformis, and acer saccharinum. Herbs, Viola palmata, Impatiens fulva, Oxalis stricta, Aster divaricatus, Pilea pemila, Apocynum cannabinum, Mentha piperita, Asplenium ebenoides, Galium trifidum, Aspidium marginale, Serojularia nodosa, Waportea canadensis.

**Beech-Ash-Maple Forest Association:** This association is found wherever the land lies in depressions with sufficient moisture for the production of this kind of forest. With a slow filling in of humus and decayed vegetation these depressions became a very fertile place for the rapid growth of large trees which make up the above association. With the lowering of the water table by the streams cutting out their beds, a change came which caused the development into either this type of woods or into the mixed climax forest, depending upon the amount of moisture remaining.

Listed as follows: Trees, Ulmus fulva, Ulmus americana,
Fraxinus nigra, Acer rubrum, Acer saccharinum, Juglans nigra, Fraxinus pennsylvanica, Quercus palustris, Quercus bicolor, Quercus rubra, Tilia americana, Populus deltoides, Quercus macrocarpa, Shrubs, Xanthoxylum americanum, Viburnum prunifolium, Benzoin benzoin, Cornus alternifolia, Carya cordiformis, Corylus americana, Carpinus carolinia, Ulmus fulva, Quercus alba, Ulmus americana, Herbs, Pilea pumila, Eupatorium perfoliatum, Acalypha gracilens, Carex comosa, Impatiens fulva, Viola striata, Allium vireale, Rumex crispus, Vernonia maxima, Hyssop officinalis, Malva rotundifolia, Lobelia inflata, Polygonum arifolium.

**Pin Oak-Swamp Oak Forest Association:** This forest group is found in several places in the county lying just below the mixed mesophytic forest. Good examples may be seen in Kingston and Brown Townships. Listed as follows; Trees, Quercus palustris, Quercus bicolor, Quercus macrocarpa, Quercus nigra, Acer saccharinum, Salix longifolia, Salix nigra, Ulmus americana, Ulmus fulva, Populus deltoides, Populus tremuloides, Fraxinus nigra, Shrubs, Salix nigra, Benzoin benzoin, Evenia atropurpurea, Solanum dulcamara, Cornus amomum, Rhus toxicodendron, Paederia quinquefolia, Herbs, Pilea pumila, Malva rotundifolia, Rumex crispus, Eupatorium perfoliatum, Angelica atropurpurea, Polygonum hydropiper, Polygonum acre, Arctium lappa, Scirpus atrovirens.

**Cottonwood-Black Willow Association:** A very fine example of this association is found south of the Powell Road on the Olentangy. Willows and cottonwood are often found in an association of their own. Listed as follows; Populus deltoides, Salix discolor, Salix fluviatilis, Salix nigra, Salix petiolafisa,

Swamp-Shrub Association: This association is found in Kingston, Porter, Orange, and Radnor Townships well developed in the low wet ground where the glacial drift has been able to hold water from draining away thru the soil. This could well be termed the 'bog meadow series', for in many places in Ohio this group is found. Some notable places might be mentioned, which the writer has visited for comparison. At Buckeye Lake there is found a very good example of the swamp shrub association. In Hancock County near Big Spring Prairie in Big Lick Township is also a very fine group. In the opinion of the writer, in the swamp associations of Ohio which have been closely observed, there is much similarity in composition.

Listed as follows; Shrubs, Cephalanthus occidentalis, Cornus stolonifera, Cornus paniculata, Cornus amomum, Rosa Carolina, Quercus palustris, Acer saccharinum, Fraxinus nigra, and Corylus americana.

White Oak-Black Oak Forest Association: In only two cases did the writer find a pure oak forest with oak seedlings coming in for a replacement. These were found in the extreme northern part of Kingston Township where Indigo Creek had cut
deep ravines thru the glacial drift and again in the Southern part of Harlem Township where Duncan Run had cut its way down thru the red shale. There was a difference in the soil of those places. The former was situated upon an almost pure glacial drift with an elevation of one thousand feet above sea level; the latter upon the red shale which Stauffer terms the 'Bad Lands'. The composition of the woods was nearly the same except the ground cover of the latter place was distinctly an oak replacement. Listed as follows: Trees, Quercus alba, Quercus rubra, Quercus coccinea, Quercus velutina, Viburnum prunifolium, Quercus nigra, Hamamelis virginiana. Seedlings were all oak. The ground cover being largely some form of reindeer moss.

Fig. 2. Shows the forest in Harlem Township.

The Ledge Plant Association: This association is of much interest because ordinarily it is found only in the mountains, however there are several places in this region where there is a well defined ledge plant growth; on Big Walnut south of Galena, on the upper course of the Whetstone, on Alum Creek at the Sunbury Pike, at High Banks on the Olentangy, on the Scioto west of Powell and in several ravines whose sides are high and rocky.

Listed as follows: Trees, seedlings of numerous trees, such as Quercus alba, Ostrya virginiana, Prunus serotina, Aesculus glabra, Carya cordiformis, Fraxinus americana, and Amalanchier canadensis. These trees will in most cases die from lack of moisture before they can gain a foothold which will mature them.
It is noticeable that the trees that gain start upon the ledge are those whose seeds are carried by animals or by the wind. The soil is so thin that the trees are not supplied with sufficient moisture to keep them alive until the roots grow deep enough to reach a plentiful supply of water. However there are some trees such as Ostrya virginiana and Cornus florida, and some of the oaks able to get a permanent hold. Fig. 3 will show how red cedars have grown in the limestone in Scioto Township until it has reached tree size. Its roots have forced their way into the rocks, spreading the fissures until they were able to obtain moisture sufficient to maintain growth.

Listed as follows: Viola blanda, Prenanthes alba, Pellea atropurpurea, Solidago nemoralis, Ostrya virginiana, Galium trifidum, Asplenium ebenoides, Ribes cynosbati. These with numerous seedlings make up the ledge plants for this section.

The Cottonwood Association: This group lies along the river in all parts of the county. There are many indications found in nearly every township, of past years existence of a cottonwood forest in the lowlands. Large trees are found standing in the clearings, along roadsides and in bottom lands. This goes to show that there were good sized cottonwood trees in the past. One notable example is the giant cottonwood tree which stands on the Ohio Wesleyan Campus. A former student stated that this tree fifty years ago was larger than it is at present, the idea being that it has not grown any in size in all this time owing to conditions of moisture being changed or
Modified. (This tree is shown in Fig. 15)

There were many others located in different parts of this section. Thousands of small cottonwood trees are springing up along the roadsides, in ditches, along small streams and in reforested areas where there is sufficient moisture to enhance their growth.

Listed as follows: Trees, Populus deltoides, Salix nigra, Salix exigua, Quercus tinctoria, Herbs, Lythrum alatum, Elymus virginicus, Angelica atropurpurea, Solidago altissima, Lupinus perennis, Silphium perfoliatum, Rudbeckia laciniata, Elymus canadensis, LepREA oryzae, Glyceria septentrionalis, Cicuta maculata, Brassica nigra, Gaura biennis, Verbena urticifolia, Aselepias syriaca, Xanthium canadense, Poa pratensis, Prunella vulgaris, Menchera americana, Aster ericoides, Gaulophyllum thalictroides, Andropogon furcatus.

This group rapidly runs out and is replaced by a more hardy forest, except on the river side where the cotton-wood can keep their hold. Occasionally, a cotton-wood has been able to hold its place by not allowing some other forest group to crowd it out. Then we find a large tree many feet in height and from two to five feet in diameter which makes a soft light lumber.

Marsh Association: This group was listed by the original surveyors as 'Swampy Prairie'. This survey was made in 1797 to 1805 by the United States Government for purposes of locating the good timber land and the tillable soil.
There were several areas in the county at that time, but now it is nearly impossible to locate an association of this type. However, the writer has had the privilege in years past to see and explore some of the peat bog swamps of this territory and to hunt and skate over the ice, covering great areas, especially in Kingston Township. Here the most marked swamp area has been in the past and there are a few places where this association may be traced at the present time very nicely.

Listed as follows; Typha latifolia, Juncus effusus, Scirpus atrovirens, Alisma plantago-aquatica, Sium sisutaefolium, Sparganium eurycarpus, Polygonum saggittatum, Onoclea sensibilis, Rumex crispus, Cyperus strigosus, Bidens frondosa, Hibiscus moscheutos, Solanum dulcamara, Cardamine rhomboidea, Rosa Carolina, Cephalanthus occidentalis.

This association is somewhat difficult to analyze on account of the drainage of the county and the encroachment of so many foreign plants which are coming in from other associations. The above association is being rapidly destroyed by drainage and cultivation, so that within a few years it will entirely disappear.

**Water Lily Association:** This association is usually partially submerged and close to the shore, so it might be called the shore succession. In this group the white and yellow water lilies are the leading plants. But one place did the writer find in this county where this association was naturally establishing itself, that being in Kingston.
Township where Little Walnut had many years ago cut an oxbow loop, and ponded, so there was a continuous supply of water. At Greenwood Lake, Delaware, there has developed a very representative association. However this is an artificial body of water with numerous plants set by man.

Listed as follows; *Casalia tuberosa*, *Nymphae avena*, *Alisma plantago-aquatica*. Just back of this group of plants are located the rushes and sedges listed as follows; *Scirpus atrovirens*, *Juncus effusus*, *Carex comosa*, *Fleischer palustris*, *Carex vulpinoides*, *Leersia oysoides*, *Iris versicolor*, *Calamagrostis canadensis*, *Sium cicutaefolium*, *Ludvigia palustris*.

**Duckweed Association:** This association being largely submerged and floating was found to be of rare occurrence. And only found in two cases fully developed, the best one being in the extreme northern part of Oxford Township in an old canal or millrace by the roadside. Here was listed the following; *Ricea fluitans*, *Lemma minor*, *Lemma trisulca*, *Potomogeton natans*, *Spirodela polyrhiza*, *Ricciocarpus natans*. There were several species of algae such as *Spirogyra*, and *Gladophora* together with some other plants which were not identified.

In the list just preceding, there might be in some cases three associations listed, but in this section, in the opinion of the writer, it was not of enough difference to be separated. The three associations could have been named as follows; *Pondweed Association*; *Liverwort Association*; and *Algae Association*. Each of these were present but the line of separation was not definitely enough drawn to list them separately.
At Buckeye Lake or at Mud Creek these associations have been noted distinctly.

The Dry Moss Association was noted in several places but was not carefully studied as it is considered sufficient to list it as one of the groups found in this territory. A complete collection of the Ohio Mosses have been mounted and named by Dr. Kellerman. They may be seen in the Herbarium of The Ohio State University.

The Lichen Association: This association was found in many places on the high outcrops of rocks along the rivers, creeks and ravines. Foliose, Granulose, Fruitose lichens together with several species of reindeer moss were found.

The Heath Association: This association is found at its best on the high bluffs of Alum Creek where the Old State Road or Sunbury Pike crosses the creek. On either side of the road, those shale banks are nearly one hundred feet in height and nearly perpendicular.

Listed as follows: Viburnum prunifolium, Vaccinium pennsylvanicum, Myosotis scorpioides, Juniperus virginiana, Rhus glabra, Anemanaria plantaginifolia, and Danthonia spicata.

Prairie Association: Found in Radnor and Harlem Townships, but not in a form to give a complete analysis. Cultivation and tile drainage have practically destroyed the old prairie of this county. However there are some remnants which might be mentioned such as: The bunch grass, Asclepias incarnata, Koelii virginiana, Juncus effusus, Juncus torreyi, Agrostis alba, and the blue grasses Poa pratensis and Poa compressa.
The last named are probably of a later invasion and not of the original prairie of Ohio.

The Burr Oak-Post Oak Association: While this group is found just over the terminal moraines in Union and Franklin Counties the writer was unable to locate it in this region. This association is somewhat like the absence of tulip trees, unaccounted for by the writer for the conditions for the growth of post oaks is as good as for the burr oaks which were found in several places.

The Pine Forest Association: The pine association is one of the uncertainties of this region. The writer found it in the extreme eastern part of the county at the summit of the high glacial drift good evidences of a former pine association, with Pinus rigida, and Juniperus virginiana in a very good state of development. Rev. Creighton in his list of 1875 found two groups of pine in this county. In the present survey the writer was able to find but one pine representative. Quercus muhlenbergii was the oak which was in close proximity to the pines which were found.
Cultivated Field Associations.

The following lists of cultivated field associations have been made from the averages taken from fields studied with classes from time to time, in several townships and many fields.

**Upland Pasture Association:** Vernonia maxima, Verbena hastata, Solanum rostratum, Plantago aristata, Potentilla canadensis, Bidens bipinnatifida, Verbascomum thapsus, Achillea millefolium, Daucus carota, Chrysanthemum leucanthemum.

**Average Pasture Association:** Plantago major, Vernonia maxima, Polygonum acaule, Verbena urticifolia, Carduus arvensis, Polygonum aviculare, Anthema eotula, Panium capillare, Rumex acetosella, Prunella vulgaris.

**Wheat Field Association:** Agrostemma Githago, Ambrosia artemisae folia, Polygonum convolvulus, Setaria glauca, Rumex crispus, Cheshorium Intybus, Bromus secalinus, Rubus nigrobasus, Silene noctifolia, Asclepias corvali.

**Oats Field Association:** Brassica arvensis, Polygonum hydropiper, Rumex crispus, Brassica nigra, Brassica juncea, Polygonum convolvulus, Rudbeckia hirta, Chaetochloa virdis, Amaranthus spinosus, Phellum pratense.

**Timothy Meadow Association:** Eragron annuus, Plantago lanceolata, Plantago major, Allium canadense, Chrysanthemum leucanthemum, Carduus arvensis, Potentilla canadensis, Trifolium repens, Panium capillare.

**Clover meadow association:** Brassica nigra, Potentilla canadensis, Trifolium repens, Oxalis stricta, Daucus carota, Cuscuta arvensis, Nepeta cataria, Solanum carolinense, Plantago lanceolata, Ambrosia artemisia folia.

Cornfield Association: *Abutilon abutilon*, *Ambrosia artemisiaefolia*, *Sesaria glauca*, *Allium vinese*, *Chenopodium album*, *Amaranthus graezianus*, *Amaranthus hybrydus*, *Asclepias syriaca*, *Portulca oleracea*, *Phelum pratense*.

Perhaps these groups, which the writer has so carefully selected for the cultivated fields, may have no direct succession in passing from one state of cultivation. However a glance at the groups will tell that there are some able to complete the crop rotation and occur in the field for more than one year. A more careful analysis will show that some of the cultivated field weeds have been active in the crowding process in the forest associations.

These groups have been selected in all the townships without regard to soil or rock formation.

A complete soil survey of the county might show an interesting graph of the cultivated field associations. Until a complete soil survey has been made, we can only speculate as to its effects on the weeds. If the soil survey was made we might be able to determine why some bottom land weeds are more persistent than are upland weeds in the same habitat.

Again if closely observed it may be seen that the amount of moisture present determines largely the weeds present.
Diagram of The Successions

Mixed Mesophytic Forest Associations

- Beech-Maple Assoc.
  - Beech Assoc.
  - Oak-Hickory Assoc.
  - Black-White Oak Assoc
  - Chestnut-Chestnut Oak Assoc.
  - Pine Assoc.
  - Burr Oak-Post Oak A.
  - Ravine A.
  - Heath Assoc.
  - Prairie Assoc.
  - Crevice Plant A
  - Dry Moss Assoc.
  - Lichen Assoc.
  - Dry

- Hard maple-Beech Assoc.
  - Beech Assoc.
  - Elm-Ash-Maple Assoc.
  - Sycamore Assoc.
  - Pin Oak-Swamp Oak A.
  - Cottonwood-Black Willow A.
  - Willow Assoc.
  - Marsh Assoc.
  - Water Lily Assoc.
  - Pond weed or Duckweed A.
  - Liverwort, Algae Assoc.
  - Submersed Wet

Fig. 8 Diagram showing the successions as a whole for this Co.
Swamps

Swamps are found in nearly every township in this region, however they are usually formed by the ponding of streams or by depressions in the glacial drift. The Black Swamp of Kingston Township was formed by the beavers throwing a dam across the upper course of Butler Run. Here was formed a typical swamp, some parts of which after being drained for many years, have areas that are filled with water.

In the early nineties drainage of this swamp was begun. At this time most of the area was a peat bog, with soil 15 to 20 inches in depth, which would burn very readily when dry. Distributed thru this area was a fine old forest of maple, elm, cottonwood, and swamp oak, together with shrubs characteristic of swamps. Some of the most important ones were buttonball bushes (Cephalanthus occidentalis), dogwoods (Cornus amomum) and (Cornus alternifolia), wild cherry (Prunus serotina), cat tails (Typha latifolia), along with water lilies, plantains, and mosses which furnished a basis for the deposits of which composed the soil. After the big ditch was cut thru and the run opened to Little Walnut Creek the water table was lowered many feet; this caused the dying out of the cat tails and other plants which could exist only in the presence of water. This is especially noticeable in the pin oaks of large size whose tops are dying down many feet from the top; because their transpiration rate is so much greater than their ability to obtain moisture for maintenance.

After the drainage operations had been successful, active
Logging took place which allowed the Sun to penetrate so that much of the surface water evaporated. Then much of the land was cleared and cultivated. At present there are few places left which show the old swamp conditions.

In one of the reforested areas a pretty well defined mesophytic forest has established itself, with hickory, oak, maple, elm, beech, ash, cotton-wood and locust taking the place of the forest which had been cut only thirty years ago. See Fig. 6 and Fig. 7 photograph by writer.

The swamp located in Brown Township about two miles distant contained nearly the same list of trees, with one exception; basswood or linden is found in the low ground growing to size suitable for lumber, while in the Black Swamp no linden is present. The writer is at loss to account for the absence of the basswood unless it is a matter of less moisture, for scarcely any peat is found in Brown Township swamp, while there is a plentiful supply in the Black Swamp of Kingston Township. The soil test after Truog shows that the soil of these two places reacts to an acid condition, but that of the Black Swamp much more so than that from Brown Township. This may be one way to account for the presence of basswood (Fiesa americana) in one place and not in the other.

In several of the other townships there are small areas of swamp land; namely, in Delaware, Porter, Oxford, Orange, Troy and Harlem. In Radnor and Thompson Townships the swamp land grades off toward the prairie, where there are small areas of land covered with tall grasses and bulrushes.
In Harlem Township is another area in which were found a number of prairie plants.

Some of the swamp woods are not complete in their successions. The reason being perhaps due to competition.

Competition is due to three causes: (Transeau)

1. Insufficient light due to close proximity of the forest trees, which have gradually crowded up to the submerged areas. They shade the edge of the submerged group.

2. Scanty water supply due to the small area of the pond.

3. Deficient supply of dissolved salts. In many places are found soils that do not contain chemical substances necessary for plant growth.

Some have thought that roots which lie side by side were in direct competition with each other, but Scherf of Chicago found that roots do not go down to compete with others but rather plants of similar structure and growth interfere most with each other.

This is just another example of a passing type of forest. It will be but few years until there will be no swamp association in this region.

In nearly every case the present swamp lands are rapidly developing toward the mesophytic forest, so with the aid of the farmer who is demanding plenty of tile for his land, and the lumber man who is trying to see how rapidly the forest may be cut away, it will not be long until this entire region of Delaware County may be classed as a reforested area covered by a mesophytic forest.
The Average Swamp of Delaware County.

Carya ovata  Quercus alba  Acer saccharum
Fagus grandifolia  Juglans nigra  Ulmus americana
Fraxinus americana  Acer saccharinum
Lycopodium virginianum  Quercus velutina

Smilax hispida

Ulmus fulva  Lemna minor  Carpinus caroliniana
Viburnum opulus  Nieso fluitans  Sium cioutaefolium
Bidens frondosa  Sparganium  Lemna minor  Benzoin aestivale
Decaying leaves  Aselepios incarnata  Carex comosa
Corylus americana  Spirodela polyrhiza  Acer rubrum
Quercus alba  Ricocarpus fluitans (Submerged area within)
Rosa carolina  Ricocarpus natans  Iris versicolor
Bidens frondosa  Spirodela polyrhiza  Cornus florida
Potomageton natans  Spirogyra  Juncus effusus
Rubes occidentalis  Elodea canadensis  Sparganium eurycaurpum
Sierspus atrovirens  Sparganium  Morus rubra
Glyceria maxima  Spirogyra  Ludwigia palustris
Polygonum amphibium  Lemna minor  Solanum dulcamara
Prunus serotina  Alisma plantago-aquatica  Sambucus canadensis

the writer has tried to show here as nearly as possible how the trees and plants appear about a pond or swamp area within the forest as it occurs in the county in several places.
Fig. 2. Shows the successions for the swamp areas of this county.
The Randolph Forest.

This tract of woodland, 325 acres in extent, lies in Brown Township eight miles northeast of Delaware, and one mile east of Kilbourne.

Fortunately this woodlot has been disturbed but little.

Here is given opportunity to observe the associations as they appear naturally. This forest is filled with fine large trees such as are not seen in many places in Ohio. There are large oaks, elms, maples, beeches and hickories some of which are as much as six feet in diameter and one hundred fifty feet in height. There are at least six associations to be listed here.

Mixed Mesophytic Forest

Beech-Maple Assoc.

Beech Assoc.

Oak-Hickory Assoc.

Black Oak-White Oak A.

Oak Assoc.

Fig. 3 Diagram showing the associations as they appear in this forest.

The composition of the various associations will be given on succeeding pages.

No written or photographed description could adequately portray the fine lines of competition—the tension lines; the shading off of associations, or the magnificence of the trees which make up this forest.
Underlying Rocks.
Mississippian Shale and Sandstone
Ohio Shale Columbus and Delaware Limestone
Oletangy Shale Monroe Limestone

It is very interesting to note the similarity of the Plant Associations which are found on each of these rock formations. Their similarity is shown graphically on the following pages.
<table>
<thead>
<tr>
<th>Forest Associations</th>
<th>Miss. Shale</th>
<th>Ohio Shale</th>
<th>Columbus Bluff Shale</th>
<th>Monroe Limestone</th>
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This chart was made for this territory. There may be other variations possible.
GLACIAL DRIFT
MAP
OF
DELAWARE COUNTY

This map shows the prominent features of gladiation.
Here are two very clearly defined areas: the Wisconsin Moraine and the Wisconsin Till Plain.

Glacial Drift of Delaware County
Ravines

There are three types of ravine in Delaware County: those that have cut their way thru sandstone; and those that have worn thru the black shale. Taken as a whole there is much resemblance in the plant associations which are found in each of the above.

Most of the streams of this region take their sources far upland in the mixed mesophytic forest or in the swamp land, where the flow of water is very slow. Some of the streams may now be traced up to the cleared land, where underground drains are laid in cultivated fields. By means of tile drains the original wearing away of the land is done away with to a great extent. Here were small streams that originally were able to take, along with the water, a load of detritus and silt which went to fill up the old valleys and creek beds, thus making alluvial fans and talus slopes. The upland stream where the farmer has not been able to lay tile is usually sluggish, and is bordered by characteristic swamp plants and grasses which help to retard its flow. Some of the plants found in this situation are: Juncus effusus, Asclepias incarnata, Epaticum perfoliatum, Bidens frondosa, Ascorus calamus, Dipsacus sylvestris, and Rumex crispus. With these are also found some shrubs such as; Salix nigra, Cephalanthus occidentalis, Rosa Carolina, Populus deltoides, Acer saccharinum, Prunus serotina, Ulmus americana, Populus grandidentata, Salix longifolia, Sambucus canadensis and Quercus palustris.

These shrubs if left to their own devices will in a few years make a good start toward the mixed mesophytic forest.
There is a continuous moist condition in some ravines which gives a wide range of plants. Then there are the ravines which run north and south, and again those that run east and west, this presents a variety of heat and light which with the variety of material of which they are composed and steepness of their sides make a variety of vegetation that makes a very interesting study.

The plants found in a ravine may run all the way from hydrophytes, thru the mesophytic stage to xerophytes.

Coulles in the article on the Chicago Region presents a diagram showing the successive stages in the development of ravines which might well be applied to this section with but few changes.

The above conditions represent the early stages in the development of the ravine.

Note position of trees.
Summary

From the variety of associations listed in the above report, there has been a number of phases in the development of this region since the glacier swept it clear of all vegetation. It has not been the purpose of this paper to point out what these stages were, but to find if possible how the plant associations were affected by glaciation, by rock formations, and by soil or other factors.

A close study and comparison shows that the amount of moisture present, and not the underlying rocks, or quality of the soil to be the limiting factor in making up the associations of this region. Drainage has changed the type of vegetation very much in places, so that much shows the effect of moisture content. The topography goes a long way toward determining the quality of vegetation a place may have. Depressions furnish a place where water is stored, here swamps are developed; glacial drift forms ridges and hills upon which the oak-hickory forest and the maple-beech forest may grow.

There has been much change in the timber land in one hundred years. In nearly all cases where the forests have been cut over at all, the reforestation has been going on toward the mesophytic stage as is shown by the photographs taken on the edge of the swamp and where the beech-maple forest had been removed for a cornfield and afterwards abandoned. In both cases a mixed mesophytic forest came in as a replacement.

The tendency is toward the mesophytic forest. Moisture and topography are the limiting factors. The swamps are rapidly passing. The beech forest will soon be crowded out by invaders.
The conclusions reached as to the tendency toward the mesophytic stage may be farther verified by saying that, two associations recorded in the surveys made 75 and 100 years ago, have almost if not quite disappeared. The prairie which old residents of Radnor Township say existed and was covered by tall grasses as high as a man's head, and again the pine association reported as late as 1875 has practically disappeared.

The fact that the tops of the large trees, located in or near to a drained swamp area, are slowly dying due to lack of sufficient moisture, is another point in favor of moisture as an active factor in determining plant associations.
Fig. 4. This shows a weed association coming in on one of the reforested areas. Verbascum thapsus as the predominating plant.

Fig. 6. This shows Scirpus atrovirens at the edge of the Black Swamp in Kingston Township.
Fig. 6. Reforested area at edge of the Black Swamp. Here are shown pin oaks, hickories, elms, maples, wild roses, and rushes all growing together to make up a new mesophytic forest.

Fig. 7. Reforested area on what was cornfield twenty-five years ago. Here are ash, hickory, maple, cottonwood, willow, locust, oak, walnut, ironwood and briars rapidly taking the place of the beech maple forest which was removed to make the cornfield.
Fig. 4. On the east bank of Scioto River. Photo taken from water's edge. Showing the river succession at its best. Willow Herb, Willow, Sycamore, with Flood Plain Forest behind.

Fig. 7. From same point as above except looking westward. This shows Sycamore, Elm-Ash and Cottonwood in very good order.
Fig. 10. This shows the high banks along Alum Creek, with the river succession in the background.

Fig. 11. This shows another view of the high banks of Alum Creek, with some of the cliff plants, such as Juniperus communis, Rhus glabra, and Populus grandidentata. The flood plain trees at back.
Fig. 2. Pure asp forest on the 'Red Hills' of Harlem Township. This view shows the forest, the ravine, the brow of the hill which is covered with reindeer moss and short grass.
Fig. 13. This shows red cedars growing in crevice on the limestone. Located on Eversole's Run in Genoerd Township.

Fig. 14. This is a complete Lizard's Tail association. (Saururus cernus) Found on Soeto River.
Fig. 15 - Giant cottonwood mentioned in report
Located at Delaware near Delaware Run on Ohio Wesleyan Campus.