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THE STRUCTURE AND PATTERN OF THE PRIMARY FORESTS OF
ATHENS AND WASHINGTON COUNTIES, OHIO
DISSERTATION

Presented in Partial Fulfillment of the
Requirements for the Degree Doctor
of Philosophy in the Graduate School of
The Ohio State University

By

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*****

The Ohio State University
1961

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INTRODUCTION

Ecology is the birthright of nations. It is the ultimate pigmentation by which the picture of man's way of life is derived. It is the story of crops and foods, of homes and habits. It is reflected in the social structure of the economy of human communities. Pre-eminent upon the landscape is the evidence of man's influence upon his environment, but these activities serve only to emphasize that extreme labor may modify, but that intelligent utilization of the environment will produce the stable and profitable materials from which lasting civilizations are built.

The interpretation of ecological expression is dependent upon the history of the vegetation, and there is no other index available which will as quickly and adequately forecast the relative success or failure of forest and cultivated crops as will the structure of the primary vegetation. This structure is the manifestation of the environmental factors operative in space and reflected through time; it presents the total act of the environment through the ages exclusive of the changes wrought by man.

This study contributes to the program of describing the primeval vegetation of Ohio, which was initiated at The Ohio State University by Dr. E. N. Transeau, Dr. H. C. Sampson and Dr. J. N. Wolfe, who with their students have contributed to this facet of research.
The study area of Athens and Washington counties includes 1141 square miles of broad, originally poorly drained, Ohio River bottoms; broad, flat, lacustrine terraces; gentle, undulating uplands, and variable steep-sided, deeply dissected hills and valleys that form a distinctive three-dimensional topography with complex environmental patterns. These have been modified by a wide variety of intensities of climatic and edaphic factors and complicated by the complex history of the region. A previous floristic study of Athens County by the late Albert W. Boetticher of Ohio University was made in 1929 (2). That this area is floristically rich is attested to by the extensive collections of Walter P. Porter (25) at the Athens High School in Athens, Ohio, and by the collections of Leslie Pontius (24) at Ohio University. With the exception of Chute (5), who analyzed the descriptions of the early surveyors, no intensive studies have been completed.

Athens and Washington counties lie in the southeastern quarter of Ohio in the low hills belt of the Cumberland and Allegheny Plateau region as described by Braun (4) and within the unglaciated Plateau of Fenneman (12). The south and eastern boundary of the area is defined topographically and climatically by the Ohio River Valley; the north and western boundaries are physiographically continuous with those of Monroe, Noble, Morgan, Hocking, Vinton and Meigs counties. The outstanding physiographic features of the area are the wide river valleys and gentle rolling terraces.
Figure 1. Showing location of Athens and Washington counties (in black) in relation to the major physiographic features of Ohio: Line A-A, Allegheny Portage escarpment after Stout (32); Area B, glaciated Allegheny Plateau and C, unglaciated Allegheny Plateau after Fenneman (12); Line D-D, Flushing escarpment after Stout (32); Area E, Till Plains; Line F-F, approximate maximum expansion of Kansan Illinoian and Wisconsin Ice Sheets (Ohio Geological Survey Map, 1939); and Area G, Glacial Drift, mostly from Illinoian Ice Sheet.
Figure 1
of the Ohio and Muskingum rivers, along with the somewhat narrower but conspicuously bottle-shaped valley of the Hocking River from which the name has been derived. Here can be seen very clearly the broad, flat, poorly drained bottoms of the upper valley and the narrow, steep-sided, V-shaped crosssection of lower valley which indicate clearly an interglacial stream reversal.

West of a line which can be traced west of and approximately parallel to the Muskingum River from the town of Rockland north through Tunnel and Lowell is the edge of a dissected plateau. To the west of this line the topography is lower and more dissected, with the ridges gently rolling with generally smooth well-rounded slopes and rather wide valleys. The ridge tops on the main ridges reach an elevation of 940 feet above sea level. East of this line the slopes are generally more abrupt and the stream valleys narrower. The ridgetop elevations are somewhat higher, about 1000 to 1200 feet above sea level and characterized by an extremely irregular horizon and little uniformity in flatness and slope.

The plateau in Athens County is deeply dissected, but presents a generally uniform elevation along the ridgetops. In the northcentral and northeastern parts of the county, conical hills rise about 100 to 150 feet above the general ridge top levels. Mount Nebo, near Chauncey in Dover Township, rises to 1055 feet and is the highest elevation in Athens County. The ridgetops are generally
narrow and the slopes are steep, with a maximum gradient of about 70 to 75 per cent and with average gradients of from 40 to 45 per cent. In much of the county the slopes are much eroded but have sufficient soil mantle to support grass for grazing, but in some places perpendicular cliffs of massive sandstone, often characterized by shallow re-entrants, stand 60 to 80 feet above talus slopes at their base.

Some of the best farming lands in the area are on the broad terraces along the Ohio, Muskingum and Hocking rivers. The largest acreages of smooth and gentle rolling surfaces in Washington County occur along the drainage pattern of Barlow Creek and other tributaries of the Teays stage Marietta River system (34). In Waterford and Watertown townships, the later development of the Muskingum and Wolfe Creek drainage patterns have largely obliterated the flat plain and terraces of that system; however, broad, smooth ridges are still in evidence around Ludlow and Tick Ridge. From the vicinity of Brown's Mill in Palmer Township and Watertown in Watertown Township south to Barlow and Vincent in Barlow Township, this smooth gentle rolling land is plainly evident and fragments of former valley land and river terraces can be identified near Veto in Dunham Township and further south at Redbush in Belpre Township.

In Ames, Carthage, Lee and Troy townships of Athens County, flats and terraces formed by the Teays stage drainage provide some of the best farm land in Athens County.
Figure 2. The major extant drainage patterns of Athens and Washington counties flowing into the Ohio River: A, The Little Muskingum River; B, Duck Creek; C, The Muskingum River; D, The Little Hocking River; E, The Hocking River; F, Shade Creek; and G, Raccoon Creek.
Near Torch, Latrobe and around Coolville, the broad rolling swells that were once the valley floor of the Teays stage Marietta River support large apple orchards and lend themselves well to the production of diverse agricultural resources. The Teays stage Albany River which was formed by the confluence of the waters of Chauncey and Luhrig Creek produced a flood plain which is today the conspicuous feature of Lee Township in Athens County. Other areas likewise modified by this period of stream development include Western Alexander Township, Central Carthage Township, The Plains in Athens Township and the Hyde and McDougal Branches of Federal Creek in Ames Township (34).

Present-day drainage in both counties flows into the Ohio River. The main streams and their branches ramify into all parts of the region; every farm is connected to this pattern by at least one watercourse stream. The main streams in Washington County include Mill Creek, Sheets Run, Leith Run, Reas Run, Reynolds Run, Dana's Run, Newell Run, Little Muskingum River, Congress Run, and Little Hocking River, all of which flow into the Ohio River. Cat Creek, Big Run, Wolfe Creek, Rainbow Creek and Indian Run are all tributaries of the Muskingum River. Two major drainage patterns occur in Athens County and include the Hocking River, which drains almost all of Athens County, and the Shade River, which drains the southern part of the county. The larger tributaries of Hocking River in Athens County are Four Mile Creek, Federal Creek, Strouds Run,
Willow Creek, Margarets Creek, Sugar Creek, Sunday Creek, Hamley Run, Minkers Run and Monday Creek. The western edge of Athens County, Lee, Waterloo and small parts of York townships are drained by tributaries of Raccoon Creek (Fig. 2).

The extreme elevations in the area, according to the United States Geological Survey topographic sheets, are something less than 580 feet above sea level near Hockingport in Troy Township, Athens County, and more than 1200 feet above sea level in Grandview Township, Washington County.

The present study is an effort to (1) describe the principal primary forest types which occurred in the area at the time of European settlement and (2) to recognize the pattern of these forest communities along with the accompanying factors of their environment insofar as valid inferences can be drawn.

Field studies of the environment and of the secondary or younger forest communities were made in an attempt to evaluate physical factors and their relation to the sites as related to the probable original forests. An attempt was made to evaluate the degrees of modification of the environment by the activities of man and to correlate this with the character of the extant vegetation in an effort to deduce what changes had occurred from primeval to present day forest stands. The field studies were augmented by the diaries and survey records of the surveyors who, under
Thomas Hutchins, surveyed the seven ranges of townships in eastern Ohio, and who under Rufus Putnam surveyed the Ohio Company Purchase Lands. These records served most valuably as collaborating evidence rather than indicators of vegetative cover. Although some of the records were quite complete, most were insufficient.
CULTURAL HISTORY

When Rene Robert Cavalier Sieur De La Salle first viewed the primeval forests of what is now Washington and Athens counties, sometime after September 30, 1669, they were inhabited by sparse groups of aborigines of the Shawnee culture or were under the control of the Shawnee Nation. Some few hunters, renegades or other wanderers, may have traversed the Ohio Valley region prior to that time. The only contender for first white man to view the sharp hills and narrow valleys of this region was probably Arnold Viele, a Dutch trader from Albany, New Netherlands, who penetrated the Ohio Valley in 1692 and spent the year 1693 in this region (26).

Previous to the Shawnee occupancy at least three previous cultures are known: the Adena, the oldest, dating back to their emergence from a people who were possibly dwellers along the ice boundaries and the streams which formed the drainage from the pleistocene glaciers in Ohio; the Hopewell, who left behind them many earthworks; and the Fort Ancient cultures. Many mounds, enclosures, village sites, and burial relics are conspicuous on broad hill tops and on the terraces along the major streams, particularly in the Muskingum Valley and the area of central Athens County. Outstanding examples are the Campus Martius group
at Marietta, Ohio, and mound groups, which are now almost destroyed, in the vicinity of The Plains near Athens. Remnant of other earthworks are scattered widely throughout the area and artifacts are commonly found during tillage of the soil in farming operations. In Washington and Athens counties together, some 165 mounds, 18 enclosures, and 9 village sites have been discovered (19) (Fig. 3).

At the time of settlement the Indian population was quite sparse and migratory. Three more or less permanent townsites are known to have been in this area: Shawnee Town, north of the present site of Athens; Wanduchales, near Torch in Trot Township, Athens County; and Kosh Koshiking in Grandview Township in Washington County. Three major Indian trails traversed the area, one parallel to the Ohio River, one following the general direction of the Hocking River and one located east of and generally parallel to the Muskingum River (31). From the accounts by early observers, it appears that little or no clearing or tilling was done by Indians unless it was in the vicinity of the three major Indian towns (43,14).

General maps of the Ohio Country were executed by Brienville de Celeron in 1749 and by Christopher Gist in 1752 (13), but the first valid maps and descriptions of this area were made by Thomas Hutchins in 1778 (3) and by Manasseh Cutler in 1787 (7). In his notes, Cutler makes particular mention of the many natural meadows along the larger streams and of their apparent luxuriant richness;
Figure 3. The location of Historical Cultural happenings in Athens and Washington counties: A, The Ohio River; B, The Muskingum Valley waterway system; C, The route of Lord Dunmore's Army; D, The Hocking Valley Canal; E, Athens; F, Farmers Castle and Belle Prairie; G, Campus Martius and Marietta; H, Fort Harmer and I, Fort Gower. Symbols: ● represent semipermanent Indian towns and ☿ represent earthworks. Composite figure from description of Authors in text.
however, he makes no mention of utilization of the soil by the Indians of the area (8). In his notes is an account of the "indigenous vegetables" of the area; here he names and describes numerous edible species but makes no mention of their cultivation by the Indians (9). In his letters to John M. Coulter he describes the area, the culture of the aboriginal tribesmen and the "indigenous vegetables" but again makes no mention of agricultural activities of the natives (9).

The hills and valleys, the broad bottom lands and the rolling ridges formed a wide variety of habitat conducive to a rich fauna. Buffalo, deer, bear, wild turkey, pigeon, grouse, beaver and many other species were abundant. Most of the first Europeans as well as the Indians who periodically visited the area came as meat and fur hunters (15), and despite the roughness of the terrain and the dangers from hostile Indians in the first 50 years of settlement and occupancy the hunters largely dissipated the wild game of the region (41).

This area was largely by-passed during the period of French and English rivalry for the Ohio Country, and the same is true of the Revolutionary War period. Though many war parties passed up and down the Ohio and to the north of this area, little or no importance was placed upon the region by the opposing forces. The only movement of consequence in the area was made by Lord Dunmore during the winter of 1774-75, when with an army of some 1200 men he
moved to the mouth of the Hocking River and established
Fort Gower in present Troy Township and marched north along
the Hocking River, camping subsequently near the mouth of
Federal Creek and near the mouth of Sunday Creek. (15).

It was not until 1784 that upon the recommendation of
General Rufus Putnam, action was taken to establish a line
of forts along the Ohio boundaries, and in 1785 Fort Harmar
was established at the mouth of the Muskingum River
(Fig. 3), Fort Harmer, although necessarily a military
post, was the first permanent settlement within the area.
Numerous squatters had periodically cleared and claimed
small tracts along the river valleys; however, it was not
until 1783 with the presentation of the Newburgh Petition
to Congress that any permanent plan of settlement was
devised for the region. Finally on May 20, 1785, a land
ordinance was passed authorizing survey of the area into
townships, lots or sections, based upon a geographer's line
to be laid off between the Ohio River and Lake Erie. The
survey was under direction of Thomas Hutchins; one of the
foremost deputies was Rufus Putnam (Fig. 4). One of the
prime forces in the opening of the entire northwest was the
New England Ohio Company of Adventurers, who stimulated and
forced completion of the survey of the seven ranges and
ultimately opened the Ohio Company Purchase tract.
Figure 4. The principal land subdivision in the growth and development of Southern Ohio.
Figure 4
Washington County was formed July 26, 1788, by proclamation of Governor St. Clair and was the first county formed within the Ohio Country. The proclamation of the original boundaries was as follows:

Beginning on the bank of the Ohio River where the western boundary line of Pennsylvania crosses it and running with that line to Lake Erie; thence along the southern shore of said Lake to the mouth of Cuyahoga River; thence up the said river to the portage between it and the Tuscarawas Branch of the Muskingum; thence down that branch to the forks at the crossing place above Ft. Laurens; thence with a line to be drawn westerly to a portage on that branch of the big Miami on which the fort stood that was taken by the French in 1752, until it meets the road from the lower Shawanese town to Sandusky thence south to the Scioto River, and thence with that river to the mouth and thence up the Ohio River to the place of beginning.

As originally laid out this tract included more than half of the present state of Ohio, but with the establishment of various seats of government and the formation of other counties, it was reduced to its present size. Belmont County was formed in 1801, Gallia County in 1803, Muskingum County in 1804, Athens County in 1805, Guernsey and Meigs counties in 1810, Coshocton County in 1811, Monroe County in 1813, and finally Morgan County in 1818 (13) (Fig. 5).

With the establishment of a permanent settlement at Marietta in 1788, the tide of immigration swelled in all directions, up the Muskingum, up Duck Creek and across the hills to the Hockhocking Valley. Settlements arose on Duck
Figure 5. The relative size of Washington County in 1776 as compared with the present-day study area.
Creek, at Big Bottom and other points on the Muskingum. Farmers Castle was built at Belle Prairie (Belpre) on the Ohio River, and a settlement established at Athens on the Hocking River (17). In 1785 townships 8 and 9 of Range 14, later to become Athens and Alexander townships of Athens County were surveyed and reserved for the benefit of a University as had been unanimously resolved in the meeting of the Ohio Company on December 16, 1785.

With the end of active hostilities after the treaty with the Indians in 1795 and the Indians' gradual movement from the area toward the north and west, the white man acquired full possession of the land. Agricultural pursuits gradually began to infringe upon the activities of the meat and fur hunters. As game became restricted, the frontiers moved on, and the pioneer was replaced by the homestead with its work-a-day tedium.

Coal was discovered in 1803 on the Hocking River and later on the Muskingum. Soon mines and strips were in evidence over the landscape. The coal industry of the area increased steadily until 1886 when there were over 50 mines producing over a total of 900,000 tons of coal annually. Mining was a major industrial occupation in the area until 1920 after which a gradual but steady decline began in production of coal.

Salt was never a plentiful item in the area until the period of the Civil War when the salt wells of Athens and Washington counties produced 80,000 barrels annually (1).
With competition from other areas, this industry soon died in the region. Gas and oil have been produced in the area since the early 1800's in relatively small quantities (17).

Washington County more than Athens County has long profited from and has been closely associated with the rivers of the area. In pioneer times the Ohio and the Muskingum were the natural arteries of commerce and travel. From the day of the canoe, the flatboat, and the broadhorn, through the heyday of the steamboat and at last to the modern, highly technical period of the cement and steel barge lines, which today are for all practical purposes floating freight systems, Washington County with its extremely long river front has depended upon the rivers for livelihood, commerce and relaxation (13).

In the early 1820's Ohio entered one of its most colorful transportation eras with the inception of the Ohio Canal plan. One branch of the Ohio Canal penetrated down the Hocking Valley to Athens in Athens County, where its remnants still persist. Another branch connected with the Ohio River by locks, slack water, river ways and right of ways through the Muskingum Valley. These provided an easy means of transporting coal, salt, brick and tile, livestock and grain to market from this region. By the late 1850's it had become quite evident that the canals could not compete with railway transportation and the state disposed of its interests to private parties, these in turn gave up their leases in 1877 and the properties were allowed to
revert to the state. Today a few locks remain; the canal bed can be seen in some areas and a few of the turning basins and reservoirs remain as public parks.

As the few small beachheads were made on the Ohio north shore and as homesteads and cabins grew across the landscape, the clearings grew and need for open land became greater. The tide of immigration rose. The security of garnered crops and the isolation of the area produced an endless parade of offspring to the people and a succession of new clearings and farmsteads to the land. Log rollings, cabin raisings, and burnings were an essential part of the pioneer life, and each new field a problem and an inception unto itself. They came as immigrants and were produced in great abundance in this land and the adventurous and the hardy passed on to carve a new frontier upon some other landscape. Those that remained to people this landscape were a diverse group. In the valleys a stable population arose from men who tenaciously held their acres against a savage enemy and built their white mansions high on second bottoms above the flood. They conceived sons to whom the value of the earth was not measured in money but in the nourishment of generations.

On the crests and ridges were another element of this population, men whose genesis is at the rising sun, whose life is one of settle, build, and move again. These were the people who came from the east, from soils worn parchment thin; people who in the course of two or three
generations had settled, built, and plowcd the fields on three or four landscapes. Here, too, they cleared the fields and plowed and raised the corn and cut the oak and ash and made the barrels in which to sell the crop. When the slopes were washed and gulleyed and when the crops were no longer profitable, they moved on again to some other crest or ridge. Some found a home and stayed in some sequestered upland valley or on some broad hilltop and learned to live with the land to survive, but by and large the cycle is complete. The hills were cleared and planted. The soil, never bountiful but sufficient, soon became depauperate. The abandonment of the land as no longer tillable and the beginning of a succession of vegetation and of afforestation followed. Behind the wave of pione­ers, unto the present, have arrived new groups who have left something worse behind them, settled here to eke out a few years subsistence upon land already submarginal, and a few crops later abandonment occurs again. So it is that upon many hill farms a succession of owners, tenants, squatters and renters come and go, each hopeful, none suc­cessful, the land more and more unfruitful.

In the present area of Athens County the first per­manent settlement was made in the early part of 1787 at the present site of Athens. In 1799 the territorial legisla­ture passed an act relative to the laying out of Athens County which in part read:

Athens County laid out from the southwest
corner of township 10, range no. 17, thence easterly until line between Gallia and Washington counties to the Ohio River, thence up said river to the mouth of the Great Hock Hocking River, thence up along the said Hock Hocking River to the east line of township 6 of range 12, thence north on said line to the northeast corner of the 8th township in the said range 12, thence west to the east line of Fairfield County, thence south on said county line and the line of Ross County to the place of the beginning (41).

The county thus established in 1805 contained 1053 square miles or about 30 regular surveyed townships. In addition to the extant townships of Athens County, this area included: five townships Columbia, Scipio, Bedford, Orange and Olive which are now part of Morgan County; and three townships, Ward, Green and Star, now part of Hocking County. Other areas now detached included seven townships, Brown, Swan, Elk, Madison, Knox, Clinton and Vinton, now in Vinton County and a strip 10 miles wide, which is now part of Washington County (Fig. 5).

In 1807 a strip ten miles long and one mile wide was added to the southeastern corner of Athens County. From 1807 until 1850 the creation of new counties and the subsequent acts of detachment by the State Legislature reduced the boundaries of Athens County to their present limits of about 484 square miles (41).

In 1811 the first phase of the Hocking Valley Canal reached Athens and a period of prosperity began in the area. Nelsonville, Floodwood, Circle Hill, Beaumont, Hocking, and Athens were flourishing ports of delivery for
a wide variety of products that were channeled north and
east to the best markets of the day, the crowded Eastern
seaboard. A flurry of mining industry followed, and great
tipples carried mule trains to convenient dump chutes above
the canal landings (Fig. 3).

With the advent of the railroads in the 1840's and
1850's and the early discovery and utilization of the
coals, salt, clays, oil, and gas in this area, early indus­
trialization and rapid increase in population resulted in
the consequent destruction of the natural vegetation. It
was necessary for the tillers of the soil to make room for
crops; lumber was necessary to build coal tipples and other
structures; railroad ties and mine timbers were produced in
great numbers. Large areas of forest on the rougher, less
desirable lands were destroyed by fires. Coal companies
bought and held many acres of the rougher lands of the area;
much of the forest land in the country is still held by
them today. The early attitude of these companies was to
remove as much coal as possible in the shortest period of
time, regardless of the consequences. This meant removal
of as much coal as possible and replacing its volume by
mine posts and great piles of heavy planking were wedged
into the space between the floor and the roof of the mine.
The vast amounts of wood employed in underground operations
helped materially to deplete the forest lands of the area.
The vast number of large companies operating as independent
producers and the larger number of smaller operators who
were present during the period before 1920 makes it impossible to estimate the number of acres of forest land utilized for this purpose. The major coal companies who retained large holdings of timber in this area included the Carbondale Coal Company, the Sunday Creek Coal Company, the George M. Jones Coal Company, the Canaanville Coal Company, the Cottingham Coal Company, the Pittsburg Coal Company, and the Johnson Brothers Coal Company. In recent years the Columbus and Southern Ohio Electric Company has purchased a large part of these coal lands in conjunction with its Poston Plant for the production of electricity. Much of this land, along with private farm holdings, has subsequently been extensively strip mined. In many places the destruction has been so great that it is difficult to recognize features of the original landscape.

The decline in the once prosperous mineral and lumber industries as the best and most accessible sources were exhausted was accompanied by a decrease in industrial employment throughout the region. This was partly due to exhaustion of raw materials, in part to the decrease in local consumption and to the attraction of industries to areas of the country with greater advantages or lesser disadvantages. Once thriving communities dwindled in population; stores closed and alternative occupations or migration faced the people. The agricultural industry of the area was expanded over much of the marginal and sub-marginal lands where cultivation was impractical and often
times almost impossible. The advent of the hillside plow with adjustable handles and turning surfaces invited the utilization of slope gradients of 50 per cent or more. This led to abandonment and afforestation or to conversion of wooded areas into marginal or submarginal pasture lands.

Desirable agricultural lands are largely confined to the river bottoms, to terraces, and to those areas modified and flattened by pre-glacial stream lines notably the area around Albany in Athens County and in Waterford and Water-town townships in Washington County. A gradual abandonment of the hill farms has been and is taking place over much of the area. Some of this land is being consolidated into larger farm units and much of it is being allowed to revert to forest. The United States Agricultural census data of 1954 relating to agricultural utilization of the land in the area is present in Table 1.

Table 1 reflects the similarity of the agricultural utilization of the terrain in the two counties which compose the study area. While the total number of acres in farms in the area appears to represent an imposing figure, it should be remembered that a significant portion not available in statistics is marginal and submarginal area, particularly that devoted to farm woodland and pasture. Table 2 is a condensation of data on the production of principle products from which a livelihood is gained by the farmers of the area.
<table>
<thead>
<tr>
<th></th>
<th>Washington County</th>
<th>Athens County</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approximate Land Area (in acres)</td>
<td>407,680</td>
<td>322,560</td>
</tr>
<tr>
<td>Approximate total acres in farms</td>
<td>300,602</td>
<td>233,318</td>
</tr>
<tr>
<td>Per cent of area in farms</td>
<td>73.7%</td>
<td>69.2%</td>
</tr>
<tr>
<td>Average size of farms (in acres)</td>
<td>112.8</td>
<td>120.00</td>
</tr>
<tr>
<td>Total cropland (in acres)</td>
<td>99,055</td>
<td>67,809</td>
</tr>
<tr>
<td>Total cropland (per cent of land area)</td>
<td>24.3%</td>
<td>21.1%</td>
</tr>
<tr>
<td>Cropland not harvested or in pasture (in acres)</td>
<td>16,542</td>
<td>9,963</td>
</tr>
<tr>
<td>Cropland not harvested or in pasture (per cent of land area)</td>
<td>4.1%</td>
<td>3.1%</td>
</tr>
<tr>
<td>Total pasture land (in acres)</td>
<td>162,549</td>
<td>135,966</td>
</tr>
<tr>
<td>Total pasture land (per cent of land area)</td>
<td>39.8%</td>
<td>42.1%</td>
</tr>
<tr>
<td>Used for pasture land only (per cent of total pasture)</td>
<td>11.9%</td>
<td>11.8%</td>
</tr>
<tr>
<td>Pastured woodlands (per cent of total pasture)</td>
<td>24.7%</td>
<td>21.8%</td>
</tr>
<tr>
<td>Other pasture not cropland or woodland (per cent of land area)</td>
<td>25.3%</td>
<td>26.9%</td>
</tr>
</tbody>
</table>
TABLE 1—continued

<table>
<thead>
<tr>
<th>Washington County</th>
<th>Athens County</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total woodland (in acres)</td>
<td>76,079</td>
</tr>
<tr>
<td>Total woodland (per cent of land area)</td>
<td>18.7%</td>
</tr>
<tr>
<td>Woodland pastured (per cent of total woodland)</td>
<td>52.7%</td>
</tr>
<tr>
<td>Woodland not pastured (per cent of total woodland)</td>
<td>47.2%</td>
</tr>
</tbody>
</table>

TABLE 2—The Farms of Athens and Washington Counties listed by the Principle Product Sold or Marketed

<table>
<thead>
<tr>
<th>Washington County</th>
<th>Athens County</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetable Farms</td>
<td>99</td>
</tr>
<tr>
<td>Fruit and Nut Farms</td>
<td>20</td>
</tr>
<tr>
<td>Dairy Farms</td>
<td>566</td>
</tr>
<tr>
<td>Poultry Farms</td>
<td>104</td>
</tr>
<tr>
<td>Other Livestock</td>
<td>442</td>
</tr>
<tr>
<td>Diversified Farms</td>
<td>1912</td>
</tr>
</tbody>
</table>

Tables 1 and 2 show what is easily recognized in the field, that in this area diversification and production of miscellaneous products by a given farm unit allows greater utilization of the diverse sites in a given area than any type of specialized farming. Almost all of the vegetable farms in the area are located in the proximity of the larger bodies of water. Such location is desirable because of the soil character of the river bottoms and because of
the climatic regime which allows early production for market. Table 2 reflects the great shoreline of the Ohio and Muskingum valleys which are devoted largely to vegetable or diversified farming.

There is apparently no relation of the fruit and nut industry to soil type, exposure or topography. Successful orchard industries are found on terrace lands, steep slopes, ridge tops and relatively flat Teays stage valley areas, without consideration of direction of slope. Adequate air and soil drainage combined with acceptable fertility and management with initiative and intelligence appear to be the important factors of success in this field. Orchards, possibly due to their longer productive life and the necessity of time for growth and development, engender a certain traditional interest in specific areas by certain families. Almost all of the larger fruit farms throughout the area are family enterprises involving several generations.

The dairy and livestock industry occupies in large part the hill land of the counties and in many cases successfully employs the marginal and submarginal slopes to produce excellent quality products. The large number of dairy farms indicates a specialization which can utilize these diverse sites and produce an enviable income for the operators.

The forest products industry in this area ranks among first seven in farm incomes; however, lumber prices in the area are depressed because of the general poor quality of the timber and the lack of local markets. At the present
time lumber prices and lumber production for Washington and Athens County are the lowest in the state. No accurate acreage figures are available for these counties with regards to timberland, woodlots, etc. Both federal and state agencies are involved in private and public owned timber stand improvement projects and are preparing census reports, these however are unavailable.¹

¹Information from Mr. Frank Newell, Farm Forester, Southeastern District of Ohio.
PHYSIOGRAPHY AND SOILS

Physiography

Physiographers and stratigraphers are not in general agreement on the details and interpretations of many events of the geological history of this region of southeastern Ohio (6, 34, 35). Many details are as yet undescribed and uninterpreted; however, the major events may be given in their general order of occurrence. One of the foremost contributors to this story has been Stout (32, 33, 34), who has worked extensively in the area and Tipton (40) who is significant as a historical figure as well as a contributor. Sturgeon (35) has prepared a Geological Survey of Athens County, and at this time similar work is underway in Washington County.

The strata now exposed in Washington and Athens counties were laid down in Pennsylvanian and Permian times, if the Dunkard series is what most geologists infer it to be. This series of events some 200,000,000 years ago, 100,000,000 years after the age of fishes, but 60,000,000 years before the appearance of the dinosaurs produced the substrate upon which a topography has been etched by the elements of climate.

During Pennsylvanian and Permian times a shallow fluctuating inland sea covered much of the area of present day Ohio. Marine deposits in contact with deposits of continental origin and directly associated with organic debris of 35
various states indicates an apparent fluctuation from below sea level to above sea level cycles throughout the entire period. Disconformities through much of the strata support this situation. The deposits of this area were derived largely from the highland of the eastern continental mass of that period which was termed Appalachia and were apparently spread by rivers over extensive piedmont areas and swampy alluvial flats that sloped westward to a shallow sea. Substantiating this situation are at least thirteen marine horizons in the Pottsville rocks of the area representing surfaces upon which sandstones are deposited which represent the fillings from old rivers as well as offshore bars and barriers. Plants and animals apparently prospered over this region and in the Pennsylvanian formations, coal is at a large number of horizons.

The early Permian deposits in the eastern part of the state rest upon the Pennsylvanian beds with no general disconformities. A general elevation of land surface apparently occurred over much of the eastern United States and extended into the central lowlands of North America which drained the swamps during the late Pennsylvanian period and gradually brought the period of coal formation to a close.

While the Pennsylvanian seas were withdrawing the land area of Appalachia continued to rise during the Permian times. The streams which flowed from the western slopes of this old land mass deposited sediments as continuous layers over the Pennsylvanian strata forming a broad gently sloping
alluvial plain. By the middle of the Permian period, considerable sand and silt had accumulated producing strata of continental origin which are nearly horizontal and consist of sandstone, sandy shales, impure limestone and a little coal. This has been termed the Dunkard series of eastern North America and occupies some 8000 square miles in West Virginia, Ohio, and Pennsylvania and may originally have extended much further west.

During the Triassic period a series of upheavals produced an upland over most of the United States and the erosion cycles which apparently became most vigorous during the Jurassic era were initiated. The area which is now Athens and Washington counties was then a surface of unknown character, perhaps some hundreds of feet above the highest hills now extant. Dinosaurs and other living things of that period lived, reproduced and died, but evidence of their presence has long since been destroyed.

With the inception of and during the Cretaceous period, erosion cycles continued, probably at a decelerated rate as a consequence of the general lowering of much of the eastern land mass and was accompanied by the evolution of what might be termed the modern types of plants. During this period vast forests consisting of many species spread across a long since obliterated landscape.

During the late Cretaceous period the eastern land mass was again uplifted and the period was brought to a close with rejuvenation of existing stream courses. In
early Tertiary there was a more or less constant increase of land height above sea level. This may have occurred as a number of uplifts or it may have been a somewhat gradual but more or less evenly occurring phenomenon. The presence of two erosion surfaces, the Harrisburg and the Lexington, has been proposed by Stout and Lamb (32). More recent evidence (35) seems to support the contention of Cole (6) that in this region only one great period of uplift and erosion is represented.

The first cycle of erosion upon which any substantial data is available was inaugurated by continued uplift in late Tertiary. The new erosion surface called the Parker was cut by a northwestward-flowing river called the Teays. This name was applied by Tight (40) to a prehistoric abandoned valley in Cabell and Putnam counties of West Virginia. The name has since come to be applied to the general period of erosion which preceded the Pleistocene glacial phenomena.

The Teays River was the master stream of the drainage system of West Virginia, eastern Kentucky and southern Ohio, had its headwaters in the Piedmont region of North Carolina and Virginia and probably developed during the mesozoic era. The principal tributary in this area was the Marietta River whose headwaters were in Washington, Noble, and Monroe counties of Ohio and Wood, Pleasants, and Tyler counties of West Virginia (Fig. 6). It emptied into the Teays River in Scioto Township of Jackson County, and its only
The maturely dissected Parker strata is a distinctive feature of the landscape, and the well defined valleys upon which slight meanders are detectable, associated with broad upland flats, silt-covered terraces, gradation plains and Minford type salts makes correlation with the Teays cycle evident (Figs. 6, 7, 8, 9). The rock floors of this ancient system lie between 710 feet at Little Hocking in the Marietta River valley to about 800 feet near Burr Oak in the headwaters of Chauncey Creek (Fig. 10).
Figure 6. The generalized major Teays stage drainage pattern in Athens and Washington County.
The Teays drainage was interrupted and ultimately destroyed by the southward advancement of an early Pleistocene glacier, presumably Kansan or Nebraskan. This wall of ice blocked the northwestward passage of Teays and the impounded waters produced a lake system in the valleys of southeastern Ohio, West Virginia and Kentucky. This lacustrine system has been called Lake Tight (45) and considerable supporting evidence has been established to indicate its existence (34, 35). Eventually, the waters of this lake system broke over the low divides and a new system of drainage was established. The master stream of this cycle of erosion was the Cincinnati River, which flowed approximately along the same line as the present day Ohio River. Because of the depth of cutting of the valleys this second cycle of erosion is known as Deep Stage.

The Deep Stage-Cincinnati cycle of erosion was interglacial and of relatively short duration. The Illinoian and Wisconsin ice sheets in turn effected further changes in master stream flow, position of drainage basins and surface character. However, the precursors of the present day drainage pattern of Athens and Washington counties were established during Deep Stage and for the most part are only modified forms of the former streams. Outwash materials have been contributed, terraces constructed and in some places new passages were formed, but extension of headwater areas before the retreating Wisconsin ice was the greatest single activity of the period. The courses of
the streams, therefore, are the composite results of the action of the deguration phases active during Teays Deep Stage, Post-Illinoian and Post-Wisconsin times.

All of the rock beds of this area are sedimentary in origin and arrayed in a great arch called the "Cincinnati Arch" or anticline which dips eastward to the Appalachian Geosyncline or one of its elements and tends to thicken toward the east. Thus the deepest and oldest members are exposed toward the west with the successively younger strata appearing progressively eastward. The dip of the surface rocks in this area is roughly thirty feet to the mile, for example, the Middle Kittanning No. 6 coal in Athens County is near the hilltops in northwestern York Township, 150 feet deep at The Plains, 200 feet deep at Athens and about 400 feet below the surface at Canaanville in Canaan Township.

The combined height of the generalized columnar section of Athens and Washington counties is approximately 1000 feet. Pennsylvanian strata outcropping somewhere in the area is represented by about 50 feet of the Pottsville series, and the complete Allegheny Conemaugh and Monongehela series. The Permian strata are all of the Dunkard series and are the most widely distributed surface rock in the area. A generalized columnar section appears in Table 3.

The Pottsville series is the basal formation of the Pennsylvanian series and to the west it is very important for its mineral resources. However, in this area it
Figure 7. Showing abandoned valley of Teays stage Chauncey Creek near Chauncey, Dover Township of Athens County, Ohio.

Figure 8. Showing abandoned valley of Teays stage Chauncey Creek at The Plains, Athens Township of Athens County, Ohio.
Figure 9. Abandoned valley of Teays stage Frost Creek in Canaan Township in Athens County, Ohio.

Figure 10. Abandoned valley of the Marietta River in Troy Township of Athens County, Ohio.
Figure 11. Photographs showing relative degree of destruction of vegetation by strip mining.
| Formation | Greene | Dunkard—Variable sandstones, shales and coal  
|           |       | Jollytown shales, sandstones and coal |
|           | Washington | Shales, limestones and sandstone  
|           |       | Upper Marietta sandstone  
|           |       | Washington "A" coal  
|           |       | Waynesburg "A" coal  
|           |       | Sandstones, shales and limestones |
|           | Homemade | Waynesburg No. 11 coal  
|           |       | Shales, sandstones, limestone and coal  
|           |       | Uniontown No. 10 coal  
|           |       | Sandstones, shales and limestone  
|           |       | Upper Sewickley sandstone  
|           |       | Haigs creek No. 9 coal  
|           |       | Clay and shale  
|           |       | Lower Sewickley sandstone  
|           |       | Fishport coal, limestones, shales and sandstone — coal, sandstone, limestone, and shale.  
|           |       | Pittsburg No. 8 coal |
|           | Pennsylvania | Pittsburg clays, shales, limestones  
|           |       | sandstones and coal  
|           |       | Morgantown sandstone-coals, sandstones  
|           |       | limestones, shales and clays  
|           |       | Ames limestones-shales, sandstones, clays  
|           |       | coals and limestone  
|           |       | Sandstones, shales, coal and clay |
|           | Allegheny | Shales and sandstones  
|           |       | Middle Kittanig No. 6 coal  
|           |       | clays, limestone, clay, flint  
|           |       | ferriferous ores, shales and coals  
|           |       | Lower Kittanig No. 5 coal  
|           |       | clay, flints, plastics, sandstones  
|           |       | ores and coals  
|           |       | limestones and coal  
|           |       | Brooksville No. 4 |
|           | Pennsylvania | Homewood clays, plastics, shales and limestone  
|           |       | Limestone, coal, clay, plastics, shales and sandstones |

* The Greene formation and the Dunkard members in particular are present in Athens County only on a limited number of knob-like hill tops in Rome and Troy Townships. The limited studies of the stratigraphy of Washington County available at present do not lend themselves to satisfactory presentation.
outcrops only at the base of Hocking River fill from the vicinity of Nelsonville to the Hocking County border and is economically unimportant. It comprises all the strata from the Mississippian rocks to the Brooksville coal, but is represented in Athens County only by exposure of the Tionesta group, the Homewood sandstones and shale and the Brooksville clay.

The Allegheny formation in Ohio is of great economic importance for its clay beds and its thick and persistent coals and sandstones. This series begins at the base of the Brooksville coal and includes all of the strata to the top of the upper Freeport coal. Although no correlation may be discovered between the occurrence of this formation and the distribution of plant communities, it has had, nevertheless a cataclysmic and catastrophic effect upon the vegetation, because of the widespread "stripping" of the Freeport and Kittanning coal veins. In certain areas this has completely destroyed every vestige of vegetation in whole creek valleys and on the sides of hills where outcroppings occur (Fig. 11). Throughout the area the exposures of Allegheny strata can now be found at first glance by the degree of strip mining. Allegheny surface rocks occur only in the western and northern townships of Athens County. In the deepest stream bottoms along the Vinton County border in Lee Township, the Freeport, Bolivar and Shawnee members are exposed. All of Hewitt Fork and its tributaries in Waterloo and York townships have cut deeply
into the Allegheny series and in this area both Number 6 and Number 7 veins of coal were mined extensively along with lesser members of the "coal measures". The Allegheny also is exposed in the Hocking Valley from near the mouth of Sunday Creek on the Hocking River to the Hocking County border and encloses all the Pottsville series to that line. This exposure continues to outcrop throughout the Sunday Creek valley and its tributary valleys through Dover and Trimble townships. Its greatest breadth of exposure occurs in the Monday Creek watershed in York Township and Trimble Township of Athens County, extending on into Ward Township of Hocking County.

The Conemaugh formation of the Pennsylvanian system embraces all of the rocks between the top of the upper Freeport Coal and the base of the Pittsburg Coal. It includes shales, limestone, sandstones, coals, clays, and nodular iron ores. Conemaugh rocks are exposed in a wide belt across the western part of Athens County. It caps the hills of the westernmost limits of Athens County from about 750 feet above sea level to their tops. In Dover, Athens, Waterloo and Lee townships it covers the major part of the landscape. All of the Margaret Creek drainage area is eroded into the Conemaugh strata. The Hocking Valley is cut into the Conemaugh rock from below Guysville in Rome Township to near the mouth of Sunday Creek in Dover Township. The eastern edge of this exposure is in the valleys of the upper tributaries of Federal Creek in Ames and Bern
townships in the Strouds Run watershed and in the creeks and upland tributaries of the Shade River in Alexander, Lodi, and in the western extreme of Carthage townships. Here it is exposed in the extreme bottoms of the streams and up to approximately 800 feet above sea level.

The Ames limestone which occurs at approximately 400 feet above the Pottsville horizon is the highest known marine deposit in this area, above this horizon the strata are all of fresh water origin.

The Morgantown sandstone which appears above the shale pit at Athens in Athens County is extremely variable, but appears to control the extensive hill tops of the area. Within the Conemaugh area, little or no correlation can be found between the occurrence of given strata and the plant communities growing there.

The Monongahela formation is found in a belt along the hilltops in Alexander, Athens, Ames and Bern townships of Athens County and covering the bulk of Rome and Lodi townships. In Carthage and Troy townships of Athens County it is confined to the valley of the Hocking River and to the deeper valleys of its tributaries in these townships. In Washington County it is exposed widely along the Little Hocking River in Belpre, Decatur and Fairfield townships, along the Wolfe Creek watershed, the Muskingum River and its tributaries, the Little Muskingum River and its tributaries and the Ohio River Valley, being the notable strata in all of the valleys north and east of Marietta.
This formation begins at the base of the Pittsburg coal and ends at the top of the Waynesburg coal. Shales, freshwater limestones, and sandstones along with coals, clays, and nodular iron ores are the main strata.

The Permian system in this region is represented by the Dunkard system of sandstones, shales, limestones and coal. It is the most variable series of rocks represented, including nearly all varieties of sediments from course to fine.

Horizons change rapidly from one place to another and the identification and mapping of strata are often arbitrary (35). Beds at different stratigraphic elevations are often very similar, and shales which are difficult to identify are the most abundant rock in the series.

The Waynesburg sandstone is probably the most conspicuous member of the Dunkard series. It is a massive course, cross-bedded gray sandstone, sometimes containing pebbles and sometimes a conglomerate, which occurs on the sides of valley walls through much of the Permian exposure. At the heads of gullies and along the sides of valley walls it forms high rock faces and great overhanging cliffs, with high blocks at their bases which have been removed by water action. Pitted and honeycombed surfaces, often accompany crescent shaped re-entrants in these situations. Where the Waynesburg occurs on the crest of hills it often weathers down into almost a pure sand, which may often be associated with Pine and Oak-Pine communities in the present forests.
The Waynesburg occurs in Washington County from the Muskingum Valley west to the borders of the Dunkard series in Athens County where it often caps the hills.

Other members worthy of note are the Mannington limestone of eastern Washington County, the Marietta, and the Jollytown sandstones which are widely quarried and used in the manufacture of grindstones, particularly in the region south and west of Marietta.

The Dunkard series occupies the highlands of all of Washington County, extending into Athens County as a cap upon the hilltops of Rome and Lodi townships and as the principal upland strata in Troy, Carthage and Bern townships.

While the Permian regions of the area are occupied almost exclusively by the more xeric communities and particularly Oak-Hickory, Mixed Oak, Oak-Pine and Pine communities, it is inferred that relationship with position is rather coincident and reflects other factors as well as those of substrate.

The stratigraphy of a region may indirectly as well as directly be reflected in the vegetation of an area. Geologists pointedly use leguminous plants as indicators of subsurface limestone strikes; however, the effects of situations such as these on the complex of plant communities can be only of limited importance. More important to the whole of a vegetation cover appears to be the reflection of rock strata upon the topography of the region. The
characteristically three dimensional topography of this unglaciated plateau have produced and are producing an infinite number of habitats and niches into which a great variety of individuals may or may not fit.

The relationship of ground water, its availability through capillarity, and its issuance as springs and seeps are important factors in the consideration of environment. Sandstones and conglomerates are ordinarily open and porous and are prominent throughout this region. Quite commonly they contain large amounts of water. Limestones are often of quite light texture unless they have been weathered and reworked, in which case they may provide storage for large amounts of water. Dense limestone and shales commonly appear to block the downward movement of ground waters thus causing them to issue as springs along the outcrop of the strata.

The exposure of a given slope, its relative steepness, the external and internal drainage, the nature and age of talus and many other factors are all present along with the physiographic and stratigraphic factors and although at one time or other apparent coincident relationships can be noted between an individual factor and a vegetational segment; disconformity on another site will soon emphasize that factors of the environment are holocoenotic and that obvious superficial relationships may only serve as traps which artificially stabilize that which is dynamic.
Soils

The soils of southeastern Ohio developed in a humid temperate climate under an essentially deciduous forest vegetation and are classified by Marbut (18) as gray-brown, podzolic soils. These are all zonal soils, and occupy the greater part of the area. They are characterized by thin humus deposits at the surface which usually merge into a shallow dark A\textsuperscript{1} horizon, a thicker and lighter A\textsuperscript{2} horizon often without distinct boundaries and a well developed brownish B horizon composed of accumulated inorganic clays. Climatic interaction with plant communities, relief, topography and properties of the parent materials have resulted in features which are the basis for classification units used in mapping the soils (23, 22).

Vegetation is a result of physiological and ecological balance of climate, the substrate, and the biome and when properly interpreted, relate to the developed soil; however, soil development and plant succession are independent processes which vary genetically because of microclimatic and vegetational differences and because of the multitude of variables which become operative from plant to plant and from character to character in the soil. The present methods of soil surveying were developed for the purpose of classifying and evaluating the soil relative to crop production. This system shows no correlation with the interdigitated pattern of either the original or the secondary vegetation.
Beatley (1) has shown that a classification system based upon the general character of drainage can be correlated in a very general way with the pattern of the original vegetation; however, on the basis of information available, the drainage categories are far too broad to be of value in vegetation mapping and she has stated: "The moisture aeration gradients which operates in the distribution of plant communities necessitate a scale in much smaller units than those employed."

Moisture aeration gradients seem wholly critical in all of the vegetation pattern and particularly so in the areas of greatest relief and complexity of dissection. With increased complexity of habitat the number of climatic and edaphic variables increases, thus the complexity of the vegetation increases. This is amply demonstrated in eastern Washington County where a superficial investigation indicates a preponderance of Mixed Mesophytic forest type situations; however, closer examination of the site and the secondary vegetation reveals rather a number of fairly distinct associations each upon its site and occupying a niche finite unto itself within the pattern of vegetation.

This same failure of correlation between the complex of edaphic factors and the distribution of vegetation has been noted by Dobbins (11) and by Sampson (27), and although Shantz (29) has intimated that a strong relationship exists between the soil type or phase and the plant community, his examples are quite general and qualified by exceptions.
Since quantitative measurements are lacking, it appears that the vegetation may be considered a valuable index to the available moisture aeration condition of the soil, while the edaphic variables active in the evolution of the plant community are as yet not demonstrable to a degree usable in this work.
Climate and vegetation and their intimate relationship to the substrate may be regarded as the active forces in soil formation. Because climate may be regarded as the ultimate control of the vegetation in this area as well as over the rest of the world's surface, vegetation may be regarded as directly related to climate and to soils as a result of fusion of physical processes and biological processes inherent in both.

In the study area elements of climate are modified in varied degrees by the topography, by the physical condition of bedrock, and by the history of the area. Therefore any expression of a climatic factor with regard to the distribution of a given plant community or a given species must be evaluated only when there is a complete knowledge of the distribution and degree of expression of that factor in a given area as related to a plant community or species.

The characterization of the variation in local climatic regimes has been pointed out by Wolfe et al. (45). Through field measurements made and recorded by Wolfe and his associates, it has been shown that many variations may be anticipated in the multitude of micro-environments present in one small valley; therefore, in an area the size of Athens and Washington counties a multitude of microhabitats have been evolved.
From the macroclimate, therefore, the causes of broad patterns of vegetation may be explained, but when used in conjunction with the other factors of the environment it can be employed only in a limited way in reproducing the interdigitated mosaic of forest types in dissected hill country. A suggestion of the means and the extremes of climatic expression to which the plants of the area have been exposed may present a generalized picture of the climatic factors of the environment.

Weather Bureau stations have been maintained in Athens County since 1888 except for the years from 1895 until 1904 and in Washington County continuously since 1860. Stations in Athens County were located at Athens on or near the vicinity of the Ohio University campus and at Amesville, Ohio. Stations located in Washington County were at Marietta, Ohio or near by.

The annual march of temperature is indicated in Graph I. Temperatures begin to increase in February and continue rising until July, after which a steady decline occurs through January. This is in direct relation to the amount and intensity of solar radiation reaching the earth surface and is responsible for the phenological aspect of season. This pattern is relative to the cosmological pattern of the solar system and is predictable, subject to those variations in meteorological phenomena which in their extremes may determine the survival or death of species or communities.
Graph I. The generalized regiment of temperature for Washington and Athens counties, Ohio.
Graph I
During the period from March to July, temperatures continue to rise and although minimum temperatures may occur during March and April, summer temperatures may occur in June. This is the active growing season throughout the deciduous forest and is characterized by the expanding growth and development of leaves and stems. Frost may occur until late May in the hill country whereas at many spots along the Ohio River bottoms frost ends by late April. Maximum temperatures during this season are always above freezing, ranging from the 40's early in the season to the 80's late in the season. Extreme variations diurnally and annually may occur at this period of the year and this may account for the limit of tolerance of some of the species which find their northern or southern limits in this area.

During July and August maximum temperature extremes are recorded in the 100's with daily maximum temperatures in the 80's and 90's and minimums mostly in the 50's and 60's. This is the hottest and driest period of the year and the period during which the plants of the area, growing in diversified habitats, are subjected to varying degrees of critical water loss. Just how critical this period of stress is for the various components of the vegetation is unknown; however the magnitude in certain habitats such as ridge tops and exposed south facing slopes is probably great enough to be considered primary in the control of the plant population.
As the angle of incidence of the sun's rays becomes less and the day-length steadily decreases during September, October and November, both the daily maximums and minimums decline rapidly. The daily range of temperature becomes greater and the first killing frost is to be expected in late October. In the area an average growing season of from 151 days in the hill country to 189 days on the Ohio River bottoms can be expected (42).

December, January and February are the cold months of the year with average maximum temperatures usually above freezing and average minimum under freezing, but maximum temperatures may reach into the 60's and 70's.

Precipitation usually occurs during every month of the year, and the annual precipitation averages 41.92 inches as measured rain or snow, varying from 27.04 inches in 1938 to 55.77 inches in 1922. Precipitation occurs in variable amounts, intensity, and kinds, and is considered as low intensity precipitation derived from cyclonic storm systems which occur all year around in this region. Local convection storms accompanying high temperatures and humidity during the summer months are responsible for the heavier precipitation types (Graph II).

Excessive precipitation records may occur during any month of the year, but usually occur during the summer season as a result of torrential rains; however, exceptions to this are exemplified by the month of January, 1937, when 10.77 inches fell, almost all in the form of rain.
Graph II. A generalized regiment of precipitation for Athens and Washington counties, Ohio.
Graph II
Almost any month may show precipitation deficiencies, but the most intense occur most frequently during September, October and November. Records of under one inch are recorded quite often with 0.10 inches being recorded for the month of October, 1925. Excessive precipitation may occur during this period as a result of torrential rains as was the case in August, 1935, when 13.86 inches of rainfall were noted at Lowell, Beverly and at the Marietta Experimental Substation. In the vicinity of Athens only approximately six inches was recorded for the same period.

The period March through June usually includes months with above average precipitation and is thus coincidental with a rising temperature regiment accompanying growth and development of the vegetation of the area. Although precipitation deficiencies may occur, abundant moisture supplied by drizzles and showers and by snow persistence and spring seepage from winter precipitation characteristically furnishes an abundance of available soil moisture to the verdant spring growth of the region.

Heavy showers and torrential rains are common during July and August, and although the total precipitation for the period may be above average, this moisture is less effective than that falling in previous months. More rapid run-off, interception by developed leaf canopy and higher evaporation rate accompanied by high temperatures usually tend to minimize effectiveness of precipitation. Availability of water to plants is doubtless more critical at
this period than any other and even though this factor does not become apparent from examination of Weather Bureau records, drought periods without doubt are common to plants in certain habitats at this time and often more critical than we might assume.

Precipitation during December, January and February consists of snow, sleet, rain and fog and usually occurs under conditions which insure maximum percolation and minimum loss. Foliar interception, run-off, and evaporation are at a minimum; torrential rains are rare, and the soils and underlying rocks are generally unfrozen to a degree which will allow maximum accumulation of percolating waters. This accumulation of water in the soil and bedrock is a phenomenon which occurs during the winter season of every year.

Snowfall may occur during the months from October until May, but is most frequent and heaviest during the period from mid-December until mid-March. Usually the greatest amount of snow falls in January; however, it has never constituted the entire precipitation of any winter period.

The persistence of snow, the depth of accumulation, and the relative availability of the resultant waters are factors of ecological significance, about which little or no data is available for individual habitats. Certain inferences can be made, however, with regard to the significance of these factors. In addition to its importance to
the resultant soil water accumulation, snow is an effective inhibitor of radiation and of conduction of heat from the soil. This tends to retard critical low soil temperatures by reducing heat loss to the atmosphere, which in turn allows greater depression of air temperatures on cloudless nights. It is apparent from this that while woody and persistent perennials must be genetically capable of great extremes, at no time is the below ground portion of plants or those parts covered by snow ever exposed to the extremely low temperatures of the winter season.
METHODS AND SOURCES OF DATA

The vegetation of Athens and Washington counties, superimposed upon a three-dimensional topography of relative variability and underlaid by a complex rock strata from which a wide variety of soils have been derived and subjected to an even greater complex of microclimates, is the expression of the passage of germinal material through time and across the "screening" viscissitudes of environment. Vegetation is not the expression of the climatic and edaphic factors reactive upon a given site alone, but rather the expression of what has occurred throughout the millenia accompanying the evolution of the extant form. Sucession, evolution, migration, and establishment have been constant chords accompanying the processes of vegetation through history and have resulted in the establishment of the vegetation of this area as a part of the deciduous forest complex of North America. The primary forest of this region represents the survivors of a complex of limiting factors which have acted upon the environment throughout the history of the area and has determined the potential from whence the modern secondary and Tertiary forest has been derived.

During the course of the field work involved in this study, it soon became evident despite the destruction and change which had occurred that considering the variable
conditions of the modern day forest a pattern of composition could be deduced. These deductions, when utilized, alone might well be misleading, but when considered carefully and used in conjunction with information from other sites, with information available from other areas and, whenever possible, with survey records it was believed that over much of the area they contained adequate information to form reliable indicators of the composition of the original forest.

During the progress of this study it became necessary to set forth certain relationships, which evolved more or less spontaneously as problems arose in the field. When these crude field notes or relationships were compared, they were found to be conspicuously similar to the set of principles that Beatley (1) evolved in the study of Jackson and Vinton counties. Because that area of study is contiguous with the present problem area and since lithology, land use, and history have necessarily been similar in the two areas, Beatley's (1) working principles have been reproduced below and have been applied in the present study:

1. The physical and chemical proportion of the soils in no region of the area have been so altered through the direct or indirect consequences of man's activities over such wide and continuous areas but what in at least some localities plant communities not unlike the original ones may still grow upon them.

2. The primary controls of the areal and seasonal availability of moisture are the nature of the bedrock, degree of dissection of the land surface, slope exposure,
and the precipitation regime. These are constant factors except for the last-named, and it is doubtful if there have been any fluctuations in seasonal precipitation since 1800 exceeding those to which the original forests have been exposed. Where there has been change in moisture availability following removal of the primary forests, it has always been in the direction of reduced availability.

3. No species today occupies a site less mesic (more xeric) than it did in the original forests, regardless of history of the site. For example, wherever Beech grows today, there must also have been moisture adequate for its growth in the original community of such sites. The community as a whole may have lost other species with greater moisture requirements (which species are present on comparable sites where there has been less disturbance), but the most mesic species present today are indicators of the least mesophytic community that could have developed on this site in the original condition. Communities which reflect less mesic conditions may occur on sites formerly occupied by a more mesic association, but the converse, i.e., the replacement of less mesic primary forests by more mesic secondary forests, has not occurred. The secondary forests, therefore, exhibit an areal increase in the more xeric (less mesic) forest types, or, as is more often the case, the more xeric phases of the original forest types.

4. Man has not brought about the extinction of a whole population of any given species in a given area, consciously or otherwise, excepting perhaps species with originally restricted distributions. Where a species is wholly absent from an area, it is more often the case, the more xeric phases of the original forest types.

5. In areas where a canopy species is abundant today, it was at least a prominent species in the original forest
and probably was a dominant, although it may be locally more prominent today than formerly. The relative abundance of the various species in a community, including both dominants and associated species, has been much more influenced by the activities of man than has the number of species. High frequency of a given species in a present-day community may represent only local variation, often due to fortuity, and while such variations also occurred in the original forests, they were probably neither as extreme nor as numerous.

6. Species with relatively narrow or relatively broad ecological amplitudes are those whose position in the original forests is most subject to incorrect interpretation on the basis of their position in present-day communities. Those species with narrow amplitudes in this area, e.g., Basswood, have undergone the greatest reduction in numbers. Those with apparent great amplitude, e.g., Shagbark Hickory, which is frequent today in a number of associations, may have increased in numerical importance at the expense of species with greater specificity of habitat. It is not true, however, that all species with broad ecological amplitudes are not more prominent than they were in the original forests (e.g., Black Gum). The general relationship between dominance and ecological amplitude, e.g., species with relatively broad amplitudes are usually the dominant species of upland communities, is no less true in the secondary than in the primary forests.

The field work for this survey involved 20 major trips which occupied a period of 121 days and covered something in excess of 10,000 miles by automobile, boat and on foot. In addition to this, many shorter trips of lesser duration were involved. Secondary and Tertiary woodlands throughout the area were visited and an attempt made to understand
something of their composition and of the relationships of the environment in which they were a part. Areas more remote were combed in an effort to find and study relatively less disturbed forest areas and wherever possible more complete study was made of them. It should be mentioned at this time that no virgin timber remains in this area and no large tracts of relatively undisturbed vegetation are existent. It any one fact became self-evident in this field work, it was that undisturbed areas are nonexistent. Increase in population, businesslike management of timber resources by the government agencies and wide-spread timber stand improvement projects subsidized by the state and federal government have all but obliterated undisturbed secondary and Tertiary woodlands from this area.

The study area lies in ranges 5, 6 and 7 of the Seven Ranges of the Congress Lands as delimited by Sherman (30) and in ranges 8, 9, 10, 11, 12, 13, 14, and 15 of the Ohio Company Purchase Lands. Both the Seven Ranges Lands and the Ohio Company Lands were divided into townships approximately six miles on a side. These townships were divided into sections, quarter sections or other subdivisions as determined by the needs at the particular time. This system and other details of the survey have been described by Sherman.

The surveyors were instructed to note in their field books courses and distances and to designate, name, and give the diameters of corner or bearing trees. All trees
falling in the course of the survey were to be marked and designated as "station or line trees". All rivers, creeks, springs and other smaller streams of water were to be marked with their width and course where they crossed survey lines and that "all kinds of timber and undergrowth with which the land was covered", all swamps, ponds, quarries and other natural or unnatural situations should be noted, along with mines, salt licks, salt springs and mill seats (20).

Witness trees were used by all surveyors, but the "line" trees were largely omitted or in some cases marked but not named. Descriptions of the vegetation, coincident with that for soil and topography were given for each mile chained; however, for the most part these descriptions were meager. All of these records are of great interest in that they offer the only description of the original forests that can be superimposed upon maps of the known terrain.

In general the descriptions from the Seven Ranges can be made to coincide more closely with the existing terrain than the survey records of the Ohio Company purchase lands. These townships were surveyed and marked into quarter sections by Ebenezer Buckingham and Levi Barker and their parties. Ranges 5 and 6 were surveyed by Buckingham while Range 7 was surveyed by Barker. Both, while not highly descriptive, give short concise descriptive notations that describe adequately the soils, the vegetation and the topography. Ranges 8 through 15 were surveyed by the parties
of Ebenezer Sproat, Benjamin Tupper and Jeffrey Mathewson. The South College Township was surveyed by Rufus Putnam and the survey of the North College Township (now Alexander and Athens townships respectively), if any survey was ever made, has been lost. The notes of Rufus Putnam on the South College Township are no longer legible. Poor care, faulty preservation, and poor handwriting make this book valueless. The surveys of Range 14 are in many cases lacking and in the remainder incomplete. In other areas the descriptions are extremely hard to comprehend, and the current township boundaries do not coincide with those of the original surveys. Valuable inferences can be drawn from generalizations made concerning the topography described and the vegetation noted thereon, but positive superimposition of a survey record upon topographic maps is not scientifically feasible in this area.

If the survey data are to be used as sources of information, we must assume first of all that the species named were correctly identified within certain definite limits. This assumption within these limits seems to be justified by the occurrence of species where we would expect them to occur and by the rather outstanding lack of anomalous reports of occurrence. We must also assume that witness trees were selected because of their position rather than through any bias on the part of the surveyor. Although selection of trees were purely subjective, the fact still
remains that we must assume that the trees were there. Beyond doubt these men were attracted by the conspicuous rather than the inconspicuous. Size, abundance and value probably were the factors responsible for selection and description in many cases.

Beatley (1) has exhaustively discussed certain generalizations which must be made concerning the use of survey data. These are reproduced at this point since they apply in their entirety to the region of Athens and Washington counties as well as to the Jackson and Vinton counties region in which she worked:

1. The survey data rather clearly indicate the following (a) the regions in which the more prominent tree species of the area were most and least abundant; (b) the dominant species of the most characteristic upland community, or communities (with certain exceptions noted below); and (c) the general part of the area in which this community pre-dominated, and sometimes a definition of its boundaries, depending upon the quality of the notes.

2. The more simple the community is floristically, the more suggestive are the survey data of its presence and real prominence, e.g., Oak-Hickory. Likewise, the more complex the community the less suggestive are the data, and where the community is composed of a relatively large number of species, e.g., Mixed Mesophytic, its presence usually would not even be suspected from the data alone, unless superior field notes are available.

3. Communities occupying a relatively small proportion of the total area are detectable only where revealed through the presence of a particular
species known to be an indicator of that community, e.g., Hemlock and the Hemlock-Mixed Mesophytic association. Since valley bottoms constitute only a small fraction of the total area, relatively few data are available for the forests of the floodplains and terraces; exceptions are in valleys a half mile or more wide.

4. The greater the dissection, in general, the fewer the inferences which can be drawn concerning any but the most widespread upland communities. This is related to an increase in the number and area of floristically complex communities.

5. Witness and line trees constitute a very small sample of a large population in any given area, but the frequency of citation of at least the more abundant species is usually in close agreement with their frequency of citation in the line descriptions. Hence the population sample is to be considered an excellent one, and somewhat greater importance can be attached to it than would ordinarily be justified in view of its size.

If survey data are to be used it must be used only in conjunction with other sources of information. Nothing resembling a detailed pattern of vegetation may be inferred from this source. In this particular study area, intensive field studies of the modern situations and their on the spot interpretation by the ecologist corroborating his inferences with the patterns produced from survey data, and any other available data, may lead him to the method of analysis most likely to constitute the maximum number of valid conclusions for a given area. This method applied against an increasing number of situations as the work
progresses enables application to variable situations with likelihood of presentation of logical interpretation and reliable information. Analysis by interpretation of several sources of data should be particularly applicable to the presentation of vegetation evaluations in the plateau region.
For the purposes of this study, the two counties to be considered have been divided somewhat arbitrarily into four areas. This distinction has been made on the basis of general physiography and vegetation. Ultimately the factor which distinguishes these areas is historical, primarily the result of Pre-Pleistocene drainage development, Pleistocene interruption of drainage and the creation of the Post-Pleistocene drainage patterns (Figure 12).

Topographically the areas are distinguishable but not totally different. The stratigraphy is not a distinguishing feature although, coincidentally, major series are related directly to the various areas because of geographical position and relief. No one of these areas is vegetationally distinct from the others and in large part the same plant communities occur with variations in all three.

At the time of settlement by the white men all four areas were covered by a mosaic of forest trees which was broken only by an occasional bottomland swamp, by upland prairie openings and probably frequent areas devoided by fire. These are referred to by the reference notes of the original surveyors and are mentioned coincidentally in journals and early histories (8, 14).
The primary factor in the distribution of plant communities appears to have been, and remains today, the character of the soil moisture and its relation to topography, slope exposure, degree of dissection and history of the land surface and to the underlying substrate. The interaction of these factors related to soil moisture may be modified by local edaphic conditions, microclimatic situations or historical events in such a way that specific floristic distribution may show marked difference. This in large part explains the variations in the relatively similar plant communities of the delineated study areas. This conclusion is supported by the recent work of Beatley (1) in Jackson and Vinton counties, whose field observations and conclusions most closely paralleled the conclusions in this paper. The work of Jones (16) in Meigs County led him to the same conclusion, but to a somewhat different interpretation. Boetticher (2) working in Athens County while floristically inclined indicates a similar definition. Personal communication with Dr. E. N. Transeau concerning the distribution of River Birch in this area and its disappearance coincidental with drainage in bottom land situations and his subsequent remarks concerning this factor as applied to the "hilly country" specifically gave conclusiveness to the contention that moisture aeration gradients are the governing principles in the orderly assemblage of vegetations both on the uplands and in the lowlands of the plateau area of Ohio.
Braun (4) has designated southeastern Ohio as within the Mixed Mesophytic forest region and considers this to be the climatic climax of forest succession in this area. Shantz and Zon (29) have relegated this entire region to the Chestnut-Chestnut Oak-Yellow Poplar association of the Eastern Deciduous Forest, geographically homogenizing this vast assemblage into a general successional climax community. Excepting those local situations where disturbance had created inconstancy there is no evidence that succession could occur without climatic or edaphic differences as long as dissection of the existing plateau area and its adjacent areas remained constant and as long as the macroclimate did not drastically change, the habitat could be expected to remain in equilibrium and the biome to continue to be perennial. Excessively drained hilltops would continue to be xeric habitats and mesic sites could be expected to remain constant governed by the source and supply of soil moisture which determined in any case the occupant vegetation. Thus on those sites occupied by a given association, replacement of that association is to be expected through the natural processes of vegetation and because of the controlling factors which differentiated that particular combination of species.

In discussing this same conclusion, drawn under relatively similar climatic and edaphic conditions, Beatley (1) has stated:
The term "climax".....is a term which appears to have little meaning when used in connection with the upland vegetation of this area. No one association represents the climax in the sense that it is the end of a theoretical forest succession on the uplands for there is no replacement of one association by another. Nor is there any one association which fits the climatic climax of Braun which "occupies the average sites," for it appears to be an impossibility to choose just what might constitute an average site in a region of such great site heterogeneity. Only in the sense that a climax community is one which is self perpetuating and is in equilibrium with the climate can the term "climax" be used in this type of topography, in which case all upland communities of the original forests described here are climatic climaxes. More appropriately, they might be referred to as edaphic or physiographic climaxes which will persist as long as the climate and topography remain unchanges.

The feasibility of presenting the complex of relationships involved in the natural determination of vegetational differences found in an area as large as the present study area becomes problematical when heterogeneity precludes precise classification and predictability becomes dependent upon infinity. Generalization becomes a greater necessity as area to be covered becomes larger and the expressive vegetation units demand specificity.

In the discussion of the vegetation of the four areas which follows, precision within tangible limits has been attempted. Generalization has been necessary in an effort to include the entire area in the total picture, and arbitrary limitations have been imposed for general clarity.
Figure 12. Showing the location of upland Areas I, II and III; and Area IV, the area of Swamp Forest succession shown in black.
AREA I: THE EASTERN DISSECTED HIGHLAND AREA

This area includes all of Washington County from approximately the 700 foot contour along the Ohio and Muskingum rivers and their tributaries north to the Monroe and Noble county borders. It extends west to a line of ridgetops that extend from center Belpre north through Fleming, East Salem School and Coal Run, across Belpre, Dunbar, Barlow, Watertown and Adams townships, but excludes the Muskingum River Valley. This was the headwater-divide area of the Marietta River of Teays stage and its relative proximity to the Flushing Escarpment had precluded the same degradation found closer to the master Teays stream.

This area is the most extremely dissected of the four areas with ridgetop elevation of 940 to 1200 feet and valley floors of 600 to 850 feet elevation. In the eastern portion, the ridgetops are commonly narrow and attenuated with steep sides which drop into deep narrow valleys. The eastern part of the area is somewhat less dissected and has been modified by the Muskingum River and its tributaries, as well as by interglacial drainage streams, but it is still more closely related to the eastern highlands than any other area.

The major part of the area is in woodland today, the tilled areas occupying either the broader hilltops or the valley areas. Most of the farm buildings are located at junctures of ridge lines or on terraces in the creek
bottoms, often near the mouths of tributary streams where the valley bottoms are somewhat wider and access to upland fields and pastures is somewhat easier.

The vegetation here is the most complex of the four areas. In some places rather marked boundaries are evident between communities, while adjacent areas may present a rather complex integration of vegetation on a very similar site, exposure and topography. The upland bedrock is all of Permian age, consisting almost entirely of sandstones and shales and covered by a Meigs silty clay loam or its steep phase. The deeper valleys have cut down into the Monongehela rocks of the Pennsylvanian strata, which consist of a wide variety of sandstone shale, limestone, clay and claystone strata. The soils here are largely of the Holston and Upshur clay types and occur more frequently in the western than in the eastern part of the area.

The following combinations of vegetational associations best describes this area:

1. The upland forests composed of associations of Oak-Pine, Oak-Chestnut, Mixed Oak and Oak-Hickory in order from the more xeric to the more mesic. No one community nor combination of associates can be designated as a prevailing upland type over large uninterrupted areas, but Oak-Hickory was probably the most widespread type and certainly in the western part of this area occupied the largest area.
2. The ravine, divide and upper cove forests included Oak, Tuliptree and significant Oak-Chestnut-Tuliptree communities. Oak-Tuliptree associations developing in the ravines of the uplands, with Oak-Chestnut-Tuliptree occupying the deeper ravines, the "low gap" or low divide areas and the upper cove areas adjacent to the uplands.

3. The Mixed Mesophytic, and Hemlock Mesophytic communities were best developed in the areas of deeper dissection and consistently along north and east exposures with occasional development along west and northwest facing slopes. Transitional communities i.e. Hemlock-Beech-Mesophytic for example, are largely lacking but were probably present in the area.

4. Beech communities included White Oak-Beech associations characteristically occupying south and south-westernly facing slopes of the area, the Beech-Sugar Maple segregate of the mixed mesophytic in coves, gulleys and ravines and the genetically different but comparable Beech-Maple associates of the terraces and talus slopes which has been segregated from the swamp forest succession.

5. The White Pine relict community of Granview Township.

The Mixed Oak association

This association differs principally from the Oak-Hickory in the relative number of Hickories that are present and is commonly transitional with Oak-Hickory in the
secondary forest. These communities commonly occur over shales and less massive sandstones and along the south and west exposures of higher more attenuated ridges with thin soils and steeper gradients. White Oak, Black Oak and Chestnut Oak are consistent associates enriched by Scarlet Oak and by Yellow Oak over limestone sites. Pignut and Mockernut were present in lesser numbers and Chestnut was conspicuously absent. The Mixed Oak association is probably more widespread and more abundant today than it was in 1800 because of the death of the Chestnut by the Chestnut Blight (*Endothis parasitical*). Although Chestnuts were not present in the original Mixed Oak association, their death created an opening in the habitat which at least on the upper slopes was filled in good part by White and Black Oak in this area. Another factor contributing to this development has been the removal of Hickory from the secondary stands as an undesirable timber tree; this has been notably true on state lands and in varying degrees on private land under forest improvement plans. Shrub and herbaceous layers of vegetation are commonly absent from this association and a common paucity of spring flowers is notable. Sparse mosses and lichens with some grasses and low weeds are about the limit of the ground cover under this association.
Figure 13. Mixed Oak forests grading into a steep north facing slope covered with Mixed Mesophytic forest in Adams Township of Washington County.

Figure 14. Oak-Hickory forest on broader hilltops and south and west facing slopes of Newport Township in Washington County.
The Oak-Hickory association

The relationship of the Oaks and the Hickories form a complex throughout the entire study area, transitional with Mixed Oak, Oak-Chestnut and Oak-Pine, the distinction of which is dependent upon the relative numbers of various species. In the secondary forests these communities are frequently well defined, but more often the composition has been modified, and it is probable that in the primary forest, variability and transitional relationships presented as complex a pattern as today.

In general the Oak-Hickory association occupies the south and west exposures of the hills and may occupy some of the north and east exposures as well as the broader and more rounded ridge tops, accompanied by gentler slopes and lower local relief.

Dominant species of the communities include White, Black and Chestnut Oaks with Mockernut and Pignut Hickories on the upper slopes, while the canopy trees on the lower slopes are White, Black and Red Oaks with Mockernut and Shagbark Hickories. Scarlet Oak, Post Oak and Yellow Oak may be prominent associates. White Oak is the most consistent member of the association, tending to decrease in numerical importance on the upper slopes. Other associated species are Black Gum, Sourwood and Chestnut. Little or no herbaceous or shrub vegetation is associated with this community, however some Dogwood must have occurred because it is cited in the journal of Ebenezer Buckingham in this area.
Line descriptions and witness tree citations by Buckingham and by Levi Barker cite White Oak more frequently than any other species, indicating its general distribution through Oak communities of this area. Black Oak, Chestnut Oak and Yellow Oak are also mentioned but not as prevalently as is White Oak. With respect to the Hickories, although not mentioned with the prevalence of White Oak, the survey records in their mention of "Oak Hickory," "Hickory," and "Hickory lands" give evidence of an abundance of Hickory in the original forest which greatly surpasses that found in the secondary forests.

The Oak-Chestnut association

Oak-Chestnut communities were apparently widespread throughout the area occurring locally with Oak-Hickory, Oak-Pine and Mixed Oak, but its area of greatest development appears in those areas of most rugged topography over the massive sandstones of Grandview, Independence, Lawrence, Newport, Muskingum and Warren townships of Washington County. Today a few snags stand as reminders of its occurrence, and here and there saplings, some developing into small trees and producing fruit, develop before being stricken by the blight.

Chestnut was associated primarily with Chestnut-Oak on the ridge tops and upper slopes and with White Oak on the lower slopes. In addition to these dominant species, Black Oak, Scarlet Oak, Yellow Oak, Mockernut, Pignut, Black Gum,
Sourwood, Pitch Pine and Virginia Pine were found on the upper slopes and Red Oak and Tuliptree enriched the assemblage on the lower slopes. Dogwood and Serviceberry formed the understory with Red Maple appearing on the somewhat deeper soils. Mountain Laurel, Blueberry, Huckleberry and Smilax were the major components of the shrub layer. Herbaceous vegetation was sparse.

The Oak-Chestnut communities occupied the sites where low soil moisture levels occurred during some part of the year. Sharp ridges and ridge ends over massive sandstones were occupied by almost pure stands of Chestnut-Oak which appears to be the most tolerant of extreme xeric conditions, followed in order by Chestnut, Black Oak, White Oak, Scarlet Oak and Yellow Oak. Broader ridges and the higher and steeper south and west facing slopes were occupied by Chestnut Oak-Chestnut and Chestnut Oak-Chestnut-Black Oak communities, which often were quite extensive in this area.

The Oak-Pine association

The communities of Oak in which Pine occur and the occurrence of Pine in small but relatively pure stands is one of the distinguishing features of this Eastern Highland Area. They occur principally over Permian rocks and consistently throughout the area. Both Ebenezer Buckingham and Levi Barker make note of Pine in their journals and as witness trees. Buckingham found Pine stands worthy of note in two places and mentions Pine "scattered and few" in the
Figures 15 and 16. Oak-Pine communities along hilltops in Area I.
descriptions of lines in six sections of Grandview Township, so located in much the same sites and over much of the same area today. The same is true for every township in this area, if Pine was mentioned by the surveyors, Pine is there somewhere today. That Pine was apparently not present in thick stands is evident from these descriptions, and that it covers large acreages in what is often fairly pure stands today is self-evident. Pine in some places has occupied area formerly occupied by Chestnut; however, fire and field abandonment on old farms has resulted in greater increase in numbers of Pine than probably any other factor.

Pitch, Shortleaf, and Virginia Pines are all present in this area. Throughout the area, Oak-Pine communities occupy the most excessively drained sites, where the soils are commonly shallow, dry, sandy, and sterile. Virginia Pine together with Chestnut Oak, Black Oak, Scarlet Oak, Pignut, Dogwood and Sourwood appear to be the most common associates. Pitch Pine in lesser numbers may occur in this association and on the less sterile sites. Shortleaf Pine may occur along the tops of south, east, and west facing outcrops of massive sandstones all along the Ohio and Muskingum rivers. This is also true of similar sites along Duck Creek, Paw Paw Creek and the Little Muskingum River. This association appears to be directly associated with conditions of excessive drainage and thin sterile soils of sandy nature and originally did not occur in anything like pure stands.
Low ericaceous shrubs form the only ground cover and include Mountain Laurel, Blueberry, and Huckleberry.

The Oak-Tuliptree communities

Throughout the upland of this area and transitional with the mosaic of the Oak forests, a segregate of the Oak complex is found in which Tuliptree is the characteristic species. This enrichment of the complex by the Tuliptree appears to be associated with topographic position and occupies the moister portions of the area ordinarily occupied by the Oaks and their xerophyllic associates. This enrichment results in Oak-Chestnut-Tuliptree, Mixed Oak-Tuliptree and in Oak-Hickory-Tuliptree associations which indiscriminantly occupy low drainage divides, moist upland ravines and upland cove areas and there is some evidence that these may well have constituted an enriching element to the vegetation of the more rolling uplands and the moist sites located at higher elevations. References to "Yellow Poplar" and to "Tulip" are to be found in the notes of Jeffrey Mathewson, Levi Barker and Ebenezer Buckingham in frequency that would indicate a prominence not indicated by its present day occurrence.

Oak-Chestnut-Tuliptree communities were probably among the best defined of this relationship, and where the Chestnut has been removed as an associate. Tuliptree has in large part replaced it. The Mixed Oak-Tuliptree and the Oak-Hickory-Tuliptree associations, while not as well
Figure 17. Black Oak, White Oak and Tuliptree in uplands of Aurelius Township in Washington County.

Figure 18. Almost pure stands of Tuliptree on the uplands of Adams Township in Washington County.
defined today were probably of greater significance formerly, largely because of their extensive clearing from more desirable lands and to their desirability as timber sources. White Oak, Red Oak, Chestnut, Pignut, Mockernut and Red Maple were associated with variable prominence in this community depending upon the completeness of the dominance of the Tuliptree. On the upper slopes this association intergraded with the Oak associations and on the lower slopes with Beech-Sugar Maple and with Mixed Mesophytic on the lower slopes and in the lower cove and richer talus slope areas.

This community, though present throughout this area, is best defined in the more westernly townships of this area notably Warren, Watertown, Muskingum, Adams, Salem and Aurelius townships, along the edges of the Permian strata, but by no means confined to it.

The Mixed Mesophytic Forests

Mixed Mesophytic communities are consistently present throughout this vegetation area on north and east facing slopes and are also well developed along west facing slopes in the Little Muskingum watershed, particularly in Lawrence, Ludlow and Independence townships of Washington County. They are best expressed and areally most prominent on the steep to precipitous north and east facing slopes, on long steep talus slopes and in the deep north facing coves of the area. These topographic features combine exposure and
Figure 19. Mixed Mesophytic Forest showing Yellow Buckeye, White Walnut, Tuliptree and Red Oak along north facing slope in Ludlow Township in Washington County.

Figure 20. Mixed Mesophytic Forest in foreground showing tops of Tuliptree, Beech, Sugar Maple, Black Walnut and Red Maple. Oak and Hickory forests on hills in background. Grandview Township in Washington County.
water holding capacity to assure continuous available moisture with uniform internal drainage and aeration and support the richest of all the upland vegetational types.

Where the Mixed Mesophytic community has reached its best development along the Little Muskingum River, Duck Creek and their tributaries, some 24 species compose the canopy. These include Chestnut Oak, White Oak, Black Oak, Red Oak, Yellow Oak, Chestnut, Bitternut Hickory, Shagbark Hickory, Shellbark Hickory, Mockernut Hickory, Tuliptree, Beech, Basswood, Black Walnut, White Walnut, Red Elm, American Elm, Red Maple, Sugar Maple, Black Gum, Sourwood, Black Cherry, Hemlock and Yellow Buckeye. These species occur in various combinations in the secondary forests and although nearly all of the species listed may occur at any elevation, those species whose moisture requirements are greater are most numerous on the lower slopes.

Shrub layers are rich in numbers and in species being composed of large numbers of juvenile individuals of the canopy species in addition to Dogwood, Wahoo, Redbud, Serviceberry, Witch Hazel, Spicebush, Pawpaw, Red Mulberry, Blue Beech, Ironwood, Hazelnut, Buckthorn, Arrowwood, Mountain Laurel and Rhododendron.

The herbaceous flora are also well developed and it is under the Mixed Mesophytic communities of this area that the richest numbers of spring flowering plants are to be found.
Less information is to be gained from the survey records about this community than possibly any other. With the vast assemblage of species possibly present and the possible combination of these on any given line, little or no indication of its presence is to be gained from the data on survey sheets. Occasional notes from the surveyors' notebooks corroborate the presence of this forest type. Spruce and Cedar notations, which probably referred to Hemlock, were considered as good indications of the presence of Mixed Mesophytic conditions. Linden, White Walnut and Tuliptree, while not positive indicators, were used as guides to sites which could be more clearly defined in the field as to their condition. Abundant mention of underbrush in conjunction with mesophytic species of canopy trees either in the surveyor's notes or line descriptions were regarded as possible site indicators.

The Hemlock Mesophytic association

The status of Hemlock and its associates throughout the entire study area is extremely hard to define in view of the fact that only scattered remnants remain. Heavy cutting and modification of the habitat have all but obliterated what was probably a small but more general population. No mention of Hemlock is made by the surveyors and their "Spruce" and "Cedar" references cannot be conclusively superimposed upon likely Hemlock-Mesophytic forest sites. The present day occurrence of Hemlock is confined
to extremely steep talus slopes, associated with massive porous sandstones and occurring on north, east, or west exposures. In some cases the Hemlock is now confined strictly to the lowest portions of the slope, often immediately adjacent to the stream beds as in the case of a remnant near Flint Mills in Section 16 of Ludlow Township or it may occupy almost all of the slopes from top to bottom as is found near Hills in Section 31 of Newport Township.

Associated with Hemlock in this area in usually limited numbers are Beech, Tuliptree, Sugar Maple, White Oak and Red Oak, with a shrub layer in exposed areas of Mountain Laurel, Wild Hydrangea, Witch Hazel and Spicebush.

From the location of the scattered remnants and the presence of likely Mesophytic habitats, although the original communities were restricted, it seems likely that scattered stands were located generally along the Little Muskingum River and its tributaries. Mill Creek and certain other tributaries of the Ohio River, as well as in Section 8 of Fearing Township. There is no evidence of its occurrence in the western part of this area and along the Muskingum River.

The distribution of Hemlock appears to have been under the control of moisture aeration conditions associated with steep talus slopes underlaid by massive porous sandstones and because of its limited distribution and the paucity of the remnants constitutes a special problem of great difficulty today.
The Beech communities

The White Oak-Beech segregate of the Mixed Mesophytic forest has been previously described by Braun (4) as a well marked forest type, which is extensively developed throughout the Mixed Mesophytic forest area. Beatley (1) has noted it in the hillier parts of Vinton and Jackson counties, where it apparently occupied significant portions of the south and west facing exposures.

The community in this area in general occupies only the lower portions of south and west facing slopes seldom occupying more than 50 to 100 feet of local relief on sites that due to their topography and exposure show little variation from the sites on which Oaks are dominant, except for the presence of Beech as a significant dominant.

The proportion of White Oak and Beech are variable with Beech usually being the most important species in the secondary forest; however, due to the utilization of White Oak as an important lumber tree and the relative exclusion of Beech from cutting practices, some bias occurs in the occurrence of the secondary forest types. Associates include Black Oak, Red Oak, Chestnut Oak, Chestnut, Pignut Hickory, Shagbark Hickory, Mockernut Hickory, Black Gum, Sourwood and Red Maple.

That this association is distinct and genetically different from the Beech-Sugar Maple is supported by the lack of Sugar Maple in the association in any case and by the absence of Sugar Maple seedlings except in the very
lower portions of the present communities. The understory here is usually well developed consisting of Oak and Beech seedlings with an abundance of Dogwood, but with little or no associated species, the presence of mesic underbrush being particularly notable. The presence of this association is also corroborated by the descriptions of the surveyors, particularly along the hills bordering the Ohio River where descriptions can be fairly well located. Citations for lower slopes and particular segments of mile lines containing descriptions of "Beech and Oak," "Dry Beech and Oak," "Middling Ground with Beech Hickory and White Oak," "Beech and Dogwood," "Scrubby Beech and Oak," are found in present day Dunham, Warren, Muskingum, Newport, Independence and Liberty townships of Washington County.

In this area the White Oak-Beech was never areally prominent, relative to the other Oak-containing forests of the area, but it would seem to relate rather to an areally limited band, not necessarily continuous, along the south and west facing exposures of the major hill bodies, as related to the major streams of the area, the Ohio River, Muskingum River, Duck Creek, and Little Muskingum River. That it was excluded in other areas is not implied; however, evidence of its existence may be lacking or interpretations of its presence may be needed.
The occurrence of Beech and Sugar Maple as associates in this area is not well defined as to genetic relationship. Certainly two distinct successional patterns occur here, one relating to the Mixed Mesophytic Forest and the other to the Swamp Forest succession. The two communities are very similar in composition and in some cases merge areally, but develop from two distinct vegetational groups and under distinctly different edaphic and climatic conditions with what is probably similar manifestations.

The Beech-Sugar Maple association as related to the Swamp Forest succession occurs principally upon alluvial terraces commonly on flats, where internal drainage, though well developed, is still imperfect or seasonally variable to a degree that precludes development of Mixed Mesophytic Forest elements. The other is characteristically an association of the lower south and west facing slopes and is usually best defined on the more gentle slopes and is adjacent to the exposures supporting Mixed Mesophytic communities. In many cases it is little more than a band separating Mixed Mesophytic and Oak communities but may be expressed strongly along the lower slopes and contiguous with the Beech-Sugar Maple of adjacent terrace lands. Internal availability of water as controlled by drainage from the higher slopes in this case probably controls the distribution of this forest type.

Associated species most commonly are White Oak, Red Oak, White Ash and Linden. Chestnut, Red Maple, Black
Walnut and Yellow Buckeye may also be present. Shrub and herbaceous layers are moderately developed with Spicebush, young Beech and Sugar Maple occurring most frequently. The herb layers consist mostly of spring blooming plants and the leaf litter is moderately pronounced.

The White Pine community

Several hundred White Pine trees in almost a pure stand was reported to the Ohio State University Herbarium from Grandview Township in Washington County by Lawrence E. Hicks. These were reported to be native trees occurring near New Matamoras, Ohio, and no more information is available about them from that source. Extensive field work in the vicinity of New Matamoras and Yellow House in Grandview Township in Washington County revealed neither White Pine nor physical evidence of its existence. Information given by local residents, members of the United States Forest Service staff and lumbermen of the area revealed that although all had heard of this community, none had actually seen it and no one knew what had become of it. All reports placed it somewhere near Yellow House, Ohio, on either the headwaters of Collins Run or in the vicinity of Mill Creek or Leith Run. No suggestion of this species is present in the survey records, although Ebenezer Buckingham, in his survey records makes note of unidentified Pine occurring in all of the section lines of this area.
AREA II: THE BARLOW RIVER VALLEY REMNANTS (TEAYS STAGE)

This area is characterized by a generally modified terrain characterized by rounded hills, extensive terraces, upland flats and benches, which are directly traceable to the Teays stage Barlow River, a dendritic stream which gathered its headwaters near Barlow in Barlow Township in Washington County and joined the Marietta River (Teays stage) near Torch in Troy Township in Athens County. This stream drained all of Washington County west of the before described western boundary of Area I and its broad drainage basin is still clearly marked on the topographic maps and in the field (Fig. 12). Erosion of this system by the deeply intrenched Muskingum and Wolfe Creek systems following Wisconsin times has resulted in obliteration of the major part of the Barlow River valley in Watertown and Waterford townships in Washington County, but its influence can be detected as far north as the Monroe County line.

The western boundary of this area is a line of knolls and ridges near the Athens-Washington County line. This boundary extends north from the Meigs-Athens County line near Vanderhouf through Coolville P. O. west of Decaturville, Cutler, Bartlett and Patton Mills to the Morgan-Washington County line. The Ohio, Muskingum and Hocking river valleys are excluded from this area and will be discussed later under a separate heading since the vegetation of these postglacial valleys is an entity unto itself and
in large part genetically unrelated to the upland vegetation (Fig. 12).

A few areas of extreme gradient and major relief occur in the southern part of this area adjacent to the Ohio River and in the vicinity of the deeply intrenched Muskingum River, Wolfe Creek and their tributaries but otherwise the character of the land is gently undulating and conducive to general cultivation, in past years supporting a large number of apple and peach orchards, vegetables and general farm crops. The forests of the area are the most poorly preserved of the entire area and are generally confined to the extremely dissected areas. These have been intensively cut over and much of the remainder is brush land of relatively low value to this study.

The major soil areas of the region are the Upshur Clay and Upshur Silty Clay Loam, the Meigs Silty Clay Loam and the Vincent Silty Loam which have developed from red clay shales, sandstone and shale; and the Monongahela Silt Loam and the Moshannon Silty Clay Loam soils which have developed from alluvial material on terraces underlain by silts and clays. Bedrock formations are almost all of the Permian system with the deeper cut streams flowing on Monongahela sandstones and shales of the Pennsylvanian series. All of the area is well drained, but excessively drained sites are not unknown; however, this area in general is distinguishable by the presence of more mesic communities and by its relatively prosperous appearing
croplands, even during severe summer drouth periods. Where present mature trees are more often confined to farm woodlots which are usually park-like in appearance; untended woodlands are commonly brushy and poorly developed.

The White Oak-Hickory community

The open forests of Oak-Hickory, with White Oak as the most abundant species undoubtedly constituted the major upland plant community of this area. The best preserved of these being in the northern part of the area in Waterford, Watertown and Palmer townships where their remnants are widespread if not abundant. Throughout the area White Oak is still one of the major trees of the area. This preponderance of White Oak in the area is supported by the observations of both Benjamin Tupper and Jeffrey Mathewson in their line descriptions and by their choice of witness trees. In Township 8 of Range 11 Mathewson utilized the following for "bearing trees" at section corners:

26 White Oaks *60 %
3 Black Oaks .06 %
3 Hickories .06 %
4 Maples .08 %
3 Yellow Oaks .06 %
2 Beech .04 %
2 Aspen .04 %
1 Black Walnut .02 %

* Per cent of bearing trees mentioned in township.
51 total trees mentioned.

Chestnut-Oak and Chestnut apparently occurred in low frequency throughout the area with the possible exception of the extreme eastern and western parts of the area where the terraces tend to become more rugged and where relief is somewhat greater than in the center of the area. This is supported by the infrequency of mention by the Ohio Company surveyors and the complete absence of mention in the Barlow River valley portion of the area. The absence of Chestnut from the area is further marked by general absence of any sign of its presence today. Although old snags and young sprouts are present in the other portions of the study area, they are conspicuously absent in this area, with the exception of the western-most area near the Athens-Washington County line.

The presence of Yellow Oak in relatively greater numbers apparently marked this area from its frequency of mention by the surveyors. While present today in much of the area, its present numbers are not apparently indicative of its occurrence in the 1800's.

Areally the Oak-Hickory forests undoubtedly varied with relief and exposure. In the areas of greater relief in this area and on the south and west facing slopes, the
Figure 21. White Oak and Hickory community near Bartlett in Wesley Township of Washington County.

Figure 22. White Oak and Hickory community near Watertown in Watertown Township of Washington County.
dominants were White Oak, Pignut, Mockernut, Black Oak and perhaps Chestnut Oak in the more extreme areas. Post Oak, Scarlet Oak, Yellow Oak, Shagbark Hickory, Black Gum, Red Maple, Sourwood and possibly Chestnut were also associated with this drier phase of the Oak-Hickory forest.

The communities occupying the north and east facing exposures and the gentler slopes and areas of milder relief were undoubtedly enriched by a number of species whose ecological amplitude is somewhat less and whose distribution was therefore somewhat more restricted. The dominants in descending order of prevalence were White Oak, Shagbark Hickory, Black Oak and Shellbark Hickory. The latter was apparently more prevalent here than possibly any of the other upland vegetational areas. Associated species included Yellow Oak, Red Oak, Mockernut, Black Gum, Red Maple, Sassafras and possibly scattered Chestnut, Tuliptree and Sugar Maple.

On the benches and flats of this area as well as on the gentle terraces, White Oak as has been indicated previously, was probably present in its greatest abundance and possibly occurred in nearly pure stands. Shagbark Hickory and Black Oak were its probable associates and from the surveyors journals it would appear that these areas were probably open and often park-like with a preponderance of Dogwood, underbrush and little else.
The Oak-Chestnut associates

Oak-Chestnut communities were limited largely to the eastern and western parts of this area as has been mentioned in conjunction with the occurrence of these species with the Oak-Hickory forests. Over the massive sandstone outcrops in the southwestern and the eastern edge of the area, where the Hocking, Muskingum and Ohio rivers have modified the terrain and where their tributaries have eroded into the Barlow River valley, Oak-Chestnut and mixed Oak became more prevalent coincident with the more rugged terrain. Wherever the Oak-Chestnut communities predominate, low moisture levels occur during the summer months and consequently these communities were more common in the upper reaches of south and west facing ridges than to other parts of the topography.

Chestnut was associated in these areas with Black Oak and White Oak with Chestnut Oak appearing on the more xeric upper slopes and immediately over rock outcrops. Associated canopy species were Mockernut, Hickory, Pignut Hickory, Black Gum, Scarlet Oak and Sourwood, enriched by Red Oak and Red Maple and possibly Tuliptree at lower levels where the association occurs. Dogwood, Mountain Laurel, Blueberry, Huckleberry and Smilax species compose the shrub layer. Ground cover and leaf litter were sparse.
The Oak-Pine association

In Belpre, Decatur, Fairfield, Palmer, Waterford and Watertown townships of Washington County and in Troy Township of Athens County, large numbers of Pines are present today. These form massive stands invading old fields and occupying large areas along hilltops and steep hill sides.

Both Virginia Pine and Shortleaf Pine occur throughout the area and both are apparently increasing in numbers as old fields are abandoned and less care is given to the farms of the area. This preponderance of Pine on these sites apparently is indicative of its presence in the original vegetation; however, it would appear that it was probably not as significant formerly as it is today.

Both Jeffrey Mathewson and Benjamin Tupper in their survey notes refer to Pine in a large number of cases, but these were interspersed with hardwood species in such a way as to indicate limited stands generally distributed rather than wholesale occurrence. Mathewson notes for Decatur Township, "on land timbered with Oak and Pine with thickets of brush......Timber Oak-Hickory with some underbrush, Dogwood." Tupper in Troy Township notes Pine in several instances and describes "Timber, White Oak, Black Oak, Hickory, Pine,......Oak, Hickory, Pine and mixed Oak, Poplars on bottom." Other notations from the area are similar.

Originally both Virginia Pine and Shortleaf Pine probably occurred in the upper slopes and ridge tops of the areas of greater dissection, particularly along the hills.
bordering the Ohio, Muskingum and Hocking rivers. Short-leaf Pine may have occurred in something approaching small stands, but Virginia Pine was probably always found in conjunction with White and Black Oak. Associates also included Pignut Hickory, Mockernut Hickory, Scarlet Oak and Post Oak. Coincidentally, the Pine stands in this area are commonly associated with Mannington, Jollytown or Waynesboro sandstone outcrops, which are responsible for the steep sided hills where they are so often found and probably supply intense internal drainage because of their open porous nature. Herbaceous vegetation and understory species are very sparse in these areas.

The Beech communities

The Beech-Sugar Maple associations might be expected to occupy much of the alluvial terrace area and stream bed portion of this region, for here there is abundant moisture and soils retentive enough to preclude seasonal lowering of moisture gradients to a critical point. The survey records appear to support this contention and probably next to the Oak-Hickory community, the Beech communities were the most prominent areally. Nearly all of the areas where this association occurred are now under cultivation and very little if any, positive indications of its presence remain. Jeffrey Mathewson in his survey records makes note on several occasions of the presence of Beech in what may have been sizable stands. Journal notes and mile descriptions
specifically refer to "bench land good soil, Beech, Sugar-
tree and White Oak," in Troy Township; in the case of Bar-
low Township to "Wheatland, Beech, Sugartree, Oak," and in
Dunham Township to "wheat soil, Beech, Sugartree, Oak,
Maple and some Walnut."

The Beech and Sugar Maple of much of this area was
apparently spotty and occupied sites upon which drainage
was somewhat retarded but where the soil moisture was not
sufficient to allow the development of species in large
enough numbers to produce Mixed Mesophytic vegetation.
Beech and Sugar Maple are apparently common on the flatter
areas and particularly those adjoining north facing stream
heads which were not steep. The Beech-Maple complex was
differentiated from the Oak-Hickory of the region under
conditions of perhaps only a few feet difference in ele­
vation or possibly because of the difference in the slight
slope of the land.

The upland communities were not developed upon this
rather undulating river valley of broad proportions and
reduced gradient from the original swamp forest which
occupied these sites. This valley must have been submerged
during the time of Lake Tight (44) and therefore the modern
forests of the 18th century uplands must have developed
from the forests preserved upon the headlands and islands
that persisted during this period. That elements of the
swamp forest must have migrated or been present at high
enough elevations to escape this flooding must be inferred
from their presence. All across this area in the headward eroding stream valleys and along the modern river terraces this element of the vegetation stands as a dominant community.

Therefore two possibilities may be suggested, (1) that the rise of Lake Tight was slow enough to allow the development of swamp forest on certain upland areas ahead of inundation or segregates of the swamp forest were present among the upland vegetation at the time of inundation, or (2) that inundation was rapid enough to destroy the existing swamp forest and that the present day swamp forest was derived from elements present in a refugia, or that the present vegetation invaded through Pleistocene or Post-Pleistocene drainage development and produced the modern day forests. If the Beech-Maple, particularly, was derived from refugia vegetation of the Lake Tight period, it is related to the swamp forest succession in this region or has it segregated from a more mesophytic type of forest which must have been represented in that refugia. If this is the case, the cool, rainy, foggy, moist atmosphere preceding the glacier must have allowed the persistence of a wide variety of species on a common site such as we might well expect in a Mixed Mesophytic area and as Lake Tight was lowered this same forest community must have prevailed with no great change and allowed subsequent migration of the refugia elements into the newly emerged lands.
Figure 23. A formerly rich Beech-Sugar Maple forest from which the Maple has been cut within the last few years. Sprouts and seedlings of Maple abundant. Wesley Township, Washington County.

Figure 24. Beech and Sugar Maple enriched by White Oak, from which much of the White Oak and Maple had been cut. Wesley Township, Washington County.
This migration with the consequent segregation of elements of the new forest must be considered in the history of the vegetation of the area. Whether the Beech and Sugar Maple of this area is related to the succession of the swamp forest elements or whether it is the result of segregation of a Mixed Mesophytic type of forest offers challenge to the tenant of relationships of vegetations in concrete successions. The problem of considering the history of vegetation as well as the climatic and edaphic regimes, in no way poses a denial of succession, but presents succession in the true light of its existence (Fig. 25). That succession does not refer to the vegetation, but rather to the expression of events which ultimately are responsible for the survival of individual elements of the vegetation upon a given site. The individual elements by virtue of similar ecological amplitudes are distributed in certain predictable patterns as segregations of a vegetation in given environmental regimes and seemingly small differences in superficial characteristics of a habitat may have considerable impact upon the biotic complex.

Along the Wolfe Creek valley and in the valley of Rainbow Creek, in particular, Beech becomes more restricted to the north-facing slopes with some tendency toward weak persistence near the base of south-facing slopes in some locations. Across the Muskingum River in the Tick Ridge area, Beech and Sugar Maple are almost non-existent, giving way to Oak-Hickory enriched primarily with Sugar Maple.
Figure 25. The general relationships of the upland forest associations in the Athens-Washington counties area as related primarily to soil moisture gradients.
The Mixed Mesophytic Forest association

Mixed Mesophytic communities were mostly absent from this area or were weakly developed with the exception of those in the Wolfe Creek area, along the north-facing hills adjacent to and immediately south of the Muskingum River and in the Coolville-Hockingport area of Troy Township. These were areally limited and weakly developed floristically. The effect of exposure was the principal modifying factor with the properties of the exposed bedrock undoubtedly playing a part in the control of the moisture gradients of the soils under these communities.

The preponderance of Oak and Hickory over much of the area is typically pronounced and the composition of the mesophytic communities consists largely of enrichment of these Oak-Hickory forests or the replacement of certain of the Oaks by other more mesic species. The presence of Tuliptree, Beech and Sugar Maple is particularly notable with Black Walnut, White Walnut, Black Cherry, Black Gum and Linden adding floristically to the assemblage.

Hemlock apparently did not occur in this area or if it did it was in very limited numbers and in no more than one or two stations. The possibility of its occurrence in the vicinity of Four Mile Creek near Coolville in the weakly developed mesophytic forests of that valley exists, but no indication of its presence was found in the survey records or in the field studies. Hemlock is present however on the north fork of Four Mile Creek in very similar locations.
The Virginia Red Cedar

Throughout Waterford, Watertown, Palmer and Wesley townships in the northern parts of Areas II and III, Virginia Red Cedar is found growing generally but not abundantly. Apparently confined to areas of outcrop of limestone rock, this species, although not a major element in the primitive forest, was apparently known to both the Indians and to the early white settlers who used it as a medicinal tea and for its aromatic wood. Its distribution and numbers have apparently increased with the advent of the white man and the subsequent clearing of the land (8).

AREA III: THE WESTERN DISSECTED HILL-LANDS

This area encompasses the whole of Athens County except for that part of Troy Township included in Area II and includes the western portions of Decatur and Wesley townships of Washington County excluding the Hocking River bottoms and the lower valleys of certain of its tributaries. It is similar in aspect to Area I in pattern of dissection, steepness of hill slopes and in the diversification of its vegetation; however, Area I lying near the Flushing escarpment has been exposed to a relatively more constant and less variable history than has this area. The Teays stage Whipple Creek, Rinard Mills Creek and upper Marietta River valleys were occupied by similar systems during Deep stage and interglacial times and by the present-day Duck Creek, Little Muskingum River and Ohio River during post-glacial
times with erosion proceeding along relatively constant lines throughout this entire period. Area III on the other hand has been subjected to greater inundations over a longer period of time and possibly repeatedly stream reversal and piracy and extreme erosion in the case of the cutting through of cols. Outwash materials from the Pleistocene glaciers are found throughout the Hocking Valley and associated with the courses of Stewart Creek which affects much of Area III, whereas the outwash deposits of the Muskingum River valley affect only the western edge of Area I. This complication in the recent Geological History of the area has served to complicate the complex of biotic regimes of the area.

The topography of Area I is greatly diversified, ranging from deeply dissected steep sided narrow valleys to rather smooth undulating plains along the valley of Teays stage Albany River, massive sandstone may produce hugh rock faces and re-entrants or the hills may be rounded into "sugar-loaf" forms with only a few or no exposed strata. In certain areas immense fossil beds are exposed and streams at places run across coal beds producing black chips and pebbles that may work the course of the stream for many miles.

The bedrocks composed of Pottsville, Allegheny, Conemaugh and Monongahela series of the Pennsylvanian era are more diversified than any other group. Both marine shallow lake and surface deposition occurred here. Discomformity
between the series of the two eras results in confusing geological interpretation. Faulting has disturbed the north and northwestern patterns of occurrence of strata, particularly in Trimble Township.

Difficulty was encountered in reconstructing the original vegetational pattern of this area. Present-day Alexander and Athens townships were apparently left unsurveyed in the original tract and portions of Lodi, Dover, Lee and Trimble townships were not surveyed until much later. The survey data since 1805 is now in the files of the State Auditor's office and are combined into engineering reports which do not make use of the same information available from the Ohio Company Purchase survey. All of the area has been extensively cut for timber, much of it is or has been under cultivation or pasture, other parts have been strip mined for coal and all of it has been more severely modified by the activities of man than any of the other areas.

The vegetational pattern, because of the history and the topography of the region, is not well defined. No clear cut correlation for any species or community can be found with either soil or stratigraphy. The history of the region both geological and cultural has been such to make difficult the definition of communities and where the community is defined they occur in complex mosaics, displaying various fascinations in adjacent areas and often modified by local conditions of a cultural nature either contemporary or historical.
The area is distinguished by no one characteristic from the other two upland areas. The following combination of vegetation types are considered to be characteristic of the area:

1. The upland Oak forest types were Oak-Chestnut, Mixed Oak, Oak-Pine and Oak-Hickory. None of these communities were probably massively prevalent over wide areas but occurred in a defined mosaic. Oak-Hickory was probably the most widespread community and although areally it perhaps covered a greater area than in Area II, it probably was not as dominant in this area.

2. The Oak-Tuliptree forests of the upland divides, ravines and coves was probably more prevalent in the northeastern and eastern parts of the county, but did not become as prevalent nor as well developed as they did in Area I.

3. The Beech communities in which Beech was present as a dominant or where it was present as a prominent member reached their best development in this area. Beech was present in this area as a member of the White Oak-Beech forests of the uplands and as a genetic portion of the swamp forest succession to Beech-Sugar Maple on the lacustrine and alluvial features of the county.

4. The Mixed Mesophytic communities including Hemlock-Mixed Mesophytic were relatively well developed in the areas of deeper dissection and greater relief. While probably as floristically rich as the Mixed Mesophytic forests of Area I, they were not areally as prominent and
were more often attenuated in this area than in that area. Hemlock-Mixed Mesophytic was restricted to a few stations and in general were never as well developed as those in Area I.

5. The prairie relicts, locally called "Buffalo Beats" were located in York, Dover, Ames, Bern and Rome townships of Athens County and in Decatur Township of Washington County. This does not preclude the possibility of a wider distribution of this vegetational type but includes only those townships with known definable stations of prairie species.

The Oak-Chestnut association

This association appears to have been widely scattered throughout the area, developing most intensely along sandy ridges and over massive sandstones in Alexander, Lodi, Troy, central Bern, northcentral Athens, southwestern York and northeastern and central Waterloo townships of Athens County. This is generally the same area mapped by Boetticher (2) and coincides with those areas of rugged topography and steep slopes which are associated with the occurrence of this association elsewhere.

On the uppermost ridge tops and on the upper south and west facing slope lines, Chestnut is associated with Black and Chestnut Oak to the exclusion of almost all other species. On the north and east slope lines and on lower and steeper slopes, White Oak and Scarlet Oak are found
Figure 26. Mixed Oak along broad ridge near Athens in Athens Township of Athens County.

Figure 27. Oak-Hickory just below figure 24 on same ridge near Athens in Athens Township of Athens County.
enriched in varying degrees by Mockernut, Pignut, Black Gum and Yellow Oak. The underbrush is generally sparse, often of ericaceous components and sometimes including Dogwood and Serviceberry. On sharp ridge tops with thin sandy soils Chestnut Oak may occur almost alone

The Mixed Oak association

The Mixed Oak community, as noted in Area I, was commonly transitional with the Oak-Hickory forests and differing from them in composition principally with regard to Hickories. In this area it was also probably contiguous with Oak-Chestnut and varied from it in its enrichment by Oak species and by the relative dearth of Chestnut. Black Oak, Chestnut Oak, and White Oak were the more prevalent species enriched by Scarlet Oak, Post Oak and Yellow Oak. Yellow Oak apparently was more common in the eastern part of the area than in the western part. Shrub and herbaceous species were sparse and where present consisted of young Oaks almost exclusively.

The Oak-Pine association

This community was never extensive in Area III, although it was probably best developed along the eastern edge of this area in Troy, Rome and Bern townships, where Pitch Pine and Virginia Pine were usually associated with Chestnut Oaks. Shortleaf Pine enriched this association in Carthage and York townships on soils that were somewhat heavier and deeper and the ridges and slopes not quite as
Figures 28 and 29. Pine on hilltops and along banks of Hocking River in Canaan Township of Athens County.
sharp and precipitous. Black Oak, Scarlet Oak and Pignut are the common associates today and probably were associated with these stands formerly. Dogwood and Sourwood were the common understory and herbaceous and low shrub layers were not well developed.

Both Jeffrey Mathewson and Ebenezer Sproat make mention of Pine lands and of Oak and Pine on the hills. These references are frequent enough to indicate that Pine probably occupied the same relative position in the vegetation in 1800 that it does today, particularly along the precipitous eastern slopes of the Hocking valley in Sections 9, 3, 32 and 29 of Troy Township of Athens County. Communities of Oak-Pine also occurred in western Waterloo, in eastern Trimble and southern Alexander townships of Athens County. The stations in Trimble and Waterloo were mapped by Chute (5); however, investigation of the sites indicates that extensive stands did not occur. In any event, this community was never as extensive in this area as it was in Area I and was probably never as well defined with the exception of the areas mentioned in eastern Athens County.

The Oak-Hickory association

Open forests of Oak-Hickory constituted the greater part of the upland forest communities in this area with White Oak being the most prominent species. Moister and drier phases of the association and intergradations of the two, with depauperation and enrichment of species created a
complex community which occupied broad ridges and slopes of varying exposure.

In general slopes of lower gradient, lower slopes in areas of greater relief and more intense dissection and north and east facing exposures were covered with White Oak, Black Oak, Red Oak and Shagbark Hickory as dominant species and with Pignut Hickory, Mockernut Hickory, Black Gum, Red Maple, Sassafras, Sourwood and White Ash as associated canopy species. On rich, moist, sandy slopes below the Mahoning Sandstone in western Athens County, Shingle Oak became a dominant in confined areas and possibly occurred as part of the assemblage or as scattered individuals wherever conditions were suitable for its growth and development.

On the drier sites of the area, broad ridges, ridge lines of lower relief and the upper south and west facing slopes, the dominants included Black Oak, Chestnut Oak, White Oak, Pignut Hickory and Mockernut Hickory, associated with Post Oak, Black Gum, Red Maple and Sourwood. Scarlet Oak was also present being most abundant over the dry, stony ridges and banks of the area, especially where the soil was very thin. Over sandstone outcrops and on the sandier ridge tops Chestnut also was added to the assemblage. Yellow Oak was more generally located in the eastern portion of the county and was associated with this community over dry limestone ridges and along limestone outcroppings in the area.
Jeffrey Mathewson, Ebenezer Sproat and Benjamin Tupper all make frequent note of the presence of Oak and Hickory throughout the areas they surveyed. Typical notations include Range 13, Township 5, Section 3, now Canaan Township, "Oak timbered hills......Sycamore, Butternut in bottom......Hills Oak, Hickory, Poplar." For the present-day Lodi Township, Range 13, Township 4, Section 5, "Hills Oak timbered, Hickory and Beech." For Troy Township, Range 11, Township 3, eastern boundary, "Oak, Pine, poor land, hills covered with Oak and Hickory."

The understory trees and shrub layer included Dogwood, Redbud, Sassafras, Arrowwood and Red Elm. Dogwood from the frequency of citation by the original surveyors was probably the prominent understory species throughout the area.

The Oak-Tuliptree communities

Scattered throughout the area, but most prevalent and best developed along the cove heads, low divides and moist upland ravines of Carthage, Rome, Canaan, Bern, Ames, Dover and Trimble townships of Athens County, Tuliptree associated with White Oak became the dominant species. This association may well have been of greater prominence than is indicated by the survey records and by its definition in the present-day forests, but it was probably never as prominent in this area as it was in Area I.

In addition to Tuliptree and White Oak, which in this area were the conspicuous dominants, Red Oak, Black Oak,
Figures 30 and 31. White Oak and Tuliptree in cove heads above Mixed Mesophytic communities in Bern Township of Athens County.
Figure 32. Mixed Mesophytic forest on northeast facing hillside in Athens Township, Athens County, consisting of Yellow Buckeye, Black Walnut, Red Elm, Tuliptree and White Walnut dominants.

Figure 33. Mixed Mesophytic forest on northeast facing hillside in Athens Township, Athens County.
Shagbark Hickory, Mockernut Hickory, Black Gum, Red Maple, Sourwood and Black Walnut were prominent associates.

From the position of this association in the forest mosaic and its topographic location as well as its complete dependence upon degree of soil moisture available, it would appear that whatever the cause, characteristically, this association was derived from Oak-Hickory. The enrichment of that association by Tuliptree to the degree that it was one of the three or four dominant species constitutes its genetic origin. Throughout these sites its dominance is evident often completely so, often dominated only by White Oak and in the majority of cases an associate confined but consistently present.

Boetticher (2) noted this occurrence but considered it to be a part of the Mixed Mesophytic forest complex or an indication of weak mesophytic forest development. Beatley (1) has defined these forest types well throughout the Vinton County and Jackson County areas and Braun (4) has described their position in the Eastern Deciduous Forest Region. Neither Jones (16) in his description of Meigs County nor Chute (5) in his work on Athens County delineated the association.

That Tuliptree was widespread throughout the forest complex is indicated by its wide distribution in variable numbers in the secondary forest. It was undoubtedly present in varying degrees in the primeval forest as well as is evidenced by its frequency of mention in a wide
variety of sites by the Ohio Company surveyors as well as by the government surveyors of the Seven Range Lands. Some bias may well have been present in their notation due to the desirability of this wood; however, we must be cognizant of its presence from their notes.

The Beech communities

The communities containing Beech are generally distributed over this area and are apparently associated with a relatively wide range of moisture gradient. Wide variations and multiple intergradations of these communities combined with their topographic relationship often adjoining or related to Mixed Mesophytic forests or mesic sites strongly suggests segregation from the Mixed Mesophytic forests.

The White Oak-Beech and the White Oak-Beech-Sugar Maple segregates of the Mixed Mesophytic forest in this area were apparently strongly developed although not areally as abundant as the Oak communities with which they were often contiguous. The White Oak-Beech, as in Area I was confined to the lower portions of south and west facing exposures often occurring only as a thin belt, although it may occur on higher elevations with gentler slopes and where preglacial and interglacial modification of the terrain has occurred. The White Oak-Beech-Sugar Maple in general occurs somewhat lower on the south and west slopes and becomes richer and more abundant on the west and north
and westerly slopes. An impoverished Beech-Sugar Maple often occurring on the northern slopes either in the lower moist hollows or as thin belts along the drainage pattern.

The proportion of White Oak and Beech in the association was apparently variable; however, it can be assumed from the frequency of citation in the survey records and its relative abundance and distribution in the secondary forest, that it was either dominant or significantly present in the community. Associates in this community included Black Oak, Red Oak, Red Maple, Pignut Hickory, Mockernut Hickory, Shagbark Hickory and White Ash. Understory species included Dogwood, Spicebush, Beech, Oak and Maple seedlings. The herbaceous vegetation was apparently not well developed consisting mostly of spring blooming plants, Beechdrops and a number of summer and fall blooming asters. The ground cover of leaves and branches was somewhat heavier than in the Oak forests.

The interpretation and differentiations of the Beech communities in Area III are largely subjective endeavours. The frequency of citation of Beech by the survey records, its scattered and often random occurrence in the secondary forest, combined with the knowledge that the aspect and structure of these communities, has been confused considerably in this area by the intense lumbering and clearing operations which have been carried on periodically or often almost continuously for 150 years often leads to questionable comparison of corroborative evidence. That
Beech was present in relatively abundant numbers is without question. That it was associated principally with White Oak and Sugar Maple in the upland forest can be safely stated. The exact relationships of the mosaic, however, is subject to discrepancies in evaluation and the true proportions of constituent members of the community can only be inferred. Boetticher (2) chose to treat the entire complex as a Beech-Maple association, oversimplifying the situation as it probably existed.

The Mixed Mesophytic communities

Mixed Mesophytic communities appear to have been moderately to well developed in this area and while no less characteristic here, were probably not as well developed nor as areally prominent as in Area I. Their best expression was found in this area along the precipitous north and east facing slopes and steep talus and cove heads of north facing exposures of Lodi, Carthage, Troy, Rome, Bern, Canaan and Ames townships of southeastern Athens County and Waterloo and York townships of western Athens County.

The combination of porous sandstone and steep slopes of relatively deep dissection provide continuously available water with uniform aeration and comparatively rich if not deep soils, resulting in various combinations of canopy species unmatched in variety by any other upland community. Twenty or more species occur in the present-day secondary forests in various combinations of which several of the
Figure 34. Hemlock-Mesophytic association with Tulip-tree, White Walnut, Beech and Sugar Maple associates in Canaan Township of Athens County.
following will be present in any given assemblage: White Oak, Red Oak, Tuliptree, Beech, Sugar Maple, Yellow Buckeye, Linden, Black Walnut, White Walnut, White Ash, Butternut Hickory, Shagbark Hickory, Mockernut Hickory, Chestnut, Red Maple, Red Elm, Black Cherry, Black Gum, Chestnut Oak, Black Oak and Sourwood; along with Kentucky Coffee Tree, Shingle Oak and Hemlock locally. The shrub layer was rich and apparently quite thick composed of: Pawpaw, Hop Hornbean, Blue Beech, Red Mulberry, Sassafras, Redbud, Box Elder, Wahoo, Witch Hazel, Hydrangea and seedlings of the canopy species. The herbaceous layer was probably the richest of all of the upland forests in both numbers of species and of individuals.

The Hemlock-Mesophytic association

The distribution of Hemlock and its associates in this area was rather limited. The deep ravines and steep north facing slopes along Four Mile Creek in Carthage Township, a few locations along Federal Creek in Bern and Rome townships, and several very limited stations along the middle and east branch of the Shade River and a very tenuous area along Rock Camp Creek in Waterloo Township is the extent of its distribution. In view of the limited number of sites available for its development, the lack of mention by the early surveyors and its complete absence today, it is doubtful if its distribution in 1800 was much greater than it is today. In all stations extant in this area, Hemlock
is confined to the very lower portion of steep, rocky ravines seldom developing above the creek level and when it does, only to the top of inner valley walls, never occupying the higher slopes, regardless of gradient and exposure. Here it ordinarily merges into Mixed Mesophytic communities.

In this area it is most commonly associated with Red Maple, Sugar Maple, Beech, White Walnut and Red Elm with a shrub layer composed of Mapleleaf Viburnum, Witch Hazel, Dogwood, Serviceberry and Hydrangea.

The Prairie Relicts

All of the Prairie Relicts located during this study were in this area and although this does not preclude its occurrence in the other areas of study, it appears that if not lacking, only a few minor stations might be located in those areas. All of the prairie areas located were limited to areas of 100 square feet or less generally occupying the tops of small knolls along relatively sharp ridge lines and in the midst of Oak-Hickory or Mixed Oak forests. The soils are generally tight clays over sandstones and shales and moisture gradients are apparently quite great. The summer aspects of these areas is usually one of considerable drouth with little vegetational development occurring, except for the grasses, Andropogon gerardi in particular, which in this area appears to continue growth and development somewhat later than the other forms. The
Figure 35. Prairie Relict showing Big Blue Stem, Shooting Star, Giant Hyssop and Horsemint in Dover Township of Athens County.

Figure 36. Prairie Relict consisting mostly of Big Blue Stem in western Decatur Township of Washington County.
spring aspect of these communities is verdant with many flowering plants developing, flowering, fruiting and then disappearing. No tree development was noted directly in the thick part of any of the prairies; however, the trees develop completely around and to the edges of them.

The following is a partial list of the species present upon the Prairie Relicts of this area. It is not presumed that all are prairie species, nor that their successional relationships are such that they could be individually considered as indicators of prairie vegetation. They do represent an assemblage common to these prairie openings and as a group give character to the vegetational aspect of these sites. These species are not to be found on all prairie areas, but are present in the larger and better preserved and are fragmentarily present on the remainder:

- Acerates viridiflora Daf. Green-flowered Milkweed
- Agastache nepetoides (L.) Ktze. Yellow Giant Hyssop
- Andropogon gerardi Vitman. Big Blue Stem
- Andropogon scoparius Michx. Little Blue Stem
- Angelica venenosa (Greenway) Fern. Angelica
- Anychia canadensis (L.) Wood Forked Chickweed
- Apocynum androsaenifolium L. Spreading Indian Hemp
- Apocynum cannabinum L. Indian Hemp
- Arabis canadensis L. Sicklepod
- Asclepias verticilliata L. Whorled Milkweed
- Aster ericoides L. Slender Aster
- Aster macrophyllus L. Large-leafed Aster
Aster patens Ait.
Aster umbellatus L.
Aster laevis L.
Campanula americana L.
Cassia marilandica L.
Ceanothus americanus L.
Cimicifuga americana Michx.
Collinsonia canadensis L.
Commandra umbellata (L.) Nutt
Desmodium nudiflorum (L.) DC.
Eryngium yuccafolium Michx.
Eupatorium sessilifolium L.
Swertia carolinensis Walt. Ktze.
Gaylussacia baccata (Wang.) K.
Gerardia virginica L. GSP.
Gillenia stipulata (Muhl.) Bail.
Houstonia longifolia Gaertn.
Hypoxis hirsuta L. Caville
Hystrix patula Moench.
Lespedeza hirta (L.) Hornem
Liatris scariosa L. Willd.
Lobelia siphilitica L.
Lysimachia quadrifolia L.
Melilotus alba Desr.
Monarda fistulosa L.
Pellaea atropurpurea L. Link.
Phlox divaricata L.

Spreading Aster
Umbellate Aster
Smooth Aster
Tall Blue Bell
Wild Senna
New Jersey Tea
Summer Cohosh
Stoneroot
Bastard Toadflax
Tick Trefoil
Rattlesnake Master
Upland Boneset
Columbo
Black Huckleberry
Downy False Foxglove
American Ipecac
Long-leafed Bluet
Stargrass
Bottle Brush Grass
Hairy Lespedeza
Scarious Blazing Star
Blue Cardinal Flower
Whorled Loosestrife
White Sweet Clover
Wild Bergamot
Cliff Brake
Blue Phlox
<table>
<thead>
<tr>
<th>Latin Name</th>
<th>Common Name</th>
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<tbody>
<tr>
<td>Phlox pilosa L.</td>
<td>Roseate Phlox</td>
</tr>
<tr>
<td>Phlox subulata L.</td>
<td>Moss Pink</td>
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<tr>
<td>Prenanthes altissima L.</td>
<td>Tall Rattlesnake Root</td>
</tr>
<tr>
<td>Prenanthes serpentaria Pursh.</td>
<td>Lions Foot</td>
</tr>
<tr>
<td>Psoralea onobrychis Nutt.</td>
<td>Scurf Pea</td>
</tr>
<tr>
<td>Pteridium aquilinum (L.) Kuhn.</td>
<td>Bracken Fern</td>
</tr>
<tr>
<td>Rumex altissimus Wood.</td>
<td>Pale Dock</td>
</tr>
<tr>
<td>Sabbatia angularis L. Pursh.</td>
<td>Bitter Bloom</td>
</tr>
<tr>
<td>Scutellaria incana Bichler.</td>
<td>Hoary Skullcap</td>
</tr>
<tr>
<td>Silene virginica L.</td>
<td>Fire Pink</td>
</tr>
<tr>
<td>Sisyrinchium angustifolium Mill.</td>
<td>Blue-eyed Grass</td>
</tr>
<tr>
<td>Solidago caesia L.</td>
<td>Blue-stem Goldenrod</td>
</tr>
<tr>
<td>Solidago canadensis L.</td>
<td>Canadian Goldenrod</td>
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<tr>
<td>Solidago erecta Pursh.</td>
<td>Upright Goldenrod</td>
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<tr>
<td>Solidago nemoralis Ait.</td>
<td>Woodland Goldenrod</td>
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<tr>
<td>Solidago rigida L.</td>
<td>Stiff Goldenrod</td>
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<tr>
<td>Sonchus oleraceus L.</td>
<td>Common Sow Thistle</td>
</tr>
<tr>
<td>Sorghastrum nutans L. Nash.</td>
<td>Indian Grass</td>
</tr>
<tr>
<td>Styrax grandifolia Ait.</td>
<td>Large-leafed Storax</td>
</tr>
<tr>
<td>Silphium perfoliatum L.</td>
<td>Cup Plant</td>
</tr>
<tr>
<td>Tradescantia virginiana L.</td>
<td>Spiderwort</td>
</tr>
<tr>
<td>Veronicastrum virginicum L. Farw.</td>
<td>Culver's Physic</td>
</tr>
<tr>
<td>Vitis labrusca L.</td>
<td>Fox Grape</td>
</tr>
</tbody>
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The Ohio, Muskingum and Hocking River valleys with their attendant tributaries were occupied by elements of the mixed Swamp Forest or elements of its successional pattern. Genetically independent and historically separated from the upland vegetation types, it presents a problem in evaluation and interpretation separate and distinct from the remainder of the vegetation of the study area.

Areally this region includes all of the bottom-lands along the Ohio and Muskingum rivers, including the "D Ring" at Newport in Newport Township of Washington County (Fig. 12). The valley floors of the streams of the watersheds of the Little Muskingum River, Duck Creek, Wolfe Creek, the Little Hocking River, the Hocking River, Shade River and the upper reaches of Raccoon Creek where it extends into Athens County are also included in this area. This forms, in part, a broad band of vegetation adjacent to the major rivers where broad bottom-lands occur and a narrow ribbon-like line of vegetation continuous with the streams of the drainage pattern, but interdigitated, often tenuously, with the vegetation of the uplands.

The communities of the Swamp Forest succession were probably segregated largely by the moisture gradients consequent to the locality and dependent upon the underlying
Figure 37. Willow fringe along Hocking River in Athens County.

Figure 38. Mixed Swamp Forest along Margaret Creek in Athens Township of Athens County.
bedrock and its attendant soils regardless of their origin, upon the physiographic character of the terrain and the surrounding topographic features and upon the history of the region with regards to preglacial deposition, interglacial and postglacial outwash patterns and the effect of drainage changes throughout the history of an immediate area. The arboreal species within this complex of habitats were distributed along patterns that while directly reflecting moisture levels did not necessarily present orderly successional patterns, particularly in areas where possibly only a few feet or a slight change in internal drainage might lead to a change in the distribution of species. Dissection of flood plains and terraces, the lowering of base levels of streams, spring flooding and changing of flow lines all combined to complicate a complex basic pattern which was never static and in many cases could be neither discerned nor predicted from the remnants of the present-day vegetation.

Few woodlands remain in this area, primarily because of the utilization of the land in agricultural pursuits and because of the availability of its few remaining trees to pulpwood cutters in the area. The woodlands that remain today are confined almost entirely to a thin line along the immediate banks of the streams and to fence rows or rougher areas, either dissected by scouring and washing or artificially produced.
Figure 41 portrays a general relationship of the Swamp Forest associations to the moisture gradient along which this succession might logically proceed. Distribution along this gradient can only be predicted locally and only general relationships can be deduced.

The successional associations of the Swamp Forest

Particularly along the Ohio, Muskingum and Hocking River valleys, Willow was apparently the pioneer woody species along stream sides where erosion, slumping and mechanical damage from spring freshets prevented stabilization of the soil. The series of dams maintained by the United States Corps of Engineers in the Ohio River has created an artificial base level for all of the major streams in the area and have thus modified much of the habitat formerly occupied by the stream side willows. The damming has also created a constant series of lakes, raising the level above that occupied formerly by the Willows and thus has created an artificial stream side condition which only reflects this original vegetation along bars, protruding rocky ledges and in coves. The vegetation on the steep stream sides of the modern-day river is Willow-Poplar-Soft Maple or on rockier or slightly steeper and larger slopes above the water is Willow-Sycamore-Soft Maple, often times enriched by American Elm.

Several species of Willow are associated with the river bank including the Sandbar Willow, the Black Willow
Figure 39. Sycamore-Elm-Ash enriched by Box Elder along Federal Creek in Canaan Township of Athens County.

Figure 40. Beech-Maple near Chauncey in Dover Township of Athens County.
and the Crack Willow. Cottonwood is the common Poplar along the banks and the Silver Maple is the major Maple species noted all along the Ohio, Muskingum and Hocking rivers. Red Maple is also present interspersed along the bank, but more common along the upland drainage pattern, talus outwash aprons and wherever broader creek bottoms occur.

In the original vegetation Willow-Poplar-Soft Maple and Willow-Sycamore-Soft Maple were to be found somewhat farther back from the river bank, particularly in those areas where spring flooding allowed current swings with subsequent damage to the vegetation and where something less than good drainage was to be found. Flood-time channels, filled oxbows and confined inner drainage areas of lower bottoms were covered with this type of vegetation.

With somewhat better drainage, lighter textured soils, relatively higher elevations or in areas of more porous, silty and sandy alluvium, Elm-Sycamore-Soft Maple and Elm-Ash-Soft Maple associations were expressed often occurring as transitional forms defying definition. These communities were subjected annually to flooding in periods of heavy precipitation accompanied by stream overflow of the flood plain. In the area occupied by these communities, deposition was generally heavier, and drainage throughout the year was generally somewhat more rapid resulting in relatively better aeration conditions.
Where White Ash began to invade the association, a more stable community began to form and definite combinations of dominants were more predictable. These two associations probably occupied large areas in the Swamp Forest region and were accompanied by Red Oak, Bitternut Hickory, Shagbark Hickory, Shellbark Hickory, Black Cherry, Sycamore, Yellow Buckeye and Red Elm. In the Rock Camp Creek area of western Athens County, Shingle Oak was probably also found, and in Trimble Township, Pin Oak and Bur Oak were locally developed in the swampy areas of the Sunday Creek valley. Because of the intensive destruction of the vegetation in this region by the railroads, by mine timber cutters, and by the destruction brought about by chemical waste, no remnants of either Pin Oak or Bur Oak remain. Evidence of their occurrence is tenuous; however, personal conversations with both H. H. Crumley, long time forester with the State Park Division and A. W. Boetticher of the Department of Botany at Ohio University, indicated that both had in the early 1900's, observed these species in this general area. The town of Bur Oak in Trimble Township was apparently named for the reported groves of Bur Oak in the vicinity.

The Mixed Swamp Forest association appears to have occupied areas of somewhat better drainage, probably forming a mosaic with Beech-Sugar Maple and with Elm-Ash-Soft Maple along the alluvial terraces and locustrine remnants of the area. Beech-Sugar Maple occupying the better
drained sites, the Mixed Swamp Forest the less well drained sites, and the Elm-Ash-Sugar Maple, probably enriched by other species, the more poorly drained or slightly lower sites.

On sites of somewhat improved drainage, American Elm, White Ash, Sycamore, White Walnut, Shellbark Hickory and Linden may also occur. These communities composed of a relatively large number of individuals of different species compose a heterogenous assemblage in which no one or two species attained a position of dominance. Where better conditions of moisture and aeration developed Beech and Sugar Maple developed and represented the last stage of Swamp Forest succession leading to the development of Beech and Sugar Maple dominance.

The Mixed Swamp Forest community occurred all along the better drained portions of the Ohio and Muskingum River bottoms developing particularly well in the high narrow bottoms of the lower Hocking River between Hockingport and Stewart, Ohio and along the Shade River bottoms. They were also well expressed on the miniature flood plains of the upland tributaries and invaded into the Albany River (Teays stage) remnants in the uplands of Area III in Alexander and Lee townships where drainage was impeded.

In Area II invasion of the Barlow River (Teays stage) remnants occurred from Wolfe Creek and its tributaries, and from the Little Hocking River and its tributaries. In this area, however, the Mixed Swamp Forest elements were largely
confined to the eroding creek bottoms of the extant drainage patterns and while Beech and Sugar Maple did invade the higher ground it was not so marked as in Area III.

The Beech-Sugar Maple association

This final stage of the Swamp Forest succession reached its best development on well drained lacustrine and alluvial terraces above the lower bottoms of the major stream courses and on eminences produced by preglacial and interglacial stream development. On some of these features such as parts of the Albany River valley (Teays stage) at The Plains, Ohio, and on the flats near Chauncey and Millfield, Beech may well have occurred as almost pure stands. These areas are referred to in the notes of Jeffrey Mathewson as "Beech flats" and in adjacent areas he refers to "Beech, Hickory, Maple timber," indicating, perhaps, that these areas were primarily, if not entirely Beech. Throughout the major river valleys "Beech and Sugar Tree" are referred to often enough to indicate that it was an important segment of the vegetation, however it is doubtful if it occupied the entire canopy. Among the trees noted most frequently in association with Beech and Sugar Maple were Hickory, Ash, Oak, Walnut, White Walnut and Linden. The most prominent associates of Beech and Sugar Maple in this area are Yellow Buckeye, Sycamore, Red Oak, Red Elm, Shagbark Hickory, White Ash and Black Cherry. Other species found throughout the region in this association
but not as generally prominent include Black Gum, Basswood, Red Maple, Shellbark Hickory, American Elm, Black Walnut and sometimes Tuliptree. In general the shrub and herbaceous layers are more luxuriant than in any other forest type. Blue Beech, Pawpaw, Witch Hazel, Spicebush, Hop Hornbean and young individuals from the assemblage characteristically form thickets and are often dense. The herbaceous species are spring flowering and often quite abundant, with a number of weedy forms occurring throughout the summer months. Grasses and sedges are not uncommon.

The River Birch associate

River Birch occurs today at someplace along almost all of the major tributaries of the Ohio, Muskingum and Hocking rivers. It occurs on Duck Creek, the Little Muskingum River, on Wolfe Creek, along the Shade River and abundantly along Rock Camp Creek and Onion Run in western Athens County. It does not, however, occur in any stream valley that contains glacial outwash. In both the Hocking and Muskingum River valleys it occurs on outwash aprons of tributary streams but never in the valleys even though moisture aeration levels are lower than in the habitat in which it is found.

Personal communications with both Dr. E. N. Transeau and Dr. J. N. Wolfe has indicated that its absence from the major valleys is due in large part to the drainage of its habitats for agricultural utilization and that it should be
found occurring naturally in these areas. Its complete absence from the present-day vegetation even in undrained areas, the fact that it is mentioned only infrequently by the early surveyors and never in the Muskingum nor Hocking valleys, along with its peculiar distribution in tributary valleys leads to the inference that some other factors are indeed active in this case and that this factor might be associated with glacial outwash parent material of these major valleys, possibly pH.

The Swamp succession

In all of the lowland areas, openings occurred that were quite wet. These were referred to as "Prairies" or as "Glades" by the surveyors and in some of the wettest of these, water apparently stood during much of the year. The principal associations of this successional pattern were Cattail-Sedge Meadow, Alder-Buttonbush-Willow and Willow-Elm-Soft Maple. Alder communities may have become quite dense and were succeeded primarily by Willow. Swamp Rose, Skunk Cabbage and possibly Swamp Mallows also occurred in these areas which were not, however, extensive anywhere in this area.
Figure 41. Swamp succession showing Cattail-Sedge Meadow, Alder-Buttonbush and Willow-Elm-Soft Maple associations.

Figure 42. Swamp succession showing Sedge Meadow, Alder-Buttonbush and Willow-Elm-Soft Maple associations. Cattails in this case are limited in number.
Figure 43. The general relationships of the Swamp Forest associations in Area IV to the moisture gradient.
SUMMARY

The objectives of this study have been (1) to describe the original forests of Athens and Washington counties as they occurred at the time of European settlement and (2) to recognize the pattern of these primary forests along with the accompanying factors of their environment in so far as valid inferences could be drawn.

Sources of data have been primarily observation of the secondary forests of the region, the sites upon which they develop, and the field notes and diaries of the Government and Ohio Company surveyors whose notes are the only vegetational records of this original vegetation.

The study area lies in the southeastern quarter of Ohio in the low hills belt of the Cumberland and Allegheny Plateau region as described by Braun (4) and within the unglaciated Plateau Region of Fenneman (12). Physiographically the area consists of wide river valleys, gentle rolling terraces, narrow V shaped river valleys and hills which may be broad and rounded or steep and narrow ridged. The extreme elevations in the area range from something less than 580 feet above sea level to more than 1200 feet above sea level and slope gradients may reach a maximum of about 75 per cent.

The area was first visited by white Europeans in 1669 and settlement of the area by the New England Company of
Adventurers began in 1788. Mining operations for both coal and salt began in 1803, and gas and oil production started in the early 1800's. All of the land in the area has been cleared of its original vegetation and much of it has had timber cut from it on more than one occasion. In the area today 73.7 \% of Washington County is considered farm land and about 69.2 \% in Athens County.

The major events of the geologic history of the region and their order of occurrence are (1) emergence near the close of the Permian era with continue uplifts during the Triassic and Jurassic periods; (2) further uplift and peneplanation during mesozoic times followed the Harrisburg and Lexington erosion cycles in the Tertiary, uplift occurred again in late Tertiary times followed by the Parker erosion cycle which was brought to a close by the Pleistocene glacial epoch; (3) the destruction of the major northwestward flowing Tertiary stream system, the Teays River and the consequent impounding of a vast lake, Lake Tight, which covered all of the lowlands of the area and probably most of the western and central part of the study area; (4) deposition of lacustrine deposits in the area covered by the lake; (5) Cols produced by down-cutting of low divides with the establishment of a new southwestward flowing river, accompanied by drainage of the lake and abandonment of major preglacial valleys; (6) deep stage drainage establishing deep canyon-like valleys; (7) advance of the Illinoian ice sheet and the Wisconsin ice sheet with deposition
and filling of the Hocking, Muskingum, and Ohio valleys by outwash materials; (8) the re-establishment of the vegetation and its development until the arrival of the white man.

The vegetation is a result of the physiological and ecological balance of climate, the substrate and the biome and when properly interpreted relate to the developed soil. The fact that this area is a deciduous forest area is the best index to its climate and that the soil is more a function than a factor of climate and vegetation presents little utility in explaining the pattern of the forest types. Throughout the area, available soil moisture and its seasonal variation appears to be the most effective variable factor in the control of vegetation. The elevation, slope exposure and steepness of slope gradients were the primary factors in this control and were associated with the water relations of the bedrock and the soil. These, in turn, were directly related to the physiographic and geologic history of the region. Modifications of the vegetation may also relate to microclimatic and microedaphic as well as historical factors, the occurrence of which are not available data at this time.

The entire area with the exception of small prairie relicts, swamps and denuded areas, was covered by forests at the time of white occupancy. Considerable doubt is cast by this study about the possibility of a feasible successional climax vegetation for this area, but rather it is
proposed that climatic or edaphic climaxes upon specific sites engender mosaics of vegetation which would probably persist as long as climate and topography remained unchanged, and are reflected in the character of the secondary forests of the region.

The study area was rather arbitrarily divided into four vegetational and physiographic areas: (I) The Eastern Dissected Highland Area; (II) The Barlow River Valley Remnants (Teays Stage); (III) The Western Dissected High-Lands; and (IV) The Swamp Forest Zone of the Ohio, Muskingum and Hocking River Valleys and their tributaries. In general the same forest types were represented on all three of the upland areas, with variations in the intensity of their expression occurring over the areas. No exact geographic pattern can be applied either to the areas or to the communities within the areas; however, the following associations occurred in the original forests and were climax in the sense that they were stable and self-perpetuating, except for areas where disturbance of some kind upset this equilibrium.

1. The upland Oak communities. Composed of associations of Oak-Pine, Oak-Chestnut, Mixed Oak and Oak-Hickory in order from the more xeric to the more mesic. No one of these communities can be designated as a prevailing upland type over long uninterrupted areas, but Oak-Hickory was probably the most wide spread type, reaching its best development in Area III. White Oak was the predominant
tree throughout the entire area and reached its greatest dominance in the White Oak-Hickory communities of Area II. South and west exposures of the hills along with the broader and more rounded ridge tops of the region were occupied by this association.

Oak-Chestnut communities were apparently widespread throughout the area reaching their greatest development in the rugged topography over massive sandstones in the eastern part of Washington County in Area I. It was associated primarily with Chestnut Oak on the ridge tops and White Oak on the lower slopes and occupied the broader ridges and the higher and steeper south and west facing slopes often transitional with Mixed Oak and Oak-Hickory.

The Mixed Oak association differs primarily from the Oak-Hickory in the relative number of Hickories present and is commonly transitional with Oak-Hickory in the secondary forests. It commonly occurs over shales and less massive sandstones and along the south and west exposures of higher more attenuated ridges. White Oak, Black Oak and Chestnut Oak are consistant associates throughout the area.

The Oak-Pine association was best developed over the Permian rocks of Area I and from the surveyors notes was as consistantly present in 1800 as it is today, but probably not as abundant. Pitch Pine, Shortleaf Pine and Virginia Pine are all present throughout the area occupying the excessively drained sites where the soils are commonly shallow, dry, sandy and sterile.
2. The upland Mesophytic communities occupy the more moist sites and are best developed in the areas of deeper dissection, occupying consistently north and east exposures with occasional development along west and northwest exposures, and with segregates occurring in various combinations among the Oak forests of the uplands and on the south and west exposures.

The Mixed Mesophytic and Hemlock-Mesophytic communities were best developed in Area I and composed of about 24 or more principal species in varying combinations. These communities were most weakly expressed in Area II and while apparently somewhat more abundant in Area III were less well expressed and areally more restricted than in Area I. The associations were composed primarily of: Chestnut Oak, White Oak, Black Oak, Red Oak, Yellow Oak, Chestnut, Bitternut Hickory, Shagbark Hickory, Shellbark Hickory, Mockernut Hickory, Tuliptree, Beech Basswood, Black Walnut, White Walnut, Red Elm, American Elm, Red Maple, Sugar Maple, Black Gum, Sourwood, Black Cherry, Hemlock, and Yellow Buckeye. The status of Hemlock and its associates throughout the entire study area is extremely hard to define in view of the fact that only scattered remnants remain. Mention of Hemlock by the original surveyors is very sparse and conclusive superimposition of their work on likely Hemlock-Mesophytic sites could not be made.
White Oak-Beech associations characteristically occupied south and southwesterly facing slopes of the area and were present throughout the study area, probably reaching their greatest development in Area III. Upland Beech-Sugar Maple was spotty throughout the study area and was a significant component of the forests in Area II along the alluvial terraces of the Barlow River remnants (Teays stage), but was apparently most abundant in the Albany River (Teays stage) area of Area III. Tuliptree, Black Walnut, White Walnut, Black Cherry, Black Gum, and Linden apparently enriched these communities.

The ravine, divide and upper cove forests included Oak-Tuliptree and Oak-Chestnut-Tuliptree associations which were quite concrete in their composition and location. They occupied moister portions of the habitat ordinarily occupied by the Oaks and their xerophytic associates and were probably somewhat more abundant in the primeval forest than the data available indicates. This community is present throughout the study area but probably reached its best development in the western part of Area I and in the eastern and northeastern part of Area III. White Oak, Red Oak, Chestnut, Pignut Hickory, Mockernut Hickory and Red Maple were associated with variable prominence in this community. This prominence depended upon the completeness of the dominance of the Tuliptree.

White Pine was present in the extreme eastern edge of this area, but no data nor any remnants are available for
study. It is assumed to have been a relict community genetically related as an outlier of the northern Appalachian Highland Division of the Hemlock-White Pine-Northern Hardwood Region of Braun (4). Its presence in this region was probably related to Pleistocene glacial phenomenon. Virginia Red Cedar occurred in this area as an interesting but not significant component of the vegetation. Prairie relicts were found scattered in small communities in Area I.

3. The communities of the Swamp Forest succession.

On the flood plains and terraces of the Ohio, Muskingum and Hocking rivers and their tributaries and on the minature flood plains of the upland streams, Swamp Forest communities dominated. Willow and Willow-Poplar-Soft Maple associations occupied the less stable river bank areas and areas where destruction by spring freshets and inundating waters occurred. In the low bottoms Willow-Sycamore-Soft Maple was distributed with American Elm entering the assemblage where drainage was slightly improved. This was succeeded by Elm-Ash-Soft Maple and on the lacustrine and alluvial terraces enrichment of this association led to establishment of the Mixed Swamp Forest. This consisted of American Elm, White Ash, Sycamore, White Walnut, Shellbark Hickory, Red Elm, Black Cherry, Swamp White Oak and in some localities Tuliptree, Honey Locust, Shagbark Hickory and Linden. The enrichment of this association by Beech and Sugar Maple were indicative of improved conditions of
moisture and aeration and represented the last stage of Swamp Forest succession leading to the development of Beech-Sugar Maple dominance.

The Beech and Sugar Maple association reached its best development on well drained lacustrine and alluvial terraces and upon eminences produced by Pleistocene phenomenon. In some areas Beech probably occurred in almost pure stands. Among the trees noted most frequently in association with Beech and Sugar Maple were Yellow Buckeye, Sycamore, Red Oak, Red Elm, Shagbark Hickory, White Ash, and Black Cherry.

Pin Oak and Bur Oak were present in Area III but were not prominent nor widespread in the assemblage.
A check list of the critical arborescent species present in the primeval forest in the order of their use in this study with the scientific names after Grays Manual of Botany, 8th Edition. 1950.

<table>
<thead>
<tr>
<th>Species</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>White Oak</td>
<td>Quercus alba L.</td>
</tr>
<tr>
<td>Black Oak</td>
<td>Quercus velutina Lam.</td>
</tr>
<tr>
<td>Chestnut Oak</td>
<td>Quercus prinus L.</td>
</tr>
<tr>
<td>Scarlet Oak</td>
<td>Quercus coccinea Muench.</td>
</tr>
<tr>
<td>Yellow Oak</td>
<td>Quercus muehlenbergii Engelm.</td>
</tr>
<tr>
<td>Red Oak</td>
<td>Quercus rubra L.</td>
</tr>
<tr>
<td>Post Oak</td>
<td>Quercus stellata Wang.</td>
</tr>
<tr>
<td>Shingle Oak</td>
<td>Quercus imbricaria Michx.</td>
</tr>
<tr>
<td>Pin Oak</td>
<td>Quercus palustris Muench.</td>
</tr>
<tr>
<td>Bur Oak</td>
<td>Quercus macrocarpa Michx.</td>
</tr>
<tr>
<td>Swamp White Oak</td>
<td>Quercus bicolor Willd.</td>
</tr>
<tr>
<td>Chestnut</td>
<td>Castanea dentata (Marsh.) Borrch.</td>
</tr>
<tr>
<td>Beech</td>
<td>Fagus grandifolia Ehr.</td>
</tr>
<tr>
<td>Shagbark Hickory</td>
<td>Carya ovata (Mill.) K. Koch.</td>
</tr>
<tr>
<td>Mockernut Hickory</td>
<td>Carya tomentosa Nutt.</td>
</tr>
<tr>
<td>Bitternut Hickory</td>
<td>Carya cordiformis (Wang.) K. Koch</td>
</tr>
<tr>
<td>Pignut Hickory</td>
<td>Carya glabra (Mill.)</td>
</tr>
<tr>
<td>Shellbark Hickory</td>
<td>Carya laciniosa (Michx.)</td>
</tr>
<tr>
<td>Black Gum</td>
<td>Nyssa sylvatica Marsh.</td>
</tr>
<tr>
<td>Sycamore</td>
<td>Platanus occidentalis L.</td>
</tr>
<tr>
<td>Sourwood</td>
<td>Oxydendrum arboreum (L.) DC.</td>
</tr>
<tr>
<td>Redbud</td>
<td>Cercis canadensis L.</td>
</tr>
<tr>
<td>Wahoo</td>
<td>Euonymus atropurpureus Jacq.</td>
</tr>
</tbody>
</table>
Flowering Dogwood  Cornus florida L.
Green Osier Dogwood  Cornus alternifolia L.
Witch Hazel  Hamamelis virginiana L.
Spicebush  Lindera benzoin (L.) Blume
Yellow Buckeye  Aesculus octandra Marsh.
Serviceberry  Amelanchier canadensis L. Medic.
Black Cherry  Prunus serotina Ehrh.
Tuliptree  Liriodendron tulipifera L.
River Birch  Betula lenta L.
Sugar Maple  Acer saccharum Marsh.
Red Maple  Acer rubrum L
Silver Maple  Acer saccharinum L.
Black Walnut  Juglans nigra L.
White Walnut  Juglans cinerea L.
Mountain Laurel  Kalmia latifolia L.
Blueberry  Vaccinium spp.
Huckleberry  Gaylussacia spp.
Greenbriar  Smilax spp.
White Pine  Pinus strobus L.
Shortleaf Pine  Pinus echinata Mill.
Virginia Pine  Pinus virginiana Mill.
Pitch Pine  Pinus rigida Mill.
Hemlock  Tsuga canadensis (L.) Carr.
Linden  Tilia americana L.
Red Elm  Ulmus rubra Muhl.
American Elm  Ulmus americana L.
Red Mulberry  Morus rubra L.
<table>
<thead>
<tr>
<th>Plant Name</th>
<th>Scientific Name</th>
</tr>
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<tbody>
<tr>
<td>Pawpaw</td>
<td>Asimina triloba (L.) Duval</td>
</tr>
<tr>
<td>Blue Beech</td>
<td>Carpinus caroliniana Walt.</td>
</tr>
<tr>
<td>Ironwood</td>
<td>Ostrya virginiana (Mill.) K. Koch</td>
</tr>
<tr>
<td>Hazelnut</td>
<td>Corylus americana Walt.</td>
</tr>
<tr>
<td>Buckthorn</td>
<td>Rhammus laceolata Pursh</td>
</tr>
<tr>
<td>Arrowwood</td>
<td>Viburnum dentatum L.</td>
</tr>
<tr>
<td>Sweet Haw</td>
<td>Viburnum prunifolium L.</td>
</tr>
<tr>
<td>Wild Hydrangea</td>
<td>Hydrangea arborescens L.</td>
</tr>
<tr>
<td>Sassafras</td>
<td>Sassafras albidum (Nutt.) Nees</td>
</tr>
<tr>
<td>White Ash</td>
<td>Fraxinus americana L.</td>
</tr>
<tr>
<td>Black Willow</td>
<td>Salix nigra Marsh</td>
</tr>
<tr>
<td>Sandbar Willow</td>
<td>Salix interior Rawlee</td>
</tr>
<tr>
<td>Crack Willow</td>
<td>Salix fragilis L.</td>
</tr>
</tbody>
</table>
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I, Richard Blaine Rypma, was born in Athens, Ohio, December 27, 1923. I received my secondary-school education in the public schools of Athens, Ohio, and my undergraduate training at Ohio University, which granted me the Bachelor of Science Degree in 1947. I received the Master of Science Degree in 1948 from Ohio University. I completed further graduate work at the Texas Agricultural and Mechanical College while employed there. I entered the Graduate College at The Ohio State University in 1952, where I held the position of graduate assistant while meeting the residence requirements.