A FLORISTIC SURVEY OF PHOENIX MOUNTAIN, ASHE COUNTY NORTH CAROLINA

A Thesis

by

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A FLORISTIC SURVEY OF PHOENIX MOUNTAIN,
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ABSTRACT

Phoenix Mountain is located in the Blue Ridge Province of North Carolina. A catalog of the vascular flora, including 440 species and 86 families, is provided. A vegetational analysis was done at six sites to quantitatively determine the canopy dominants of forests on Phoenix Mountain. Presence lists were constructed for the other forest layers. Forest types on Phoenix Mountain included: 1) white oak forest, 2) cove hardwood transitional forest, 3) north slope beech forest, 4) alluvial mixed hardwoods, 5) mixed hardwoods successional community, and 6) red oak forest. Presence lists were compiled for plants found on rock outcrops at the summit and in seepage bogs. Rare species occurring on the mountain include *Lilium grayi* Watson, *Panax quinquefolium* L. and the Appalachian endemics *Carex purpurifera* Mackenzie and *Geum radiatum* Gray. Other species of limited occurrence on Phoenix Mountain include *Lycopodium selago* L., *Woodsia scopulina* DC., *Elymus riparius* Wiegand, *Panicum linearifolium* Scribner, *Carex baileyi* Britton, *Habenaria orbiculata* (Pursh.) Torrey, *Arenaria groenlandica* (Retzius) Sprengel, *Parnassia grandifolia* DC., *Spiraea virginiana* Britton, *Panax trifolium* L. and *Phlox subulata* L. The flora on Phoenix Mountain compares favorably with those on other mountains in the Southern Appalachians.

DEDICATION

This manuscript is dedicated to the residents of Phoenix Mountain, in particular, Mr. and Mrs. John R. Taylor, Senior who cared for the flowers, the forests and the mountain.

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CHAPTER I

INTRODUCTION

Phoenix Mountain is situated in the Blue Ridge Province of the Southern Appalachian mountains in Ashe County, North Carolina. It is one of several outlier peaks of the Blue Ridge, rising abruptly above the New River. Phoenix Mountain rises from a broad base with an elevation of 945 meters to a summit of 1436 meters. Diverse habitats from rock outcrops along the summit to seepage bogs, are found on the mountain. Red oak forest is the dominant vegetation type on most of Phoenix Mountain. Varying edaphic and climatic conditions have favored some localized plant communities such as north-slope beech forests and cove hardwood transitional forests. Most of the forests are in stages of secondary succession.

Phoenix is a mountain of unusual elevation and position. It rises approximately 500 meters above the surrounding countryside. Bluff Mountain, Mount Jefferson and Threetop Mountain are the only other major peaks in the

Journal style followed: Castanea

area that are of comparable size and elevation. Bluff Mountain is the only peak in Ashe County that has been systematically collected and the results published (Tucker, 1972). Phoenix and the other mountains provide unusual habitats in which montane floras, rich in rare and endangered species, flourish. The area of Phoenix Mountain covered by this investigation is under private ownership and is largely undeveloped. The unique position and rich vascular flora of Phoenix Mountain make it a suitable subject for a thorough floristic study.

CHAPTER II

HISTORY OF THE AREA

A. Botanical Exploration

The earliest recorded visit of a botanist to Ashe County was in 1841 by Asa Gray (Sargent, 1889). Gray's party made several collecting trips to the peaks of Phoenix and Bluff Mountains and Mount Jefferson. Asa Gray subsequently visited Ashe County in 1843 and 1879. M. A. Curtis (1860) recorded several plant collections from Phoenix Mountain by Asa Gray confirming his presence in this area.

Dr. A. E. Radford of the University of North Carolina at Chapel Hill has collected plants throughout Ashe County since the late 1930's. Dr. Radford, in company with his wife and other associates, has visited several sites in Ashe County, including the north slope of Phoenix Mountain. Plant collections made in Ashe County by Radford and his associates, including S. Spongberg and S. W. Leonard, are deposited in the herbarium at the University of North Carolina at Chapel Hill.

B. Land Use

The first permanent settlement in Ashe County was in 1772 when three men built homes along Walling Creek (Smith, 1974). The town of Jefferson which lies at the south base of Phoenix Mountain, was established as the county seat of Ashe County in 1800 (Fletcher, 1963). Permanent settlement on Phoenix Mountain can be assumed from the start of the nineteenth century.

Uses of land on and around Phoenix Mountain are primarily agricultural, residential and non-industrial with several small public tracts around the lower slopes. A branch of the Norfolk and Western Railway skirts Phoenix Mountain extending from West Jefferson to Bina and then northward to Abington, Virginia. A gravel quarry is found on a lower slope of Phoenix Mountain, one mile northwest of the town of Jefferson.

Logging, farming and fires have altered the vegetation of Phoenix Mountain. Evidence of forests fires was observed in most sites visited on the mountain. According to local residents, a major forest fire occurred about forty years ago. Lightning strikes near the summit of Phoenix Mountain are believed to have been responsible for several minor

fires. However, larger fires seem to have followed logging operations that selectively denuded the mountain of large and valuable hardwoods during the 1930's and 1940's. No major logging operations have occurred on Phoenix Mountain for several decades.

The steep grades of the upper slopes and the stoniness of the soil have discouraged development of Phoenix Mountain. A few permanent homes are found on the mountain above 915 meters; several abandoned home sites can be found in the woods with the highest site occurring at 1220 meters. Some small-scale farming occurs on Phoenix either for family gardens or tobacco. Phoenix Mountain has been used in past years for summer pasturage of cattle. Several of the local farmers drove their herds up the mountain in the spring in search of new forage and brought them down again in the fall. Dr. John Foster, a retired professor of agriculture who grew up in the shadow of Phoenix, was able to point out old summer pastures and trails which are now reclaimed as young woodlands (Personal communication with Dr. J. Foster, 1978).

Removal of medicinal and ornamental plants has been a problem on Phoenix Mountain. Local people have been digging herbs and shrubs on Phoenix for decades. As a

result, certain species have been either exterminated or greatly reduced in numbers. Such plants as *Panax quinquefolium* L. and *Cypripedium calceolus* var. *pubescens* (Willd.) Correll have been greatly reduced or have disappeared from the more accessible sites. The delicate habitats on the rock outcrops near the summit have also been disturbed by the activity of herb collectors and hikers.

CHAPTER III

DESCRIPTION OF THE AREA

A. Location

Phoenix Mountain is situated in Ashe County, North Carolina at latitude 81° 28' west and longitude 36° 27' north. Ashe County is bounded on the north by Grayson County, Virginia and on the west by Johnson County, Tennessee. Allegheny, Watauga and Wilkes Counties, North Carolina, lie to the east and south. Mount Jefferson lies 6.5 kilometers to the southeast of Phoenix Mountain. Bluff Mountain and Threetop Mountain is 8.0 kilometers to the west. The town of Jefferson is to the immediate south of Phoenix Mountain. The area of the mountain includes approximately 23.3 square kilometers. A topographic map of Phoenix Mountain is included in Figure 1. Only the slopes of Phoenix Mountain ranging in elevation from 945 meters to 1436 meters are included in this investigation.

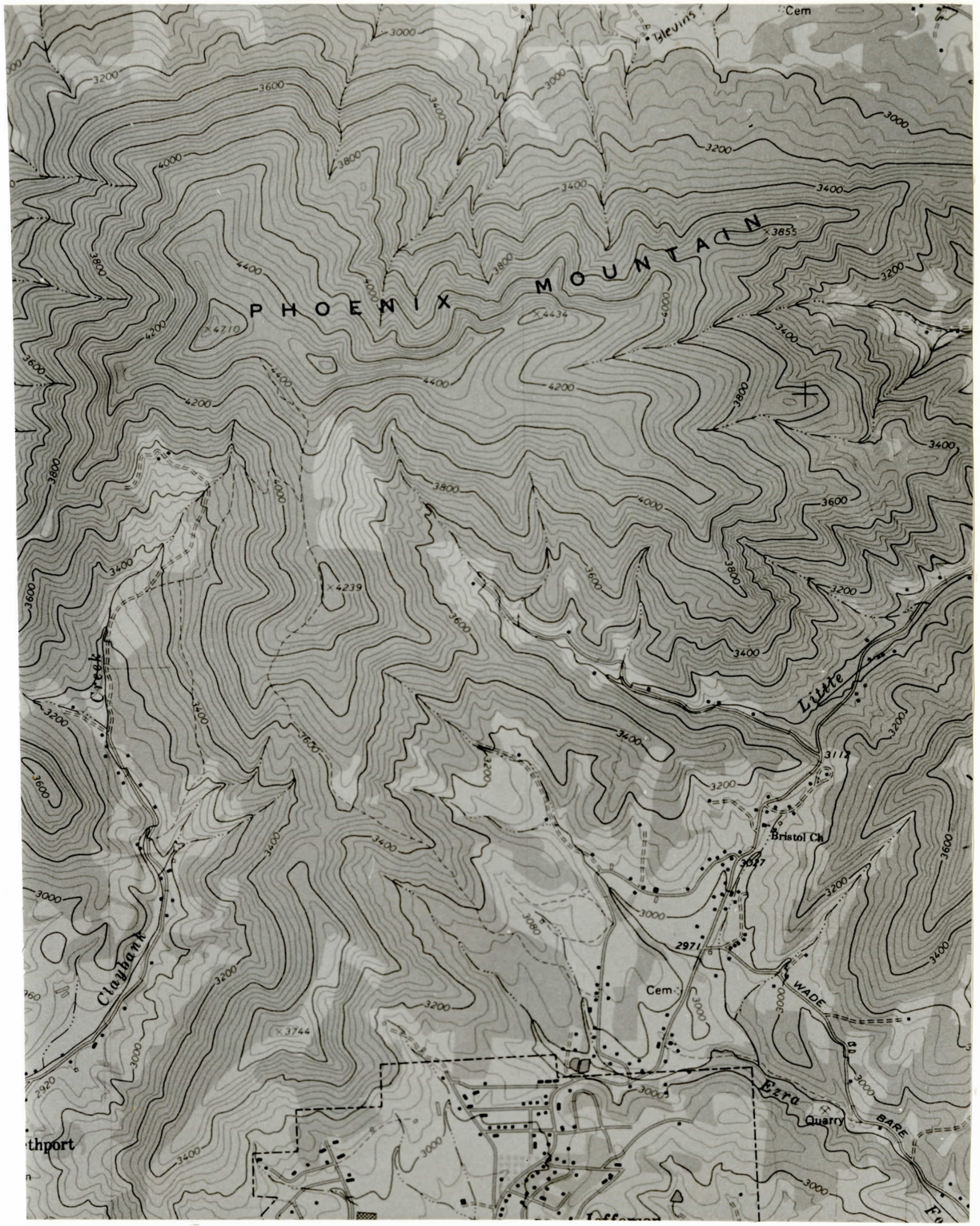

Figure 1. Topographic Map of Phoenix Mountain

B. Climate

The climate of the Southern Appalachians exhibits more precipitation, higher wind velocities and cooler temperatures than the adjacent Piedmont Plateau to the east. This characterization of the climate of the Southern Appalachians may also be applied to the climate of Phoenix Mountain. Precise weather data for Phoenix Mountain is not available; the nearest weather station is at Jefferson, approximately two kilometers to the south at an elevation of 902 meters. W. G. Smith (1974) states that the climate of Ashe County is temperate with a mean annual temperature of 11.7°C. The average July temperature is 21°C while the average January temperature is 2.7°C. The annual precipitation ranges from 127 to 137 centimeters; the annual snowfall ranges from 40.8 to 81.3 centimeters. The humidity is fairly stable at sixty to seventy percent throughout the year. The frost-free growing season is 150-170 days (Smith, 1974). Phoenix Mountain lies in one of several temperature corridors in Ashe County caused by its exposed position and the lack of neighboring mountains to the northwest. The temperatures on Phoenix Mountain may range from 8° to 11°C below temperatures in the town of Jefferson. Temperature

corridors cause varying changes in temperature and precipitation based on differences in elevation, degree of slope, slope exposure and air currents on Phoenix Mountain (Smith, 1974).

C. Physiography

Phoenix Mountain is in the physiographic province of the Older Appalachians. It lies in the Appalachian Highlands of the Blue Ridge (Fenneman, 1938). Phoenix Mountain consists of a ridge with three peaks. The elevations of these three peaks range from 1436 meters to 1352 meters. The ridge has a northeasternly strike with steep, bare rock cliffs on the north side and more gentle, forested slopes on the south side. Many small streams dissect the slopes of Phoenix Mountain but only two are large enough to have names. Claybank Creek drains the southern slopes of Phoenix Mountain while Little Phoenix Creek drains the southeastern and eastern slopes. All creeks on Phoenix Mountain drain into the North Fork of the New River which bounds the mountain on its north side (USGS Map, 1968). The New River then flows north, emptying into the Ohio River.

D. Geology

Phoenix Mountain lies approximately seventeen kilometers west of the escarpment front of the Blue Ridge. Its ridges run northeast and dip to the southeast following the northeasternly strike of most rock strata in Ashe County (Brown, 1968). Phoenix Mountain is an outlier of the Blue Ridge Mountains. It is composed of metamorphic rock of the Ashe Formation. The Blue Ridge and Sauratown Mountains are of older pre-Cambrian age and lie to the west of the Ashe Formation. The Alligator Back Formation which underlies the Blue Ridge escarpment is of early Paleozoic and/or pre-Cambrian age and lies to the east of this outcrop belt of the Ashe Formation (Rankin, 1973).

The rocks of the Ashe Formation are fine-grained, thinly layered sulfidic biotite-muscovite gneiss, interlayered with mica schist and amphibolite (Rankin, 1973). This is distinctly different rock from the granitic gneiss of the Blue Ridge or the mica gneiss and schist of the Alligator Back Formation. The lithologic assemblage in the Ashe Formation consists of ferromagnesian metagraywackes, both fine-grained and gritty. The dominant rock type of the Ashe Formation, a biotite-muscovite gneiss, is a porphyritic gneiss with visible

grains of quartz and feldspar. This gneiss has been interpreted as metamorphosed graywacke which is a grade of sandstone (Rankin, 1973). According to Rankin (1973), the most obvious regional variation within the Ashe Formation is the high concentration of amphibolite, particularly in the area west and southwest of Jefferson. Amphibolite appears to be the major constituent of the rocks on Phoenix Mountain.

Amphibolite is a metamorphic facies of basalt. Amphibolite is a granoblastic rock made up of plagioclase feldspar and amphibole with variable amounts of garnet, quartz and epidote. It is typically only faintly foliated (Gilluly, Walters and Woodford, 1968). The darker amphibole apparent on Phoenix Mountain reflects a high grade of metamorphism (Jackson, 1970). The chemical composition of amphibole is an assemblage of solid-solution silicates of calcium, magnesium, iron and aluminium. Amphiboles range in color from light gray to black, with the color dependent upon the amount of iron oxide present. Plagioclase feldspar is a sodalime feldspar consisting of sodium-aluminium silicates and calcium-aluminium silicates (Gilluly, Walters and Woodford, 1968). The combined weathering of plagioclase and amphibole produces a brown soil.

The significance of the weathering of amphibolite is that calcium and magnesium cations are released from its calcium and magnesium silicates. A lack of exchangeable cations and an overbundance of hydrogen ions is one explanation of soil acidity. The addition of calcium and, to a lesser extent, magnesium to the soil raises soil pH. A circumneutral soil pH close to six or seven releases more of the essential elements for plant growth. For example, when the pH is low, inorganic phosphorus is bound up as aluminium and iron phosphates. Calcium raises the pH by replacing hydrogen ions in the surface of clay micelles in the soil. This disturbs the equilibrium of the aluminium and iron phosphates and frees phosphorus for plant absorption (Devlin, 1969). The calcium and magnesium ions freed by the decomposition of calcium and magnesium silicates of amphibolite influence soil pH and, hence, the availability of other essential elements. The availability of essential elements, in turn, can affect the composition of plant communities.

E. Soils

The principal soil series on Phoenix Mountain are Clifton and Porters soils which are both typical soils from dark, gneissic bedrock. The soils of the Clifton and Porters associations are dark, moderately deep soils on mountain uplands. Clifton soils are typically brown to dark reddish brown soils which fall within the soil families of clayey, mixed and mesic soils. Porters soils are gray-brown soils within the soil families of fine-loamy, mixed and mesic soils. Porters soils are also moderately deep and well-drained, occurring on the narrow ridges and steep side slopes of mountains. The Clifton and Porters soils become progressively shallower near and on the ridgetops of Phoenix Mountain. The depth to bedrock ranges from five to fifteen centimeters. They become stony soils of the Rockland Complex which are rocky, shallow, upland units on the ridges of mountains rising above 915 kilometers in elevation. Stones, rock outcrops and boulders may constitute up to fifty percent of the total soil mass in such areas. The basic amphibolite gneiss of Phoenix Mountain weathers to yield colluvial soils resembling soils of the Tusquitee association. Tusquitee soils are brown to dark brown soils which are

deep, well-drained soils of the fine-loamy, mixed and mesic soil families. They occur in coves, benches, and at bases of toe slopes. All of the soils of Phoenix Mountain are moderately fertile but their stoniness, the decreasing depth to bedrock, and the steepness of the slopes serve to better characterize these soils (Campbell and Brewer, 1976).

CHAPTER IV

MATERIALS AND METHODS

Collection and identification of the vascular flora of Phoenix Mountain began in the spring of 1977 and was concluded in the spring of 1979. Collection trips were made at weekly intervals throughout the growing season. Bi-weekly visits occurred during peak blooming periods. Random collections were made at all elevations on each visit following line intersects up the mountain. Plants were collected four meters on both sides of a line intersect. Approximately 1000 plant specimens were collected and identified. Voucher specimens are housed in the herbarium at Appalachian State University in Boone, North Carolina.

Equipment used in the field included an altimeter, compass, topographic maps, county road map and standard collecting equipment. Soil pH readings were taken at most sites visited on the mountain. Soil pH values mentioned in the text represent an average of three readings. A La Motte soil pH test kit was used. Quadrats were measured by the use of a metal surveying tape and compass. Quadrats used to determine canopy composition were ten by ten meter square areas located randomly in a site being quantitatively analyzed.

A field study of six representative plant communities was made in the fall of 1978. Six-tenths of a hectare of forest communities was analyzed with respect to composition and distribution of species. The composition of the canopy, subcanopy, shrub and herb layers of six sites on Phoenix Mountain was determined. The relative densities, frequencies and dominances of each species in the canopy were calculated and summed to give importance values for canopy species. The mathematical formulas used to calculate numerical values for canopy species were those of A. E. Radford (1976). Presence lists were compiled for the other forest layers. The six sites on Phoenix Mountain included: 1) white oak woods near the rocky summit; 2) cove hardwood transitional forest in a mesic location at 1296 meters; 3) beech forest in a rocky site on a lower north slope of Phoenix; 4) alluvial mixed hardwoods on a floodplain; 5) mixed hardwoods successional community on a sheltered, mesic slope and 6) red oak forest on a submesic upper slope. These sites are indicated on a map of Phoenix Mountain in Figure 2. Presence lists were also compiled for two other habitats on Phoenix Mountain. The unusual plant associations on the rock outcrops of the summit and seepage bogs on Phoenix Mountain were also recorded.

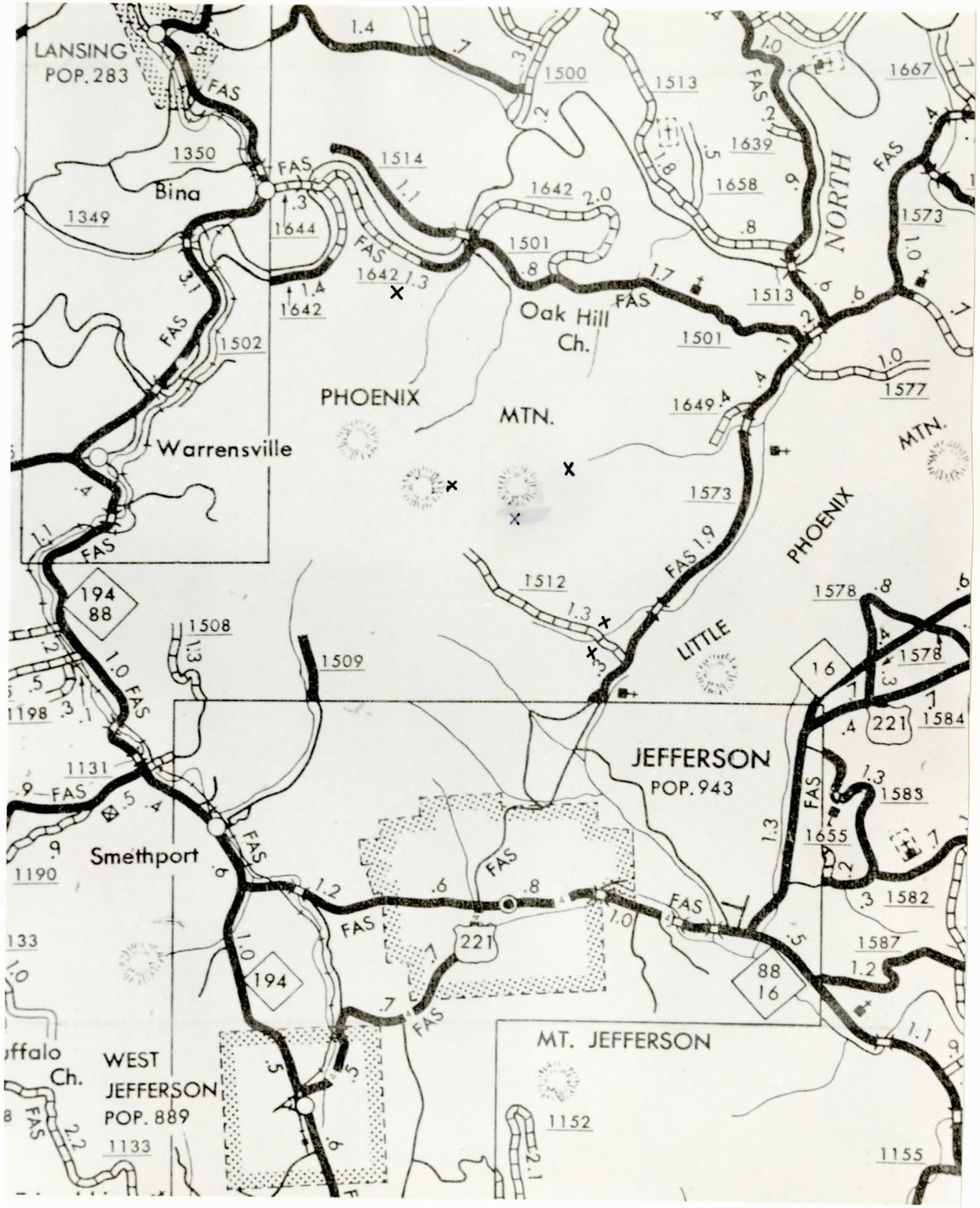

Figure 2. Sites Used in Vegetational Analysis of Phoenix Mountain

CHAPTER V

LITERATURE REVIEW

Many of the genera found on the Southern Appalachians exhibit ancient or endemic distribution suggesting their persistance from Arctotertiary forests as discussed by S. A. Cain (Cain, 1943). Cain states that it is reasonable to suppose that the Blue Ridge was elevated from 304 to 1219 meters above sea level during the Tertiary period. This elevation was enough to have supported a temperate montane vegetation. Thus, the Appalachian Highlands have been available for continuous habitation by such a flora since, at least, the early Tertiary. Arctotertiary forests were chiefly composed of deciduous trees and some conifers. Important genera were *Fagus, Castanea, Ulmus, Alnus, Betula, Corylus, Populus, Carpinus, Liquidambar, Sequoia* and *Ginkgo* (Cain, 1943). It is interesting that the important canopy species of modern cove hardwoods were also major constituents of the Arctotertiary canopy. Modern forest dominants such as *Fagus, Castanea* and *Betula* are all genera of ancient origin. Species of solely American endemic genera are not frequent, dominant, or common elements of the modern cove hardwoods. American endemic tree genera

are *Robinia, Oxydendrum* and *Magnolia (Magnolia acuminata* L. of the section Tulipastrum) (Cain, 1943). American endemic herb genera are *Monarda, Rudbeckia, Hydrophyllum, Medeola, Phlox, Phacelia, Zizia, Heuchera, Collinsonia, Taenidia* and *Houstonia* (Cain, 1943). American endemic genera do not characterize either the herb or canopy layer which bolsters the hypothesis that cove hardwoods evolved from a circumboreal forest type. Southern Appalachian plants that have maintained a circumboreal distribution since the Pleistocene or earlier times include: *Erythronium, Aster, Dentaria, Anemone, Viola, Solidago, Eupatorium, Cimicifuga, Oxalis, Ranunculus, Polygonatum, Impatiens, Poa, Galium, Carex, Hepatica, Veratrum, Cuscuta, Sedum, Cryptotaenia, Geum, Geranium, Lilium, Circaea, Senecio, Juncus, Thalictrum, Panicum, Asclepias* and *Lysimachia* (Cain, 1943). Some genera of the Southern Appalachians show disjunct patterns of distribution. Southern Appalachian tree and shrub genera that occur only in eastern Asia and eastern North America are *Tsuga, Hicoria, Magnolia, Liriodendron, Hamamelis, Liquidambar, Gleditsia, Cladrastis, Saccharodendron, Sassafras, Benzoin, Nyssa, Pieris, Halesia, Chionanthus* and *Catalpa* (Cain, 1943). The shrub *Kalmia* is found only in southeastern North America and

western India. There are also many herb genera in the Southern Appalachians that display the familiar disjunct pattern of occurring only in eastern North America and eastern Asia. These genera are *Tiarella, Urtica, Panax, Mitchella, Caulophyllum, Claytonia, Trillium, Osmorhiza, Disporum, Tovara, Arisaema, Podophyllum, Mitella, Diphylleia, Clintonia* and *Monotropa* (Cain, 1943). Cain believed that the modern distribution patterns of Southern Appalachian genera were significant evidence that these forests all evolved from an ancestral and circumboreal Arctotertiary forest very similar to present cove hardwood communities.

Whereas S. A. Cain (1943) and R. H. Whittaker (1956) both maintain cove hardwood forests are the direct descendants of Arctotertiary forests, E. L. Braun (1950) concludes mixed mesophytic forests are closer to the ancestral forest type. Braun also established mixed mesophytic forests as the most important climax association in the deciduous forest formation for eastern North America. They reach their best development in the Cumberland Mountains and extend throughout the Appalachian Highlands. Mixed mesophytic forests are composed of association-segregates of two or three of the following species: *Fagus grandifolia* Ehrhart, *Liriodendron tulipifera* L.,

Tilia species, *Acer saccharum* Marshall, *Castanea dentata* (Marshall) Bokh., *Aesculua octandra* Marshall, *Quercus rubra* var. *borealis* (Michaux f.) Farwell, *Q. alba* L. and *Tsuga canadensis* (L.) Carr (Braun, 1950). Other mesic tree species appear less frequently in the canopy. The number of possible canopy species may be as high as twenty-five.

The oak-chestnut forest association is a less mesic grouping and the principal climax association throughout the Blue Ridge. Braun continues to use the term, oak-chestnut, because it was too soon after the demise of the American chestnut to predict the new canopy dominants in these forests. The dominance of oak-chestnut forests in the Southern Appalachians is correlated with the climatic factor of a higher incidence of summer drought and the edaphic factors of steep slope and shallow soil. Mixed mesophytic forests do occur in the Blue Ridge but only in mesic cove situations. Since oak-chestnut forests occur on noncalcareous substrata in the Cumberlands, they are considered by Braun to be local association-segregates of mixed mesophytic forests. Braun feels that oak-chestnut forests were also derived from the Arctotertiary forests but only indirectly so, by the segregation of less mesic tree species from mixed mesophytic forests.

The vegetation types of Whittaker (1956) differ from those previously established by E. L. Braun (1950). The two authors also differ as to which vegetation was the center of adaptive radiation. The cove hardwoods of Whittaker is a vegetation type comparable to the mixed mesophytic forest association of Braun. *Tsuga canadensis* (L.) Carr, *Halesia monticola* (Redh.) Sarg., *Tilia heterophylla* Vent, *Acer saccharum* Marshall, *Aesculus octandra* Marshall and *Betula lutea* Michaux f. are the canopy dominants of cove hardwood forests, comprising eighty to ninety percent of the canopy trees. *Liriodendron tulipifera* L. and *Fagus grandifolia* Ehrhart are important canopy constituents in some situations. The shrub layer is composed of deciduous shrub species such as *Hydrangea arborescens* L., *Cornus alternifolia* L. f. and *Viburnum alnifolium* Marshall (Whittaker, 1956). Shrub coverage is usually low. The herbaceous layer displays an inverse relation to the shrub layer. Summer ground coverage is approximately eighty percent. There is a layering of tall, spreading herbs over smaller ones. The herbs are mesic or submesic species preferring the rich mull humus produced in mixed hardwood stands. Fern growth is usually luxuriant and the forest floor has an open aspect.

Whittaker (1956) suggested that the mixed mesophytic forest association used by Braun is too broad a grouping of tree species and that these species have varying moisture requirements (ranging from the submesic *Quercus* and *Liriodendron* to the mesic *Aesculus* and *Tilia*). The mixed mesophytic association probably represents: 1) truly mesophytic forests such as *Acer saccharum* Marshall, *Tilia heterophylla* Vent., *Aesculus octandra* Marshall; 2) highly mixed transitional stands; and 3) various segregate types of both mesophytic and transitional situations (Whittaker, 1956).

Cove hardwood transitional forests occupy less mesic sites than do cove hardwoods. The cove dominants become mixed with more *Quercus* species and there is heavier growth of small trees and shrubs. Shrub coverage increases to twenty to fifty percent with ericaceous species predominating, particularly, *Rhododendron maximum* L. This increase in shrub and understory coverage lowers the herb coverage. These transitional forests lack the spacious aspect of the true cove stand. Cove hardwood transitional forests are described by Whittaker (1956) as the center of modern forest radiation from the ancestral Tertiary forest.

The oak-chestnut forests of the Southern Appalachians are divided into four vegetation types by R. H. Whittaker (1956). The term oak-chestnut is retained by Whittaker despite the loss of chestnut from forest canopies. The chestnut oak-chestnut forest and heath occur on subxeric sites while red oak-chestnut and white oak-chestnut forest are on submesic sites. Ericaceous shrubs characterize these woods. Shrub coverage ranges from twenty to fifty percent and increases to nearly one hundred percent in the chestnut oak-chestnut heaths. Chestnut oak-chestnut forests and heaths have few herbs with coverage up to thirty percent of the forest floor. These herbs are of the submesic, subxeric and xeric plant unions. Red and white oak-chestnut stands have a greater herb coverage of fifty percent. Flame azalea, *Rhododendron calendulaceum* (Michaux) Torrey, is a common shrub in both red and white oak-chestnut forests. It is frequently hard to distinguish between red oak-chestnut forests (Whittaker, 1956). However, white oak-chestnut forests become a distinctive community on exposed, southwestern ridges above 1372 meters. This high forest has a more open aspect and a fairly rich herbaceous

layer in which grasses, sedges and ferns are conspicuous. Herbs in white oak-chestnut forests belong to the mesic, submesic and subxeric plant unions and are similar in both of these oak-chestnut communities.

CHAPTER VI

VEGETATIONAL ANALYSIS

A. Introduction

The vegetational analyses of Southern Appalachian forests by E. L. Braun (1950) and R. H. Whittaker (1956) and the paleobotanical evidence assembled by S. A. Cain (1943) were used in the preliminary analysis of the vegetation of Phoenix Mountain. The prevailing climax vegetation in the Southern Appalachians determines what forest elements are available to colonize Phoenix Mountain both in the disturbed and undisturbed aspects. Disturbance by fire and clearing has favored the establishment of oak forests. The herb layer is uncharacteristically rich in some young oak stands in mesic locations. These herb layers contain a high percentage of mull geophytes and occur on mull humus. Mor humus, and not mull, is the type of humus usually produced under an oak canopy. Mixed hardwood forests usually produce mull humus. Therefore, these young oak stands occur on sites that once harbored mixed hardwoods. It is likely that mixed hardwood forests were distributed more widely on Phoenix Mountain in the past.

Because chestnut has not been a viable canopy dominant on Phoenix Mountain for several decades, forests that would be oak-chestnut under the classification systems of Braun and Whittaker will be referred to as simply oak forests. The term mixed mesophytic forest will not be used because the canopy composition of mixed mesophytic forests will vary, depending on which forest classification system is used. Mixed hardwoods, cove hardwoods or mixed oak and hardwoods better describe the vegetation patterns found on Phoenix Mountain.

B. Forest Types

Six different sites were analyzed to give a representative sampling of the varying forest composition on Phoenix Mountain. The forest type on most of the mountain is red oak while white oak forests were found near the rocky summit. Cove hardwood transitional forests occurred in sheltered coves. Beech forest was found on a lower north slope of Phoenix Mountain. Mixed hardwood successional communities occurred on disturbed, sheltered slopes. Alluvial mixed hardwoods were found on floodplains and in vegetation belts along creeks. The following discussions include the species composition of forest layers in six representative communities on Phoenix Mountain.

1. White Oak Forest

This site includes the rocky woods on the summit of Phoenix Mountain adjacent to bare rock outcrops. The community is on a gentle, southeastern slope at an elevation of 1417 meters. Moisture conditions range from submesic to subxeric. The rocky woods fit the white oak-chestnut pattern described by R. H. Whittaker (1956). *Quercus alba* L., *Q. rubra* var. *borealis* (Michaux f.) Farwell and *Q. prinus* L. are important canopy dominants with *Q. alba* L. being the most important. Other canopy associates are *Tsuga canadensis* (L.) Carr, *Acer rubrum* L., *Acer saccharum* Marshall, and *Fagus grandifolia* Ehrhart. The relative density, frequency, dominance and importance values of the canopy species are listed in Table 1. These woods have an open aspect and a moderately rich herb layer. Shrub coverage of the forest floor does not exceed forty percent.

Grasses and sedges are a conspicuous feature of white oak forests. *Andropogon scoparius* Michaux, *Danthonia sericea* Nuttall, five species of *Panicum* and four species of *Carex* were found in this summit forest. *Carex purpurifera* Mackenzie, an endemic species of the Southern Appalachians, occurred here.

Dryopteris marginalis (L.) Gray and *Athyrium asplenioides* (Michaux) A.A. Eaton share the forest floor with submesic, subxeric and high-elevation submesic herbs. Submesic herbs include *Smilacina racemosa* (L.) Desf., *Cypripedium acaule* Aiton, *Aureolaria laevigata* (Raf.) Raf., *Eupatorium rugosum* Houttuyn, and *Aster* species, particularly, *Aster divaricatus* L. *Galax aphylla* L. and *Pteridium aquilinum* (L.) Kuhn are typical subxeric herbs. An unexpected number of mesic species were found here. These included *Convallaria majalis* var. *montana* (Raf.) Ahles, *Lilium grayi* Watson, *Cimicifuga racemosa* Nuttall, *Trillium grandiflorum* (Michaux) Salisbury, *Caulophyllum thalictroides* (L.) Michaux and *Aralia nudicaulis* L. A complete list of all plants collected at this site can be found in the Appendix.

Table 1. Canopy Composition of White Oak Forest

Canopy Species	Importance Value	Relative Density	Relative Frequency	Relative Dominance
Quercus alba	90.1	32.0	21.0	37.1
Q. rubra var. *borealis*	81.1	28.0	21.0	32.1
Q. prinus	44.8	13.3	18.5	13.0
Tsuga canadensis	23.9	6.7	10.5	6.7
Acer rubrum	23.4	8.0	10.5	4.9
Acer saccharum	18.3	6.7	8.0	3.6
Fagus grandifolia	18.5	5.3	10.5	2.7

Canopy Height: *Quercus alba*, 15 meters.
Soils: Clifton Stony Loam; topsoil pH = 4.0, subsoil pH = 5.0.
Area sampled: 0.08 hectare. 948 trees/hectare

2. Cove Hardwood Transitional Community

This site is in an east southeast-facing valley flat with an elevation of 1296 meters. A seepage bog occurs along a stream in the center of this area. Adjacent woods on the ridges and drier slopes are dominanted by *Quercus rubra* var. *borealis* (Michaux f.) Farwell. Evidence of selective cutting exists. Stumps are sparsely scattered throughout, indicating some disturbance of the stand. The canopy consists of a mixture of oak and mesic hardwood species. The canopy species are listed in Table 2. *Quercus rubra* var. *borealis* (Michaux f.) Farwell is the most important canopy dominant along with *Q. alba* L., *Liriodendron tulipifera* L., *Quercus prinus* L., *Acer rubrum* L., *Betula lenta* L., *Fagus grandifolia* Ehrhart, *Carya glabra* (Miller) Sweet, *Magnolia acuminata* L., *Acer saccharum* Marshall and *Betula lutea* Michaux f. Trunks of *Liriodendron tulipifera* L. are all of similar diameters, possibly indicating that this intolerant species took advantage of temporary openings of the canopy. The forest, as a whole, appears to be an all-age stand with a strong trangressive layer of mesophytic species. *Quercus* and *Liriodendron* are not well-represented in the trangressive

layer. The different *Quercus* species appear throughout the valley but are abundant in submesic and marginal areas. There is a high number of trees (1383) per hectare; this is the highest value for any of the communities quantitatively considered on Phoenix Mountain. Shrub coverage ranges from thirty to fifty percent of the forest floor. The shrubs are primarily deciduous and non-ericaceous. *Sambucus pubens* Michaux, a high-elevation mesic shrub, is scattered throughout the woods along with other mesic species such as *Ribes rotundifolium* Michaux. The vine *Aristolochia macrophylla* Lam. occurs scattered throughout the valley. There is a rich herb stratum characteristic of sites with mull humus. Mull geophytes included *Erythronium americanum* Ker, *Trillium erectum* L., *T. grandiflorum* (Michaux) Salisbury, *T. undulatum* Willd., *Thalictrum revolutum* DC. and *Mitella diphylla* L. There is a layering of tall, spreading herbs over smaller ones within the herb layer. Fern growth is luxuriant with up to ten species noted. Two rare species *Elymus riparius* Wiegand and *Carex baileyi* Britton occur here. *Aconitum uncinatum* L. is abundant throughout the more mesic sites. *Delphinium tricorne* Michaux, *Diphylleia cymosa* Michaux and *Collinsonia canadensis* L. and other mesic herbs are

characteristic species for rich woods. *Habenaria orbiculata* (Pursh.) Torrey occurs with *H. clavellata* (Michaux) Sprengel on the margins of the bog. The southern endemic *Parnassia grandifolia* DC. is found on rocks on the seepage bog. Other associates with *Parnassia grandifolia* DC. include *Chelone glabra* L., *Oxypolis rigidior* (L.) Raf., *Lycopodium lucidulum* Michaux, *Carex* species, *Trautvetteria caroliniensis* (Walter) Vail, *Saxifraga micranthidifolia* (Haw.) Steudel and *Diphylleia cymosa* Michaux. A complete list of plant species collected at this site is available in the Appendix.

Table 2. Canopy Composition of Cove Hardwood Transitional Forest

Canopy Species	Importance Value	Relative Density	Relative Frequency	Relative Dominance
Quercus rubra var. *borealis*	51.9	20.2	11.5	20.2
Q. alba	38.7	10.6	13.4	14.7
Liriodendron tulipifera	34.8	11.7	11.5	11.6
Quercus prinus	28.9	8.5	11.5	8.9
Acer rubrum	25.0	9.6	7.7	7.7
Betula lenta	24.4	7.5	7.7	9.2
Fagus grandifolia	24.1	8.5	9.5	6.1
Carya glabra	13.1	4.3	5.8	3.0
Magnolia acuminata	12.6	3.2	5.8	3.6
Acer saccharum	12.6	5.3	3.9	3.4
Quercus coccinea	11.9	4.3	3.9	3.7
Betula lutea	11.7	3.2	3.9	4.6
Carya tormentosa	10.5	3.2	3.9	3.4

Canopy Height: 30 meters
Soils: Tusquitee Stony Loam; topsoil pH = 5.0, subsoil pH = 6.0
Area sampled: 0.08 hectare 1383 trees/hectare

3. North Slope Beech Forest

This site is on a sheltered, concave slope facing northeast. The plant community is primarily beech and occurs at an elevation of 914 meters. Patches of *Tsuga*, mixed with *Fagus*, are scattered along the slope. The shrubs *Rhododendrox maximum* L. and *Kalmia latifolia* L. occur only under *Tsuga*. *Fagus* is the most important tree in the canopy although other tree species are well-represented on the slope. Mesophytic tree species such as *Acer saccharum* Marshall and *Betula lenta* L. are the most important associates with *Fagus grandifolia* in more mesic situations. Other canopy associates of significance are *Quercus rubra* var. *borealis* (Michaux f.) Farwell, *Liriodendron tulipifera* L., *Magnolia acuminata* L., *Quercus prinus* L. and *Acer rubrum* L. The relative densities, frequencies, dominances and importance values of all canopy species are listed in Table 3. *Quercus rubra* var. *borealis* (Michaux f.) Farwell and *Liriodendron tulipifera* L. are present throughout the stand but are more frequent near the drier top of the slope. A dirt road cuts through this site at the lower edge. It is here in the disturbed road area that submesic trees such as *Carya*

were found. The *Fagus* forest occurs in a limited area where the slope is sheltered and concave, moisture conditions mesic, and the soil quite stony. The understory and trangressives are well-represented. There are numerous stump sprouts and small trees of *Fagus grandifolia* Ehrhart and *Acer saccharum* Marshall. The shrub layer is very sparse, consisting of only a few species. The herb layer is very rich with a sixty percent coverage of the forest floor. Ferns are well-represented with abundant *Athyrium asplenioides* (Michaux) A.A. Eaton and *Cystopteris protrusa* (Weatherby) Blasdell. *Botrychium virginianum* (L.) Swartz, *Adiantum pedatum* L., *Dryopteris intermedia* (Willd.) Gray, *D. marginalis* (L.) Gray, *Thelypteris noveboracensis* (L.) Nieuwland and *Polypodium virginianum* L. also occur. Grasses and sedges compose five percent of the herbs. Mesic herbs of rich woods such as *Arisaema triphyllum* (L.) Schott, *Convallaria majalis* var. *montana* (Raf.) Ahles, *Disporum lanuginosum* (Michaux) Nicholson, *Erythronium americanum* Ker., *Trillium grandiflorum* (Michaux) Salisbury, *T. undulatum* Willd., *Claytonia caroliniana* Michaux, *C. virginica* L. and *Tiarella cordifolia* L. characterize the beech stand. *Panax quinquefolium* L. and *Panax trifolium* L., both endemic species, occur here. Herbs

such as *Polygonatum pubescens* (Willd.) Pursh., *Asarum canadense* L., *Delphinium tricorne* Michaux, *Dicentra canadensis* (Goldie) Walpers, *Alliaria petiolata* (Bieb.) Cavara & Grande, *Phacelia fimbriata* Michaux, *Osmorhiza claytonii* (Michaux) Clarke and *Osmorhiza longistylis* (Torrey) DC. serve as indication of the richness of the forest floor. This beech stand exhibits the greatest species diversity of any herb layer in the plant communities sampled. A complete plant list for this site can be found in the Appendix.

Table 3. Canopy Composition of North-slope Beech Forest

Canopy Species	Importance Value	Relative Density	Relative Frequency	Relative Dominance
Fagus grandifolia	64.8	22.1	18.8	23.9
Tsuga canadensis	44.0	15.8	12.5	15.7
Acer saccharum	29.6	8.4	14.5	6.7
Quercus rubra var. *borealis*	27.0	9.5	8.3	9.2
Liriodendron tulipifera	26.2	10.5	6.3	9.4
Betula lenta	25.4	7.4	8.3	9.7
Magnolia acuminata	23.6	8.4	6.3	8.9
Quercus prinus	12.5	3.2	4.3	5.0
Acer rubrum	12.0	4.2	4.3	3.5
Carya glabra	8.2	2.1	4.3	1.4
Carya tormentosa	7.8	3.2	2.0	3.0
Oxydendrum arboreum	7.8	2.1	4.3	1.4
Prunus serotina	4.0	1.1	2.0	0.9
Carpinus caroliniana	3.9	1.1	2.0	0.8
Betula lutea	3.7	1.1	2.0	0.6

Canopy Height: *Liriodendron tulipifera*, 21 meters.
Soils: Clifton or Porters Stony Loam;
topsoil pH = 5.0, subsoil pH = 6.0.
Area sampled: 0.12 hectare. 793 trees/hectare

4. Alluvial Mixed Hardwoods

This site includes a mesic stand of mixed hardwoods occurring on silty bottomland sheltered by a steep, northeast-facing slope. Soil pHs vary from an average of 5.0 in the topsoil to 5.5 in the subsoil. Submesic *Quercus* species occur on the drier portions of the plain, probably introduced by seed from the drier oak woods upslope. The area has been disturbed both by logging and dumping of trash. *Liriodendron tulipifera* L., *Betula lutea* Michaux f., *Quercus rubra* var. *borealis* (Michaux f.) Farwell, *Acer rubrum* L., *Fagus grandifolia* Ehrhart, *Quercus coccinea* Muenchh., *Betula lenta* L., *Magnolia acuminata* L. and *Acer saccharum* Marshall are listed in Table 4, in order of decreasing importance in the canopy. The trunks of *Liriodendron* are of similar diameters and there are virtually no *Liriodendron* seedlings. Trangressives are strongly represented by mesic hardwood seedlings, particularly, *Fagus grandifolia* Ehrhart, *Acer saccharum* Marshall and *Aesculus octandra* Marshall. There is a rich understory composed of small, mesic trees such as *Ostrya* and *Carpinus*. Shrubs are not a significant feature on the floodplain; shrubs cover only eight percent of the forest floor.

Shrub genera include *Hydrangea, Kalmia, Leucothoe, Lindera* and *Vaccinium*. The richness of the herb layer is the most striking feature of this community. Mesic herbs such as *Claytonia virginica* L., *Anemone quinquefolia* L., *Sanguinaria canadensis* L., *Arabis canadensis* L., *Ligusticum canadense* (L.) Britton and *Collinsonia canadensis* L. are distributed throughout the silty floodplain of Little Phoenix Creek. *Symplocarpus foetidus* (L.) Nuttall, a northern species present here near its southernmost limit, is found in a marshy area. *Allium tricoccum* Aiton, *Mitella diphylla* L., *Asarum canadense* L., *Cardamine concatenata* (Michaux) Ahles, *Orchis spectabilis* L., *Aplectrum hyemale* (Muhl. ex Willd.) Torrey and several species of *Viola* are abundant along the creek banks. Herb coverage reaches at least fifty percent in the spring of the year. These alluvial woods are a preclimax community dominated by *Liriodendron* and mesic hardwoods. A mixture of beech-buckeye-sugar maple seems to be the most likely climax pattern. A complete list of plants collected at this site can be found in the Appendix.

Table 4. Canopy Composition of Alluvial Mixed Hardwoods

Canopy Species	Importance Value	Relative Density	Relative Frequency	Relative Dominance
Liriodendron tulipifera	67.4	20.0	17.7	29.7
Betula lutea	64.4	25.0	17.7	21.7
Quercus rubra var. *borealis*	35.6	11.3	12.6	11.7
Acer rubrum	33.4	11.3	12.6	9.5
Fagus grandifolia	31.3	12.5	10.1	8.7
Quercus coccinea	19.5	5.0	7.6	6.9
Betula lenta	16.5	5.0	7.6	3.9
Magnolia acuminata	12.7	3.8	5.1	3.8
Acer saccharum	9.4	3.8	3.0	2.6
Oxydendrum arboreum	5.1	1.3	3.0	0.8
Carya glabra	5.1	1.3	3.0	0.8

Canopy Height: *Liriodendron tulipifera*, 21 meters.
Soils: Tusquitee Loam;
topsoil pH = 5.0
subsoil pH = 5.5.
Area sampled: 0.08 hectare. 1000 trees/hectare

5. Mixed Hardwoods Successional Community

This ecotonal stand at an elevation of 960 meters occurs on a steep, sheltered slope facing to the northeast. This mesic community has mixed elements of oak species from an upper slope oak forest and mesophytic species from the alluvial situation at the slope base. The canopy dominants are listed in Table 5 as being *Liriodendron tulipifera* L., *Quercus rubra* var. *borealis* (Michaux f.) Farwell, *Fagus grandifolia* Ehrhart and *Acer saccharum* Marshall in order of decreasing importance. The major canopy dominant, *Liriodendron*, is part of a successional stage that would be expected to decrease in importance as the community approaches climax. Its successional nature is suggested by the lack of young *Liriodendron* and the even ages of existing trees. The area has been considerably disturbed by both logging and trash dumping. The present trangressives are all mesophytic species and not *Quercus* or *Liriodendron*. Seedlings of *Aesculus octandra* Marshall, *Fagus grandifolia* Ehrhart and *Acer saccharum* Marshall are particularly abundant. Shrubs are poorly established on the slope, having a coverage on the forest floor of eight percent. The herb layer is striking, reaching a spring

time coverage as high as sixty percent. *Orchis spectabilis* L. and *Obolaria virginica* L. are abundant on the steep slope. *Aplectrum hyemale* (Muhl. ex Willd.) Torrey, *Habenaria orbiculata* (Pursh.) Torrey, *Asarum canadense* L., *Arabis canadensis* L., *Osmorhiza claytonii* (Michaux) Clarke and *Collinsonia canadensis* L. are other mesic herbs occurring less frequently on the slope. Mull geophytes such as *Erythronium americanum* Ker. and *Claytonia virginica* L. characterize the herb layer indicating the soil humus is mull. Mull humus is produced by leaf litter of a mesophytic forest. Hence, it is more likely that the original forest composition was mesophytic and not oak which produces a mor humus (Braun, 1952). The high percentage of mesic tree species in the trangressive layer probably indicates the area is slowly recovering from prior disturbance. The expected climax should be one of mixed hardwoods with or without oak in the canopy. This disturbed forest is typical of many sites on Phoenix Mountain. A complete list of all plants collected on this site can be found in the Appendix.

Table 5. Canopy Composition of Mixed Hardwoods Successional Community

Canopy Species	Importance Value	Relative Density	Relative Frequency	Relative Dominance
Liriodendron tulipifera	91.3	30.8	19.6	40.9
Quercus rubra var. *borealis*	43.3	14.0	15.8	13.5
Fagus grandifolia	36.7	13.1	15.8	7.8
Acer saccharum	34.6	13.1	11.7	9.8
Betula lenta	27.8	9.4	9.9	8.5
Acer rubrum	18.4	6.6	5.9	3.2
Magnolia acuminata	12.8	3.7	5.9	3.2
Quercus coccinea	11.7	2.8	5.9	3.0
Carya tormentosa	11.5	3.7	3.8	4.0
Quercus alba	8.2	1.9	3.8	2.5
Carya glabra	3.6	0.9	2.0	0.7

Canopy Height: *Liriodendron tulipifera*, 27 meters.
Soils: Porters Loam; topsoil pH = 4.0,
subsoil pH = 5.0.
Area sampled: 0.13 hectare 835 trees/hectare

6. Red Oak Forest

This successional stand occurs on the upper slope of a northeast-facing ridge. Moisture conditions are submesic to mesic. The site elevation is 975 meters. *Liriodendron tulipifera* L. and *Quercus rubra* var. *borealis* (Michaux f.) Farwell are listed in Table 6 as the two most important canopy dominants. The high importance value of *Liriodendron* should decrease as there are few *Liriodendron* seedlings present. The even-age *Liriodendron* is a successional element developing after disturbance of the area by logging. The subcanopy is composed of mostly submesic species such as *Hamamelis virginiana* L., *Cornus florida* L., *Prunus serotina* Ehrhart and *Oxydendrum arboreum* (L.) DC. Trangressive seedlings are of submesic trees such as *Quercus* and *Carya*. The shrub layer is poor and of low coverage on the forest floor. Herbs are either submesic or mesic with herbs covering thirty percent of the forest floor. Orchids such as *Orchis spectabilis* L., *Aplectrum hyemale* (Muhl. ex Willd.) *Cypripedium acaule* Aiton and *Goodyera repens* var. *ophioides* Fernald are well-represented on the slope. The herb layer is fairly rich but much less so than lower, more sheltered communities on the same slope.

This upper slope is in a more exposed position than is the lower slope. It is likely that *Quercus rubra* var. *borealis* (Michaux f.) Farwell will continue to have a selective advantage and the area will eventually move toward a red oak climax. A complete list of plants found in the herb and other layers can be found in the Appendix.

Table 6. Canopy Composition of Red Oak Forest

Canopy Species	Importance Value	Relative Density	Relative Frequency	Relative Dominance
Liriodendron tulipifera	117.7	42.3	28.8	46.6
Quercus rubra var. *borealis*	69.1	23.1	19.9	26.1
Fagus grandifolia	30.6	10.3	13.3	7.0
Carya tormentosa	23.8	7.7	8.9	7.2
Betula lenta	21.7	6.4	11.2	4.1
Quercus coccinea	19.0	5.1	8.9	5.0
Magnolia acuminata	13.2	3.9	6.6	2.7
Carya glabra	4.9	1.3	2.3	1.3

Canopy Height: *Liriodendron tulipifera*, 27 meters.
Soils: Porters Loam; topsoil pH = 4.0,
subsoil pH = 5.0
Area sampled: 0.13 hectare 608 trees/hectare

C. Specialized Habitats

Two unusual habitats occur on Phoenix Mountain. The rock outcrops on the summit provide a specialized habitat for an assemblage of plants that occur nowhere else on Phoenix Mountain. Seepage bogs are found in several locations on Phoenix Mountain and contain interesting and distinctive arrays of bog species. The following discussions include the characteristic plants that distinguish both habitats.

1. Rock Outcrops at the Summit of Phoenix Mountain

The summit of Phoenix Mountain (1436 meters) is a bare rocky ridge that strikes to the northeast. The northeast sides of the cliffs display a sharp drop-off of approximately sixty meters to the lower forested slopes. The southern side has a more gradual slope with forests extending almost to the summit. Lichens and mosses are pioneer plants on the bare rock. *Selaginella rupestris* (L.) Spring, *Bulbostylis capillaris* (L.) Clarke and *Lycopodium selago* L. are found in areas where a little soil has accumulated. Grasses *Andropogon, Agrostis* and *Danthonia* appear in the thicker mats of vegetation. The average soil pH is 4.0 in these areas. *Paronychia agyrocoma* (Michaux) Nuttall is present in many of these primary successional communities. *Arenaria groenlandica* (Retzius) Sprengel dominates vegetation mats on rock outcrops where *Paronychia* does not occur. *Sedum telephioides* Michaux, *Saxifraga michauxii* Britton, *Senecio smallii* Britton and *Liatris spicata* (L.) Willd. are found in mats throughout the rock outcrops. The vascular cryptogams *Woodsia scopulina* DC., *Asplenium montanum* Willd., *Polypodium virginianum* L. and *Lycopodium selago* L. are found in crevices on steep rock

faces. Several populations of *Geum radiatum* Gray, an Appalachian endemic, can be seen on narrow ledges with northern exposure along the entire ridge. The shrubs *Rhododendron catawbiense* Michaux, *Rhododendron maximum* L., *Spiraea virginiana* Britton, *Vaccinium vacillans* Torrey, *Viburnum cassinoides* L. and *Kalmia latifolia* L. occur in deeper soils on the summit. *Sorbus americana* Marshall is strikingly distributed along the ridge with its showy corymbs of white blooms and, later, red pomes. *Tsuga caroliniana* Engelm., another small tree, occurs only on the summit of Phoenix Mountain. *Thelypteris noveboracensis* (L.) Nieuwland, *Athyrium asplenioides* (Michaux) A.A. Eaton, *Lycopodium selago* L. and *Aralia nudicaulis* L. characterize the vegetation at the moist, shaded bases of cliffs. Shrubs such as *Clethra acuminata* Michaux, *Menziesia pilosa* (Michaux) Jussieu and *Rhododendron maximum* L. form almost impenetrable thickets in these mesic situations. *Lilium grayi* Watson occurs in the rocky woods bordering the summit and in protected locations on the cliffs. The Appalachian endemic *Carex purpurifera* Mackenzie is found only in the rocky woods surrounding the summit. Stunted trees occur in patches

between rock outcrops and are chiefly species from the surrounding white oak woods. A complete list of all plants collected on the summit can be found in the Appendix.

2. Seepage Bogs on Phoenix Mountain

Boggy situations occur wherever level locations with poor drainage exist. The most extensive seepage area on Phoenix Mountain occurs at 1295 meters at a spot known as Twin Springs. The seepage area is in the middle of a broad cove facing to the southeast. The forest surrounding the bog is mixed hardwoods and oaks. A thicket predominated by *Rhododendron maximum* L. marks the drier margins of the bog. It is here that *Cypripedium acaule* Aiton, *Habenaria clavellata* (Michaux) Sprengel and *H. orbiculata* (Pursh.) Torrey exist. The herb layer is otherwise sparse under the *Rhododendron* thicket; the soil pH averaged 4.0 at this site. Mesic shrubs such as *Clethra acuminata* Michaux, *Leucothoe recurva* (Buckley) Gray and *Viburnum alnifolium* Marshall are found in the wetter sites. Clumps of *Sphagnum* occur in the very wet and marshy spots. Associated with *Sphagnum* are *Andropogon virginicus* L., *Bromus purgans* L., *Carex aestivalis* M.A. Curtis and *Scirpus* species. *Carex baileyi* Britton and *Elymus riparius* Wiegand, two rare species, also occur here. A stream runs through the middle of the seepage bog. *Diphylleia cymosa* Michaux and *Veratrum viride* Aiton are the dominant species in this

area of the bog. The fern *Osmunda cinnamomea* L. is also abundant. Species growing under these larger herbs include *Lycopodium lucidulum* Michaux and *Selaginella apoda* (L.) Spring. *Aconitum uncinatum* L. occurs scattered throughout the seepage area associated with *Trautvetteria caroliniensis* (Walter) Vail. Soil pH readings at Twin Springs were usually acidic (pH = 4.0) but readings of 6.0 were found in several spots of mucky ground under *Aconitum uncinatum* L.

Parnassia grandifolia DC. is found where the small stream in the center of Twin Springs becomes more shallow, flowing over wide patches of bare rocks. *P. grandifolia* DC. was the predominant plant over a ten by ten meter square area. Associated in the immediate area were *Lycopodium lucidulum* Michaux, *Selaginella apoda* (L.) Spring, and *Senecio aureus* L. The plants grew in mucky soil between rocks in slowly moving water with a soil pH of 6.0. *Chelone glabra* L., *Oxypolis rigidior* (L.) Raf., *Ligusticum canadense* (L.) Britton, *Aconitum uncinatum* L., *Trautvetteria caroliniensis* (Walter) Vail and *Delphinium tricorne* Michaux grew adjacent to the *Parnassia grandifolia* DC. population on less wet ground. Other small populations of *P. grandifolia* DC. occurred downstream as far as two kilometers away.

Members of the family Asteraceae were abundant in the seepage bog in denser woods at Twin Springs. Here, *Aster prenanthoides* Muhl. ex Willd., *Helenium autumnale* L., *Solidago puberula* Nuttall and *Verbesina alternifolia* (L.) Britton ex Kearney occurred along with the fern *Osmunda regalis* var. *spectabilis* (Willd.) Gray.

Another seepage area occurs at 1128 meters adjacent to CR 1509 on the southwest side of Phoenix Mountain. This was an acidic seepage bog (pH of 4.0) characterized by the ferns *Onoclea sensibilis* L., *Osmunda regalis* var. *spectabilis* (Willd.) Gray and *Osmunda cinnamomea* L. *Aconitum uncinatum* L., *Trautvetteria caroliniensis* (Walter) Vail and *Tovara virginiana* (L.) Raf. were also found here. Below the intersection of CR 1512 and paved CR 1573 along Little Phoenix Creek, *Symplocarpus foetidus* (L.) Nuttall, *Allium tricoccum* Aiton, *Taenidia integerrmia* (L.) Drude, *Oxypolis rigidior* (L.) Raf. as well as species of *Scirpus* and *Carex* occur in another seepage community. A complete list for all plant species collected in seepage bogs can be found in the Appendix.

CHAPTER VII

CATALOG OF VASCULAR FLORA

The following is a list of the vascular plants collected on Phoenix Mountain by the author. Taxa collected in the area that do not occur on the distribution maps for Manual of the Vascular Flora of the Carolinas (Radford, Ahles and Bell, 1968) for Ashe County are prefixed with an asterisk. A complete set of the author's collections are deposited at Appalachian State University.

Phylogeny and nomenclature generally follow the treatment of Radford, Ahles and Bell (1968).

EQUISETACEAE

Equisetum arvense L.

LYCOPODIACEAE

Lycopodium flabelliforme (Fernald) Blanchard
L. lucidulum Michaux
L. selago L.

SELAGINELLACEAE

Selaginella apoda (L.) Spring
S. rupestris (L.) Spring

OPHIOGLOSSACEAE

Botrychium dissectum Sprengel
B. virginianum (L.) Swartz

OSMUNDACEAE

Osmunda cinnamomea L.
O. claytoniana L.
O. regalis var. *spectabilis* (Willd.) Gray

PTERIDACEAE

Adiantum pedatum L.
Dennstaedtia punctilobula (Michaux) Moore
Pteridium aquilinum (L.) Kuhn

ASPIDIACEAE

Athyrium asplenioides (Michaux) A.A. Eaton
Cystopteris protrusa (Weatherby) Blasdell
Dryopteris intermedia (Willd.) Gray
D. marginalis (L.) Gray
Onoclea sensibilis L.
Polystichum acrostichoides (Michaux) Schott
Thelypteris noveboracensis (L.) Nieuwland
Woodsia scopulina DC.

ASPLENIACEAE

Asplenium montanum Willd.

POLYPODIACEAE

Polypodium virginianum L.

PINACEAE

Pinus strobus L.
Tsuga canadensis (L.) Carr.
T. caroliniana Engelm.

POACEAE

Agrostis perennans (Walter) Tuckerman
A. stolonifera L.
Andropogon scoparius Michaux
A. virginicus L.
Bromus commutatus Schrader
**B. inermis* Leysser
B. purgans L.
Dactylis glomerata L.
Danthonia compressa Austin
**D. sericea* Nuttall
D. spicata (L.) Beauvois ex R.&S.
Digitaria ischaemum (Schreber) Schreber ex Muhl.
Echinochloa crusgalli (L.) Beauvois
**Elymus riparius* Wiegand
Eragrostis capillaris (L.) Nees.
Festuca elatior L.
F. myuros L.
**Glyceria melicaria* (Michaux) Hubbard
Holcus lanatus L.
Hordeum vulgare L.
Miscanthus sinensis var. *variegatus* Beal.
Muhlenbergia tenuiflora (Willd.) BSP.
**Panicum clandestinum* L.
P. depauperatum Muhl.
P. dichotomum L.
P. lanuginosum Ell.
**P. laxiflorum* Lam.
**P. linearifolium* Schribner
Paspalum setaceum Michaux
Phleum pratense L.
**Poa palustris* L.
Setaria geniculata (Lam.) Beauvois
S. glauca (L.) Beauvois

CYPERACEAE

Bulbostylis capillaris (L.) Clarke
Carex aestivalis M.A. Curtis
C. baileyi Britton
C. communis Bailey
C. nigromarginata Schweinitz
C. pensylvanica Lam.
**C. purpurifera* Mackenzie
C. rosea Schkuhr.
C. vulpinoidea Michaux
Scirpus atrovirens Willd.
S. cyperinus (L.) Kunth.
S. expansus Fernald

ARACEAE

Arisaema triphyllum (L.) Schott
Symplocarpus foetidus (L.) Nuttall

COMMELINACEAE

Commelina communis L.
Tradescantia subaspera Ker.

JUNCACEAE

**Juncus brevicaudatus* (Engelm.) Fernald
J. effusus L.
Luzula acuminata var. *carolinae* (Watson) Fernald
L. echinata (Small) Hermann

LILIACEAE

Allium tricoccum Aiton
Amaianthium muscaetoxicum (Walter) Gray
Clintonia umbellulata (Michaux) Morong
Convallaria majalis var. *montana* (Raf.) Ahles
Disporum lanuginosum (Michaux) Nicholson
Erythronium americanum Ker
Lilium grayi Watson
L. michauxii Poiret
L. superbum L.
Maianthemum canadense Desf.
Medeola virginiana L.
Polygonatum biflorum (Walter) Ell.
P. pubescens (Willd.) Pursh.
Smilacina racemosa (L.) Desf.
Smilax herbacea L.

LILIACEAE (continued)

Trillium erectum L.
T. grandiflorum (Michaux) Salisbury
T. undulatum Willd.
Uvularia grandiflora Smith
U. perfoliata L.
U. pudica (Walter) Fernald
Veratrum parviflorum Michaux
V. viride Aiton

DIOSCOREACEAE

Dioscorea villosa L.

AMARYLLIDACEAE

Hypoxis hirsuta (L.) Coville

IRIDACEAE

Iris cristata Aiton
**I. germanica* L.
Sisyrinchium mucronatum var. *atlanticum* (Bicknell) Ahles

ORCHIDACEAE

Aplectrum hyemale (Muhl. ex Willd.) Torrey
Cypripedium acaule Aiton
Goodyera pubescens (Willd.) R. Brown
G. repens var. *ophioides* Fernald
Habenaria clavellata (Michaux) Sprengel
H. orbiculata (Pursh.) Torrey
H. viridis var. *bracteata* (Muhl. ex Willd.) Gray
Orchis spectabilis L.
Spiranthes cernua (L.) Richard
S. gracilis (Bigelow) Beck.

SALICACEAE

Populus candicans Aiton
Salix humilis Marshall
S. sericea Marshall

JUGLANDACEAE

Carya glabra (Miller) Sweet
C. tormentosa (Poiret) Nuttall
Juglans nigra L.

BETULACEAE

Betula lenta L.
B. lutea Michaux f.
Carpinus caroliniana Walter
Corylus cornuta Marshall
Ostrya virginiana (Miller) K. Koch

FAGACEAE

Castanea dentata (Marshall) Bokh.
Fagus grandifolia Ehrhart
Quercus alba L.
**Q. coccinea* Muenchh.
Q. prinus L.
Q. rubra var. *borealis* (Michaux f.) Farwell
Q. rubra L.

MORACEAE

**Morus rubra* L.

URTICACEAE

Laportea canadensis (L.) Weddell
Pilea pumila (L.) Gray

SANTALACEAE

Pyrularia pubera Michaux

ARISTOLOCHIACEAE

Aristolochia macrophylla Lam.
Asarum canadense L.

POLYGONACEAE

**Polygonum cilinode* Michaux
**P. cuspidatum* Siebold & Zucc.
P. persicaria L.
Rumex acetosella L.
R. obtusifolius L.

POLYGONACEAE (continued)

Tovara virginiana (L.) Raf.

PHYTOLACCACEAE

Phytolacca americana L.

PORTULACACEAE

Claytonia caroliniana Michaux
C. virginica L.

CARYOPHYLLACEAE

**Arenaria groenlandica* (Retzius) Sprengel
**Cerastium semidecandrum* L.
Dianthus armeria L.
Paronychia agyrocoma (Michaux) Nuttall
P. canadensis (L.) Wood
Silene stellata (L.) Aiton f.
S. virginica L.
Stellaria graminea L.
S. media (L.) Cyrillo
S. pubera Michaux

RANUNCULACEAE

Aconitum uncinatum L.
Anemone quinquefolia L.
A. virginiana L.
Aquilegia canadensis L.
Cimicifuga racemosa Nuttall
Clematis viorna L.
C. virginiana L.
Delphinium tricorne Michaux
Hepatica acutiloba DC.
Ranunculus abortivus L.
**R. acris* L.
R. hispidus Michaux
R. recurvatus Poiret
Thalictrum clavatum DC.
T. dioicum L.
T. revolutum DC.
Trautvetteria caroliniensis (Walter) Vail

BERIBERIDACEAE

Caulophyllum thalictroides (L.) Michaux
Diphylleia cymosa Michaux
Podophyllum peltatum L.

MAGNOLIACEAE

Liriodendron tulipifera L.
Magnolia acuminata L.
M. fraseri Walter

CALYCANTHACEAE

**Calycanthus floridus* var. *laevigatus* (Willd.) T.&G.

LAURACEAE

Lindera benzoin (L.) Blume
Sassafras albidum (Nuttall) Nees.

PAPAVERACEAE

Sanguinaria canadensis L.

FUMARIACEAE

Dicentra canadensis (Goldie) Walpers

BRASSICACEAE

**Alliaria petiolata* (Bieb.) Cavara & Grande
Arabis canadensis L.
Barbarea vulgaris var. *arcuata* (Opiz.) Fries.
**Brassica juncea* (L.) Cosson
Capsella bursa-pastoris (L.) Medicus
Cardamine concatenata (Michaux) Ahles
C. pensylvanica Muhl.
**Erysimum cheiranthoides* L.
Lepidium virginicum L.

CRASSULACEAE

Sedum telephioides Michaux
S. ternatum Michaux

SAXIFRAGACEAE

Heuchera villosa Michaux
Hydrangea arborescens L.
Mitella diphylla L.
Parnassia grandifolia DC.
**Ribes glandulosum* Grauer
R. rotundifolium Michaux
Saxifraga michauxii Britton
**S. micranthidifolia* (Haw.) Steudel
Tiarella cordifolia L.

HAMAMELIDACEAE

Hamamelis virginiana L.

PLATANACEAE

Platanus occidentalis L.

ROSACEAE

Agrimonia gryposepala Wallroth
Amelanchier arborea (Michaux f.) Fernald
A. arborea var. *laevis* (Wiegand) Ahles
Aruncus dioicus (Walter) Fernald
**Crataegus coccinea* L.
C. flabellata (Bosc.) K. Koch
C. punctata Jacquin
Fragaria virginiana Duchesne
Geum radiatum Gray
Gillenia trifoliata (L.) Moench.
Malus coronaria (L.) Miller
M. pumila Miller
M. prunifolia Borkh.
Physocarpus opulifolius (L.) Maxim.
Potentilla canadensis L.
P. norvegica L.
P. recta L.
Prunus avium L.
P. pensylvanica L. f.
P. serotina Ehrhart
Rosa carolina L.
R. cathayensis Bailey X *Rosa borboniana* Desp.
R. gallica L.
R. palustris Marshall
Rubus allegheniensis Porter
R. canadensis L.

ROSACEAE (continued)

R. flagellaris Willd.
R. occidentalis L.
R. odoratus L.
Sorbus americana Marshall
**S. arbutifolia* (L.) Heynhold
Spiraea virginiana Britton

FABACEAE

Medicago lupulina L.
Robinia pseudo-acacia L.
Trifolium agrarium L.
T. pratense L.
T. repens L.
Vicia caroliniana Walter

OXALIDACEAE

Oxalis stricta L.

GERANIACEAE

Geranium maculatum L.

EUPHORBIACEAE

Euphorbia corollata L.
E. corollata var. *zinniifolia* (Small) Ahles
E. supina Raf.

ANACARDIACEAE

Rhus glabra L.
R. radicans L.
R. typhina L.

ACERACEAE

Acer pensylvanicum L.
A. rubrum L.
A. saccharum Marshall

HIPPOCASTANACEAE

Aesculus octandra Marshall

BALSAMINACEAE

Impatiens capensis Meerb.
I. pallida Nuttall

VITACEAE

Parthenocissus quinquefolia (L.) Planchon
Vitis labrusca L.

TILIACEAE

Tilia heterophylla Vent.

HYPERICACEAE

Hypericum mitchellianum Rydberg
H. mutilum L.
H. perforatum L.

CISTACEAE

**Lechea racemulosa* Michaux

VIOLACEAE

Viola blanda Willd.
**V. canadensis* L.
V. canadensis var. *rugulosa* (Greene) C.L. Hitchcock
V. eriocarpa var. *leiocarpa* Fernald & Wiegand
V. palmata var. *sororia* (Willd.) Pollard
V. papilionacea Pursh.
V. pedata L.
V. rotundifolia Michaux
V. sagittata Aiton

ONAGRACEAE

Circaea lutetiana ssp. *canadensis* (L.) Ascherson & Magnus
Oenothera biennis L.
**O. fruticosa* L.

ARALIACEAE

Aralia nudicaulis L.
Panax quinquefolium L.
P. trifolium L.

APIACEAE

Angelica venenosa (Greenway) Fernald
Cryptotaenia canadensis (L.) DC.
Daucus carota L.
Ligusticum canadense (L.) Britton
Osmorhiza claytonii (Michaux) Clarke
O. longistylis (Torrey) DC.
Oxypolis rigidior (L.) Raf.
Sanicula canadensis L.
Taenidia integerrima (L.) Drude
Thaspium barbinode (Michaux) Nuttall
T. trifoliatum (L.) Gray
**T. trifoliatum* var. *flavum* Blake
Zizia trifoliata (Michaux) Fernald

NYSSACEAE

**Nyssa sylvatica* Marshall

CORNACEAE

Cornus alternifolia L. f.
C. florida L.

CLETHRACEAE

Clethra acuminata Michaux

ERICACEAE

Chimaphila maculata (L.) Pursh
Gaylussacia baccata (Wang) K. Koch
Kalmia latifolia L.
Leucothoe recurva (Buckley) Gray
Menziesia pilosa (Michaux) Jussieu
Monotropa uniflora L.
Oxydendrum arboreum (L.) DC.
Pyrola rotundifolia var. *americana* (Sweet) Fernald
Rhododendron calendulaceum (Michaux) Torrey
R. catawbiense Michaux
R. maximum L.
Vaccinium constablaei Gray
V. erythrocarpum Michaux
V. stamineum var. *melanocarpum* Michaux
V. vacillans Torrey

DIAPENSIACEAE

Galax aphylla L.

PRIMULACEAE

Lysimachia quadrifolia L.

STYRACACEAE

Halesia carolina L.

OLEACEAE

Fraxinus americana L.
Syringa vulgaris L.

GENTIANACEAE

Gentiana clausa Raf.
G. decora Pollard
G. quinquefolia L.
Obolaria virginica L.

APOCYNACEAE

Apocynum androsaemifolium L.

ASCLEPIADACEAE

Asclepias exaltata L.
A. quadrifolia Jacquin
A. syriaca L.

CONVOLVULACEAE

Calystegia sepium (L.) R. Brown
Cuscutta rostrata Shuttlew. ex Engelm.

POLEMONIACEAE

Phlox ovata L.
P. paniculata L.
P. subulata L.

HYDROPHYLLACEAE

Hydrophyllum canadense L.
H. virginianum L.
Phacelia fimbriata Michaux

BORAGINACEAE

Cynoglossum virginianum L.
Echium vulgare L.

VERBENACEAE

Verbena urticifolia L.

LAMIACEAE

Collinsonia canadensis L.
Glecoma hederacea L.
Lycopus virginicus L.
Mentha piperita L.
M. spicata L.
Monarda clinopodia L.
M. didyma L.
Nepeta cataria L.
Prunella vulgaris L.
Pycnathemum incanum (L.) Michaux
Satureja vulgaris (L.) Fritsch
Stachys latidens Small

SOLANACEAE

Solanum carolinense L.

SCROPHULARIACEAE

Aureolaria flava (L.) Farwell
A. laevigata (Raf.) Raf.
Chelone glabra L.
Pedicularis canadensis L.
Verbascum thapsus L.
Veronica persica Poiret

OROBANCHACEAE

Conopholis americana (L.) Wallroth

PLANTAGINACEAE

Plantago lanceolata L.
P. rugelii Dcne.

RUBIACEAE

Diodia teres Walter
Galium aparine L.
G. circaezans Michaux
G. latifolium Michaux
G. pilosum Aiton
G. triflorum Michaux
Houstonia caerulea L.
H. purpurea L.
Mitchella repens L.

CAPRIFOLIACEAE

Sambucus canadensis L.
S. pubens Michaux
Viburnum acerifolium L.
V. alnifolium Marshall
V. cassinoides L.

CAMPANULACEAE

Campanula americana L.
C. divaricata Michaux
Lobelia inflata L.
L. siphilitica L.

ASTERACEAE

Achillea millefolium L.
Ambrosia artemisiifolia L.
A. trifida L.
Antennaria plantaginifolia (L.) Richardson
Arctium minus (Hill) Bernh.
Aster acuminatus Michaux
A. cordifolius L.
A. divaricatus L.
A. linariifolius L.
A. macrophyllus L.
A. novae-angliae L.
A. patens Aiton
A. paternus Cronquist
A. prenanthoides Muhl. ex Willd.
A. undulatus L.
Bidens bipinnata L.
Cacalia artiplicifolia L.
Carduus lanceolatus L.
Chrysanthemum leucanthemum L.

ASTERACEAE (continued)

Cichorium intybus L.
Coreopsis major var. *stellata* (Nuttall) Robinson
Crepis capillaris (L.) Wallroth
Erigeron annus (L.) Persoon
E. philadelphicus L.
E. pulchellus Michaux
E. strigosus Muhl. ex Willd.
Eupatorium fistulosum Barratt
E. maculatum L.
E. perfoliatum L.
E. purpureum L.
E. rugosum Houttuyn
Galinsoga ciliata (Raf.) Blake
Helenium autumnale L.
Heleopsis helianthioides (L.) BSP.
H. microcephalus T.&G.
Heterotheca mariana (L.) Shinners
Hieracium gronovii L.
H. paniculatum L.
H. pilosella L.
H. pratense Tausch
H. venosum L.
Lactuca canadensis L.
Liatris spicata (L.) Willd.
Matricaria matricarioides (Lessing) Porter
Prenanthes trifoliata (Cassini) Fernald
Rudbeckia hirta L.
R. laciniata L.
Senecio aureus L.
S. smallii Britton
Solidago bicolor L.
S. curtisii T.&G.
S. erecta Pursh.
S. nemoralis Aiton
S. puberula Nuttall
S. roanensis Porter
Sonchus oleraceus L.
Taraxacum officinale Wiggers
Verbesina alternifolia (L.) Britton ex Kearney
Vernonia noveboracensis (L.) Michaux

CHAPTER VIII

FLORISTICS

The distribution patterns of the different plant species on Phoenix Mountain are the results of several factors. These are: 1) the past floristic history of Phoenix Mountain; 2) the prevailing climatic and edaphic conditions; and 3) the vegetation of surrounding areas. These factors determine what plant species and plant communities exist on the mountain.

Several basophilous plant species occur on Phoenix Mountain. *Parnassia grandifolia* DC. and *Taenidia integerrima* (L.) Drude, two basophilous species, are found in seepage bogs on Phoenix Mountain. These bogs do not lie over a calcareous substratum. However, the soil pH in most bogs on Phoenix Mountain (which is usually 4.0 in these bogs) increases to 6.0 underneath these plants.

Bromus purgans L. and *Elymus riparius* Wiegand, grasses usually found on basic or circumneutral soils in rich woods, occur in a mesic hardwood stand on Phoenix Mountain. *Arabis canadensis* L. and *Impatiens pallida* Nuttall usually associated with basic or circumneutral soils, also occurred in mesic locations in mixed hardwood forests on Phoenix Mountain.

Amphibolite, part of the bedrock of Phoenix, is composed of magnesium and calcium silicates. The decomposition of these silicates releases magnesium and calcium cations. Enough of these cations released into the overlying soil would raise soil pH, accounting for the presence of some basophilous species. Other basophilous species such as *Bromus purgans* L. are found in soils with deep, mull humus. Leaf litter capable of producing mull humus would also return some bases to the topsoil and raise soil pH locally. It is in sheltered locations with a canopy of mixed hardwoods that this deep leaf litter and occasional circumneutral soils (pH = 6.0) are found on Phoenix Mountain.

The extremely restricted habitat on the rocky summit of Phoenix harbors an assemblage of plants unique to this area. Harsh living conditions preclude other plants from this community. *Ribes glandulosum* Grauer and *Sorbus americana* Marshall, two species usually associated with spruce-fir forests and balds, are found in the rocky woods and cliffs. *Geum radiatum* Gray, *Paronychia agyrocoma* (Michaux) Nuttall and *Arenaria groenlandica* (Retzius) Sprengel are restricted to the rock outcrops on the summit.

Many cultivated species persist in the woods around abandoned homesites on Phoenix Mountain. *Iris germanica* L. and *Miscanthus sinensis* var. *variegatus* Beal. occur at unlikely locations in woods as high as 1219 meters. Trees such as *Prunus avium* L., *P. serotina* Ehrhart, *Malus coronaria* (L.) Miller, *M. pumila* Miller and *M. prunifolia* Borkh. are found on woodland borders and in pastures. A large number of weedy species abound on roadbanks, pastures or clearings. These include *Alliaria petiolata* (Bieb.) Cavara & Grande, *Brassica juncea* (L.) Cosson, *Erysimum cheiranthoides* L., *Cerastium semidecandrum* L. and *Calycanthus floridus* var. *laevigatus* (Willd.) T. & G. *Morus rubra* L. and *Populus candicans* Aiton are abundant along several streams.

Morphological variations can be seen in some of the plants that characterize the rock cliffs. The most notable, *Lycopodium selago* L., occurs there in two forms. Plants that grow in xeric, exposed sites are shorter, tufted plants with strongly appressed leaves. Plants with a much more sprawling habit occur in shady locations along cliff bases. These sprawling plants are frequently longer than the maximum length of 1.5 decimeters described in Radford, Ahles and Bell (1968); the leaves are spreading

and not appressed. However, the leaf morphology is characteristic of *Lycopodium selago* L., and not *L. porophilum* Lloyd and Underwood which has spreading leaves and more sprawling growth pattern. *Lycopodium selago* L. var. *selago* and *L. selago* var. *patens* (Beauvois) Desvaux as given in Gleason (1952) seem better characterizations of the two morphological forms of *Lycopodium selago* L. occurring on Phoenix Mountain. This variation within the species *L. selago* L. is found in populations throughout the rocky summit area. The fern *Athyrium asplenioides* (Michaux) Eaton also occurs in two forms on the summit. Unusual tripinnate fronds of *A. asplenioides* (Michaux) Eaton occur in shady, mesic locations and fit the description for *A. asplenioides* (Michaux) Eaton forma. *subtripinnatum* Butters given by J. M. Shaver in 1954. He found tripinnate populations in the high mountains of Tennessee. The typical *Athyrium* frond is bipinnately divided and is the usual form encountered on Phoenix Mountain. Tripinnate fronds are infrequently scattered throughout the summit populations of *Athyrium* and are most likely encountered in shaded rock crevices on steep rock faces.

Eleven of the ninety-one plant species on the list, North Carolina Endangered and Threatened Vascular Plants (1977), occur in Ashe County. Four species on this list occur on Phoenix Mountain. *Carex purpurifera* Mackenzie and *Geum radiatum* Gray, both Appalachian endemics occurring on Phoenix Mountain, are plants rapidly disappearing from North Carolina. *Lilium grayi* Watson and *Panax quinquefolium* L., both rare species, are also found on Phoenix Mountain. Eleven other, less rare species on the North Carolina Endangered and Threatened Plants list of 1977 also occur on Phoenix Mountain. These include *Lycopodium selago* L., *Woodsia scopulina* DC., *Elymus riparius* Wiegand, *Panicum linearifolium* Scribner, *Carex baileyi* Britton, *Habenaria orbiculata* (Pursh) Torrey, *Arenaria groenlandica* (Retzius) Sprengel, *Parnassia grandifolia* DC., *Spiraea virginiana* Britton, *Panax trifolium* L. and *Phlox subulata* L.

CHAPTER IX

DISCUSSION AND SUMMARY

Phoenix Mountain is a unique area both for its floristic diversity and its geographical position as an outlier peak of the Blue Ridge. It is one of only a few peaks in Ashe County and the only peak to be bounded on its north side by the New River. The varied terrain produces a wide range of habitats for colonization.

The prevailing forest type on most of Phoenix Mountain is red oak. Red oak forests may be distinguished by a strong ericaceous layer predominated by *Rhododendron calendulaceum* (Michaux) Torrey. Red oak woods occur wherever moisture conditions are intermediate. White oak forests were found on rocky, southern slopes near the summit. The white oak woods had a more open aspect with fewer shrubs and a relatively rich herb layer. White oak dominated the more xeric slopes, particularly those with southern exposures and thin soil. Mesic habitats in sheltered coves and/or slopes were characterized by canopies of mesic hardwood species with or without oak. The mixed hardwood stands have distinctive and abundant herb layers, particularly in spring. Shrubs are not an

important feature, being largely replaced by rich understory and canopy layers. The best example of cove hardwoods occurred in a southeastern cove at 1296 meters. Even here, oak was present as a transitional element. Other mesic areas on Phoenix Mountain included a beech stand on a lower north slope. This beech stand has a rich herb layer which includes *Panax quinquefolium* L. and *Panax trifolium* L. A well-developed floodplain exists along Little Phoenix Creek with mixed hardwoods forming the canopy. Seepage bogs occur in several, poorly drained areas on Phoenix Mountain. These bogs contain the highest number of basophilous species on Phoenix Mountain. Basophiles found here include *Parnassia grandifolia* DC., *Taenidia integerrima* (L.) Drude and *Bromus purgans* L.

Many species of the summit communities occur nowhere else on Phoenix Mountain. Populations of *Geum radiatum* Gray as well as *Asplenium montanum* Willd. and *Woodsia scopulina* DC., occur on inaccessible rock ledges along the summit cliffs. Many of the species here are restricted to high elevations and rock outcrops. Seven of the fifteen species on Phoenix Mountain that are on the North Carolina list of endangered vascular plants occur on the rocky summit. This high incidence of rare species marks the summit as the most unusual habitat on Phoenix Mountain.

Forests on Phoenix Mountain are in stages of secondary succession that have followed disturbances by logging or fires. Many communities display a canopy more xeric than the original canopy composition and there is an unexpected richness of the herb and humus layers in many of the oak forests. Mull humus and mull geophytes are found under mixed hardwoods. Their occurrence under secondary forests of oak indicates that the original forests were more mesic. If succession continues undisturbed, mixed or cove hardwoods can be the expected climax forest in submesic to subxeric sites. Spruce-fir and hemlock forests are two major plant communities typical of the higher elevations of the Blue Ridge. These do not occur on Phoenix Mountain. Even though no spruce or fir occur on the summit, several associates of these high-elevation forests do occur--notably, *Ribes glandulosum* Grauer and *Sorbus americana* Marshall.

The only mountain in the literature with a comparable vegetation is nearby Bluff Mountain. When the floristic lists from both mountains are compared, 353 species are found to be common to both locations. Fifty-two percent of the species collected on Bluff Mountain by G. E. Tucker (1972) were also collected on Phoenix. The bedrock of

both mountains is a dark, resistant rock containing hornblende. Exposed rock outcrops characterize the summits of both Bluff and Phoenix Mountains. Species restricted to the rocky summit of Phoenix also occur on the summit of Bluff, with few exceptions. The Appalachian endemic *Carex misera* Buckley occurs only on the summit of Bluff whereas the related *Carex purpurifera* Mackenzie, also an Appalachian endemic, occurs only on Phoenix Mountain. Similar exposed rock cliffs also exist on Mount Jefferson. Although no floristic list exists in the literature for Mount Jefferson, it is likely that it, too, has a similar flora. Boggy areas were more frequent and diverse on Bluff Mountain than on Phoenix Mountain. No counterpart to Calloway Glades, a high-elevation bog-fen on Bluff, exists on Phoenix Mountain. Boggy situations on Phoenix Mountain are better characterized as seepage bogs due to their acidic nature and the presence of *Sphagnum* and ericads. Forests on Bluff Mountain were predominately oak-hickory or oak with mesophytic forests occurring in sheltered, mesic situations. Much of the same situation occurs on Phoenix Mountain except that chestnut oak or red oak forests, and not oak-hickory, occupy the subxeric sites. There are few situations on Phoenix Mountain where

Carya is frequent enough to be considered a major canopy dominant. Forests on both Bluff and Phoenix Mountains show varying evidences of disturbance.

Phoenix Mountain like other peaks of the Southern Appalachians, has been available as a refugium for montane plants since the Tertiary period (Cain, 1943). The overwhelming diversity of plants as well as the endemic or rare status of many of the species indicate that Phoenix Mountain has been occupied by an upland flora for a very long time.

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CHAPTER X

APPENDIX

A. Presence Lists For Forest Types

1. White Oak Forest near the Summit

Subcanopy Layer

Acer pensylvanicum L.
Amelanchier arborea (Michaux f.) Fernald
Carya species
Castanea dentata (Marshall) Bokh.
Fagus grandifolia Ehrhart
Hamamelis virginiana L.
Oxydendrum arboreum (L.) DC.
Sassafras albidum (Nuttall) Nees.

Shrub Layer

Clethra acuminata Michaux
Corylus cornuta Marshall
Hydrangea arborescens L.
Kalmia latifolia L.
Menziesia pilosa (Michaux) Jussieu
Rhododendron catawbiense Michaux
R. calendulaceum (Michaux) Torrey
R. maximum L.
Vaccinium constablaei Gray
V. stamineum var. *melanocarpum* Michaux
V. vacillans Torrey
Viburnum acerifolium L.
V. alnifolium Marshall
V. cassinoides L.

Vines

Parthenocissus quinquefolia (L.) Planchon
Smilax herbacea L.

Herb Layer

Athyrium asplenioides (Michaux) A.A. Eaton
Dennstaedtia punctilobula (Michaux) Moore
Osmunda regalis var. *spectabilis* (Willd.) Gray
Polypodium virginianum L.
Polystichum acrostichoides (Michaux) Schott
Pteridium aquilinum (L.) Kuhn
Thelypteris noveboracensis (L.) Nieuwland

Andropogon scoparius Michaux
Carex communis Bailey
C. pensylvanica Lam.
C. purpurifera Mackenzie
C. rosea Schkuhr.
Danthonia sericea Nuttall
Luzula acuminata var. *carolinae* (Watson) Fernald
L. echinata (Small) Hermann
Panicum depauperatum Muhl.
P. dichotomum L.
P. lanuginosum Ell.
P. laxiflorum Lam.
P. linearifolium Scribner.

Amaianthium muscaetoxicum (Walter) Gray
Anemone quinquefolia L.
Aquilegia canadensis L.
Aralis nudicaulis L.
Aruncus dioicus (Walter) Fernald
Aster acuminatus Michaux
A. cordifolius L.
A. divaricatus L.
A. macrophyllus L.
A. patens Aiton
A. paternus Cronquist
Aureolaria flava (L.) Farwell
A. laevigata (Raf.) Raf.
Campanula americana L.
C. divaricata Michaux
Caulophyllum thalictroides (L.) Michaux
Cimicifuga racemosa Nuttall
Clintonia umbellulata (Michaux) Morong
Conopholis americana (L.) Wallroth
Convallaria majalis var. *montana* (Raf.) Ahles

Herb Layer (continued)

Cypripedium acaule Aiton
Eupatorium rugosum Houttuyn
Galax aphylla L.
Galium aparine L.
G. triflorum Michaux
Geranium maculatum L.
Gillenia trifoliata (L.) Moench.
Gentiana clausa Raf.
G. decora Pollard
G. quinquefolia L.
Heuchera villosa Michaux
Hieracium paniculatum L.
Iris cristata Aiton
Lilium grayi Watson
L. michauxii Poiret
L. superbum L.
Maianthemum canadense Desf.
Medeola virginiana L.
Mitchella repens L.
Polygonatum biflorum (Walter) Ell.
Sanguinaria canadensis L.
Sedum ternatum Michaux
Silene stellata (L.) Aiton f.
S. virginica L.
Smilacina racemosa (L.) Desf.
Solidago roanensis Porter
Stellaria pubera Michaux
Thalictrum dioicum L.
T. revolutum DC.
Thaspium trifoliatum (L.) Gray
Tradescantia subaspera Ker.
Trillium erectum L.
T. grandiflorum (Michaux) Salisbury
T. undulatum Willd.
Viola papilionacea Pursh.
V. pedata L.

2. Cove Hardwood Transitional Forest

Subcanopy Layer

Acer pensylvanicum L.
Aesculus octandra Marshall
Amelanchier arborea (Michaux f.) Fernald
Carpinus caroliniana Walter
Castanea dentata (Marshall) Bokh.
Cornus alternifolia L. f.
C. florida L.
Hamamelis virginiana L.
Magnolia fraseri Walter
Ostrya virginiana (Miller) K. Koch
Prunus serotina Ehrhart
Sassafras albidum (Nuttall) Nees.
Tilia heterophylla Vent.

Shrub Layer

Hydrangea arborescens L.
Kalmia latifolia L.
Leucothoe recurva (Buckley) Gray
Lindera benzoin (L.) Blume
Ribes rotundifolium Michaux
Rhododendron calendulaceum (Michaux) Torrey
R. maximum L.
Sambucus canadensis L.
S. pubens Michaux
Sorbus arbutifolia (L.) Heynhold
Vaccinium erythrocarpum Michaux
Viburnum acerifolium L.
V. alnifolium Marshall
V. cassinoides L.

Vines

Aristolochia macrophylla Lam.
Parthenocissus quinquefolia (L.) Planchon
Smilax herbacea L.

Herb Layer

Adiantum pedatum L.
Athyrium asplenioides (Michaux) A.A. Eaton
Botrychium dissectum Sprengel
B. virginianum (L.) Swartz
Dryopteris intermedia (Willd.) Gray
D. marginalis (L.) Gray
Lycopodium lucidulum Michaux
Onoclea sensibilis L.
Osmunda cinnamomea L.
O. regalis var. *spectabilis* (Willd.) Gray
Polypodium virginianum L.
Polystichum acrostichoides (Michaux) Schott
Selaginella apoda (L.) Spring
Thelypteris noveboracensis (L.) Nieuwland

Andropogon virginicus L.
Bromus purgans L.
Carex aestivalis M.A. Curtis
C. baileyi Britton
Elymus riparius Wiegand
Glyceria melicaria (Michaux) Hubbard
Juncus effusus L.
Luzula acuminata var. *carolinae* (Watson) Fernald
Scirpus atrovirens Willd.
S. cyperinus (L.) Kunth.

Aconitum uncinatum L.
Amaianthium muscaetoxicum (Walter) Gray
Anemone quinquefolia L.
Anemone virginiana L.
Aplectrum hyemale (Muhl. ex Willd.) Torrey
Arisaema triphyllum (L.) Schott
Aruncus dioicus (Walter) Fernald
Asclepias exaltata L.
Aster acuminatus Michaux
A. cordifolius L.
A. divaricatus L.
A. macrophyllus L.
A. novae-angliae L.
A. patens Aiton
A. paternus Cronquist
A. prenanthoides Muhl. ex Willd.
Cacalia atriplicifolia L.
Campanula americana L.
C. divaricata Michaux
Cardamine concatenata (Michaux) Ahles
C. pensylvanica Muhl.

Herb Layer (continued)

Chelone glabra L.
Cimicifuga racemosa Nuttall
Clintonia umbellulata (Michaux) Morong
Collinsonia canadensis L.
Conopholis americana (L.) Wallroth
Coreopsis major var. *stellata* (Nuttall) Robinson
Cypripedium acaule Aiton
Delphinium tricorne Michaux
Diphylleia cymosa Michaux
Erigeron pulchellus Michaux
Erythronium americanum Ker
Eupatorium fistulosum Barratt
E. rugosum Houttuyn
Galium aparine L.
G. circaezans Michaux
G. latifolium Michaux
G. pilosum Aiton
G. triflorum Michaux
Geranium maculatum L.
Habenaria clavellata (Michaux) Sprengel
H. orbiculata (Pursh.) Torrey
Helenium autumnale L.
Hepatica acutiloba DC.
Heuchera villosa Michaux
Impatiens capensis Meerb.
Impatiens pallida Nuttall
Ligusticum canadense (L.) Britton
Lobelia siphilitica L.
Mitella diphylla L.
Oxypolis rigidior (L.) Raf.
Parnassia grandifolia DC.
Podophyllum peltatum L.
Polygonatum biflorum (Walter) Ell.
Prenanthes trifoliata (Cassini) Fernald
Ranunculus recurvatus Poiret
Rudbeckia laciniata L.
Saxifraga micranthidifolia (Haw) Steudel
Sedum ternatum Michaux
Senecio aureus L.
Silene stellata (L.) Aiton f.
Smilacina racemosa (L.) Desf.
Solidago puberula Nuttall
Stellaria graminea L.
S. pubera Michaux

Herb Layer (continued)

Thalictrum revolutum DC.
Thaspium barbinode (Michaux) Nuttall
T. trifoliatum (L.) Gray
Tiarella cordifolia L.
Trautvetteria caroliniensis (Walter) Vail
Trillium erectum L.
T. grandiflorum (Michaux) Salisbury
T. undulatum Willd.
Veratrum viride Aiton
Verbesina alternifolia (L.) Britton ex Kearney
Viola blanda Willd.
V. canadensis L.
V. canadensis var. *rugulosa* (Greene) C. L. Hitchcock
V. eriocarpa var. *leiocarpa* Fernald & Wiegand

3. North Slope Beech Forest

Subcanopy Layer

Acer pensylvanicum L.
Aesculus octandra Marshall
Amelanchier arborea (Michaux f.) Fernald
Halesia carolina L.
Hamamelis virginiana L.
Magnolia fraseri Walter
Ostrya virginiana (Miller) K. Koch
Populus candicans Aiton

Shrub Layer

Hydrangea arborescens L.
Kalmia latifolia L. (associated with *Tsuga canadensis*)
Rhododendron maximum L. (associated with *Tsuga canadensis*)
Ribes rotundifolium Michaux
Viburnum alnifolium Marshall
V. cassinoides L.

Vines

Aristolochia macrophylla Lam.
Parthenocissus quinquefolia (L.) Planchon

Herb Layer

Adiantum pedatum L.
Athyrium asplenioides (Michaux) A.A. Eaton
Botrychium virginianum (L.) Swartz
Cystopteris protrusa (Weatherby) Blasdell
Dryopteris marginalis (L.) Gray
Polypodium virginianum L.
Thelypteris noveboracensis (L.) Nieuwland

Herb Layer (continued)

Carex species
Glyceria melicaria (Michaux) Hubbard
Luzula acuminata var. *carolinae* (Watson) Fernald
L. echinata (Small) Hermann
Panicum species

Alliaria petiolata (Bieb.) Cavara & Grande
Amaianthium muscaetoxicum (Walter) Gray
Arisaema triphyllum (L.) Schott
Asarum canadense L.
Aster species
Cimicifuga racemosa Nuttall
Claytonia caroliniana Michaux
C. virginica L.
Clintonia umbellulata (Michaux) Morong
Convallaria majalis var. *montana* (Raf.) Ahles
Delphinium tricorne Michaux
Dicentra canadensis (Goldie) Walpers
Disporum lanuginosum (Michaux) Nicholson
Erigeron pulchellus Michaux
Erythronium americanum Ker
Eupatorium rugosum Houttuyn
Hydrophyllum canadense L.
Lilium michauxii Poiret
L. superbum L.
Maianthemum canadense Desf.
Medeola virginiana L.
Osmorhiza claytonii (Michaux) Clarke
O. longistylis (Torrey) DC.
Panax trifolium L.
P. quinquefolium L.
Phacelia fimbriata Michaux
Podophyllum peltatum L.
Polygonatum biflorum (Walter) Ell.
P. pubescens (Willd.) Pursh.
Sedum ternatum Michaux
Senecio aureus L.
Smilacina racemosa (L.) Desf.
Stellaria pubera Michaux
Tiarella cordifolia L.
Trautvetteria caroliniensis (Walter) Vain
Trillium grandiflorum (Michaux) Salisbury
T. undulatum Willd.
Viola blanda Willd.
V. canadensis L.
V. canadensis var. *rugulosa* (Greene) C.L. Hitchcock

Herb Layer (continued)

Allium tricoccum Aiton
Anemone quinquefolia L.
Aplectrum hyemale (Muhl. ex Willd.) Torrey
Arabis canadensis L.
Arisaema triphyllum (L.) Schott
Asarum canadense L.
Aster species
Cardamine concatenata (Michaux) Ahles
C. pensylvanica Muhl.
Claytonia virginica L.
Collinsonia canadensis L.
Cynoglossum virginianum L.
Erythronium americanum Ker
Eupatorium rugosum Houttuyn
Galium aparine L.
Galium latifolium Michaux
G. triflorum Michaux
Hepatica acutiloba DC.
Impatiens capensis Meerb.
I. pallida Nuttall
Laportea canadensis (L.) Weddell
Ligusticum canadense (L.) Britton
Maianthemum canadense Desf.
Medeola virginiana L.
Mitella diphylla L.
Monarda didyma L.
Orchis spectabilis L.
Oxypolis rigidior (L.) Raf.
Polygonatum biflorum (Walter) Ell.
Ranunculus abortivus L.
R. hispidus Michaux
Sanguinaria canadensis L.
Sedum ternatum Michaux
Senecio aureus L.
Smilacina racemosa (L.) Desf.
Stellaria pubera Michaux
Symplocarpus foetidus (L.) Nuttall
Taenidia integerrima (L.) Drude
Thalictrum clavatum DC.
T. dioicum L.
T. revolutum DC.
Thaspium trifoliatum (L.) Gray
T. trifoliatum var. *flavum* Blake
Tiarella cordifolia L.
Trautvetteria caroliniensis (Walter) Vain
Trillium undulatum Willd.

4. Alluvial Mixed Hardwoods

Subcanopy Layer

Acer pensylvanicum L.
Aesculus octandra Marshall
Carpinus caroliniana Walter
Crataegus species
Hamamelis virginiana L.
Ostrya virginiana (Miller) K. Koch
Prunus serotina Ehrhart
Sassafras albidum (Nuttall) Nees.

Shrub Layer

Hydrangea arborescens L.
Kalmia latifolia L.
Leucothoe recurva (Buckley) Gray
Lindera benzoin (L.) Blume
Vaccinium species

Vines

Dioscorea villosa L.
Parthenocissus quinquefolia (L.) Planchon

Herb Layer

Botrychium dissectum Sprengel
Lycopodium lucidulum Michaux
Osmunda cinnamomea L.
O. claytoniana L.
Polystichum acrostichoides (Michaux) Schott
Selaginella apoda (L.) Spring

Carex species
Luzula acuminata var. *carolinae* (Watson) Fernald
L. echinata (Small) Hermann

Herb Layer (continued)

Viola canadensis L.
V. eriocarpa var. *leiocarpa* Fernald & Wiegand
V. palmata var. *sororia* (Willd.) Pollard
V. rotundifolia Michaux
Zizia trifoliata (Michaux) Fernald

5. Mixed Hardwoods Successional Community

Subcanopy Layer

Acer pensylanicum L.
Aesculus octandra Marshall
Cornus florida L.
Hamamelis virginiana L.
Oxydendrum arboreum (L.) DC.
Prunus serotina Ehrhart

Shrub Layer

Crataegus species
Hydrangea arborescens L.
Kalmia latifolia L.
Lindera benzoin (L.) Blume
Vaccinium species

Vines

Aristolochia macrophylla Lam.
Dioscorea villosa L.
Parthenocissus quinquefolia (L.) Planchon
Vitis labrusca L.

Herb Layer

Adiantum pedatum L.
Botrychium dissectum Sprengel
B. virginianum (L.) Swartz
Dennstaedtia punctilobula (Michaux) Moore
Dryopteris marginalis (L.) Gray
Osmunda cinnamomea L.
Polystichum acrostichoides (Michaux) Schott

Herb Layer (continued)

Carex species
Echinochloa crusgalli (L.) Beauvois
Luzula acuminata var. *carolinae* (Watson) Fernald
Panicum species

Anemone quinquefolia L.
Aplectrum hyemale (Muhl. ex Willd.) Torrey
Arabis canadensis L.
Arisaema triphyllum (L.) Schott
Aruncus dioicus (Walter) Fernald
Asarum canadense L.
Aster species
Campanula americana L.
C. divaricata Michaux
Cardamine concatenata (Michaux) Ahles
C. pensylvanica Muhl.
Caulophyllum thalictroides (L.) Michaux
Chimaphila maculata (L.) Pursh
Claytonia virginica L.
Clintonia umbellulata (Michaux) Morong
Collinsonia canadensis L.
Disporum lanuginosum (Michaux) Nicholson
Erigeron pulchellus Michaux
Erythronium americanum Ker
Eupatorium rugosum Houttuyn
Galium latifolium Michaux
Gentiana quinquefolia L.
Geranium maculatum L.
Goodyera pubescens (Willd.) R. Brown
G. repens var. *ophioides* Fernald
Habenaria orbiculata (Pursh.) Torrey
Hepatica acutiloba DC.
Iris cristata Aiton
Laportea canadensis (L.) Weddell
Ligusticum canadense (L.) Britton
Maianthemum canadense Desf.
Medeola virginiana L.
Obolaria virginica L.
Orchis spectabilis L.
Osmorhiza claytonii (Michaux) Clarke
Podophyllum peltatum L.
Polygonatum biflorum (Walter) Ell.
Sanguinaria canadensis L.
Sanicula canadensis L.
Senecio aureus L.
Silene stellata (L.) Aiton f.

Herb Layer (continued)

Smilacina racemosa (L.) Desf.
Stellaria pubera Michaux
Taenidia integerrima (L.) Drude
Thalictrum clavatum DC.
T. dioicum L.
T. revolutum DC.
Thaspium barbinode (Michaux) Nuttall
T. trifoliatum (L.) Gray
Trillium erectum L.
T. grandiflorum (Michaux) Salisbury
T. undulatum Willd.
Uvularia grandiflora Smith
Viola canadensis L.
V. canadensis var. *rugulosa* (Greene) C.L. Hitchcock
V. palmata var. *sororia* (Willd.) Pollard
V. papilionacea Pursh.
V. rotundifolia Michaux
Zizia trifoliata (Michaux) Fernald

6. Red Oak Forest

Subcanopy Layer

Acer pensylvanicum L.
Aesculus octandra Marshall
Cornus florida L.
Hamamelis virginiana L.
Oxydendrum arboreum (L.) DC.
Prunus serotina Ehrhart
Sassafras albidum (Nuttall) Nees.

Shrub Layer

Gaylussacia baccata (Wang) K. Koch
Hydrangea arborescens L.
Kalmia latifolia L.
Rhododendron calendulaceum (Michaux) Torrey
Vaccinium constablaei Gray

Vines

Dioscorea villosa L.
Parthenocissus quinquefolia (L.) Planchon
Smilax herbacea L.
Vitis labrusca L.

Herb Layer

Adiantum pedatum L.
Dennstaedtia punctilobula (Michaux) Moore
Polypodium virginianum L.
Polystichum acrostichoides (Michaux) Schott

Carex species
Luzula acuminata var. *carolinae* (Watson) Fernald
Panicum species

Herb Layer (continued)

Amaianthium muscaetoxicum (Walter) Gray
Aplectrum hyemale (Muhl. ex Willd.) Torrey
Arisaema triphyllum (L.) Schott
Aster species
Campanula divaricata Michaux
Cardamine concatenata (Michaux) Ahles
C. pensylvanica Muhl.
Caulophyllum thalictroides (L.) Michaux
Chimaphila maculata (L.) Pursh.
Conopholis americana (L.) Wallroth
Cypripedium acaule Aiton
Erigeron pulchellus Michaux
Eupatorium rugosum Houttuyn
Galium species
Gentiana quinquefolia L.
Geranium maculatum L.
Gillenia trifoliata (L.) Moench.
Goodyera repens var. *ophioides* Fernald
Hepatica acutiloba DC.
Iris cristata Aiton
Maianthemum canadense Desf.
Medeola virginiana L.
Obolaria virginica L.
Orchis spectabilis L.
Sanicula canadense L.
Senecio aureus L.
Silene stellata (L.) Aiton f.
Smilacina racemosa (L.) Desf.
Stellaria pubera Michaux
Thaspium trifoliatum (L.) Gray
Trillium erectum L.
T. undulatum Willd.
Uvularia grandiflora Smith
U. pudica (Walter) Fernald
Viola pedata L.
V. papilionacea Pursh.
V. rotundifolia Michaux

B. Presence Lists for Specialized Habitats

1. Rock Outcrops on the Summit

Athyrium asplenioides (Michaux) A.S. Eaton
Asplenium montanum Willd.
Dryopteris marginalis (L.) Gray
Lycopodium selago L.
Polypodium virginianum L.
Polystichum acrostichoides (Michaux) Schott
Selaginella rupestris (L.) Spring
Thelypteris noveboracensis (L.) Niewland
Woodsia scopulina DC.

Agrostis perennans (Walter) Tuckerman
A. stolonifera L.
Andropogon scoparius Michaux
Bulbostylis capillaris (L.) Clarke
Carex communis Bailey
C. pensylvanica Lam.
C. purpurifera Mackenzie
C. rosea Schkuhr.
Danthonia compressa Austin
D. spicata (L.) Beauvois ex R.& S.
Panicum depauperatum Muhl.
P. dichotomum L.
P. lanuginosum Ell.
P. laxiflorum Lam.
P. linearifolium Scribner.
Luzula acuminata var. *carolinae* (Watson) Fernald

Acer pensylvanicum L.
Acer rubrum L.
A. saccharum Marshall
Amelanchier arborea (Michaux f.) Fernald
A. arborea var. *laevis* (Wiegand) Ahles
Aquilegia canadensis L.
Aralis nudicaulis L.
Arenaria groenlandica (Retzius) Sprengel
Aster linariifolius L.
Aureolaria flava (L.) Farwell
A. laevigata (Raf.) Raf.
Betula lutea Michaux f.
Castanea dentata (Marshall) Bokh.
Clethra acuminata Michaux
Clintonia umbellulata (Michaux) Morong
Convallaria majalis var. *montanum* (Raf.) Ahles
Corylus cornuta Marshall

Herb Layer (continued)

Fagus grandifolia Ehrhart
Galax aphylla L.
Gaylussacia baccata (Wang) K. Koch
Gentiana clausa Raf.
G. decora Pollard
G. quinquefolia L.
Geum radiatum Gray
Gillenia trifoliata (L.) Moench.
Hamamelis virginiana L.
Heuchera villosa Michaux
Hieracium paniculatum L.
H. pratense Tausch
H. venosum L.
Iris cristata Aiton
Kalmia latifolia L.
Leucothoe recurva (Buckley) Gray
Liatris spicata (L.) Willd.
Lilium grayi Watson
L. michauxii Poiret
Maianthemum canadense Desf.
Medeola virginiana L.
Menziesia pilosa (Michaux) Jussieu
Mitchella repens L.
Oxydendrum arboreum (L.) DC.
Paronychia agyrocoma (Michaux) Nuttall
Parthenocissus quinquefolia (L.) Planchon
Prunus serotina Ehrhart
Quercus alba L.
Q. prinus L.
Q. rubra var. *borealis* (Michaux f.) Farwell
Rhododendron catawbiense Michaux
R. maximum L.
Ribes rotundifolium Michaux
Rubus allegheniensis Porter
R. canadensis L.
Sassafras albidum (Nuttall) Nees.
Saxifraga michauxii Britton
Sedum telephioides Michaux
S. ternatum Michaux
Senecio smallii Britton
Silene virginica L.
Solidago bicolor L.
S. curtisii T.& G.
S. erecta Pursh.
S. nemoralis Aiton
Sorbus americana Marshall

Herb Layer (continued)

Spiraea virginiana Britton
Thaspium trifoliatum (L.) Gray
Tsuga canadensis (L.) Carr.
T. caroliniana Engelm.
Vaccinium constablaei Gray
V. stamineum var. *melanocarpum* Michaux
V. vacillans Torrey
Viburnum alnifolium Marshall
V. cassinoides L.
V. papilionacea Pursh.
Viola pedata L.

2. Seepage Bogs

Athyrium asplenioides (Michaux) A.A. Eaton
Dryopteris intermedia (Willd.) Gray
D. marginalis (L.) Gray
Lycopodium lucidulum Michaux
Onoclea sensibilis L.
Osmunda cinnamomea L.
O. regalis var. *spectabilis* (Willd.) Gray
Selaginella apoda (L.) Spring
Thelypteris noveboracensis (L.) Nieuwland

Andropogon virginicus L.
Bromus purgans L.
Carex aestivalis M.A. Curtis
C. baileyi Britton
Elymus riparius Wiegand
Glyceria melicaria (Michaux) Hubbard
Juncus effusus L.
Luzula acuminata var. *carolinae* (Watson) Fernald
L. echinata (Small) Hermann
Scirpus atrovirens Willd.
S. cyperinus (L.) Kunth.

Aconitum uncinatum L.
Asclepias exaltata L.
Aster prenanthoides Muhl. ex Willd.
Chelone glabra L.
Clethra acuminata Michaux
Collinsonia canadensis L.
Cypripedium acaule Aiton
Delphinium tricorne Michaux
Diphylleia cymosa Michaux
Eupatorium fistulosum Barratt
Habenaria clavellata (Michaux) Sprengel
H. orbiculata (Pursh.) Torrey
Helenium autumnale L.
Leucothoe recurva (Buckley) Gray
Ligusticum canadense (L.) Britton
Oxypolis rigidior (L.) Raf.
Parnassia grandifolia DC.
Physocarpus opulifolius (L.) Maxim.
Sambucus pubens Michaux

Seepage Bogs (continued)

Sedum ternatum Michaux
Senecio aureus L.
Solidago puberula Nuttall
Sorbus arbutifolia (L.) Heynhold
Symplocarpus foetidus (L.) Nuttall
Taenidia integerrima (L.) Drude
Thalictrum revolutum DC
Thaspium trifoliatum (L.) Gray
Tovara virginiana (L.) Raf.
Trautvetteria caroliniensis (Walter) Vail
Vaccinium constablaei Gray
V. erythrocarpum Michaux
V. stamineum var. *melanocarpum* Michaux
Verbesina alternifolia (L.) Britton ex Kearney
Viburnum alnifolium Marshall
V. cassinoides L.

VITA

Victoria Hollowell Lacey was born on May 25, 1954 in Charlotte, North Carolina. Her parents are Dr. and Mrs. Victor Boyce Hollowell of Charlotte, North Carolina. She graduated from Myers Park High School in Charlotte, North Carolina in 1972. Upon graduation from high school, she entered the University of North Carolina at Chapel Hill and received the B.S. degree with a major in biology in May, 1976.

Upon completion of her undergraduate program, she entered Appalachian State University and began work toward the Master of Arts degree in January of 1977.

The typist for this thesis was Mrs. Janice Ashley.