VASCULAR FLORA OF NORTHWESTERN HIGHLAND COUNTY, VIRGINIA

A thesis

Presented to

The Faculty of the Department of Biology

The College of William and Mary in Virginia

by

Theresa Alee Theodose

1989

APPROVAL SHEET

This thesis is submitted in partial fulfillment of

the requirements for the degree of

Master of Arts

Author

Approved, August 1989.

Gustav W. Hall

Martin C. Mathes

Donna M. E. Ware

Stewart A. Ware

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

I would like to thank Dr. Gustav Hall, commmittee chairman, for his help in the field, his assistance in the identification process, and his constant encouragement. Thanks are extended to Dr. Stewart Ware for his instruction and suggestions in the vegetational analysis, and to Dr. Martin Mathes for his support. Special thanks is extended to Dr. Donna Ware for her help in identifying specimens. I am indebted to all committee members for their careful reading and editing of the manuscript and for their valuable suggestions.

I am grateful to Chuck Bailey for his assistance with collecting and sampling; and for his help in identifying trees in the winter condition.

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Highland County is located in central western Virginia, along the West Virginia border. It is bounded to the east by Augusta County, to the south by Bath County, and to the north and west by West Virginia. The study area is located in the northwest corner of Highland County and covers approximately thirty-five square miles of land. The study area straddles two physiographic provinces: the Ridge and Valley Province to the east and the Allegheny Mountain Province to the west.

A total of 48 collecting trips were made during the summers of 1987, 1988, and sporadically in 1989. Seven habitat types were investigated regularily: red spruce forests, boggy areas, mesophytic oak woods, dry oak woods, wooded ravines, open streams, and disturbed areas. The woody vegetation of eight high elevation stands was sampled using the Bitterlich method. Four stands were located in the Ridge and Valley Province and four along the Allegheny Front. *Quercus rubra* was the leading dominant in all Ridge and Valley stands; *Acer saccharum* was important in only the highest. *Picea rubens* was important in one Allegheny stand; in all others dominance was shared between *Q. rubra* and *A. saccharum*.

A total of 475 species were collected, representing 275 genera and 81 families. Of these, 98 are records for Highland County and one, *Galeopsis tetrahit* is a Virginia record. Seven species listed by the Virginia Natural Heritage program as rare or uncommon were documented.

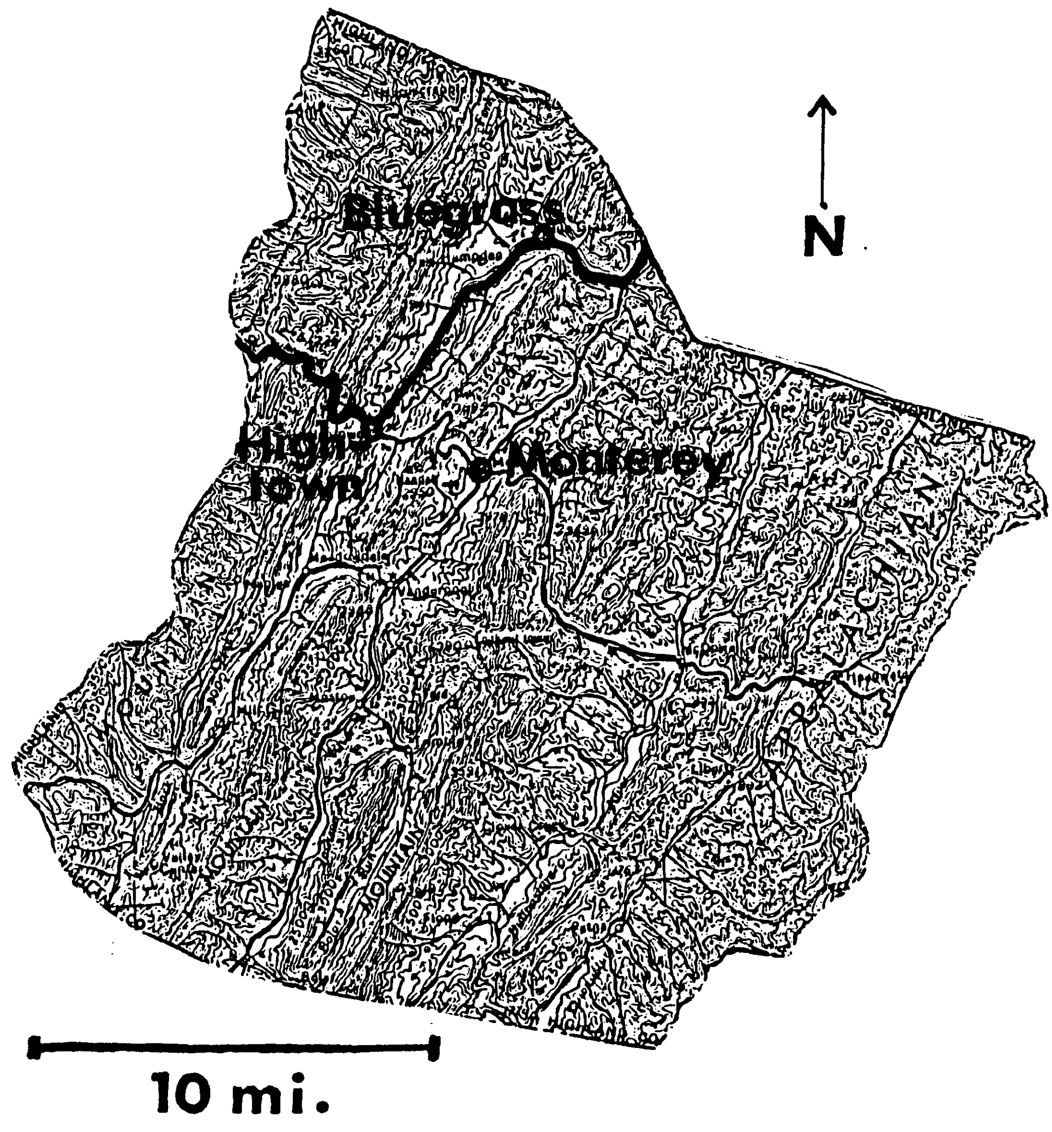
VASCULAR FLORA OF NORTHWESTERN
HIGHLAND COUNTY, VIRGINIA

INTRODUCTION

Highland County is located in west-central Virginia along the Virginia, West Virginia border. It is bounded to the east by Augusta County and to the south by Bath County. To the north lies Pendleton County, West Virginia, and to the west Pocahontas County, West Virginia. Elevations in the county range from 1620 feet to 4546 feet, with the highest mean elevation of any county east of the Mississippi (Central Shenandoah Planning District Commission 1988). The study area is in the extreme northwest portion of the county, bounded to the north and west by the West Virginia state line, to the south by U.S. Route 250, and to the east by Route 640, 642, 220, and a small stretch of the Potomac River. The study area encompasses approximately 35 square miles (Figure 1).

A portion of Highland County was chosen for study because it is a county for which there is no documented record for many plant species recorded in surrounding counties (Harvill, et. al. 1986). In addition, the western portion of the county is one of the few areas of Virginia that falls within the Allegheny Mountain Physiographic Province (Figure 2).

FIGURE 1

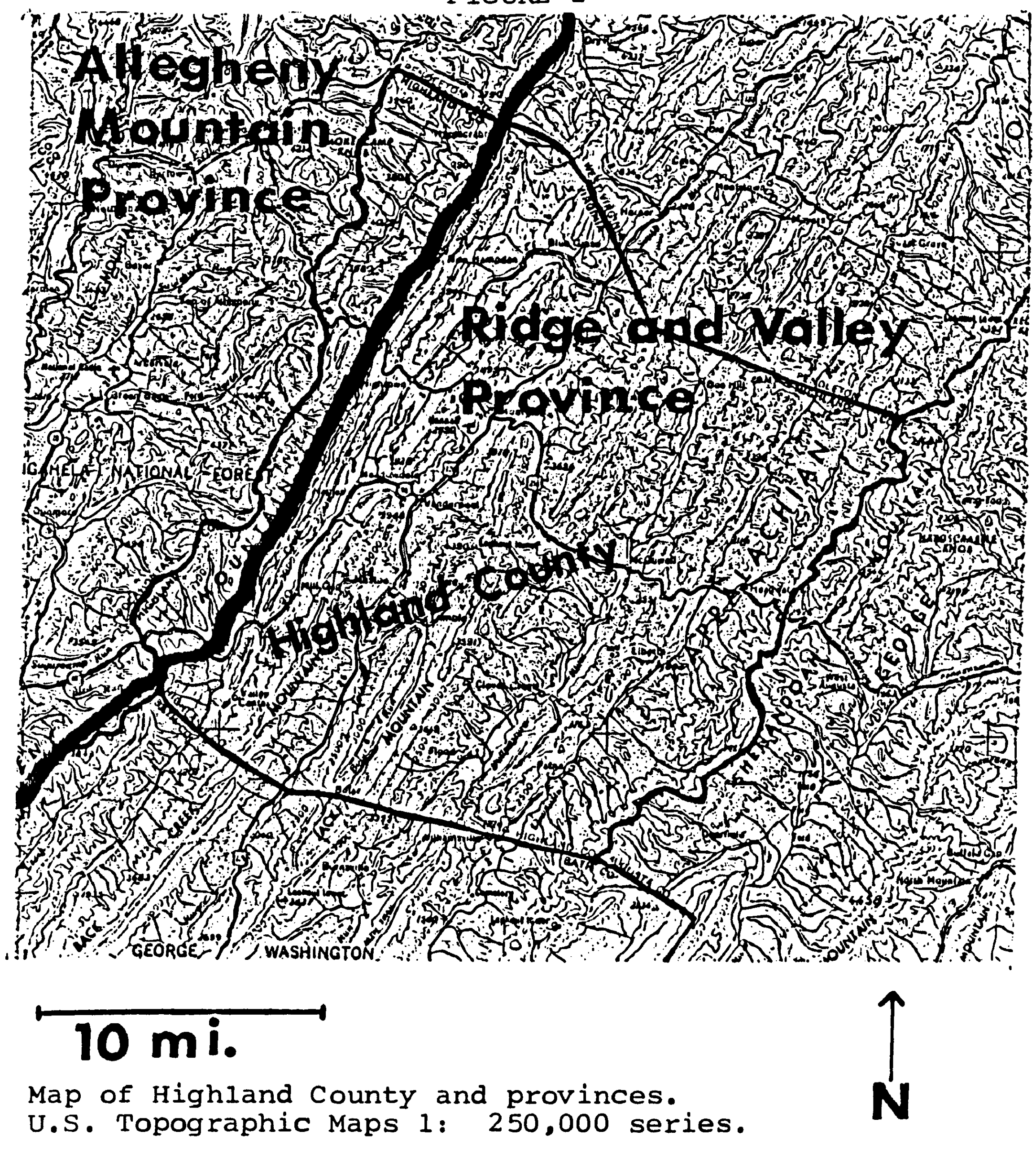


Map of Highland County with the study area in its northwest portion. U.S. topographic Maps 1: 250,000 series.

According to Braun (1950) this province is characterized by mixed mesophytic vegetation, with higher elevation sites having forests of northern affinity. This characteristic, coupled with the county's location at the state line, make it a potential site of southern or eastern range extensions.

The purpose of this study was to document with voucher specimens the complete vascular flora of the study area, including those species not previously recorded for Highland County. Eventually this information, along with the work of many others, will contribute to the compilation of a comprehensive flora of the state of Virginia.

FIGURE 2



Map of Highland County and provinces.
U.S. Topographic Maps 1: 250,000 series.

HISTORY AND ECONOMY

In 1847, 416 sqare miles of mountain terrain were formed into Highland County. This land was originally part of Bath County, Virginia, and Pendleton County, West Virginia. The town of Highland was established in 1848. The name was later changed to Monterey in honor of General Zachary Taylor's defeat of the Mexican army in the city of that name; Monterey is now the county seat. Several Civil War battles were fought in Highland County, notably the Battle of McDowell and the first of Stonewall Jackson's Valley Campaigns (Central Shenandoah Planning District Commission 1988).

The economy of Highland County was, and still is, closely tied to the land. Early industry centered around logging operations. The first great logging of the Laurel Fork area took place in 1920 (Pielke 1928). Such logging records provide the only early botanical information on the area.

In 1950 the Hook brothers opened their sawmill in Monterey, closely followed by other lumber companies including the Taylor-Ramsey Corporation and Westvaco.

Considering that approximately 70% of Highland County remains forested, logging and its associated industries remain major contributers to the economy of the county (Central Shenandoah Planning District Commission 1988).

The cleared portions of the county are mostly concentrated in the valleys, although a few mountain-tops have been logged. Most of these areas are used as pastureland for cattle and sheep. Cattle and calf production are the major agricultural activities. Wool is also a major commodity: in 1982, 74,000 lbs of wool were produced, the second largest amount by any Virginia county (Central Shenandoah Planning District Commission 1988).

Presently the population of Highland County is estimated at 2600, a decrease from the 1980 figure of 2937. Most are employed in agriculture, forestry, fisheries, and mining industries, or in the firms that manufacture these goods (Central Shenandoah planning District Commission 1988). Tourism has become a major source of income for many residents. Outdoor enthusiasts enjoy the natural beauty of the area, and the annual Maple Sugar Festival draws thousands of tourists to Monterey each spring. Highland County's present productivity remains dependent on the natural resources upon which its economy was built.

CLIMATE

Weather data from two stations, both located outside of the study area, were consulted. The Monterey station is located just east of the study area at an elevation of 2920 feet. The Spruce Knob station is located northwest of the study area in Pendleton county, West Virginia, at an elevation of 3050 feet. The Monterey station falls in the Ridge and Valley Physiographic Province, while the Spruce Knob station is located in the Alleghenies. Both stations are located at relatively low elevations; the weather at high elevation sites within the study area may differ.

The climate of Highland County is continental, although modified considerably by elevation. The winters are relatively cold (for Virginia) and the summers mild. The average annual temperature for the last 15 years was recorded as 49.6°F (9.7°C) at the Monterey station, and 47.5°F (8.5°C) at Spruce Knob. The lowest temperature of the last 15 years was a chilling -26°F (-33°C), recorded at Monterey during the winter of 1985. The highest temperature on record was 93°F (34°C) at Monterey during the summer of 1983. The average growing season is 139 days for Monterey, and 149 days for Spruce Knob (based on records from the past 15 years).

Precipitation is fairly well distributed throughout the year, with the greatest amount falling in July and the least in November. In the summer much of the rain falls during thunderstorms; in winter, precipitation falls primarily as snow.

Although the Allegheny Mountain Province has been recognized as a more mesic area than the Ridge and Valley (Braun, 1950; Core, 1966), the precipitation data from the two weather stations does not reflect this. However, this could be due to differences in exposure of the two stations. Spruce Knob is cooler than Monterey, probably because of its greater elevation (Tables 1 and 2).

Table 1
Annual Summaries of Climatological Data Collected at the Monterey Weather Station in Highland County, Virginia*

	Temperature °F Mean	High	Low	Annual Precip. (in.)	Last Spring Min. of 32°F	First Fall Min. of 32°F	Frost Free Days
1973	50.2	90	-3	48.30	5/18	10/6	141
1974	49.0	87	4	42.00	5/28	9/22	117
1975	49.5	88	--	45.58	4/27	9/14	140
1976	48.7	87	-6	42.00	5/9	9/23	137
1977	49.3	91	-14	36.28	6/8	10/5	119
1978	48.6	89	-7	42.28	5/3	9/29	149
1979	48.8	87	-8	55.41	5/17	10/10	146
1980	49.4	92	-8	36.55	5/10	10/6	149
1981	48.6	88	-5	37.01	5/13	9/29	139
1982	50.0	85	-18	46.74	5/1	9/24	146
1983	49.7	93	-10	44.83	5/10	9/23	136
1984	50.8	89	-10	46.07	5/17	10/3	139
1985	50.3	88	-26	46.42	5/4	9/14	133
1986	50.8	88	-2	36.36	5/10	0/17	150
1987	50.7	91	-5	47.66	5/5	10/2	150
Avg.	49.6			43.58			139

* From the U.S. Department of Commerce Weather Bureau Climatological Data (Virginia Annual Summaries 1973-1987) Vols. 83-97.

Table 2

Annual Summaries of Climatological Data Collected at the Spruceknob Wether Station in Pendleton County, West Virginia*

	Temperature °F Mean	High	Low	Annual Precip. (in.)	Last Spring Min. of 32 °F	First Fall Min of 32 °F	Frost Free Days
1973	49.7	89	-4	48.09	5/17	10/9	155
1974	--	86	5	38.99	5/8	9/23	138
1975	48.2	87	-5	51.07	4/27	9/14	140
1976	43.6	85	-13	53.07	5/19	9/6	116
1977	--	88	-24	36.13	6/8	--	--
1978	46.7	86	--	42.65	5/4	9/29	148
1979	--	--	--	--	--	--	--
1980	--	--	-8	42.65	6/12	10/45	115
1981	46.5	85	-9	36.99	5/7	10/13	149
1982	47.4	82	-24	40.63	4/29	10/17	171
1983	46.4	88	-22	38.74	5/10	9/22	135
1984	47.8	84	-15	43.79	5/17	11/3	170
1985	48.2	85	-25	48.91	4/11	10/29	201
1986	49.0	84	-11	38.58	5/5	10/7	155
1987	48.7	89	-3	39.30	5/6	10/4	151
Avg.	47.5			42.3			149

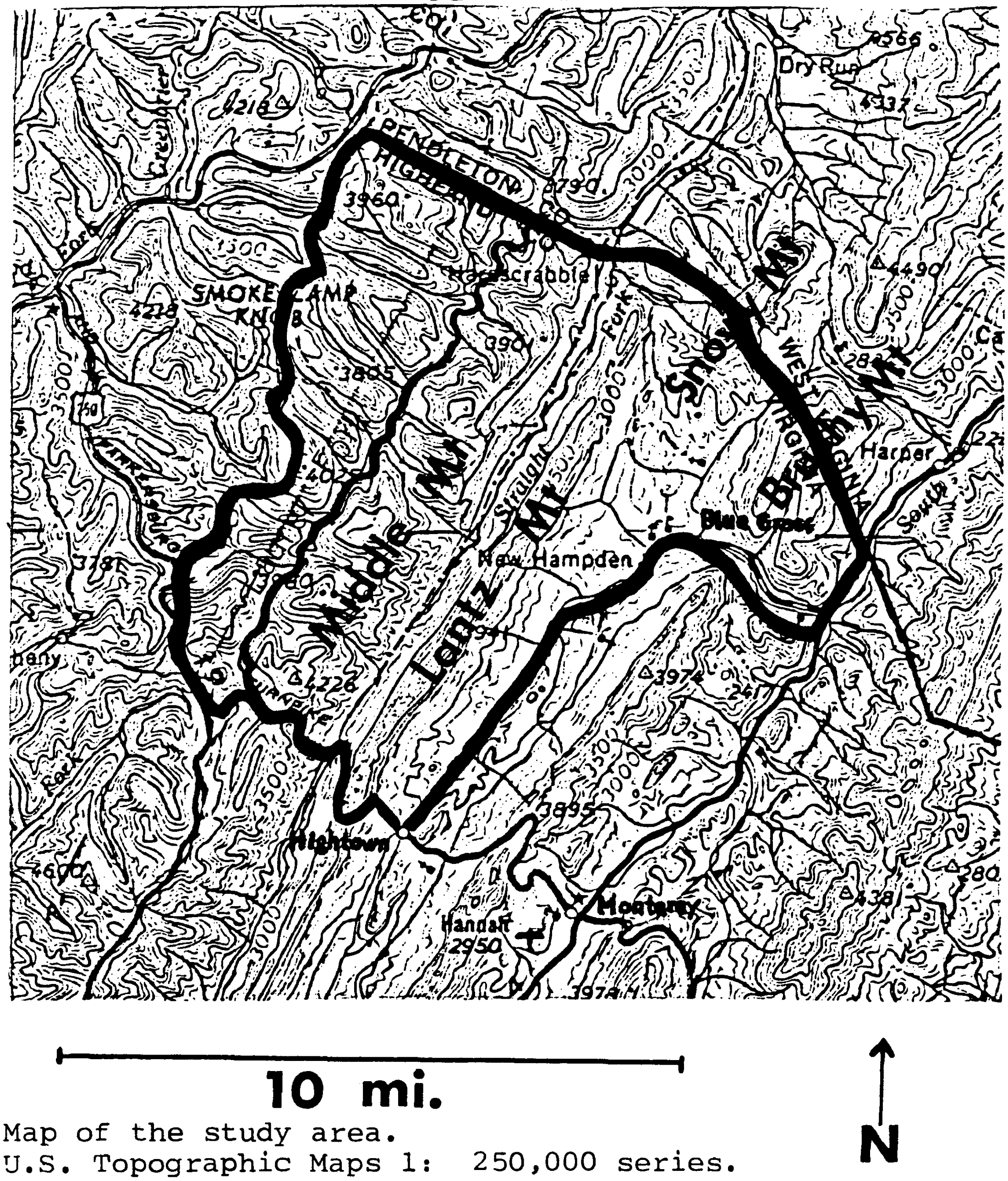
* From the U.S. Department of Commerce Weather Bureau Climatological Data (West Virginia Annual Summaries 1973-1987) Vols. 83-97.

GEOLOGY

The study area straddles two physiographic provinces, the Allegheny Mountain province to the west and the Ridge and Valley Province to the east. The boundary between the two provinces is generally recognized as the Allegheny Front, which in Highland County is represented by Middle Mountain. In this study all land west of the front, including Middle Mountain itself, is considered part of the Alleghenies. All land east of this mountain, beginning with the Straight Fork Valley, is considered part of the Ridge and Valley Province (Figure 3).

Within the study area, the Ridge and Valley section spans an elevation of 2500 to 4500 feet. The ridges run parallel in a southwest to northeast direction, with narrow valleys between them. The ridges are generally formed from folded sandstone that has resisted erosion, whereas the underlying rock in the valleys is of softer limestones and shales. The streams that drain these valleys mostly flow parallel to the ridges, and are thus of the trellis type (Core 1966; Bevin 1933).

FIGURE 3



Map of the study area.
U.S. Topographic Maps 1: 250,000 series.

In the easternmost portion of the study area lie the Silurian Age formations of Brushy Mountain. Included are fossiliferous shales of the Tonoloway formation and sandstones of the Willscreek and Williamsport formations. These rocks tend to be greenish-brown to white in color (Cardwell, et. al. 1968; Milici, et al. 1963). The western extension of Brushy Mountain is marked by a striking outcrop of Tuscaroran sandstone known as the Devil's Backbone. This sandstone was also deposited in the Silurian Period (Cardwell, et al. 1968). The Backbone continues north into West Virginia and southward in Virginia along the crest of Monterey Mountain. Only a small portion, approximately one mile long, is represented in the study area.

Along the western slope of this ridge, formations of the Ordovician age surface. The Juniata formation is thin-bedded and is composed of red sandstone and shale. In places, the Juniata formation is underlain by Oswego sandstone. This slope dips down into the relatively wide Bluegrass Valley (Cardwell, et al. 1968; Milici, et. al. 1963).

The Bluegrass Valley has an elevation between 2500 and 3200 feet. The shales of this valley correspond to the Martinsburg formation deposited in the Silurian. Scattered throughout the valley are intrusive igneous rocks, probably of Triassic age. In the northern portion of the valley stands Snowy Mountain, with the highest elevation in the study area. It reaches its peak just across the West Virginia line at 4545 feet. Snowy Mountain corresponds to the Juniata and Oswego formations of the Silurian (Cardwell, _et_. _al_. 1968; Milici, _et_. _al_. 1963).

The westernmost mountain still falling within the Ridge and Valley Province is Lantz Mountain, a long but narrow ridge that reaches an altitude of 3939 feet in the southern portion of the study area, just north of Route 250. This mountain is composed of sandstones and dolomites, mostly of Silurian age.
Included are the McKenzie formation and the Clinton group, both composed of Keefer sandstones and dark red shales. The eastern and western slopes of the ridge reveal the Ordovician, Juniata and Oswego formations. The crest of Lantz Mountain is Tuscaroran sandstone but here it does not form a jagged outcrop as prominent as Devil's Backbone (Cardwell, _et_. _al_. 1968; Milici, _et_. _al_. 1963).

The narrow Straight Fork Valley just east of Lantz Mountain marks the western edge of the Ridge and Valley section. This valley is underlain mostly by olive-gray marine shales of the Brallier formation, deposited in the Mid Devonian (Cardwell, et.al. 1968; Minici, et. al. 1963) (Figure 3).

The Allegheny mountain section is of a different character from the Ridge and Valley. Within the study area this province reaches an elevation of 4360 feet on Tamarack Ridge, with no portion less than 3000 feet. The surface, primarily of horizontal sandstones and shales, is dissected into hills and valleys that generally have gentler slopes than those of the Ridge and Valley Province. This portion of the study area is drained by Laurel Fork, a southern tributary of the Potomac. Like most streams in the Alleghenies, it exhibits drainage of the dendritic type (Core 1966; Bevin 1933).

The east-facing slope of Middle Mountain marks the Allegheny Front in Highland County. Here the Allegheny Mountain Province is represented mostly by the Chemung formation of the Devonian. This formation is composed of sandstone and shale and tends to be greenish-gray in color. Much of this formation is fossiliferous. Scattered throughout the Chemung are regions corresponding to the Hampshire

Formation. These rocks are composed mostly of shale and sandstone and tend to be reddish in color. This formation also dates back to the Devonian (Cardwell, et. al. 1968; Minici, et. al. 1963). (Fig. 3).

No detailed soil analysis has been conducted in Highland County. However, soil data collected in this study show that mountain-top soils of the Ridge and Valley and the Allegheny Front are acidic, with an average pH of 3.9. In the Alleghenies these soils would probably be classified as podzolic, the typical soil type found under northern hardwood forests. On the ridges of the Ridge and Valley Province, the soils are considered gray-brown podzolic soils. This soil type is found on ridges and usually supports an ericaceous understory (Braun 1950). Low elevation sites in the Allegheny province may have melanized soils. This soil type is present under mixed mesophytic forests and in sheltered coves of the Ridge and Valley province (Braun 1950).

HABITAT DESCRIPTIONS AND VEGETATIONAL ANALYSIS

Habitat Descriptions

Seven habitat types were identified within the study area. Along the Allegheny Front, four of these are represented. Spruce forests occur at some high elevation sites. These forests make up a relatively small portion of the study area. Boggy areas also are present at high elevations along the Front and are usually associated with spruce forests. Most forests in this portion of the study area are deciduous. Although dominated by northern red oak, these woods contain many tree species characteristic of the Mixed Mesophytic Forest to the west. Forests of the Allegheny portion are therefore referred to as Mesophytic Oak forests. Ravines within this province support an even more mesophytic forest type and are considered the fourth habitat type. The most notable of these is the ravine formed by Laurel Fork, the largest stream in the study area.

Similar ravines occur in the Ridge and Valley Province. However, this habitat type constitutes a very small part of the Ridge and Valley portion of the study area. In general the wooded areas of the Ridge and Valley Province appear to be more xerophytic and less diverse than Allegheny forests. These dry oak woods, restricted to ridge-tops within the Ridge and Valley Province, make up the fifth habitat type. Within the study area intervening valleys of the Ridge and Valley Province have been cleared for pasture. Streams meander through these pastures and support a flora distinct from that of wooded ravines. This habitat type was not well represented in the Allegheny portion of the study area. The last habitat type recognized incorporates all pastures and roadsides of both provinces. These disturbed areas support a flora of distinct composition, mostly of European origins.

Spruce Forests: Native spruce stands occur at several high elevation sites in the study area. These stands tend to be more abundant in the western portion, along the Allegheny Front. In Highland County natural spruce stands rarely occur below 3800 feet; those few sites below this tend to be swampy.

The dominant canopy species is red spruce (*Picea rubens*) often mixed with subdominant hardwoods. In swampy stands black cherry (*Prunus serotina*), sweet birch (*Betula lenta*), and yellow birch (*B. alleghaniensis*) are important. On drier sites red maple (*Acer rubrum*) and northern red oak (*Quercus* *rubra*) are more abundant. In pure spruce stands, the understory is minimal, but in mixed stands striped maple (*Acer pensylvanicum*) and service berry (*Amelanchier arborea*) are plentiful. Dense stands of mountain laurel (*Kalmia latifolia*) may be present on drier sites.

The herbaceous layer is usually dominated by various species of *Lycopodium* (clubmoss), with *L. clavatum* and *L. obscurum* being the most abundant. *Lycopodium annotinum* is also present and *L. lucidulum* occurs sporadically. The genus *Dryopteris* is well-represented among the ferns present in the herbaceous layer, with *D. intermedia* being the most common. Hay-scented fern (*Dennstaedtia punctilobula*) forms thick colonies in gaps receiving greater amounts of sunlight.

The herbaceous angiosperms appearing in spruce stands tend to be species of northern origins. The most noteworthy of these is *Oxalis montana*, which occurred in every spruce stand examined. Other northern species frequently encountered included *Trientalis borealis* and Canada Mayflower (*Maianthemum canadense*). Although these species were closely associated with spruce forests, they were also abundant in high elevation hardwood stands. Most of the herbaceous angiosperms present in the spruce forests also occur in the adjacent deciduous woods.

High Elevation Boggy Areas: No true bogs such as the extensive glades of West Virginia are present in the study area. However, due to topography and the activity of beavers, boggy or swampy areas of poor drainage occur frequently in the Allegheny portion. Most occur at high elevations, and many are associated with red spruce.

Many northern mesophytic species are present. Northern white violet (*Viola macloskeyi* var. *pallens*), *Aster umbellatus*, and alpine enchanter's nightshade (*Circaea alpina*) are abundant. Two northern sedges were present: *Carex muricata*, and *C. leptonervia*. The orchids *Habenaria clavellata* and *Spiranthes cernua* were found only in this habitat. Shrubs occurring at the edges of these areas include *Rubus hispidus*, huckleberry (*Gaylussacia baccata*), and several species of blueberry (*Vaccinium*). The surrounding forest is usually dominated by red spruce and Canada hemlock (*Tsuga canadensis*).

Mesophytic Oak Forests: That portion of the study area west of the Bluegrass Valley has been classified by Braun (1950) as a transition area between the Oak-chestnut region to the east and the Mixed Mesophytic region to the west. Here northern red oak is plentiful, but the presence of several other species in the canopy reveals the mixed mesophytic nature of this forest type. Sugar maple (Acer saccharum), basswood (Tilia americana), yellow birch, sweet birch, black cherry, and white ash (Fraxinus americana) occur in abundance. Small trees found in the subcanopy include striped maple, mountain maple (Acer spicatum), mountain magnolia (Magnolia fraseri), cucumber tree (M. acuminata), and service berry . Also encountered in the understory were mountain holly (Ilex montana) and witchhazel (Hamamelis virginiana). The herbaceous layer is very rich, with a spectacular spring flora. Trillium grandiflorum and Viola canadensis are abundant; toad's trillium (Trillium erectum), trout lily (Erythronium americanum), and windflower (Anemone quinquefolia) are occassional.

At higher elevations along the Allegheny Front, some sites reveal a transition to the beech and maple-dominated northern hardwood association. Canopy species that gain importance to rival oak include sugar maple and red spruce. The understory in which beech (Fagus grandifolia) and sugar maple saplings are plentiful, further illustrates the nothern hardwood affinity (Tables 7-10). Hobblebush (Viburnum alnifolium), Canada mayflower, and Oxalis montana, northern hardwood indicator species, occur frequently in these stands. Painted trillium (Trillium undulatum) and T. grandiflorum are abundant. Trientalis borealis, although more abundant under spruce, was also encountered in mesophytic oak woods. The northern shrub, fly honeysuckle (*Lonicera canadensis*) was present, but rare.

Dry oak forests: On steep slopes, especially in the Ridge and Valley portion of the study area, are forests clearly dominated by oaks. Northern red oak is the major dominant, with white oak (*Q. alba*)and chestnut oak (*Q. prinus*) present in varying degrees. Present in the understory are scrub oak (*Quercus ilicifolia*), mountain laurel, and in disturbed sites *Sassafras albidum*. Ericaceous shrubs are common, including Allegheny Menziesia (*Menziesia pilosa*) and several species of blueberry. The herbaceous layer is rather sparse, but pink lady's slipper (*Cypripedium acaule*), dwarf iris (*Iris verna*), and gaywings (*Polygala paucifolia*) are present.

Wooded Ravines: Wooded ravines on both sides of the Allegheny Front tend to be similar in plant composition. Yellow birch and Canada hemlock dominate the canopy. Great laurel (*Rhododendron maximum*) forms dense thickets along the streambanks of Laurel Fork, but only occurs sporadically in ravines east of the Alleghenies. The herbaceous layer along streams includes foam-flower (*Tiarella cordifolia*), crooked-stem aster (*Aster prenanthoides*), and northern bugleweed

(*Lycopus uniflorus*). Among the wet rocks were lettuce saxifrage (*Saxifraga micranthidifolia*), thyme-leaved speedwell (*Veronica serpyllifolia*), and bittercress (*Cardamine pensylvanica*).

Open streambeds: Most valleys in the study area have been cleared for pasture. Many streams meander through these fields and support a flora not found along shaded brooks. American brooklime (*Veronica americana*), water speedwell (*V. anagallis-aquatica*), watercress (*Nasturtium officinale*), and marsh marigold (*Caltha palustris*) were encountered frequently. In the summer, spearmint (*Mentha spicata*), peppermint (*M. piperita*), and blue vervain (*Verbena hastata*) were plentiful among the rocks. In the fall, composites such as sneezeweed (*Helenium autumnale*) and beggar-ticks (*Bidens cernua*) were abundant. High elevation species, such as northern bugleweed and forget-me-not (*Myosotis scorpioides*), were also encountered in this habitat, as well as more ubiquitous species such as skunk cabbage (*Symplocarpus foetidus*) and *Viola striata*.

Disturbed areas: Most of the valleys in the Ridge and Valley section of the study area have been cleared. These pastures, along with grassy roadsides, support many plants, most of

European origin. In the early spring colt's foot (Tussilago farfara), buttercup (Ranunculus bulbosus), and yellow rocket (Barbarea vulgaris) are abundant. Later, dame's rocket (Hesperis matronalis), and pussytoes (Antennaria plantaginifolia) are plentiful. Throughout the summer blue devil (Echium vulgare), motherwort (Leonurus cardiaca), bouncing bet (Saponaria officinalis), and many species of the Asteraceae flower. In the fall the Asteraceae dominate, with heartleaf aster (Aster cordifolius), A. pilosus, Jerusalem-artichoke (Helianthus tuberosus), and goldenrod (Solidago spp.) abundant.

Roadside banks along the ridges of the Ridge and Valley province tend to be steep and shaley. These banks are not technically considered shale barrens, and no shale barren endemics were found. However, certain nonendemic plants occurred in these areas consistently. Included are wild pink (Silene caroliniana), whorled loosestrife (Lysimachia quadrifolia) and shale barren aster (Aster obtusifolia).

Vegetation Analysis of High Elevation Sites

A portion of the Allegheny Front, represented by Middle Mountain, falls within the study area. Braun (1950) loosely classifies those forests to the east of the Allegheny Front as Oak-Chestnut. That strip west of the Front and east of the state line is considered a transition area between Oak-Chestnut forests of the Valley and Ridge and Mixed Mesophytic forests of the Alleghenies.

Braun (1950) classifies high elevation forests of the Mixed Mesophytic region as beech, maple, birch or northern hardwoods. Because so few peaks in the central Virginia Ridge and Valley province are high enough to show pronounced altitudinal gradations, their vegetation was not described in detail by Braun. This study seeks to quantify vegetation of high elevation sites in the Ridge and Valley province and along the transitional Allegheny Front.

That portion of the Ridge and Valley region within Highland County contains some ridges with elevations above 4000 feet, including Snowy Mountain, falling within the study area, and Jack Mountain, located just east of the study area. In order to quantify the vegetation of high Ridge and Valley peaks, two sites were sampled on each mountain. Four sites of similar elevation, slope, and exposure were sampled on the Allegheny Front.

Potential stands were located using topographic maps, and only those stands that showed no significant recent disturbance were sampled. Dominance (basal area) was obtained using the Bitterlich method (Cox 1967). Large tree density was obtained by counting all trees over 10cm dbh within a 10m radius circle at each point. Small tree density was obtained by counting all trees in the same circle with a dbh between 2.5 cm and 10 cm. Relative density was calculated for species in both size classes. Relative dominance and importance were calculated for large trees only. Results are given in tables 3-10.

Soil samples were taken from all points in a stand and were mixed for each stand. Samples were sent to the Virginia Polytechnical Institute and State University Soil Testing Laboratory, Blacksburg, Virginia, where they were tested for P, Ca, Mg, K, N, % organic matter, and pH. Results are given in Tables 3-10. Moisture data was obtained using Bouyoucus blocks.

Ridge and Valley Stands: In all Ridge and Valley stands sampled (RV), Quercus rubra was the overwhelmingly dominant canopy species. However, due to differences in elevation, slope, exposure, and possibly soil, the associates and understory differed somewhat between stands.

In RV1, a north-west facing stand located on Snowy Mountain at 4200 ft, Q. rubra had a relative basal area of 73.3% and an IV of 61.6 (Table 3). The two most important associates were Betula lenta and Acer rubrum. The sapling layer was dominated by B. lenta and A. rubrum. Together these two species made up 70.9% of all understory trees. Quercus rubra saplings were not abundant in the understory, having a relative density of only 6.4%.

RV2 is also located on Snowy Mountain but has a south-east exposure, steep slope, and 4450 feet elevation. Qercus rubra was again the dominant species (BA =66.6%) but in this case the most important associate was Acer saccharum. Carya ovata was also important (Table 4). The most abundant saplings were A. saccharum and Prunus serotina. Hamamelis virginiana was the most plentiful small tree and made up 6.3% of the understory density.

Table 3

Vegetation Analysis of Stand RV1*

Species	Relative **Dominance	Relative Large tree Density	Importance Value	Relative Small Tree Density
Quercus rubra	73.3	50.0	61.6	6.4
Betula lenta	11.7	11.9	11.8	37.1
Acer rubrum	5.8	14.3	10.1	33.8
Acer saccharum	1.7	14.3	8.0	6.5
Acer pensylvanicum	5.8	7.1	6.4	6.5
Hamamelis virginiana	--	--	--	4.8
Castanea dentata	--	--	--	4.8

* Ridge and Valley Stand #1
Located on Snowy Mountain at an elevation of 4200 feet.
The stand has a north-west exposure and steep slope.
Moisture = 82% (10/23/88).

** Relative dominance = relative basal area

Table 4

Vegetation Analysis of Stand RV2*

Species	Relative **Dominance	Relative Large tree Density	Importance Value	Relative Small Tree Density
Quercus rubra	66.6	42.4	54.5	15.84
Acer saccharum	19.3	30.3	24.8	19.7
Carya ovata	9.3	15.2	12.2	4.0
Prunus serotina	2.4	6.1	4.2	19.7
Crataegus sp.	--	3.0	1.5	11.9
Quercus alba	2.4	3.0	2.7	--
Hamamelis virginiana	--	--	--	26.3
Castanea dentata	--	--	--	2.6

* Ridge and Valley Stand #2
Located on Snowy Mountain at an elevation of 4450 feet.
The stand has a south-east exposure and steep slope.
Moisture = 79% (10/23/88).

**Relative dominance = relative basal area

Table 5

Vegetation Analysis of Stand RV3*

Species	Relative **Dominance	Relative Large Tree Density	Importance Value	Relative Small Tree Density
Quercus rubra	52.6	49.5	51.1	2.9
Acer rubrum	23.7	33.4	28.5	60.0
Quercus prinus	9.1	7.1	8.1	--
Prunus serotina	3.9	3.0	3.4	--
Betula lenta	2.7	3.0	2.9	14.3
Acer saccharum	2.7	2.0	2.4	--
Quercus alba	2.7	2.0	2.3	5.7
Castanea dentata	1.3	--	0.6	2.8
Hamamelis virginiana	--	--	--	5.7
Acer spicatum	--	--	--	2.9
Fagus grandifolia	--	--	--	2.9
Kalmia latifolia	--	--	--	2.8

* Ridge and Valley Stand #3
Located on Jack Mountain at an elevation of 3800 feet.
The stand has a south-east exposure and gentle slope.
Moisture = 89% (11/7/88).

**Relative dominance = relative basal area

Stand RV3, located on Jack Mountain, also had a southeast exposure, but a gentle slope and an elevation of only 3800 feet. Acer rubrum was the most important associate of Q. rubra (Table 5). The understory was dominated by Acer rubrum and Betula lenta. Together, these two species made up 64.3% of the subcanopy.

Stand RV4 was also on Jack Mountain with an elevation of 3800 feet but was level. Here the codominants of Q. rubra were Q. alba, Acer rubrum and B. lenta (Table 6). Again A. rubrum and B. lenta were abundant in the sapling layer, but in this stand Q. rubra appears to be reproducing with a relative density of 24.5%. The most abundant small tree was Acer pensylvanicum.

In all four Ridge and Valley stands Quercus rubra was the dominant species. Because Quercus rubra was the dominant species, these stands can be classified as Northern Red Oak forests such as those sampled by Rheinhardt and Ware (1984) and Adams and Stephenson (1989). As in their studies, Betula lenta and Acer rubrum were important associates of Q. rubra. In the Jack Mountain stands Q. alba and Q. prinus were important. Quercus prinus was subdominant on the southern exposure (RV3). Braun (1950) states that Q. prinus

Table 6

Vegetation Analysis of Stand RV4*

Species	**Relative Dominance	Relative Large Tree Density	Importance Value	Relative Small Tree Density
Quercus rubra	34.8	30.0	32.4	24.5
Acer rubrum	18.7	21.7	20.2	34.7
Quercus alba	23.0	16.7	19.8	2.0
Betula lenta	11.7	18.3	15.0	12.2
Carya ovata	7.4	10.0	8.7	2.1
Carya ovalis	2.9	--	1.4	--
Acer saccharum	1.5	1.7	1.6	--
Acer pensylvanicum	--	1.6	0.8	14.3
Hamamelis virginiana	--	--	--	4.1
Prunus serotina	--	--	--	6.1

* Ridge and Valley Stand #4
Located on Jack Mountain at an elevation of 3800 feet.
The stand has flat terrain.
Moisture = 84% (11/7/88).

**Relative dominance = relative basal area

tends to be important on drier sites such as south-facing slopes. In this study Q. alba was present in all but the north-facing stand. It achieved subdominant status only in the flat Jack Mountain stand (RV4). Adams and Stephenson (1989) also found Q. alba to be an important associate of northern red oak. In their study, this species had a greater dominance than Acer rubrum only on southern exposures.

The only stand that showed any evidence of altitudinal zonation was RV2 which had the highest elevation. Although it was a south-east facing slope, Q. prinus was not present and Q. alba had very low importance. Acer saccharum was second in importance to Q. rubra with an IV of 24.8, whereas in all other Ridge and Valley stands it was unimportant. It may be that the 200 feet increase in elevation over stand RV1 is enough to account for this increase in Acer saccharum dominance and density.

In all stands except the high RV2, Acer rubrum and Betula lenta saplings are abundant in the understory. Both species rarely become dominants in the canopy (Keever 1973; Kasmer, Kasmer, and Ware 1984). Because of this the future canopy of stands RV1 and RV3 cannot be predicted. Although no major canopy gaps were noted in stand RV4, Q. rubra appears to be replacing itself fairly well. It can therefore be surmised that this stand will remain dominated by northern red oak in the future. Again, Q. rubra appears to be reproducing in the high RV2. Due to the dwarfed, orchard-like appearance of many trees in this stand, there may well be sufficient light available for these oak saplings. More abundant than oak saplings were those of Acer saccharum. It can be predicted that this forest will remain a northern red oak and sugar maple stand, with A. saccharum becoming the more important. This type of forest has been referred to as Mesophytic Oak (Rheinhardt and Ware 1984).

Allegheny Front Stands: Quercus rubra is present in all Allegheny stands (AF), but is the leading dominant in only one and important in only three. In three stands Acer saccharum was red oak's most important associate, even exceeding it in importance in two of them. In one stand (AF1) Picea rubens is a dominant species.

In AF1, a north-west facing slope at 4240 feet, dominance

Table 7

Vegetation Analysis of Stand AF1*

Species	Relative **Dominance	Relative Large Tree Density	Importance Value	Relative Small Tree Density
Acer rubrum	22.0	25.6	23.8	1.9
Picea rubens	22.0	23.1	22.5	23.8
Betula lenta	11.9	10.3	11.1	14.3
Acer saccharum	11.9	9.0	10.5	15.2
Prunus serotina	8.8	2.6	10.1	4.8
Quercus rubra	8.8	10.3	9.5	--
Betula alleghaniensis	5.7	3.8	4.8	2.9
Fagus grandifolia	4.4	5.1	4.7	9.5
Acer pensylvanicum	3.2	5.1	4.2	24.8
Tsuga canadensis	1.3	3.8	2.5	1.0
Acer spicatum	--	1.3	0.6	--
Magnolia acuminata	--	--	--	0.9
Ilex montana	--	--	--	0.9

* Allegheny Front Stand #1
Located on Allegheny Mountain along Virginia, West Virginia border, just south of U.S. Route 250 in Pocahontas County, West Virginia. The stand has a steep slope, a north-west exposure, and an elevation 4240 feet. It is located at the top of a ravine. Moisture = 87% (11/7/88).

**Relative dominance = relative basal area

is shared between _Picea rubens_ (IV =22.5) and _Acer rubrum_ (IV =23.8) (Table 7). _Betula lenta_ was an important associate. Also present in the canopy were _Betula alleghaniensis_ and _Fagus grandifolia_. The most abundant understory species with canopy potential were _Picea rubens_ and _Acer saccharum._ The small tree with highest density was _Acer pensylvanicum_, while _Ilex montana_ was just barely present.

Stand AF2 is located on a steep south-facing slope at 4250 feet. Here _Quercus rubra_ and _Acer sacharum_ share dominance, both having importance values over 40 (Table 8). _Quercus rubra_ saplings were sparse, whereas _Acer saccharum_ saplings comprised 46.5% of the understory. _Fagus grandifolia_ was present but unimportant in the canopy or understory. The most abundant small tree was _Acer pensylvanicum_ with a relative density of 25.2%.

AF3 is also located on a slope with southeastern exposure. This stand is not as steep as AF2 and has a lower elevation (3800 feet). _Quercus rubra_ was the most important species with an IV of 32.3 (Table 9). Subdominant status was shared between _Acer saccharum_ and _Carya tomentosa_. _Acer rubrum_ was also an important associate. The most abundant

Table 8

Vegetation Analysis of Stand AF2*

Species	Relative **Dominance	Relative Large Tree Density	Importance Value	Relative Small Tree Density
Acer saccharum	28.8	56.9	42.8	46.5
Quercus rubra	47.8	17.6	41.5	2.0
Acer rubrum	8.2	5.9	7.0	4.0
Carya glabra	5.4	5.9	5.6	3.0
Fagus grandifolia	7.0	3.9	5.5	8.1
Prunus serotina	--	3.9	1.9	5.1
Carya ovata	1.4	3.9	2.7	--
Robinia pseudo-acacia	--	2.0	2.0	5.1
Acer pensylvanicum	1.4	--	0.7	25.2
Crataegus sp.	--	--	--	1.0

* Allegheny Front Stand #2
Located on Smokecamp Knob, Pocahontas County, West Virginia. The stand has a steep slope and south-east exposure, at an elevation of 4250 feet.
Moisture = 85% (11/7/88).

**Relative dominance = relative basal area

Table 9

Vegetation Analysis of Stand AF3*

Species	Relative **Dominance	Relative Large Tree Density	Importance Value	Relative Small Tree Density
Quercus rubra	28.1	36.6	32.3	--
Acer saccharum	14.7	24.4	19.5	26.5
Carya tomentosa	21.9	2.4	12.1	--
Acer rubrum	7.2	14.6	10.9	17.6
Fagus grandifolia	10.3	4.9	7.6	50.0
Prunus serotina	8.5	4.9	6.7	--
Robinia pseudo-acacia	3.1	4.9	4.0	--
Carya ovata	3.1	2.5	2.8	--
Carya ovalis	3.1	2.4	2.6	--
Betula lenta	--	2.4	1.2	--
Acer pensylvanicum	--	--	--	5.9

* Allegheny Front Stand #3
Located just south of Locust Spring Picnic Area at an elevation of 3800 feet. The stand has a gentle slope and a south-east exposure.
Moisture = 83% (11/7/88).

**Relative Dominance = relative basal area

Table 10

Vegetation Analysis of Stand AF4*

Species	Relative **Dominance	Relative Large Tree Density	Importance Value	Relative Small Tree Density
<u>Acer saccharum</u>	21.9	46.0	34.0	60.9
<u>Quercus rubra</u>	40.7	10.8	25.7	1.2
<u>Carya glabra</u>	6.6	10.8	8.7	3.7
<u>Fagus grandifolia</u>	8.7	5.4	7.1	19.5
<u>Carya ovalis</u>	3.4	10.8	7.1	--
<u>Robinia pseudo-acacia</u>	10.2	2.7	6.6	3.7
<u>Acer rubrum</u>	3.4	5.4	4.4	3.7
<u>Prunus serotina</u>	1.7	2.7	2.2	1.2
<u>Amelanchier arborea</u>	1.7	2.7	2.2	--
<u>Crataegus sp.</u>	1.7	2.7	2.2	--
<u>Acer pensylvanicum</u>	--	--	--	7.0

* Allegheny Front Stand #4
Located just south of Locust Spring Picnic area at an elevation of 3800 feet. The stand has flat terrain. Moisture = 82% (11/7/88).

**Relative dominance = relative basal area

sapling with canopy potential was *Fagus grandifolia*, making up 50% of the understory. *Acer saccharum* was also plentiful in the subcanopy with a relative density of 26.5%. The only small tree present was *Acer pensylvanicum*.

AF4 is located on flat terrain with an elevation of 3800 feet. Again, dominance is shared between *Quercus rubra* and *Acer saccharum* (Table 10). *Acer saccharum*, with an IV of 34, had greater importance than *Quercus rubra* (IV=25.7). *Robinia pseudoacacia* achieved subdominant status, with a relative basal area of 10.2%. *Fagus grandifolia* was present in the canopy but unimportant. Saplings of this species were abundant, making up almost 20% of the understory. The most abundant canopy species in the understory was *Acer saccharum*. *Acer pensylvanicum* was present but not plentiful.

A northern transition may be represented in all stands but is most obvious in AF1. Here, the importance of spruce reveals this altitudinal effect. Although stand AF2 has a similar elevation, the northern exposure and ravine habitat may make AF1 more suitable for spruce. The presence of *Betula alleghaniensis* also reveals this northern character, although its presence may be related to the ravine habitat as well. *Picea rubens* appears to be reproducing itself.

Presently, and probably in the future, this can be described as a mixed spruce stand.

The three remaining stands are similar in that they all are dominated by *Quercus rubra* and *Acer saccharum*. *Acer saccharum* reaches greatest importance in AF2, but does not dominate over *Quercus rubra*. Only in the flat AF4 does *A. saccharum* have a greater relative basal area value than *Q. rubra*, but in this case the latter has a higher importance value. Due to the prevalence of oak, these forests cannot be described as Mixed Mesophytic. The importance of sugar maple and the presence of such species as *Fagus grandifolia*, *Prunus serotina* and *Magnolia accuminata*, do reveal a mesophytic nature. All Allegheny stands other than AF1 can be classified as mesophytic oak, such as those sampled by Rheinhardt and Ware (1984). This forest type does appear to be a transition between Mixed Mesophytic and Oak, as noted by Braun (1950). Upon examination of the sapling layer, it appears that the vegetation of these Allegheny Front peaks is moving towards a climax dominated by beech and maple. Such high elevation forests of the Mixed Mesophytic forest region have been described as northern hardwoods (Braun 1950). This may also be the ultimate high elevation forest type, other than spruce, that occurs along the more eastern Allegheny Front.

Discussion: Differences in vegetation between the two provinces have long been attributed to the more mesic conditions in the Alleghenies (Strahler 1972). No tendency towards greater precipitation can be gleaned from the moisture data of this study or climate data from the weather stations. Bailey (1989) also found no significant moisture differences between the two provinces. Although the Allegheny Province may generally be more mesophytic, perhaps its eastern portion recieves no more precipitation than the Ridge and Valley. However, moisture may be greater when considering conditions other than precipitation. Core (1966) suggests that fog may be a determining factor in the occurence of spruce forests at higher elevations in the Alleghenies.

In this study soil mineral content does not differ markedly between the two provinces. Previous studies (Adams and Stephenson 1989; Pielke 1981) have found no real soil differences between high elevation sites of the Alleghenies and the Valley and Ridge. Both have acidic soils that can be classified as sandy loams. Only two minerals appeared to vary according to province. P and Mg had lower concentrations in the Ridge and Valley (Table 11). Due to small sample size, no correlations between individual species and soil mineral content can be found.

In this study the most striking difference between the two provinces is the importance of northern species in the Alleghenies and their virtual abscence in the Ridge and Valley province. *Picea rubens* is a dominant in one AF stand, while in all others *Acer saccharum* is the most important associate of red oak. Spruce is not present in any Ridge and Valley stand, and *Acer saccharum* is important in only the highest. It appears that in the Alleghenies, the elevation where sugar maple can gain importance on open slopes is about 3800 feet and possibly lower; it is not important on open slopes in the Ridge and Valley stands until the elevation reaches 4200 feet.

The sapling layer also differs markedly between the provinces. In two Ridge and Valley stands *Quercus rubra* appears to be replacing itself. In the remaining two Ridge and Valley stands, the future dominants cannot be predicted. In the Allegheny Front stands, the most abundant saplings are

Table 11

Soil Mineral Content as Analyzed by the
Cooperative Extension Service of the VPI
Soil Testing and Plant Analysis Laboratory

	PPM						
Site	P	K	Ca	Mg	NO3	%OM*	pH
RV 1	7	61	288	47	15	15.0	3.8
RV 2	27	91	408	54	68	12.4	4.0
RV 3	35	116	540	56	83	15.0	3.7
RV 4	23	50	168	25	8	7.7	4.4
AF 1	3	58	120	23	33	11.0	3.8
AF 2	7	67	396	36	88	13.0	3.8
AF 3	4	59	312	33	45	10.3	3.8
AF 4	7	93	252	26	93	8.6	3.9

*Organic material

RV = Ridge and Valley stand
AF = Allegheny Front stand

of beech and sugar maple. The persistence of both species from understory to canopy is well known (Keever 1973; Ware, pers. comm.). The future forests of high elevations along the Allegheny Front may well be dominated by beech and sugar maple as are such forests of the Mixed Mesophytic region to the west. In addition, the presence of beech in the sapling layer may indicate its importance in the past. Since beech is known to reproduce primarily by vegetative means in some parts of its range (Keever, 1973; Kasmer, Kasmer, and Ware 1984), many of these saplings may be sprouts. If so, beech may have been an important constituent of these forests prior to logging.

The causative factors controlling these differences in vegetation between the two provinces are unclear. Although distributions may be attributed to differences in moisture, precipitation data from weather stations and moisture data collected in this study do not support this contention. Perhaps temperature differences are enough to lower evapotranspiration rates in the Alleghenies and lower moisture stress, as suggested by Bailey (1989). It has recently been proposed that the abundance of spruce in the Alleghenies, and its virtual absence in the Ridge and Valley, is due to the restriction of topography on spruce reexpansion following the Hypsithermal Interval (Bailey 1989). During reexpansion spruce may have been unable to migrate to adjacent peaks of the Ridge and Valley due to the low elevation of intervening valleys. In contrast, valleys of the Alleghenies rarely dip below 3500 feet, causing no such restriction to spruce migration. Spruce would have therefore been able to recolonize peaks in the Alleghenies as it was unable to do in the Ridge and Valley province (Bailey 1989). This would explain the present distribution of spruce in Virginia. Perhaps the high elevation northern hardwoods forest, known to form an altitudinal belt just below spruce in the Alleghenies (Core, 1966; Braun 1950), is in part a product of similar influences.

FLORISTIC ANALYSIS

Methods for Floristic Survey

Plants were collected during the growing seasons of 1987 and 1988. Collecting trips were made bimonthly in 1987 and weekly in 1988, with a total of 49 days in the field. Representative habitats, chosen with the help of topographic maps, were visited regularly. In addition, other sites were investigated as time permitted.

Plant specimens were collected in duplicate or triplicate unless rare in the study area. Abundance, immediate habitat, and location were recorded, as well as characteristics (*e. g.* flower color) that could be lost in pressing. When time permitted, plants were identified while fresh. The specimens were then pressed, dried, and later identified if necessary. Voucher specimens will be deposited in the William and Mary Herbarium (WILLI). Partial duplicate sets of voucher specimens will go to the West Virginia University Herbarium (WVA) and to James Madison University.

The following manuals were consulted in the identification process: Fernald (1950), Gleason (1952), Gleason and Cronquist (1963), Harvill (1970), Newcomb (1977), Petrides (1988), Radford *et*. *al*. (1968), and Strausbaugh and Core (1978). Nomenclature generally follows that of the *Atlas of the Virginia Flora* (Harvill, *et*. *al*. 1986).

Phytogeography of Rare and Selected Species

All range information in the following discussion was obtained from Gleason and Cronquist (1963), Small (1933), Strausbaugh and Core (1978), and Radford *et al* (1968). Virginia county records were determined using the *Atlas of Virginia Flora* (Harvill, *et al*., 1986).

Because of its mountainous terrain, a great portion of Highland County's flora is of northern affinity. Many of these species extend south only along the Appalachians. Some reach their southern limit in Virginia; a few appear to approach it in Highland County.

Galeopsis tetrahit, a European native, is a record for Virginia. It is found along roadsides and in fields and wasteplaces throughout its American range. It appears to have naturalized throughout Canada and the northeast United States. In West Virginia it has been recorded from seven counties, all localities are at high elevations. The species is locally abundant in certain mountain counties of North Carolina.

Seven species treated in this study are recognized by the Virginia Natural Heritage Program as rare or uncommon in the state of Virginia. All are common globally (Ludwig, 1989). These are the following:

1. Blephilia hirsuta (Hairy Woodmint). This species' range extends north to Quebec and west to Minnesota. In the southern part of its range it is found south to Georgia and west to Texas. It has been reported from six Virginia counties and has a state rank of S1/S2 (Extremely rare/ very rare) (Ludwig 1989). It is frequent in West Virginia and occurs in moist shaded areas.

2. Carex leptonervia. This is a widely distributed northern species whose range extends to Newfoundland, west to Michigan and Ohio. It follows the mountains south to North Carolina. Throughout its range it occurs on moist acid soil, usually in wooded areas. This sedge has been recorded in six Virginia

mountain counties and carries a state rank of S2. It is reported from two West Virginia counties: Tucker and Randolph. Both stations were in maple woods at high altitudes. Specimens found in this study were on a moist wooded streambank at high elevation.

3. _Geranium robertianum_ (Herb Robert). A northeastern geranium that is also present in Eurasia, this species reaches its southern limit in Highland County. It had previously been recorded only from Page County, Virginia, and it carries a ranking of S1. In West Virginia it is found only in the South Branch Valley which falls within three counties: Grant, Hampshire, and Pendleton. It tends to be restricted to limestone outcrops throughout its range.

4. _Juncus articulatus_ L. A circumboreal species, this rush is found in bogs, wet meadows, and shores. In the United States its range extends west to Oregon and south along the Appalachians to Virginia. Previously recorded only from Bland county, Virginia, this species carries a state rank of S1. This specimen was collected in an open marshy streambed.

5. _Juniperis communis_ var. _depressa_ (Common Juniper). This juniper has been reported elsewhere in Virginia only in Brunswick County. The species carries a state rank of S1,

reflecting its extreme rarity in the state. It is circumboreal, common in Canada and Eurasia. In the northeast United States it extends as far west as Minnesota and follows the Appalachians south to North Carolina. This juniper is found in scattered localities throughout its range and occurs on dry rocky soil. Since this specimen was found on a steep slope in a mountain pasture, it may have been introduced.

6. Lonicera canadensis (Fly Honeysuckle). Fly Honeysuckle is another northern species common in Canada. In the United States its range extends west to Minnesota. It is found at high elevations as far south as North Carolina, where it is recorded in three counties. In Virginia it has been recorded in seven counties, carrying a state rank of S2. Within the southern portion of its range, including the study area, Fly Honeysuckle is found only in cool mountain woods.

7. Lycopodium annotinum. Like Juniperis communis, this clubmoss is a circumboreal species. In the United States its range extends west to Minnesota and south along the mountains to Virginia and West Virginia. The southern limit to its range is Wyoming County, West Virginia. In that state it is a common constituent of high elevation spruce forests and glades. It has been reported from Virginia in nine mountain

counties and is ranked as S2. In this study it occurred in spruce stands.

Another northern species, although not considered rare, approaches its southern limit in Highland County. Quaking Aspen (<u>Populus tremuloides</u>) ranges as far west as Alaska. It is common in the Rockies and extends down the Appalachians to Virginia and West Virginia. In West Virginia it is found in most mountain counties. Prior to this county record, the southernmost Virginia location was Madison County. Quaking aspen is found in dry or moist soil and is common in successional areas.

One species approaches its northern limit in Highland County. Umbrella Tree (<u>Magnolia fraseri</u>), a southern Appalachian species, has a range from Georgia west to Alabama, and north to Kentucky and West Virginia. Its northernmost locations are in Monongalia and Webster Counties, West Virginia. It is found in mesophytic woods and tends to prefer west-facing slopes. Highland County is its northern limit in Virginia.

One Coastal Plain species is present in Highland County. <u>Lemna valdiviana</u> is common from Florida to Massachusettes.

This duckweed is also a constituent of the floras of California, Mexico, and South America. In the eastern United States this species has been recorded as far west as Wisconsin, but its only other Virginia mountain location is Bath County.

Summary and Explanation of the Checklist

In this study a total of four hundred and seventy-five species and two additional varieties of vascular plants were collected from Highland County. Two hundred and seventy-five genera and eighty-one families are represented. Ninety-eight species are considered county records, while one (Galeopsis tetrahit) is a state record. These records were determined using the Atlas of the Virginia Flora (Harvill, et. al. 1986). Twenty-two percent of the species documented in this study are introduced. Nomenclature follows that of the Atlas with exceptions noted in the checklist. When a species or variety is not listed in the Atlas, its collection number is followed by the letters "snA" or "vnA". These species and varieties follow Strausbaugh and Core (1978). Forsythia suspensa (Thumb) Vahl and Narcissus pseudo-narcissus L., two cultivated species that were found persistent in the study area, follow Gleason (1952). Two ambiguous specimens have been sent to experts for further study. These are listed in the Checklist as ?Gentiana clausa Raf. and ?Eupatoriadelphus fistulosus (Barratt) K. & R. x E. maculatus (L.) K. & R.

Throughout the checklist, county records are indicated by an asterisk (*) directly preceding the species. Relative abundance is given after the species name and is indicated by the following letters: A (abundant), C (common), O (occassional), and R (rare). If a species occurred only locally the relative abundance is preceded by the letter "L". If a species is considered rare in the study area, but is in no way rare in surrounding counties, the R is followed by an asterisk (*). These species are indicated by the letter "i" following the species name. The author's collection number(s) concludes each entry.

TABLE 12

Summary of the taxa

	FAMILIES	GENERA	SPECIES
PTERIDOPHYTA	4	14	22
CONIFEROPHYTA	2	4	9
ANTHOPHYTA			
MONOCOTYLEDONEAE	10	48	85
DICOTYLEDONEAE	65	209	335
TOTALS	81	275	475

ANNOTATED CHECKLIST

PTEROPHYTA

EQUISETACEAE: *Equisetum arvense* L., LC, open marshy areas; 283.

LYCOPODIACEAE: *Lycopodium annotinum* L., O, moist spruce stands; 321, 546. *L. clavatum* L., A, boggy areas and spruce stands; 625. *L. digitatum* A. Braun, C, rich woods and streambeds; 22, 62. *L. lucidulum* Michaux, O, spruce stands; 754. *L. obscurum* L., C, moist woods; 19. *L. tristachyum* Pursh, O, rich woods; 21.

OSMUNDACEAE: *Osmunda cinnamomea* L., C, woods and streambeds; 63. *O. claytoniana* L., C, grassy streambeds and rich woods; 68.

POLYPODIACEAE: *Adiantum pedatum* L., C, rich woodland borders; 198. *Asplenium trichomanes* L. O, shaded rocky banks; 281. *A. platyneuron* (L.) Oakes, C, shaded rocky areas; 509, 684. *Athyrium asplenioides* (Michaux) A. Eaton, O, open woods and disturbed areas; 724. *Dennstaedtia punctilobula* (Michaux) Moore, A, mountain pastures and open spruce stands; 688. *Dryopteris intermedia* (Willdenow) Gray, A, shaded rocky areas and rich woods; 527, 668, 687, 823. *D. marginalis* (L.) Gray, A, rich woods; 3, 143, 526, 650, 652, 739. *Onoclea sensibilis* L., O, grassy streambeds and rich woods; 64, 871. *Polypodium virginianum* L., C, shaded rocky areas; 140, 234. *Polystichum acrostichoides* (Michaux) Schott, A, woods and woodland borders; 86. *Pteridium aquilinum* (L.) Kuhn, A, open woods; 671. *Thelypteris noveboracensis* (L.) Nieuwland, A, rich woods and moist thickets; 670, 686, 688. *Woodsia obtusa* (Sprengel) Torrey, O, shaded rocky areas; 178.

CONIFEROPHYTA

CUPRESSACEAE: **Juniperis communis* L. var. *depressa* Pursh, R, high mountain pasture; 821. **J. virginiana* L., O, open roadsides and fields; 558.

PINACEAE: *Picea abies* (L.) Karst (i), O, old homesites and forest service plantings; 886. *P. rubens* Sargent, A, high elevations along the Allegheny Front; 333. *Pinus banksiana* Lamb, R, old homesite; 888 (snA). **P. echinata* Miller, O, roadsides; 864. *P. sylvesris* L., O, old homesites; 861, 865 (snA). *P. strobus* L., O, roadsides and woodland borders; 860. *Tsuga canadensis* (L.) Carr., A, moist wooded ravines; 5.

ANTHOPHYTA

MONOCOTYLEDONEAE

AMARYLLIDACEAE: *Hypoxis hirsuta* (L.) Coville, R*, open rocky woods, 387. *Narcissus pseudo-narcissus* L. (i), O, persistent on abandoned homesites; 24.

ARACEAE: *Arisaema triphyllum* (L.) Schott, C, rich woods; 297. *Symplocarpus foetidus* (L.) Nuttall, LC, springy areas and open streambeds; 18.

CYPERACEAE: *Carex crinita* Lam., O, open marshy areas; 535, 603. *C. gracillima* Schweinitz, O, open mountain woods; 442. *C. howei* Mackenzie, R, boggy area; 481. *C. hystericina* Willdenow, LC, open rocky streambeds; 396. *C. interior* Bailey, R*, boggy area; 413. *C. leptonervia* Fernald, R, moist streambed in mountain woods; 60. *C. pensylvanica* Lam., C, dry oak woods; 7, 241. *C. platyphylla* Carey, C, dry oak woods; 6. *C. prasina* Wahlenberg, O, open mountain woods; 334. *C. scabrata*

Schweinitz, LC, marshy streambeds in the mountains; 322. C. scoparia Willdenow, C, open, marshy areas; 521. C. stipata Willdenow, C, open marshy areas; 477. C. tribuloides Wahlenberg, C, open, marshy areas; 132. C. vulpinoidea Michaux, A, moist shaded streambanks; 602. *Cyperus rivularis Kunth, C, open marshy areas; 793. *Eleocharis erythropoda Steudel, LC, open marshy areas; 504. E. obtusa (Willdenow) Schultes, LC, open, marshy areas; 130, 523. E. tenuis (Willdenow) Schultes, C, open marshy areas; 480. Scirpus atrovirens Willdenow, C, open marshy areas; 506. S. atrovirens Willdenow var. georgianus (Harper) Fernald, O, partially shaded marshy areas; 606 (vnA). S. cyperinus (L.) Kunth, LA, marshy areas; 145, 764. S. expansus Fernald, O, marshy areas; 479. S. polyphyllus Vahl, C, open boggy areas; 620. S. validus Vahl var. creber Fernald, C, open marshy areas; 566 (vnA).

DIOSCOREACEAE: Dioscorea villosa L. var. villosa, C, moist thickets and woods; 382, 432 (vnA).

IRIDACEAE: Iris germanica L. (i), LR, persistent in roadside ditch; 431. I. verna L., LC, open oak woods; 244. Sisyrinchium angustifolium Miller, C, open grassy areas; 458, 487. *S. mucronatum* Michaux, O, open grassy areas; 51, 256.

JUNCACEAE: *Juncus effusus* L. var. *solutus* Fernald & Wieg., A, marshy areas; 416, 522 (vnA). **J. articulatus* L., R, open marshy area; 507. *Luzula acuminata* Raf., C, partially shaded grassy areas; 12, 421. **L. bulbosa* (Wood) Rydberg, O, woodland borders; 422, 868.

LEMNACEAE: **Lemna valdiviana* Philippi, O, open streams; 850.

LILIACEAE: *Allium cernuum* Roth var. *allegheniense* Small, O, shaded rocky bank; 643 (vnA). *Convallaria montana* Raf., LC, rich mountain woods; 349. **Erythronium americanum* Ker, O, moist woods; 13. *Maianthemum canadense* Desf, A, rich woods at high elevations; 38. *Polygonatum biflorum* (Walter) Ell., C, rich woods and moist thickets; 338, 449. **P. pubescens* (Willdenow) Pursh, O, oak woods; 269. *Smilacina racemosa* (L.) Desf. dry woods and woodland borders; 409. **Smilax rotundifolia* L., C, open woods and thickets; 508. **S. tamnoides* L., C, thickets; 490. *Stenanthium gramineum* (Ker) Morong, O, woodland borders; 752. *Trillium erectum* L., O, rich mountain woods; 293. *T. grandiflorum* (Michaux) Salisbury, A, rich woods; 312. *T. undulatum*

Willdenow, C, rich woods at high elevations; 292. *Uvularia pudica* (Walter) Fernald, O, open oak woods; 272. *Yucca filamentosa* L. var. *smalliana* (Fernald) Ahles., O, open roadsides; 556 (vnA).

ORCHIDACEAE: *Cypripedium acaule* Aiton, LC, open oak woods; 403. *Habenaria clavellata* (Michaux) Sprengel; O, high elevation boggy areas; 152, 673. *Spiranthes cernua* (L.) Richard, R*, high elevation boggy area; 230.

POACEAE: **Agrostis capillaris* L. (i), O, marshy areas; 128, 599. *A. perennans* (Walter) Tuckerman, C, open marshy areas, 550. *A. stolonifera* L., O, open marshy areas, 604. *Anthoxanthum odoratum* L. (i), A, pastures and roadsides; 71, 305. *Arrhenatherum elatius* (L.) Presl (i), roadsides; 438, 872. **Bromus inermis* Leysser (i), O, roadsides and thickets; 315, .63. **B. japonicus* Murray (i), C, roadsides; 499. *Dactylis glomerata* L. (i), C, open marshy areas; 31, 44, 397. *Dichanthelium acuminatum* (Swartz) G. & C., C, shaley roadside banks; 501. *D. clandestinum* (L.) Gould, C, moist roadsides; 513. **D. latifolium* (L.) Harvill, O, roadsides; 871. **D. oligosanthes* (Schultes) Gould var. *scribnerianum* (Nash) Gould, O, roadsides; 398 (vnA). **Echinochloa crusgalli* (L.) Beauvois (i), A, moist roadside ditches; 661, 713, 794. Elymus riparius Wiegland, C, disturbed areas and roadsides; 707. *Eragrostis cilianensis (All.) Mosher (i), C, disturbed areas; 710. Glyceria melicaria (Michaux) Hubbard, O, roadsides and wasteplaces; 129, 762. Holcus lanatus L. (i), A, moist roadsides and pastures; 162, 478, 547. Hystrix patula Moench, O, moist roadsides and woods; 161, 642. *Lolium perenne L. (i), C, fields and roadsides; 529. Leersia oryzoides (L.) Swartz, C, roadside swales; 187. *Panicum capillare L. var. campestris, R*, shaded roadside; 872 (vnA). Phalaris arundinacea L., C, moist shaded roadsides; 158. Phleum pratense L. (i), A, roadsides and pastures; 170, 497, 551. Poa alsodes Gray, C, roadsides; 316, 331. P. compressa L. (i), A, roadsides; 45. P. cuspidata Nuttall, O, open woods; 11, 326. P. pratensis L., A, open roadsides; 317, 424. Secale cereale L. (i), R*, roadside; 528. *Setaria faberi W. Herrmann (i), C, roadsides and wasteplaces; 709, 795. *S. glauca (L.) Beauvois (i), C, roadsides and wasteplaces; 193, 660, 709, 775. *S. viridis (L.) Beauvois (i), O, roadsides and wasteplaces; 709.

DICOTYLEDONEAE

ACERACEAE: Acer pensylvanicum L., A, rich woods; 253. A. rubrum L., A, moist and dry woods; 232. A. saccharum Marshall, A, rich woods; 201. A. spicatum Lam., C, rich woods at high elevations; 313, 654, 465.

AMARANTHACEAE: Amaranthus hybridus L. (i), O, disturbed areas; 705, 808.

ANACARDIACEAE: Rhus glabra L., A, roadsides and woodland borders; 555. R. typhina L., C, roadsides and woodland borders; 104.

APIACEAE: Cryptotaenia canadensis (L.) DC., C, woodland borders; 453. Daucus carota L. (i), A, roadsides and wasteplaces; 103. *Ligusticum canadense (L.) Britton, O, woodland borders; 577. Osmorhiza claytoni (Michaux) Clarke, C, rich woods and woodland borders; 339, 433. Pastinaca sativa L. (i), C, open grassy areas; 119, 435. Thaspium barbinode (Michaux) Nuttall, O, rich woods and woodland borders; 469, 517. Zizia aptera (Gray) Fernald, O, moist shaded areas; 70.

APOCYNACEAE: Apocynum androsaemifolium L., LC, roadsides and wasteplaces; 495. A. cannabinum L. var.

nemorale (G.S. Mill) Fernald, C, roadsides and woodland borders; 578 (vnA).

AQUIFOLIACEAE: Ilex montana T. & G., O, rich woods at high elevations; 175, 852.

ARALIACEAE: Aralia nudicaulis L., LC, rich woods; 350. A. spinosa L., R*, old abandoned homesite; 855. Panax trifolium L., C, rich mountain woods, 251, 345.

ARISTOLOCHIACEAE: Aristolochia macrophylla Lam., C, rich woods; 343. Asarum canadense L., C, rich woods; 282.

ASCLEPIADACEAE: *Asclepias exaltata L., R*, steep bank in open woods; 519. *A. syriaca L., A, roadsides and wasteplaces; 136, 155.

ASTERACEAE: Achillea millefolium L. (i), A, roadsides and fields; 134, 689. Ageratina altissima (L.) K. & R., O, rocky banks; 200, 665. Ambrosia artemisiifolia L., A, roadsides and fields at low elevations; 655, 695, 778. *Antennaria plantaginifolia (L.) Richardson, A, open woods, fields, and thickets; 52, 267. *Anthemis arvensis L. (i), O, open roadside banks and wasteplaces; 455. *A. cotula L. (i), C, roadsides; 331, 369, 631. Arctium minus Schkuhr, A, roadsides and wasteplaces; 589. Aster acuminatus

Michaux, O, open woods at high elevations; 681. *A. cordifolius L., A, thickets and woodland borders; 176, 766, 802. A. divaricatus L., roadsides and woodland borders; 205. A. infirmus Michaux, O, streambeds and boggy areas; 635. A. lowrieanus Porter, O, open woods and thickets; 226. A. novae-angliae L., R*, pasture; 847. *A. oblongifolius Nuttall, LC, shaley roadsides; 825. A. pilosus Willdenow var. pilosus, A, roadsides and wasteplaces; 227, 773, 849. (vnA). *A. prenanthoides Willdenow, C, woodland borders; 756. A. puniceus L., LC, open marshy areas; 789. A. umbellatus Miller, C, streambeds and boggy areas at high elevations; 742, 813. A. vimineus Lam., O, roadsides; 812. Bidens cernua L., C, open streambeds; 786. B. frondosa L., C, rocky banks and wasteplaces; 184, 797. Carduus acanthoides L. (i), O, roadsides and pastures; 781. *Centaurea maculosa Lam. (i), O, roadsides and wasteplaces; 172, 597. Chrysanthemum leucanthemum L. (i), A, roadsides and wasteplaces; 419. Cichorium intybus L. (i), A, roadsides and wasteplaces; 882. *Cirsium discolor (Willdenow) Nuttall (i), O, open roadsides and pastures; 669, 782, 820. C. muticum Michaux, O, open roadsides and pastures; 675. C. pumilum (Nuttall)

Sprengel, C, mountain pastures; 819. Erigeron annuus (L.) Persoon, A, roadsides and wasteplaces; 166, 645, 785. E. philadelphicus L., A, roadsides and wasteplaces; 391, 468. E. strigosus Willdenow, A, roadsides and wasteplaces; 485, 785, 799, 800. Eupatoriadelphus fistulosus (Barratt) K. & R. x E. maculatus (L.) K. & R., R, open marshy area; 727. Galinsoga quadriradiata Ruiz & Pavon (i), C, marshy ditches; 206, 534. *Gnaphalium obtusifolium L., O, open marshy areas; 815. Helenium autumnale L. var parviflorum (Nuttall) Fernald, C, open marshy areas; 787. Helianthus tuberosus L., A, roadsides; 801. Heliopsis helianthoides (L.) Sweet, A, open roadsides and pastures; 704, 735, 783. H. helianthoides var. scabra Dunal, O, open roadsides; 569 (vnA). Hieracium paniculatum L., O, roadsides and woodland borders; 720. *H. pilosella L. (i), LC, roadsides and pastures; 367. H. pratense Lausch (i), LC, roadsides and pastures; 108, 368. *H. venosum L., C, dry oak woods; 96. Inula helenium L. (i), R*, open grassy slope; 163. Lactuca serriola L., C, fields and wasteplaces; 716. Matricaria matricarioides (Lessing) Porter (i), R*, disturbed rocky site; 443. *Polymnia canadensis L., O, shaded roadsides and ditches; 641. R. hirta L., O, open roadsides; 156, 586. *R. laciniata* L., O, open grassy roadsides; 656. *Senecio aureus* L., A, mountain streambeds and marshes; 250, 298. *S. obovatus* Willdenow, C, open grassy streambanks; 257. *Silphium trifoliatum* L., O, grassy roadsides; 70, 570. *Solidago arguta* Aiton, O, open fields and roadsides; 796. *S. bicolor* L., A, roadsides, fields, and thickets; 191, 753. **S. canadensis* L., C, moist thickets and bogs; 702, 826. *S. curtisii* T. & G., C, rich mountain woods; 748, 759, 810. *S. graminifolia* (L.) Salisbury, C, open fields and streambeds; 726, 732. *S. juncea* Aiton, O, open fields and roadsides; 183. **S. nemoralis* Aiton, C, open fields and roadsides; 740, 818. *S. rugosa* Miller, C, fields, roadsides, and thickets; 212, 700, 715. **S. roanensis* Porter, O, marshy areas; 677, 767. **Sonchus arvensis* L. (i), C, fields, roadsides and wasteplaces; 779. *S. oleraceus* L. (i), O, partially shaded grassy roadside; 464. *Taraxacum officinale* Wiggers (i), A, roadsides; 28. **Tragopogon dubius* Scopoli (i), O, open grassy roadsides; 401. *Tussilago farfara* L. (i), A, open roadsides; 1. *Verbesina alternifolia* (L.) Britton, C, shaded banks and roadsides; 173. **Vernonia gigantea* (Walter) Trelease, R, partially shaded streambed; 730.

BALSAMINACEAE: Impatiens capensis Meerburg, C, shaded streams and ditches; 160. I. pallida Nuttall, C, shaded streams and ditches; 154.

BERBERIDACEAE: Caulophyllum thalictroides (L.) Michaux, O, moist thickets; 280. Podophyllum peltatum L., A, rich woods; 491.

BETULACEAE: Betula alleghaniensis Britton, A, moist mountain ravines; 88. B. lenta L., A, rich woods; 867. Ostrya virginiana (Miller) K. Koch, O, rich mountain woods; 870.

BORAGINACEAE: Cynoglossum officinale L. (i), O, roadsides and wasteplaces; 263. Echium vulgare L. (i), A, fields, roadsides, and wasteplaces; 444. Myosotis laxa Lehmann, O, open rocky streambeds; 393. M. scorpioides L. (i), O, open rocky streambeds; 629.

BRASSICACEAE: Alyssum alyssoides L., O, open gravelly roadsides; 264. Arabis laevigata (Willdenow) Poiret, A, dry banks and wasteplaces; 268, 290. *Barbarea vulgaris R. Brown (i), A, fields and roadsides; 238. Brassica campestris L. (i), C, shaley roadside banks; 711. B. nigra (L.) Koch (i), C, open disturbed sites; 503. *Camelina microcarpa Andrz. (i), O, open grassy roadsides;

373. Cardamine pensylvanica Willdenow, C, moist shaded streambeds; 389, 355, 418. Dentaria dyphylla Michaux, LC, rich mountain woods; 248. Hesperis matronalis L. (i), A, roadsides and pastures; 366, 442. Lepidium campestre (L.) R. Brown (i), C, open streambanks; 258. L. virginicum L., A, fields, roadsides, and wasteplaces; 780. Nasturtium officinale R. Brown (i), springy areas; 593. *Thlapsi perfoliatum L. (i), O, shaley roadside banks; 265.

CAMPANULACEAE: Campanula americana L., C, moist thickets; 585. C. divaricata Michaux, O, dry roadside banks; 721. Lobelia inflata L., C, dry bank; 676. L. spicata Lam. O, edge of rich woods; 516. L. siphilitica L., C, moist open areas; 190, 718. Triodanis perfoliata (L.) Nieuwland, O, open grassy areas in rich woods; 531.

CAPRIFOLIACEAE: *Lonicera canadensis Bartram, R, rich woods at high elevation; 300. Sambucus canadensis L., O, rich woods; 574. S. pubens Michaux, C, rocky woods; 291, 466, 514. Viburnum acerifolium L., C, woodland borders; 471. V. alnifolium Marshall, O, rich woods at high elevations; 303. V. prunifolium L., C, open pastures; 354.

CARYOPHYLLACEAE: Arenaria serpyllifolia L. (i), C, open grassy roadsides; 376. *Cerastium vulgatum L. (i), C, dry rocky areas; 260. *Dianthus armeria L. (i), C, roadsides and pastures; 484. *Lychnis alba Miller (i), C, grassy roadsides; 447. Paronychia argyrocoma (Michaux) Nuttall, O, sandstone outcrops; 144. *P. canadensis (L.) Wood, O, steep rocky banks; 719. P. fastigiata (Raf.) Fernald, O, dry shaley soil in open woods; 836. Saponaria officinalis L. (i), A, roadsides and pastures; 554. Silene caroliniana Walter, C, open shaley banks; 270, 301. S. stellata (L.) Aiton F., O, open shaley bank; 617. S. virginica L., dry rocky woods; 461, 524. *S. vulgaris (Moench) Garcke (i), O, open roadsides and fields; 445. Stellaria gramineae L. (i), C, open roadsides and pastures; 394, 460. S. media (L.) Villars (i), C, steep grassy bank; 295. S. pubera Michaux, C, rich woods; 245.

CHENOPODIACEAE: Chenopodium album L. (i), O, roadsides and wasteplaces; 692.

CISTACEAE: *Lechea intermedia Leggett, R, dry soil in open woods; 180. L. racemulosa Michaux, O, dry soil in open woods; 180, 836.

CONVOLVULACEAE: Convolvulus arvensis L., O, open disturbed areas; 568. *Ipomoea pandurata (L.) Meyer, O, dry gravelly roadsides; 636.

CORNACEAE: Cornus florida L., O, dry woods; 885.

CRASSULACEAE: *Sedum ternatum Michaux, LA, rocky outcrops in rich woods; 342.

DIPSACACEAE: Dipsacus sylvestris Hudson (i), A, roadsides and wasteplaces; 171.

ERICACEAE: Epigaea repens L., O, oak woods; 8. Gaylussacia baccata (Wang.) K. Koch, C, dry rocky woods; 348, 411. Kalmia latifolia L., A, dry open woods; 98. Lyonia ligustrina (L.) DC., O, woodland borders; 510. Menziesia pilosa (Michaux) Jussieu, C, woods and thickets; 41, 346. Monotropa uniflora L., O, rocky woods; 142. Pyrola rotundifolia L., R*, rich soil at edge of spruce stand; 624. Rhododendron calendulaceum (Michaux) Torrey, C, woods and thickets; 85, 434. R. maximum L., A, ravines in Alleghenies; 544. R. prinophyllum (Small) Millais, C, woods and thickets; 40, 407. Vaccinium angustifolium Aiton, A, dry soil and boggy areas; 306, 411. V. pallidum Aiton, A, dry soil and open spruce stands; 388, 450. *V. stamineum* L., C, dry woods and thickets; 347, 311.

EUPHORBIACEAE: *Euphorbia maculata* L., A, open gravel; 196.

FABACEAE: *Coronilla varia* L. (i), C, open roadside banks; 79. *Lathyrus latifolius* L. (i), C, open grassy roadsides; 164. *Medicago lupulina* L. (i), C, roadsides and wasteplaces; 372. *Melilotus alba* Desr. (i), C, roadsides and wasteplaces; 116. *M. officinalis* (L.) Pallas (i), C, roadsides and wasteplaces; 77, 633. *Robinia pseudo-acacia* L., A, pastures and open woods; 58. **Trifolium arvense* L. (i), C, roadsides and wasteplaces; 685. *T. aureum* Pollich, C, open grassy areas in woods; 133. *T. campestre* Schreber (i), C, roadsides and wasteplaces; 371. *T. pratense* L. (i), C, roadsides and wasteplaces; 73. *T. repens* L. (i), A, roadsides and wasteplaces; 102. *Vicia caroliniana* Walter, C, open rocky slopes; 254. **V. dasycarpa* Tenore (i), O, shaley roadside banks; 370. **V. villosa* Roth (i), LC, open grassy roadside; 83.

FAGACEAE: *Castanea dentata* (Marshall) Borkh, C, oak woods; 831. *Fagus grandifolia* Ehrhart, A, rich woods;

887. Quercus alba L., A, dry woods; 830. *Q. coccimea Muenchh., O, dry open woods; 858. Q. ilicifolia Wang, A, dry open woods and thickets; 830. Q. prinus L., C, dry woods; 829. Q. rubra L., A, mountain woods; 273, 828.

FUMARIACEAE: *Adlumia fungosa (Aiton) BSP., R, edge of rich woods; 884. *Dicentra canadensis (Goldie) Walpers, R*, shaded bank in rich woods; 307. D. cucullaria (L.) Bernh., LA, moist shaded areas; 17. D. eximia (Ker) Torrey, LC, rich rocky woods; 2.

GENTIANACEAE: *Gentiana clausa Raf., R*, open streambed in rich mountain woods; 811. G. quinquefolia L., LC, rich open areas; 202, 221.

GERANIACEAE: *Geranium columbinum L. (i), C, roadsides and wasteplaces; 300, 457. G. maculatum L., C, open areas; 34. *G. molle L. (i), C, roadsides; 261, 384. *G. robertianum L., R, partially shaded roadside; 611.

HAMAMELIDACEAE: Hamamelis virginiana L., A, rich and dry woods; 228, 233, 383.

HYDROPHYLLACEAE: Hydrophyllum virginianum L., C, rich mountain woods; 87, 430.

HYPERICACEAE: Hypericum perforatum L. (i), C, fields, roadsides, and wasteplaces; 500, 768. H. prolificum L., C, partially shaded slopes; 113, 168, 646. H. punctatum Lam., O, disturbed areas; 146, 619.

JUGLANDACEAE: *Carya cordiformis (Wang) K. Koch, C, rich woods; 700. C. glabra (Miller) Sweet, C, woods throughout; 741, 833. C. ovata (Miller) K. Koch, A, rich woods; 881. Juglans nigra L., R*, old abandoned homesite; 854.

LAMIACEAE: *Blephilia hirsuta (Pursh) Bentham (i), R, partially shaded trail in rich woods; 150. *Galeopsis tetrahit L. (i), R, roadside bank at high elevation; 610. Glechoma hederacea L. (i), C, fields and roadsides; 30. *Hedeoma pulegioides (L.) Persoon, C, dry roadside banks; 179. Leonurus cardiaca L. (i), A, roadsides and wasteplaces; 539, 712. Lycopus americanus Barton, C, open marshy areas; 638. L. uniflorus Michaux, O, marshy areas in rich woods; 757. Mentha piperita L. (i), LC, open streambeds; 626. M. spicata L. (i), LC, open streambeds; 627. Monarda clinopodia L., LC, rich woods; 581. M. didyma L., O, woodland borders; 169. M. fistulosa L., C, woodland borders; 648. Nepeta cataria L. (i), O, disturbed rocky sites; 194. Prunella vulgaris L. (i), A, grassy areas in woods; 219, Satureja vulgaris

(L.) Fritsch, A, open roadsides; 552, 594, 647, 672. *Teucrium canadensis* L., C, shaded banks; 649.

LAURACEAE: *Sassafras albidum* (Nuttall) Nees var. *molle* (Raf.) Fernald, C, dry oak woods; 276 (vnA).

MAGNOLIACEAE: *Magnolia acuminata* (L.) L., O, rich woods at high elevations; 851. *M. fraseri* Walter, C, rich woods at high elevations; 358.

MALVACEAE: *Malva moschata* L. (i), O, open roadsides and fields; 584,

OLEACEAE: *Fraxinus americana* , C, rich woods; 177, 203. *Forsythia suspensa* (Thumb.) Vahl. (i), R, persistent on abandoned homesite; 13 (snA).

ONAGRACEAE: *Circaea alpina* L., C, marshy areas and bogs at high elevations; 149, 532. *C. lutetiana* L., ssp. *canadensis* (L.) A. & M., O, woodland borders; 272. *Epilobium angustifolium* L., C, roadsides and woodland borders; 583. *E. coloratum* Biehler, C, moist ditches; 186, 792. *Oenothera biennis* L., C, moist open areas; 698. *O. fruticosa* L., marshy areas in rich woods; 543. *O. perennis* L., C, moist open areas; 548.

OROBANCHACEAE: *Epifagus virginiana* (L.) Barton, O, high elevation woods; 770.

OXALIDACEAE: <u>Oxalis</u> <u>montana</u> Raf., O, spruce stands and mountain woods; 427. *<u>O</u>. <u>stricta</u> L. (i), C, roadsides and wasteplaces; 379, 530.

PAPAVERACEAE: *<u>Chelidonium</u> <u>majus</u> L. (i), O. moist partially shaded roadsides; 341, 482. *<u>Papaver</u> <u>dubium</u> L. (i), R*, open pasture; 377. <u>Sanguinaria</u> <u>canadensis</u> L., rich woods and moist roadsides; 18.

PHRYMACEAE: <u>Phryma</u> <u>leptostachya</u> L., O, woodland borders; 615.

PHYTOLACCACEAE: <u>Phytolacca</u> <u>americana</u> L., C, roadsides; 210.

PLANTAGINACEAE: <u>Plantago</u> <u>lanceolata</u> L. (i), disturbed areas; 78, 353. *<u>P</u>. <u>major</u> L. (i), O, roadsides and pastures; 157. <u>P</u>. <u>rugelii</u> Dcne., C, open grassy areas; 126.

PLATANACEAE: *<u>Platanus</u> <u>occidentalis</u> L., O, low elevation streambanks; 863.

POLEMONIACEAE: *<u>Phlox</u> <u>paniculata</u> L., O, open roadsides; 174, 701. <u>P</u>. <u>stolonifera</u> Sims, C, marshy streambed; 286.

POLYGALACEAE: <u>Polygala</u> <u>paucifolia</u> Willdenow, C, dry and moist woods; 36.

POLYGONACEAE: Polygonum aviculare L. (i), A, roadsides and wasteplaces; 197, 769, 816. P. cilinode Michaux, O, high elevation shaded areas; 542. *P. convolvulus L. (i), C, roadsides; 600. P. erectum L., C, roadsides and wasteplaces; 612. *P. hydropiperoides Michaux, C, marshy areas and streambanks; 185. *P. persicaria L. (i), C, moist roadside ditches; 167, 185, 562. P. sagittatum L., C, boggy and marshy areas; 622, 755. P. scandens L., C, moist roadside thickets; 738. P. virginianum L., C, roadsides; 723. Rumex acetosella L. (i), A, mountain pastures; 406. R. crispus L. (i), A, roadsides and wasteplaces; 440, 605. R. obtusifolius L. (i), A, roadsides and wasteplaces; 541, 682.

PORTULACAEAE: Claytonia caroliniana Michaux, C, moist thickets and woods; 15. C. virginica L., A, moist and dry woods; 10.

PRIMULACEAE: Lysimachia ciliata L., C, open grassy areas; 595. L. quadrifolia L., C, shaley banks; 483. Trientalis borealis Raf., C, spruce stands and nountain woods; 355.

RANUNCULACEAE: Actaea pachypoda Elliott, O, rich woods; 525. Anemone quinquefolia L., C, rich woods; 242,

289. *A. virginiana* L., C, roadside thickets; 37, 289, 494. *Aquilegia canadensis* L., A, rocky roadside banks; 56. *Caltha palustris* L., O, marshy streambeds and bogs; 27. *Cimicifuga racemosa* (L.) Nuttall, moist thickets; 579. *Clematis occidentalis* (Hornemann) DC., R, moist thicket on mountain top; 277. *C. virginiana* L., C, streambanks; 563, 703, 743. *Hepatica acutiloba* DC., C, moist and dry woods; 14. *Ranunculus acris* L. (i), O, woodland borders; 392. *R. bulbosus* L. (i), C, roadsides and wasteplaces; 443. *R. recurvatus* Poiret, C, rich mountain woods; 66. **R. septentrionalis* Poiret, C, open marshy streambeds; 262. **Thalictrum dioicum* L., O, woodland borders; 288. *T. pubescens* Pursh, O, marshy streambeds; 124, 565.

RHAMNACEAE: *Ceanothus americanus* L., O, woodland borders; 567.

ROSACEAE: *Agrimonia gryposepala* Wallroth, O, rich woods; 616. **A. pubescens* Wallroth, O, rich woods; 725. *Amelanchier arborea* (Michaux f.) Fernald, C, disturbed woods; 6, 537. *Aronia prunifolia* (Marshall) Rehder, boggy areas; 412. *Aruncus dioicus* (Walter) Fernald, C, woodland borders; 114. *Crataegus flabellata* (Bosc) K. Koch, C, forest borders; 731, 764. *C. punctata* Jacquin, C, high mountain pastures; 771. *<u>Fragaria</u> <u>vesca</u> L., R, edge of rich woods; 278. <u>F</u>. <u>virginiana</u> Duchesne, C, roadsides and pastures; 37. <u>Geum</u> <u>canadense</u> Jacquin, C, wooded roadside banks; 538, 601. <u>Gillenia</u> <u>trifoliata</u> (L.) Moench, C, rich woods; 448. <u>Malus</u> <u>pumila</u> Miller (i), O, mountain pastures; 325. <u>Potentilla</u> <u>recta</u> L. (i), C, roadsides and wasteplaces; 76, 457. <u>P</u>. <u>simplex</u> Michaux, A, roadsides and wasteplaces; 35, 50, 318. <u>Prunus</u> <u>pensylvanica</u> L. f., C, shaley banks, 279. <u>P</u>. <u>serotina</u> Ehrhart, A, rich woods; 54, 734. <u>Rosa</u> <u>carolina</u> L., C, roadsides and pastures; 540. <u>R</u>. <u>micrantha</u> Smith (i), R*, high elevation pasture; 549. <u>Rubus</u> <u>allegheniensis</u> Porter, A, open fields and thickets; 49, 467, 476. <u>R</u>. <u>argutus</u> Link, LA, mountain pasture; 465. <u>R</u>. <u>hispidus</u> L., O, boggy areas; 148, 621. <u>R</u>. <u>odoratus</u> L., C, thickets, 540. <u>Waldsteinia</u> <u>fragarioides</u> (Michaux) Tratt., O, open moist areas; 285.

RUBIACEAE: <u>Galium</u> <u>aparine</u> L., A, shaded roadsides and woods; 340, 473. *<u>G</u>. <u>mollugo</u> L. (i), O, dry woodland borders; 536. *<u>G</u>. <u>obtusum</u> Bigelow, O, shaded streambeds: 545. <u>G</u>. <u>tinctorium</u> L., C, streambeds and bogs; 623, 674. <u>G</u>. <u>triflorum</u> Michaux, C, rich woods; 614, 644. <u>Houstonia</u> <u>caerulea</u> L., C, open grassy areas; 31. <u>H</u>. <u>longifolia</u>

Gaertner, O, open woods; 390. *H. tenuifolia* Nuttall, C, open woods; 533. *Mitchella repens* L., C, moist woods; 23.

SALICACEAE: *Populus grandidentata* Michaux, O, rich mountain woods; 357. **P. tremuloides* Michaux, R, open mountain pasture near spruce stand; 772. **Salix sericea* Marshall, LA, marshy areas and streambanks; 299, 405.

SAXIFRAGACEAE: *Heuchera americana* L., C, rocky woods and thickets; 488, 576. *Hydrangea arborescens* A, rich woods and woodland borders; 512. *Mitella diphylla* L., C, rich woods; 72. *Ribes cynosbati* L., O, rocky mountain woods; 19, 337. *R. rotundifolium* Michaux, C, rocky woods; 243. **R. sativum* Syme (i), R, shaded streambank in pasture; 474. *Saxifraga micranthidifolia* (Haw.) Steudel, C, wooded mountain streams; 224. **S. virginiensis* Michaux, C, wooded streambanks; 239. *Tiarella cordifolia* L., C, wooded streambanks; 304.

SCROPHULARIACEAE: *Chelone glabra* L., R*, moist open area; 750. *Linaria vulgaris* Hill (i), O, shaley banks; 634. *Melampyrum lineare* Desr., O, dry oak woods; 608. *Pedicularis canadensis* L., C, moist thickets; 33. *Penstemon canescens* Britton, A, shaded roadsides and thickets; 380, 493. *Verbascum thapsus L. (i), C, roadsides; 806. Veronica americana (Raf.) Bentham, O, moist open areas; 475. *V. anagallis-aquatica L., O, grassy streambeds; 560. V. arvensis L. (i), C, roadsides and wasteplaces; 375. V. officinalis L., A, roadsides and wasteplaces; 402, 425. V. serpyllifolia L. (i), C, open grassy areas; 415.

SOLANACEAE: *Datura stramonium L. (i), R*, rocky disturbed site; 195. Physalis virginiana var. subglabrata (M. & B.) Water., C, roadside thickets; 853, 777. *Solanum americanum Miller, R*, old abandoned homesite; 857. *S. carolinense L., C, dry rocky roadsides; 657. S. dulcamara L. (i), O, rocky streambanks; 182.

TILIACEAE: Tilia americana L., rich woods; 613, 838.

ULMACEAE: *Ulmus rubra Muhl., O, open woods and woodland borders; 231, 252, 834.

URTICACEAE: *Pilea pumila (L.) Gray, C, shaded streambanks and bogs; 758.

VERBENACEAE: Verbena hastata L., O, open grassy areas; 637. V. urticifolia L., C, roadsides; 120.

VIOLACEAE: Viola blanda Willdenow, C, partially shaded roadsides; 25. V. canadensis L., A, rich mountain woods;

69, 287. *_V_. _fimbriatula_ Smith, R*, shaley soil in open woods; 274, 837. _V_. _hastata_ Michaux, O, rich mountain woods; 237. _V_. _macloskeyi_ Lloyd var. _pallens_ (DC.) Hitchcock, O, boggy areas at high elevations; 240, 247. _V_. _palmata_ L., A, streambeds and boggy areas; 249. _V_. _pubescens_ Aiton; C, moist woods; 246, 330. _V_. _striata_ Aiton, A, shaded roadsides; 452.

VITACEAE: _Parthenocissus_ _quinquefolia_ (L.) Planchon, C, thickets; 361. *_Vitis_ _vulpina_ L., O, thickets; 362, 502.

LITERATURE CITED

Adams, H. S. and S. Stephenson. 1989. The high-elevation red oak community type in western Virginia. Castanea. In press.

Bailey, C. M. 1989. Composition and distribution of red spruce forests in Highland County, Virginia. Honors Thesis, College of William and Mary, 88 p.

Bevin, A. 1933. Guidebook to Northern Virginia. United States Printing Office, Washington, D. C. 43 p.

Braun, E. L. 1950. Deciduous forests of eastern North America. Hafner, New York. 596 p.

Cardwell, D. H., R. B. Erwin, and H. P. Woodward. 1968. Geologic Map of Virginia. West Virginia Geological and Economic Survey.

Central Shenandoah Planning District Commission. 1988. Economic overview of Highland County and the town of Monterey. Monterey, Virginia. 52 p.

Core, E. G. Vegetation of West Virginia. McClain Printing Company, Parsons, West Virginia. 217 p.

Cox, G. W. 1967. Laboratory manual of general ecology. WMC Brown Co., Dubuque, Iowa. 165 p.

Fernald, M. L. 1950. Gray's Manual of botany, eighth edition. American Book Company, New York. 1632 p.

Gleason, H. A. 1952. The new Britton and Brown illustrated flora of northeast United States and adjacent Canada. Lancaster Press, Inc, Lancaster, Pennsylvania. 3v.

Gleason, H. A. and A. Cronquist. 1963. Manual of vascular plants of north-eastern United States and adjacent Canada.
Van Nostrand Reinhold Company, New York. 810 p.

Harvill, A. M. 1970. Spring flora of Virginia. McClain Printing Company, Parsons, West Virginia. 240 p.

Harvill, A. M., T. R. Bradley, C. E. Stevens, T. F. Wieboldt, D. M. E. Ware, and D. W. Ogle. 1986. Atlas of the Virginia flora. Virginia Botanical Associates, Farmville, Virginia. 135 p.

Kasmer, J., P. Kasmer, and S. Ware. 1984. Edaphic factors and vegetation in the Piedmont lowland of southeastern Pennsylvania. Castanea 49: 147-157.

Keever, C. 1973. Distribution of major forest species in southeastern Pennsylvania. Ecological Monographs 43: 303-327.

Ludwig, J. C. 1989. The biological and legal status of Virginia's rare and uncommon vascular plants. Jeffersonia 20: number 1.

Minici, R. C., C. T. Spiker, Jr., and J. M. Wilson. 1963. Geologic map of Virginia. Commonwealth of Virginia, Department of Conservation and Economic Developement.

Newcomb. L. 1977. Newcomb's wildflower guide. Little, Brown and Company, Boston. 490 p.

Petrides, G. A. 1988. A field guide to eastern trees. Houghton Mifflin Company, Boston. 272 p.

Pielke, R. A. 1981. The distribution of spruce in west-central Virginia before lumbering. Castanea 46: 201-216.

Radford, A. E., H. E. Ahles, and C. R. Bell. 1968. Manual of the vascular flora of the Carolinas. Univ. of N. C. Press, Chapel Hill, North Carolina. 1183 p.

Small, J. K. 1933. Manual of the southeastern flora. University of North Carolina Press, Chapel Hill. 1554 p.

Rheinhardt, R. D. and S. A. Ware. 1984. The vegetation of the Balsam Mountains of southwest Virginia: a phytosociological study. Bull. Torrey Bot. Club 111: 287-300.

Strahler, A. N. 1972. Forests of the Fairfax Line, Annals of Geography, December. 664-684.

Strausbaugh, P. D. and E. L. Core. 1978. Flora of West Virginia, second edition. Seneca Books, Inc., Grantsville, West Virginia. 1079 p.

VITA

Theresa A. Theodose

Born in Charlottesville, Virginia on August 9, 1962. Graduated from Albemarle High School, Charlottesville, Virginia in June 1980. Graduated from James Madison University, Harrisonburg, Virginia with a B. S. in Biology in May 1985. Entered The College of William and Mary in the spring of 1987 to pursue a graduate studies in Biology.