THE VASCULAR FLORA OF HIGH MOUNTAIN COMMUNITIES OF THE SOUTHERN APPALACHIANS[1]

By George S. Ramseur

Department of Biology, The University of the South, Sewanee, Tennessee

The spruce-fir forest of the higher peaks and ridges of the Southern Appalachian Mountains is similar in growth form to the northern conifer forest which is centered in southeastern Canada (Oosting, 1948). This southern extension is unique in that Fraser's fir, *Abies fraseri* (Pursh) Poir., takes the place of balsam fir, *Abies balsamea* (L.) Mill., as the species co-dominant with red spruce, *Picea rubens* Sarg. Not only is the southern spruce-fir forest located a great distance from the main body, but also it is broken up into several isolated areas. Since the main forest is located in an area which was formerly covered by a sheet of ice (Fernald, 1931), its ancestral form must have occupied a southern area (Harshberger, 1903; Cain, 1930). The isolation, the antiquity, and the possibility of geographical relationships to the northern conifer forest suggested that a study of the southern spruce-fir forest region would be worthwhile.

The Southern Appalachian Mountain region has attracted botanists for many years. Botanical explorations to the mountains probably started with William Bartram in 1776. He was followed by: Andre Michaux, 1787 and 1794; Fraser, 1789; Lyon, probably before 1802; F. A. Michaux, 1802; Nuttall, 1816; Gray, 1841; Buckley, 1842; Rugel, 1842; Sullivant, 1843; and Dow, 1844 (Curtis, 1860; Harshberger, 1899). Of M. A. Curtis, a North Carolina botanist, Asa Gray (1841) said, "No living botanist is so well acquainted with the vegetation of the Southern Alleghany Mountains or has explored those of North Carolina so extensively as Reverend M. A. Curtis."

These early botanists discovered and named many new plants from this region. During the period from the close of the War Between the States and the early 1900's, the search for high mountain plants was led by Ashe and Harbison. Heller (1891) and Small and Heller (1892) also explored the high mountain region.

In 1903 John W. Harshberger published an ecological study of Roan Mountain, Grandfather Mountain, and the Mt. Mitchell area. In more recent years other broad ecological studies have been made of various areas. These include work on Roan Mountain by Brown (1941) on the Black Mountains by Davis (1930), and in the Smoky Mountains by Whittaker (1956) and Crandall (1958).

The establishment of a national park in the Great Smoky Mountains saved most of the forest from the devastation of lumbering and fire which have destroyed much of the spruce-fir forest of the other areas. The Smoky Mountains area has become a center for the study of southern mountain vegetation. One of the most prolific worker in this area has been Stanley A. Cain (1930, 1945). His studies deal primarily with the ecology and phytogeography of this area. Camp (1931, 1936) has made several studies in this area, including one on grass balds (1931). Oosting and Billings (1951) in a comparison of the spruce-fir forests of the northern and southern Appalachian system, found the southern Appalachian forest to be distinct, but yet a part of the boreal forest formation (Northern Conifer Forest). The grass balds of the region have been studied by Wells (1936, 1937) and Mark (1958, 1959). It is noteworthy that only these studies of balds have dealt with the three largest mountain areas—the Black Mountains, the Balsam Mountains, and the Great Smoky Mountains. The Balsam Mountains have received very little attention from the botanists of the past.

The four objectives of the present study were: to make a taxonomic study of the entire southern spruce-fir region; to compare the flora of the various isolated areas; to study the stages of succession leading to the climax spruce-fir forest; and to study the geographical ranges of the dominant species.

[1] This paper is part of a thesis submitted to the Faculty of the University of North Carolina in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Botany. I wish to express my sincere appreciation to Dr. A. E. Radford who directed this study. Grateful acknowledgment is also made for a grant-in-aid from the National Science Foundation administered through the Highlands Biological Station, Inc.

Field studies and collections were made during the summers of 1956 and 1957, and in June of 1958. Visits to the areas were timed so that the early, middle and late summer plants could be adequately sampled. A series of nested quadrats (10 x 10 meters for canopy, 4 x 4 meters for understory, and 2 x 2 meters for floorcover) was plotted and sampled in each community. A total of 162 quadrats was studied. Canopy trees were studied for percentage composition, relative size and age. Soil from the different communities was tested for pH.

LOCATION OF THE REGION

For purposes of this study, the high mountain region includes all areas of the Southern Appalachians which have either a well developed spruce-fir forest or a significant area above an elevation of 5500 feet. This is about the average elevation for the zone of transition between the spruce-fir forest and the deciduous forest. In this region there are ten areas isolated by gaps which are believed to provide climatic barriers (See Figures 1 and 2). These areas are the higher peaks and ridges of:

1. The Great Smoky Mountains
2. The Plott Balsam Mountains
3. The Balsam Mountains
4. Pisgah Ridge
5. The Great Craggy Mountains
6. The Black Mountains
7. Roan Mountain
8. Grandfather Mountain
9. Whitetop Mountain
10. Mt. Rogers

These mountains may be pictured as forming a triangle with the Unaka Range on the northwestern side, the Blue Ridge on the southeastern side and the Plott Balsams, Balsams, and Pisgah Ridge on the southwestern side. Along the North Carolina-Tennessee border the Unaka Range includes the Smokies and Roan Mountain, and in southwestern Virginia includes the Balsam Mountains. (The name "Balsam Mountains" is applied to a range in Virginia as well as the previously noted range in North Carolina.) Only one high peak, Grandfather Mountain, is located on the Blue Ridge. The Black Mountains and the Craggy Mountains are considered as cross ranges between the Unakas and the Blue Ridge.

The scattered locations of the ten high mountain areas are shown in Figure 1. Figure 2 shows a profile passing through these areas and the intervening valleys.

TOPOGRAPHY

These ancient mountains have passed through several cycles of uplift and erosion (King and Stupka, 1950). With this complex origin, it is not possible to give a general description for the whole area. Most of these mountains are subdued, with generally rounded domes covered by a mantle of decayed rock which is usually forested (Fenneman, 1938). Several localized areas such as Mt. LeConte and Grandfather Mountain present a more rugged profile.

The extent and altitudes of the separate areas are shown in Table 1.

One of the outstanding features of this region is the drainage pattern. The high mountain springs are widely spaced, but abundantly flowing, even in the drier seasons. The resulting streams are widely spaced, giving a coarse drainage pattern (Fenneman, 1938). This large area of high rainfall and abundant cloud cover is an important watershed. The divide is formed by the Blue Ridge, which is one of the lower mountain formations. With only two small exceptions, the waters of this region flow into the tributaries of the Tennessee River. The exceptions are the southern slopes of the Balsam Mountains of Virginia, which flow into the Ohio River via the New River, and the western and southern slopes of Grandfather Mountain (on the Blue Ridge) which flow into tributaries of the Catawba.

GEOLOGY

Geologically the high mountain areas may be grouped into five units. The Great Smoky Mountains and the Plott Balsam Mountains are formed of the Great Smokies Conglomerate, a graywacke sandstone and conglomerate in thick graded beds with interbeds of slate (Stuckey, 1958). Areas of exposed slate are found in the Mt. LeConte area, around the Jump Off and on Laurel Top. The Balsam Mountains, Mt. Pisgah, and the Black Mountains are formed of Mica gneiss, chiefly mica gneiss including mica schist and a variety of other gneisses and schists. The Great Craggy Mountains and Roan Mountain are Hornblende gneiss, chiefly hornblende gneiss and schist with interbeds of mica schist. Grandfather Mountain in the Blue Ridge is a part of the Unicoi formation, predominantly sandstone, quartzite and conglomerate with interbedded shale and slate (Stuckey, 1958). Mt. Rogers and Whitetop Mountain of the Balsam Mountains of Virginia are formed of aporhyolite, altered rhyolitic lava

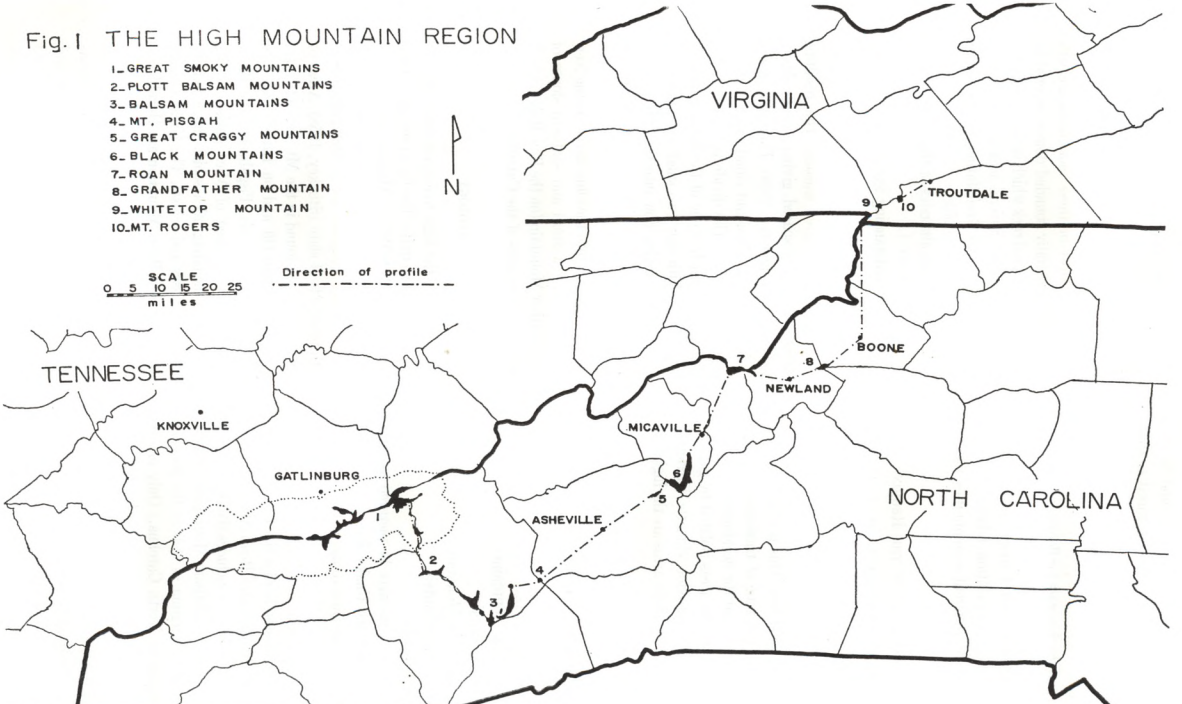

FIG. 1. A map of western North Carolina, eastern Tennessee, and southwestern Virginia, showing the location of the ten high mountain areas of the Southern Appalachian region. The broken line shows the direction of the profile which is shown in Fig. 2. The Great Smoky Mountain National Park boundary is represented by a finely dotted line.

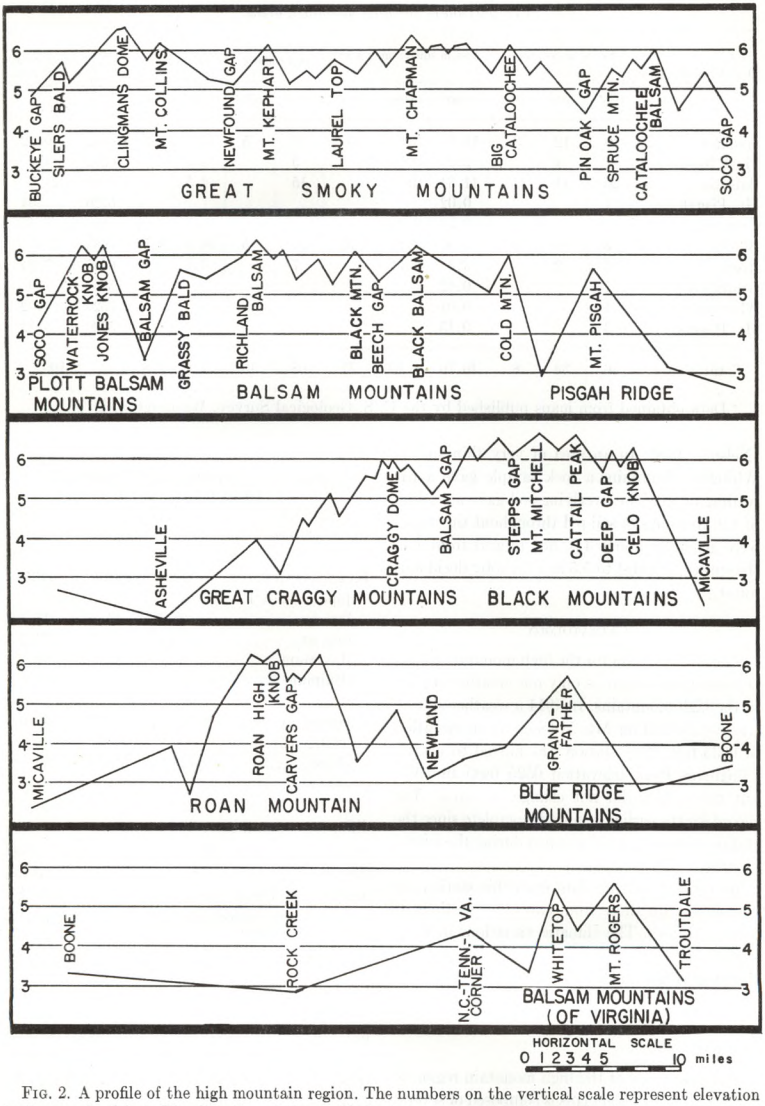

FIG. 2. A profile of the high mountain region. The numbers on the vertical scale represent elevation in thousands of feet. The direction of the profile is shown as a broken line in Fig. 1.

TABLE 1

*Comparison of the high mountain areas**

High Mountain Area	No. of areas above			Area in square miles above			Number of peaks above		Miles of ridges above		Highest elevation (in feet)	% of total high mtn. region
	5500′	6000′	6500′	5500′	6000′	6500′	6000′	6500′	6000′	6500′		
Smokies	10	12	3	18.9	3.5	.16	19	5	12.0	1.3	6642	40.42
Plott Balsams	1	4		2.2	0.14		5		1.5		6292	4.7
Balsams	20	11		11.34	0.6		15		4.5		6410	24.3
Mt. Pisgah	1			0.02							5720	.04
Craggies	1	1		0.76	0.006		1		0.1		6080	1.56
Blacks	5	4	5	9.56	3.17	.15	21	5	10.5	1.5	6684	20.5
Roan	3	2		3.4	0.74		7		3.0		6285	7.24
Grandfather	1			0.42							5964	.9
Whitetop	1			0.01							5520	.02
Mt. Rogers	3			0.15							5720	.32
Total	46	34	8	46.76	8.156	.31	68	10	31.6	2.8		100.

* Data obtained from maps published by the U. S. Geological Survey, Washington, D. C.

(Nelson, 1928). In an area of very thin soil on Whitetop Mountain, a rock sample gave a pH reading of 8.0. The overlying soil gave a reading of 4.0. Readings of soil pH throughout the region were generally about 4.5, but ranged from 4 in the spruce-fir forest to 5.5 in a shrubby deciduous forest.

CLIMATOLOGY

The climatic data for the high mountain region is limited since there is only one weather station in the high mountains. In 1914 a weather station was established on Mt. Mitchell at an elevation of 6635 feet. This station was moved to nearby Clingmans Peak (elevation 6525 feet) in 1953, but the station did not change its name. The record for the earlier years is incomplete since the station was not always manned during the winter months.

In Table 2 weather data from this station are compared with those from two other stations at lower altitudes. The climatic variations of these stations are influenced by the location of surrounding ridges and valleys as well as altitude.

TABLE 2

Summary of weather data through 1954 (from Carney, 1955)

Station	Mt. Mitchell	Highlands	Morganton
Elevation (ft.)	6635	3350	1135
Temperature (°F)			
Jan. av.	28.7	40.3	43.1
July av.	59.2	70.4	77.2
Maximum	87	97	106
Minimum	−21	−5	−10
Precipitation (ins.)			
Annual av.	71.20	79.77	50.64
Growing season (days)	128	178	190

PLANT COMMUNITIES[2]

GENERAL

The vegetation of the high mountain region of the Southern Appalachians is composed of several different communities. The climatic climax community is the spruce-fir forest, but in many areas the forest has been removed by fires following lumbering. These areas are now occupied by secondary succession communities dominated by fire cherry, *Prunus pensylvanica* L.f. Several anomalous communities occupy small portions of the high mountain region. The presence of grass balds, heath balds, shrub balds, and beech gaps has not been explained fully, although several studies have been made of these areas. In this study they are considered to be subclimax or postclimax communities. Roadsides, trails, and campsite areas are disclimax communities which are maintained by mowing and seeding.

[2] (Community and climax concepts of Oosting, 1948.)

DESCRIPTION OF COMMUNITIES

1. Spruce-fir forest community

The spruce-fir forest reaches its maximum development at altitudes of about 6000 feet. Here spruce and fir make up 95 % or more of the canopy trees. Mountain ash, *Sorbus americana* Marsh., and yellow birch, *Betula lutea* Michx. f., are usually present but only rarely do they reach the canopy. Fire cherry, *Prunus pensylvanica* L.f., is occasionally found as a canopy tree, probably a relic from a minor disturbance. At lower elevations near the transition zone, beech, *Fagus grandifolia* Ehrh., and Sarviceberry, *Amelanchier laevis* Wieg., are sometimes found as canopy trees. The southern range of paper birch, *Betula papyrifera* var. *cordifolia* (Regel) Fern., is limited to the Black Mountains. Here it forms a canopy tree but is rare.

The ratio of spruce to fir is variable, but there is a general correlation to altitude with spruce dominating at lower elevations, fir dominating at higher elevations. The use of number of trees to determine dominance of fir over spruce is misleading since spruce is a much larger tree. Separate studies of trees on Clingmans Dome and Mt. Mitchell reveal that the spruce trees of a mature stand have twice the trunk diameter of fir trees. This also correlates with the size record trees for the Great Smoky Mountains National Park—a circumference of 14′ 1″ for spruce, 6′ 7″ for fir (King and Stupka, 1950). Studies of annual rings of sawed stumps and cores obtained with a fourteen inch increment borer revealed that fir trees rarely are over 150 years old, but spruce trees are frequently over 300 years old.

The understory of the spruce-fir forest forms an uneven layer. Various sized seedlings of the canopy species are abundant. *Vaccinium erythrocarpum*[3] and *Viburnum alnifolium* are usually present. *Sambucus pubens* and *Rubus canadensis* are frequently where there has been a slight opening in the canopy.

The dominant herbaceous plants are the ferns, *Dryopteris austriaca* and *Athyrium filix-femina*. *Oxalis acetosella* is usually abundant. Other herbaceous plants usually found, but not in dense stands, are as follows: *Clintonia borealis*, *Aster acuminatus*, *Aster chlorolepis*, *Trillium erectum*, *Arisaema triphyllum* and *Chelone lyoni*. Plants frequently found are *Impatiens pallida*, *Euptorium rugosum*, *Streptopus roseus*, *Lycopodium lucidulum*, *Polypodium virginianum* (on rocks) and *Viola blanda* (in moist areas).

An extensive spruce-fir forest is found in the Smokies. Although a few well-developed stands remain on the Black Mountains, the Balsam Mountains, the Plott Balsams, and Mt. Rogers, most of the forest of these areas has been removed by lumbering and fire. The limited spruce-fir forest on Roan Mountain has suffered from lumbering in the past and continues to be disturbed by the annual Christmas tree selling program. The small high area of Grandfather Mountain has so many rugged, exposed cliffs that the spruce-fir forest present has little chance of reaching a full development. Fir is absent from the Craggies and Mt. Pisgah, although both of these areas are well within the altitudinal range for this species. Spruce is present but only as scattered trees. A well-developed spruce forest is found on Whitetop Mountain. Although it has the general features of a spruce-fir forest, fir is not found there.

Several stands of spruce are found along the lower altitudinal limit of the spruce-fir forest. One isolated stand is found near Soco Bald on the edge of the Smokies. One distinctive feature of the Whitetop Mountain spruce forest is the small size of the trees. A portion of the spruce forest was being cut at the time the area was studied. Growth ring counts of recently cut stumps showed that the growth of the larger trees had practically stopped, although no tree was found to be as much as 150 years old and none was as large as two feet in diameter. Several of the larger trees were dead. A timber cuter explained that this was "white spruce", the sawed lumber differing in "texture and color" from the red spruce he had cut from the larger trees in West Virginia. Trees in this stand have ben reported as black spruce (*Picea mariana* B. S. & P.) (Coker and Totten, 1945). The cones of the trees examined did not appear significantly different from those of the red spruce. Perhaps the difference in growth habit may be attributed to ecological factors.

The statement that spruce is dominant at lower altitudes and fir dominant at higher altitudes must be taken as a generality. In a mature spruce-fir stand at an elevation of 5550 feet near Double Springs Gap spruce trees were slightly outnumbered by fir. This stand is at the southern

[3] Authorities for species names are included with plant names in the catalog of vascular plants.

limit of the spruce-fir forest in the Smokies. Percentage composition studies near the summit of Clingmans Dome and in two stands near the summit of Mt. Mitchell show spruce to represent from 14–18% of the canopy trees. A rather extensive pure fir stand is found on top of Mt. LeConte.

2. Fire cherry community

The vast areas of secondary succession communities of the Balsam and Black mountains are the result of man's destructive activity. In the early 1900's lumbermen moved into these areas and began cutting the trees for timber and pulp. Some idea of the magnitude of these lumbering operations is still visible today in the extensive railroad beds and lumber-camp sites. During the exceptionally dry spring of 1916, fires swept over these lumbered areas (Holmes, 1918). The dried out soil, the slashings from the cut trees, and the reproductive vegetation were largely consumed.

Smaller fires have occurred throughout the region since that time. A rather extensive fire burned over the western ridge of the Balsam Mountains about 20 years ago. In the Smokies, fires have burned areas in the vicinity of Mt. Buckley, Dry Sluice Gap, and Big Cataloochee. In 1946 a plane crashed into the ridge just west of Clingmans Dome and a small area was severely damaged. The most recent fire in the high mountain region occurred on the west ridge of Waterrock Knob about three years before the area was studied.

The great variety of plant associations found in the various areas of the fire cherry community is due in part to differences in the extent and severity of the forces which destroyed the original vegetation. Another important factor is location in relation to a seed-supplying source. One of the most prominent secondary succession plants is fire cherry, *Prunus pensylvanica*. It is associated with several other dominant plants in a series of communities. The six communities of this developmental series are described below. The subtle change in species composition and the general abundance of fire cherry give considerable uniformity to the series. For this reason, these six communities are referred to collectively as the fire cherry community in this study.

Early fire cherry community. Fire cherry is singly dominant only during the earlier stages of secondary succession. In the Waterrock Knob area that was burned three years ago, large fire cherry seedlings are scattered throughout the area. Blackberry, *Rubus canadensis*, is also abundant but in localized stands. Woody plant seedlings include *Sambucus pubens*, *Diervilla sessilifolia*, *Betula lutea*, *Sorbus americana*, *Rhododendron catawbiense*, *Abies fraseri*, and *Acer rubrum*. The most abundant plant is the liverwort, *Marchantia polymorpha* L. Frequently occurring herbaceous plants are *Eupatorium purpureum*, *Aster acuminatus*, *Carex brunnescens*, and *Senecio aureus*. Rarer species are *Hieracium pilosella*, *Phytolacca americana*, and *Erigeron annuus*. There is a considerable amount of open ground.

In the area near Clingmans Dome, which was burned over 10 years ago, fire cherry is still dominant. In this area the trees are about 10 feet tall and up to three inches in diameter. This stand is more dense than the one described above, but the canopy is still about half open. There are no very small trees or seedlings of fire cherry. The absence of fire cherry seedlings from all of the older successional communities indicates that seedlings may be established only during the first few years after fire. *Sambucus pubens* is the only shrub species represented. Blackberries are abundant but do not form a definite understory. The herbaceous species which are fairly abundant are: *Athyrium filix-femina*, *Angelica triquinata*, *Impatiens pallida*, *Carex intumescens*, *Cinna latifolia* and *Poa alsodes*. A few plants of *Oxalis montana* and *Clintonia borealis* are present, even though they are not usually found in the fire cherry community. Their presence may be attributed to the fact that the disturbed area is small and surrounded by a spruce-fir forest.

The remaining fire cherry communities will be discussed in general terms, since the different stands show considerable variation, especially in the content of herbaceous species.

Fire cherry-blackberry community. As a fire cherry community, such as the one just discussed, becomes older, the fire cherry trees decrease in numbers as evidenced by the presence of dead trees and snags and absence of seedlings. Blackberry forms an understory layer which, in extreme forms, may allow very little light to reach the ground. Clusters of small trees and shrubs such as *Sorbus americana*, *Acer spicatum*, *Amelanchier laevis*, *Salix humilis*, *Sambucus pubens*, *Vaccinium corymbosum*, *Vaccinium erythrocarpum*, *Kalmia latifolia*, *Rhododendron catawbiense*, *Diervilla sessilifolia* and *Ribes rotundifolium* may rise above the understory as scattered humps.

Fire cherry-heath community. The species found in this community are similar to the one above. The relative scarcity of blackberry and greater abundance of shrubs, especially *Rhododendron* and *Vaccinium* make this a distinctive community.

Heath-weed community. This community seems to be an extension of the fire cherry-heath or the fire cherry-blackberry community. Here most of the fire cherry trees have died and blackberry is rare. The clusters of shrubs and trees are larger, and occupy from one third to two thirds of the community. The remainder of the area is covered by a number of different plants. *Veratrum viride* is dominant in localized areas in early summer, and *Angelica triquinata* is widespread as the dominant late summer species. *Solidago glomerata* is usually abundant. In some stands great clusters of ferns are found—usually *Athyrium filix-femina*, but in some stands this species is mixed with *Dennstaedtia punctilobula*. Numerous other species are commonly found, but they are either scattered or their dominance is limited to very small areas. This community is best developed on exposed ridges.

Fire cherry-weed community. This community probably follows the fire cherry community. Here blackberry does not form a prominent part of the community, and the heath and other shrubs are more scattered than in the heath-weed community. The fire cherry trees may vary considerably in size from one stand to another. Although the trees are usually scattered, they do not seem to be dying out as was noted in the fire cherry-blackberry community. Herbaceous species are similar to those in the heath-weed community. This community is also associated with exposed ridges.

Fire cherry-yellow birch community. Perhaps the most widespread secondary succession community is the fire cherry-yellow birch community. This community was not observed in a young stage, but limited age studies indicate that yellow birch may not appear in the community until sometime after fire cherry is established. Yellow birch is usually dominant over fire cherry, and there is more variation in its size. *Acer spicatum* is usually present in the community but scattered. *Sorbis americana*, spruce, and fir are occasionally found, the latter two as small trees or seedlings. In the Black Mountains, paper birch is usually found scattered among the yellow birch.

Blackberry is fairly abundant, especially in the more open stands. *Diervilla sessilifolia*, *Ribes rotundifolium*, *Ribes glandulosum*, and *Vaccinium erythrocarpum* are usually found. *Rhododendron maximum* is scattered at lower elevations and *Rhododendron catawbiense* is scattered in the higher stands. The hybrid, *Rhododendron* × *wellesleyanum*, is found at 5600 feet in this community (Ramseur, 1959). Other scattered shrubs are *Viburnum alnifolium*, *Sambucus pubens*, *Viburnum cassinoides*, and *Cornus alternifolia*. Some of the frequently found herbaceous species are: *Aster chlorolepis*, *Luzula acuminata*, *Eupatorium rugosum*, *Impatiens pallida*, *Cheloni lyoni*, *Athyrium filix-femina*, *Dryopteris austriaca*, and *Carex laxiflora*. The fire cherry-yellow birch community is best developed on gentle protected slopes or coves. Usually the fire cherry trees are about four inches in diameter and the yellow birch are four to six inches in diameter. In several isolated stands, however, both species form trees up to about eight to ten inches in diameter.

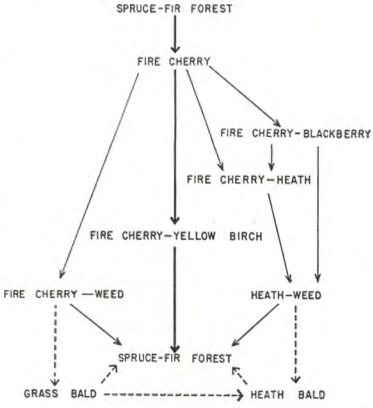

FIG. 3. A summary of secondary succession communities of the high mountain region and their probable relationship.

Figure 3 is a summary of secondary succession communities of the high mountain region and their probable relationship.

3. Grass bald community

Several studies of grass balds have been reported (Camp, 1931; Wells, 1936, 1937; Mark, 1958; et. al.). Most of these balds are found at lower elevations (below 5500 feet). It is stated by Billings and Mark (1958) that the balds are an ecotonal phenomena associated with the forest

margin. For these reasons, the present study of these balds was limited to observations and an enumeration of vascular plant species. Visits were made to all of the high mountain balds included in the study by Wells (1937) and to two balds—Judaculla Fields and a bald on Whitetop Mountin—which were not studied by Wells or Mark (1958).

A comparison of Andrews Bald with the photograph and descripion by Wells (1937) indicates that considerable invasion by spruce, fir and shrubby species has occurred in the past 32 years. (Wells states that he visited the area in 1925.) Cold Mountain Bald appears much as it was described by Wells. The other balds either show evidence of grazing with little change in form or they show signs of invasion.

The highest grass bald observed was Judaculla Fields (near Richland Balsam Mountain) which has an upper border at an elevation of about 6200 feet. This is an extensive bald with very few shrubby species. Several large trees of *Crataegus* are found on the bald proper. Fringes of spruce-fir extend into the bald along the lower border. Invasion by spruce-fir is evident only near the borders. *Angelica triquinata*, which is a late-summer dominant on Andrews Bald and in open secondary succession areas, was not observed on an August 1 visit to this bald. A large number of herbaceous species were present including many composites, grasses and carices. The history of this bald is not known, but there is no evidence of recent grazing.

On the ridge northwest from the top of Whitetop Mountain is a small grass bald. A few scattered shrubs and spruce trees are present. Older trees located several yards from the present border of the bald have large limbs near the ground—evidence of an encroachment upon the bald by the spruce forest. There is no indication of grazing on the bald although a number of sheep were observed grazing on the open southern slope of the mountain. *Potentilla tridentata* is abundant throughout the bald area.

General observations of a number of balds indicate that there is a great fluctuation in dominant species from spring to summer. Wells (1937) stressed the dominance of the mountain oat grass (*Danthonia compressa*). Although this grass is still abundant, a number of other herbaceous plants are now also plentiful and, in combination, dominate many of the bald areas.

4. Heath bald community

The term heath bald is applied to any treeless area dominated by plants of the Ericales (Cain, 1930). There are two types of heath balds in the high mountain region—the heath slick and the Rhododendron garden. The heath slicks are found on steep exposed ridges in the Mt. LeConte-Laurel Top vicinity of the Smokies. These balds are generally limited in extent and associated with exposed slate. Cain (1930) described six heath balds on Mt. LeConte. They are dominated by *Rhododendron carolinianum*, which usually forms extensive uninterrupted "slicks". The other type of heath bald is found on Roan Mountain and the Craggies. Here extensive stands of heath bald may cover gaps, slopes, and summits. The dense clusters of heath, dominated by *Rhododendron catawbiense* are often separated by bands of low growth of a grass bald form. These Rhododendron gardens are tourist attractions, but the influence of man in maintaining this community is not known.

In some areas it appears that typical heath bald shrubs are invading grass balds. Where this invasion is extensive, the resulting vegetation is difficult to classify as either heath bald or grass bald.

5. Shrub bald community

The shrub bald community has some aspects of the intermediate grass-heath bald vegetation but differs in that shrubby trees of species usually associated with lower elevations are numerous. This community is limited to certain areas of Cold Mountain, Mt. Pisgah, and Craggy Dome. These stands are dominated by a combination of species including *Fagus grandifolia*, *Betula lutea*, *Quercus borealis*, *Amelanchier laevis*, *Castanea dentata*, *Fraxinus sp.*, *Pinus rigida*, *Cornus alternifolia* and *Corylus cornuta*.

6. Beech forest community

The beech forest community of the high mountains is confined to certain gaps along the ridges of the Smokies and the Balsams. Russell (1953) suggests that these forests are maintained by wind. Beech (*Fagus grandifolia*) is usually a component of the deciduous forest which borders the lower altitudinal limit of the spruce-fir forest.

On the south ridge of Black Mountain (in the Balsams) a beech forest extends from an elevation of about 5750 feet down to Black Mountain Gap which is about 5500 feet. This stand is

dominated by beech trees up to 14 inches in diameter. Buckeye (*Aesculus octandra*) makes up about five per cent of the canopy. Beech seedlings or root suckers are frequent, and a few seedlings of spruce are present. Shrubs are rare, but *Sambucus pubens* and *Sorbus americana* are present. The more abundant herbaceous species are *Eupatorium rugosum, Aster acuminatus, Aster chlorolepis, Carex brunnescens, Luzula acuminata* and *Laportea candensis.*

Other beech stands observed are smaller in size and the trees are considerably smaller. One striking feature of the beech stands is the abrupt transition line which separates them from the surrounding spruce-fir forest.

A shrubby deciduous community dominated by beech is found on the exposed summits of Cold Mountain, Mt. Pisgah, and Craggy Dome. This community also differs from the beech forest in that it is not associated with gaps nor with the spruce-fir forest, but with a shrub bald or heath bald. The presence on these high mountains of beech and other species normally associated with lower elevations is exceptional. Perhaps the long steep slopes and general absence of intermediate peaks and ridges do not allow an altitudinal stratification of the climate.

7. Disclimax communities

No attempt was made to analyze areas of vegetation which are altered by man. Specimens were collected from these continually disturbed areas to see what introduced species had become established. The rather frequent use of horses on the trails of the Smokies provides an opportunity for the introduction of numerous seeds of some weed and crop species.

8. Transition

Specimens were collected from the transition zone between the spruce-fir forest and the deciduous forest when it occurred at elevations above 5500 feet.

FLORISTIC DISCUSSION

GENERAL

A total of 3707 specimens were collected for this study. These represent 63 families, 214 genera and 391 species and varieties. The most abundantly represented family is Compositae with 26 genera and 59 species. *Carex*, with 18 species, is the largest genus. Nearly half (30) of the families are represented by only one genus.

TABLE 3
Floristic summary—major categories

Category	No. of Families	No. of Genera	No. of Species
Pteridophytes	4	11	17
Gymnosperms	1	5	8
Angiosperms	58	198	366
Monocotyledons	10	44	95
Dicotyledons	48	154	271
Total vascular plants	63	214	391

The following 10 families, with number of genera and number of species, represent over half of the genera and species: Gramineae, 14, 31; Cyperaceae, 3, 20; Liliaceae, 18, 27; Ranunculaceae, 9, 17; Rosaceae, 13, 22; Violaceae, 1, 10; Umbelliferae, 9, 11; Ericaceae, 10, 20; Scrophulariaceae, 8, 12; Compositae, 26, 59.

The representation of major classification categories (Fernald, 1950) is summarized in Table 3.

Of the 10 high mountain areas, the Balsam Mountains area, with 265 species, is best represented in the collections (See Table 5). This is the only area in which all of the eight community types are present.

The following species are found in all 10 of the mountain areas: *Athyrium filix-femina, Polypodium virginianum, Picea rubens, Carex brunnescens, Arisaema triphyllum, Maianthemum canadense, Betula lutea, Rubus canadensis, Sorbus americana, Vaccinium erythrocarpum, Viburnum alnifolium, Sambucus pubens, Eupatorium rugosum, Aster chlorolepis.*

The following species are found in nine of the high mountain areas: *Dryopteris austriaca, Clintonia borealis, Fagus grandifolia, Ribes rotundifolium, Ribes glandulosum, Amelanchier laevis, Potentilla canadensis, Prunus pensylvanica, Oxalis acetosella, Acer spicatum, Rhododendron maximum, Menziesia pilosa, Vaccinium corymbosum, Houstonia serpyllifolia, Aster acuminatus, Hieracium pratense.*

The following species are found in seven or eight of the high mountain areas: *Abies fraseri, Danthonia compressa, Carex intumescens, Luzula echinata, Veratrum viride, Trillium erectum, Trillium undulatum, Rumex acetosella, Trautvetteria caroliniensis, Saxifraga michauxii, Heuchera villosa, Aronia melanocarpa, Fragaria virginiana, Ilex montana, Impatiens pallida, Viola cucullata, Viola blanda, Angelica triquinata, Cornus alterni-*

TABLE 4

Floristic summary—communities

Community	Spruce-fir	Fire cherry	Grass bald	Heath bald	Shrub bald	Beech forest	Disclimax	Transition zone	Total
Vascular plants	145	201	236	102	128	30	84	178	391
Angiosperms	131	183	222	93	126	25	84	167	366
Dicotyledons	87	135	166	76	93	15	61	122	271
Monocotyledons	44	48	56	17	33	10	23	45	95
Gymnosperms	4	4	6	2	1	2		4	8
Pteridophytes	10	14	8	7	1	3		7	17
Trees	18	20	21	10	13	5		20	28
Shrubs	19	28	30	24	26	2	3	24	40
Herbs	108	153	185	68	89	23	80	134	323

folia, Rhododendron catawbiense, Kalmia latifolia, Solidago glomerata, Achillea millefolium, Chrysanthemum leucanthemum.

A total of 127 species is found in only one of the high mountain areas, and 84 species are found in only two areas. The Balsam Mountains area, which has the largest number of species, also has the largest number of species (35) which are found in only one high mountain area.

More species (236) are found in the grass bald communities than any other (See Table 4). This fact is more striking when one realizes the very small portion of the total high mountain areas occupied by these communities (certinly less than five per cent). No one species is found in all eight communities. Three of the communities–disclimax, transition zone, and beech forest—are included in this study due to a geographic (altitudinal) affinity rather than one of floristics.

The following species are found in all of the other communities: *Dryopteris austricaca, Athyrium filix-femina, Picea rubens, Deschampsia flexuosa, Carex brunnescens, Carex debilis, Luzula echinata, Fagus grandifolia, Heuchera villosa, Hydrangea arborescens, Ribes rotundifolium, Aronia melanocarpa, Amelanchier laevis, Rubus canadensis, Prunus pensylvanica, Sorbus americana, Ilex montana, Acer spicatum, Viola blanda, Angelica triquinata, Cornus alternifolia, Rhododendron catawbiense, Menziesia pilosa, Vaccinium erythrocarpum, Vaccinium corymbosum, Galax aphylla, Houstonia longifolia, Houstonia serpyllifolia, Diervilla sessilifolia, Viburnum alnifolium, Viburnum cassinoides, Sambucus pubens, Eupatorium rugosum, Solidago glomerata, Aster chlorolepis, Aster acuminatus.*

One hundred and ten species are found in both the spruce-fir and the fire cherry communities. A total of one hundred and three species is found in only one community.

COMPARISON OF THE TEN HIGH MOUNTAIN AREAS

An attempt to compare the vegetation of the different high mountain areas by a study of the catalogue or the floristic summary in Table 5 may be misleading since they do not show relative abundance of the various species. The fact that only a small number of species is common to all or most of the areas is offset by the fact that some of these species make up a large percentage of the total number of plants in each area. The species which are found in only one area usually make up a small percentage of the total number of plants in the areas where they are found.

These variations in number of species and relative abundance explain the general uniformity of the flora, although there is a difference in number of species found in the various areas.

The change of vegetation from one community to another is only of local interest since the spruce-fir forest and fire cherry communities occupy more than 90 per cent of the high mountain region. These two communities share a number of common species—nearly 75 per cent of the species found in the spruce-fir forest are also found in the fire cherry community. The absence of these two communities from Cold Mountain, in the Balsam Mountains area, Mt. Pisgah, and the Craggies, suggests that these areas are atypical. These areas are discussed in connection with the beech forest previously mentioned.

There are differences among some of the other areas which give those areas distinctive floras. *Senecio rugelia* is endemic to the Smokies where it forms a conspicuous part of the flora. Paper birch, *Betula papyrifera* var. *cordifolia*, in the southern

TABLE 5

Floristic summary—areas

Area	Smokies	Plott balsams	Balsams	Pisgah	Craggies	Blacks	Roan	Grandfather	Whitetop	Mt. Rogers	Total
Vascular plants	201	107	265	124	106	139	112	67	82	49	391
Angiosperms	194	100	244	114	98	130	105	58	76	43	366
Dicotyledons	138	76	175	86	69	90	82	44	58	29	271
Monocotyledons	56	24	69	28	29	40	23	14	18	14	95
Gymnosperms	5	2	6	4	1	3	4	2	1	2	8
Pteridophytes	11	5	15	6	7	6	3	6	5	4	17
Trees	20	12	22	16	9	14	13	7	11	10	28
Shrubs	22	18	33	25	18	20	16	12	9	7	40
Herbs	168	77	210	83	79	96	83	47	62	32	323

high mountain region is limited to the Black Mountains. Here it is scattered throughout most of the area. There are two species on Roan Mountain which have disjunct northern ranges but are not found in other southern high mountain areas. These are *Alnus crispa* and *Arenaria groenlandica*. Grass balds and heath balds occupy a larger portion of the total area on Roan than on any other high mountain area.

PLANT GEOGRAPHY

A study of the ranges of individual species indicate that the high mountain flora is composed of several geographical elements. These elements are considered here only in terms of general range centers since a number of species are found in scattered areas some distance from their main distribution. The constant reports of range extensions in local flora studies indicate that our knowledge of plant distribution is far from complete.

The following categories are recognized in this study:

1. Southern Appalachian species
2. Appalachian species
3. Northern species extending southward only in the uplands or mountains
4. Northern species of general distribution but near their southern limit
5. Southern species near their northern limit
6. Species which are widespread in eastern North America
7. Introduced species

1. Southern Appalachian species. This category includes species which may extend as far northward as West Virginia or as far westward as the Ozark Plateau, but most of which have more localized ranges. One local endemic, *Calamagrostis caini*, is found only near the summit of Mt. LeConte in the Smokies. *Senecio rugelia* is restricted to the Great Smoky Mountains. *Glyceria nubigena* is reported from outside the Smokies for the first time in this study. It was found in the Balsam Mountains. Several species which are abundant and widespread in the higher mountains are *Abies fraseri, Rhododendron catawbiense, Vaccinium erythrocarpum*, and *Diervilla sessilifolia*. Species which are scattered and rare include *Geum radiatum, Tsuga caroliniana*, and *Krigia montana*. Other Southern Appalachian species are listed below. *Carex ruthii, Melanthium parviflorum, Silene ovata, Clematis viorna, Thalictrum clavatum, Diphylleia cymosa, Cardamine clematitis, Parnassia asarifolia, Saxifraga michauxii, Heuchera villosa, Geum geniculatum, Hypericum mitchellianum, Hypericum graveolens, Hypericum buckleyii, Rhododendron carolinianum, Rhododendron* X *wellesleyanum, Pieris floribunda, Leucothoe editorum, Galax aphylla, Cuscuta rostrata, Stachys clingmanii, Pycnanthemum montanum, Chelone lyoni, Penstemon smallii, Houstonia montana, Eupatorium rugosum* var. *roanense, Solidago curtisii, Solidago roanensis, Solidago glomerata, Prenanthes cylindrica.*

Leiophyllum buxifolium is included in this group for convenience, but it probably deserves a separate category. The taxonomic treatment of this plant has been variable, but it is here treated as a single species. It is associated with the Southern Appalachians, including eastern Kentucky, and with the coastal plain and sandy pine-barrens from South Carolina to New Jersey.

2. Appalachian species. Species of this category are associated with the Appalachian range, but do not extend into Canada. The following species are included: *Asplenium montanum, Poa cuspi-*

data, Carex aestivalis, Listera smallii, Paronychia argyrocoma, Aconitum uncinatum, Cimicifuga americana, Sedum telephioides, Angelica triquinata, Rhododendron calendulaceum, Rhododendron arborescens, Menziesia pilosa, Asclepias exaltata, Penstemon canescens, Aureolaria laevigata, Galium latifolium, Houstonia serpyllifolia.

3. Northern species extending southward only in the uplands or mountains. These species generally have a wide range in Canada and the northern United States, but are limited to the uplands and mountains in the Southern Appalachians. Several species have widely disjunct ranges. *Betula papyrifera* var. *cordifolia* in its northern range extends southward to northern New York and New England. A southern range includes the main ridge of the Black Mountains. *Alnus crispa* has a northern range similar to that of *Betula papyrifera* var. *cordifolia*, but its southern range is limited to Roan Mountain. *Scirpus cespitosus* in its northern range extends from the Arctic region to the mountains of northern New York and northern New England. Its southern range is western North Carolina, eastern Tennessee and northern Georgia. This species is also found in Europe. The American plant is slightly different and may be distinguished as *Scirpus cespitosus* var. *callosus* Bigel. *Juncus trifidus* is found from Greenland to the higher mountains of New England and New York. It is also found in the higher mountains of Eurasia. In the southern range it is found in Virginia and North Carolina. The southern plants may be designated as *Juncus trifidus* var. *monanthos* (Jacq.) Bluff. and Fing.

Other northern species include: *Lycopodium clavatum, Lycopodium tristachyum, Dryopteris austriaca, Tsuga canadensis, Picea rubens, Pinus strobus, Pinus rigida, Glyceria melicaria, Poa alsodes, Danthonia compressa, Calamagrostis canadensis, Agrostis borealis, Cinna latifolia, Carex brunnescens, Carex pensylvanica, Carex communis, Carex scabrata, Carex gracillima, Juncus brevicaudatus, Veratrum viride, Allium cernuum, Allium tricoccum, Lilium philadelphicum, Clintonia borealis, Clintonia umbellulata, Maianthemum canadense, Streptopus roseus, Polygonatum pubescens, Trillium erectum, Trillium grandiflorum, Trillium undulatum, Smilax herbacea, Sisyrinchium montanum, Habenaria psycodes, Comptonia peregrina, Betula lutea, Polygonum cilinode, Claytonia caroliniana, Arenaria groenlandica, Caulophyllum thalictroides, Tiarella cordifolia, Ribes rotundifolium, Ribes glandulosum, Potentilla tridentata, Rubes idaesu* var. *canadensis, Rubus canadensis, Agrimonia gryposepala, Prunus pensylvanica, Sorbus americana, Oxalis acetosella, Acer spicatum, Acer pensylvanicum, Viola pallens, Viola incognita, Viola blanda, Viola rotundifolia, Epilobium angustifolium, Circaea alpina, Rhododendron maximum, Monarda didyma, Melampyrum lineare, Diervilla lonicera, Viburnum alnifolium, Viburnum cassinoides, Sambucus pubens, Aster chlorolepis, Aster macrophyllus, Aster acuminatus, Aster umbellatus, Cirsium muticum, Hieracium scabrum.*

4. Northern species of general distribution but near their southern limit. The following species are included in this category: *Lycopodium lucidulum, Lycopodium obscurum, Lycopodium complanatum, Osmunda claytoniana, Cystopteris fragilis, Dennstaedtia punctilobula, Polypodium virginianum, Carex normalis, Carex crinita, Luzula acuminata, Smilacina racemosa, Medeola virginiana, Smilax herbacea, Sisyrinchium mucronatum, Corylus cornuta, Silene virginica, Ranunculus recurvatus, Thalictrum polyganum, Anemone quinquefolia, Physocarpus opulifolius, Aruncus dioicus, Gillenia trifoliata, Aronia melanocarpa, Amelanchier laevis, Crataegus punctata, Fragaria virginiana, Potentilla monspeliensis, Rubus odoratus, Geranium maculatum, Ilex montana, Acer saccharum, Aesculus octandra, Impatiens pallida, Tilia americana, Hypericum canadense, Viola pedata, Viola cucullata, Viola cucullata* X *sagittata, Oenothera tetragona, Aralia nudicaulis, Osmorhiza claytoni, Zizia aptera, Heracleum lanatum, Lysimachia quadrifolia, Gentiana puberula, Gentiana andrewsii, Asclepias exaltata, Monarda clinopodia, Blephilia hirsuta, Lobelia spicata, Eupatorium rugosum, Solidago bicolor, Solidago erecta, Solidago arguta, Aster lowrieanus, Aster prenanthoides, Aster lateriflorus, Hieracium paniculatum.*

5. Southern species near their northern limit. The following species are included in this category: *Selaginella tortipila, Robinia hispida, Rhododendron vaseyi, Campanula divaricata, Helianthus atrorubens, Coreopsis pubescens, Coreopsis major* var. *stellata.*

6. Species which are widespread in eastern North America. The 144 species of this category are not listed because of their unusually minor role in the high mountain flora.

TABLE 6

Floristic summary—geographical categories

Species Category	No. of Species	% of Total Flora
1. Southern Appalachian	41	10.5
2. Appalachian	17	4.4
3. Northern—south in mtns	75	19.2
4. Northern—near southern limit	58	14.8
5. Southern—near northern limit	7	1.8
6. Widespread in eastern N. A.	144	36.8
7. Introduced	49	12.5
Total	391	100.0

7. Introduced species. In the high mountain region, introduced and naturalized plants are represented by 49 species they are not listed here, but are indicated in the catalog by an asterisk preceding the species name.

PLANTS OF INTEREST

Range extensions are reported for these species as follows:

Glyceria nubigena from the vicinity of Clingmans Dome in the Smokies to Silvermine Bald in the Balsam Mountains.

Agrostis borealis. The southern range is extended from Roan Mountain to the Black Mountains.

A summary of the taxonomic treatment of the genus *Abies* in the eastern United States is included here. The writer believes that an understanding of this conspicuous genus, with its widely disjunct range and several taxonomic entities, would be of value in the overall understanding of the relationship between southern mountain flora and the northern flora.

Abies fraseri in the Southern Appalachian region has received a fairly stable taxonomic treatment. Coker and Totten (1945) report *Abies balsamea* on Mt. Rogers, and Small (1933) states that *Abies balsamea* may be found in North Carolina. No specimens were found by the writer to support either of these possibilities. The treatment of *Abies balsamea* of the northern United States is not as stable as that of *Abies fraseri*. One variety (*Abies balsamea* var. *phanerolepis*) was described by Fernald (1909) and a form of this variety (*Abies balsamea* var. *phanerolepis* forma *aurayana*) was described by Boivin (1938). In 1932 Fernald and Weatherby described a form of the species, *Abies balsamea* forma *hudsonia*.

The taxonomic history of *Abies* in the mid-Appalachian region of West Virginia and northern Virginia is a story of confusion. In 1892 and 1896 Millspaugh reported the West Virginia *Abies* to be *Abies balsamea*. In 1913 he referred to the West Virginia trees as *Abies fraseri*. In the same year Gibson (1913) and Britton and Brown (1913) included West Virginia in the range of *Abies fraseri* but did not include it in the range of *Abies balsamea*. A sketch by Brooks (1920) in his *West Virginia Trees* shows the large exserted and reflexed bracts of *Abies fraseri* properly named. He stated in the introduction that the drawings were made from specimens he had collected.

Rydberg (1926) commented on the fact that the species of balsam in West Virginia was in dispute. Freer (1933) identified a specimen from Crescent Rock as *Abies balsamea*. He noted that a 1901 collection by Steel from the same area had been distributed by the National Herbarium as *Abies fraseri*. A Mr. Walker of the National Museum checked the Steel collection and suggested that it was in error.

Core in 1934 added a new dimension to the story by a paper including sketches of *Abies balsamea* from Vermont, *Abies fraseri* from North Carolina, and *Abies ?* from West Virginia. He suggested that the latter might represent a new species of possible hybrid origin since the West Virginia trees were located midway between the range of *Abies balsamea* and *Abies fraseri*. He pointed out that there seemed to be two races of this species in West Virginia. Camp in 1936 stated, "On Crescent Rock in the Blues, it is neither *Abies fraseri* nor is it the northern balsam (*Abies balsamea*). Rather it merits description as a separate species." Camp's words were not to go unheeded, for in the same year Fulling (1936) published a description of *Abies intermedia* from the northern Virginia region (Hawksbill Mountain). The chief characters for identification of the new species were the slightly exserted and recurved bracts, and scales distinctly auriculate at the base.

In 1941 Fosberg stated that collections from the Hawksbill area showed great irregularity in the degree to which the bracts were exserted and recurved. He further stated that only occasionally are the scale bases auriculate. Fernald (1950) included West Virginia in the range of *Abies bal-*

samea only. In 1952 Strausbaugh and Core listed only *Abies balsamea* in West Virginia. Gleason (1952) did not include *Abies balsamea* var. *phanerolepis*. He included West Virginia and Virginia in the range of *Abies balsamea*. Little in 1953 included West Virginia and northern Virginia in the range of *Abies balsamea* var. *phanerolepis*. He further pointed out that the name chosen by Fulling, *Abies intermedia*, had been used in 1882 to describe a Pliocene fossil in France.

The writer has examined *Abies* specimens from the herbaria of the University of North Carolina, Duke University, University of West Virginia and New York Botanical Garden, and can see how it is possible that this mid-Appalachian material has been included in four different taxa. Of the mid-Appalachian specimens examined, none had bracts which were exserted and reflexed to the degree found in *Abies fraseri*, but one specimen (Wherry, West Virginia—no further location or number) is closer to *Abies fraseri* in appearance than to *Abies balsamea*.

A solution to this taxonomic puzzle is beyond the scope of the present study, but several observations have been made which may be useful in its eventual solution.

Abies fraseri occupies a range consisting of seven disjunct areas. Although the distance in miles between these areas is not great, the intervening areas of lower altitudes provide effective climatic separation. There is no evidence to indicate that any genetic exchange between these areas has occurred since their isolation, probably at the time of the establishment of the modern climate. The morphological characters of this species are constant throughout its range.

A large number of species have a common range including areas north of the terminal moraine, and areas in the higher southern mountains. In many of these species, plants in the northern part of the range differ from those in the southern part. These differences have led to the description of many varieties. In the same manner, closely related plants of a genus might differ sufficiently to be recognized as distinct species. In such case, confusion may arise when plants from the middle of the range have intermediate morphological characters.

The presence of species with ranges in the higher southern mountains disjunct from areas north of the terminal moraine suggests to the writer that the ancestral range of these species was near or in the higher southern mountains. As plants migrated northward, after the last great ice sheet had receded, the changing environment may have favored slight variations, leading to the establishment of new species or varieties in the northern range.

It seems clear that future attempts to evaluate the taxonomic position of the mid-Appalachian *Abies* should be based on a thorough distributional as well as morphological study of the various entities of *Abies*. Some values may be derived from a thorough study of trends of variation in other species which may have migrated along a similar route.

ORIGIN OF THE FLORA

The evidence gained in this study has led the writer to the belief that most of the southern high mountain flora is a relic of an ancient flora which moved southward ahead of the Labrador ice sheet and later moved into the northern region. The great similarity between the northern flora and the southern high mountain flora (Oosting and Billings, 1951) suggests a common origin, but distinct differences between the two floras indicate that different selective forces have been in operation on them.

The southern Appalachian endemics represent ancient species which were unable to adjust to conditions encountered by the northward migrating flora, but were able to survive in the southern mountains.

A portion of the flora, represented by many species, but only a few individuals, is composed of introduced species and invaders from the surrounding region.

The writer suggests that an intense study of the plants with north-south disjunct ranges might reveal some pattern of morphological characters which are adaptive.

EXPLANATION OF THE CATALOG

The arrangement of families, genera, and species follows as closely as possible that of the eighth edition of *Gray's Manual of Botany* (Fernald, 1950). Every effort was made to use the most recent taxonomic literature to determine species and varieties. Commonly used synonyms are placed below the preferred name and enclosed in parentheses. Sub-specific names have been given to a number of mountain plants, but an attempt was made to include only those which are morphologically distinctive.

The areas where the plants were collected are shown as column headings and the community locations are indicated by the letter abbreviations. Letters refer to communities as follows:

s—spruce-fir forest
f—fire cherry
g—grass bald
h—heath bald
u—shrub bald
b—beech forest
d—disclimax
t—transition zone

For example, the fourth entry of the catalog indicates that *Lycopodium complanatum* was found in the fire cherry and the grass bald comumnities of the Balsam Mountains and in the grass bald community of the Great Craggy Mountains.

Introduced specimens are indicated by an asterisk preceding the plant name.

Voucher specimens are deposited in the Herbarium of the University of North Carolina.

CATALOG OF VASCULAR PLANTS

	Smokies	Plott Balsams	Balsams	Pisgah	Craggies	Blacks	Roan	Grand-father	Whitetop	Rogers
LYCOPODIACEAE										
Lycopodium lucidulum Michx.	s,f,h	...	s	...	h	s	...	f	s	s
L. clavatum L.	s,f	...	f,g	...	...	...	...	...	...	...
L. obscurum L.	f	...	f,g,h	...	...	...	...	...	...	...
L. complanatum L.	...	...	f,g	...	g	...	...	...	...	...
L. tristachyum Pursh	f	...	f	...	...	...	...	...	...	...
SELAGINELLACEAE										
Selaginella tortipila A. Br.	...	...	g	u	...	...	...	...	...	...
OSMUNDACEAE										
Osmunda claytoniana L.	...	...	f,b	...	...	...	...	...	t	...
O. cinnamomea L.	s	...	f,t	...	...	...	...	...	...	...
POLYPODIACEAE										
Cystopteris fragilis (L.) Bernh.	...	...	t	...	...	s	...	f	...	...
Dryopteris noveboracensis (L.) Gray	...	...	...	u	u	...	...	...	...	...
D. austriaca (Jacq.) Woynar (*D. spinulosa var. americana* (Fisch.) Fern.)	sf,h,t	s,f	s,f,b	...	u	s,f	g	s	s	s
Polystichum acrostichoides (Michx.) Schott	...	...	s,f	...	...	...	...	...	...	...
Dennstaedtia punctilobula (Michx.) Moore	s,f,g,t	f	f,g	u	...	...	...	...	...	...
Athyrium filix-femina (L.) Roth	s,f,h	s	s,f,g,b,t	u	g	s,f	g,h	s,f	s,g	s
Asplenium montanum Willd.	s	...	s,t	...	h	s	...	s	...	...
Pteridium aquilinum (L.) Kuhn	f	...	g,h	u	...	...	...	...	...	...
Polypodium virginianum L. (*P. vulgare* L.)	s,f	s	s,h,u	u	h	s,f	h	s	s	s
PINACEAE										
Abies fraseri (Pursh) Poir.	s,f,h	s,f	s,f,g,h,b	...	...	s,f	s,g	s	...	s
Tsuga canadensis (L.) Carr.	s,f,t	...	f,g	u	...	f	...	...	...	...
T. caroliniana Engelm.	...	...	u	...	...	...	...	...	...	...
Picea rubens Sarg.	s,f,h,t	s,f	s,f,g,h,b,t	u	t	s,f	s,g,t	s,t	s	s
Pinus strobus L.	...	...	...	...	...	...	g	...	...	...
P. virginiana Mill.	s	...	...	t	...	...	g	...	...	...
P. rigida Mill.	f	...	f,g,t	u	...	...	...	...	...	...
Juniperus virginiana L.	...	...	g,t	...	...	...	...	...	...	...
GRAMINEAE										
**Bromus inermis* Leyss.	d	...	...	...	...	...	...	...	...	...
**B. tectorum* L.	d	...	...	...	...	d	...	...	...	...
**Festuca ovina* L.	...	...	...	...	...	d	...	...	...	...

**F. elatior* L.	...	...	h	...	...	d	...	...	...	...
F. obtusa Biehler	f	...	f,b,t	...	...	...	...	...	...	...
F. octoflora Walt.	...	...	...	...	g	...	...	...	...	...
Glyceria melicaria (Michx.) Hubbard	s	...	f	...	...	f,d	...	f	...	...
G. nubigena W. A. Anderson	s,d	...	s	...	...	...	...	...	...	...
**Poa annua* L.	s	...	...	...	...	...	...	...	...	...
**P. compressa* L.	...	...	...	u,t	...	...	...	...	...	...
**P. pratensis* L.	s,f,g,d	...	f,g,t	u	g	...	g	...	g,d	...
P. cuspidata Nutt.	...	t	b	...	...	...	...	...	...	t
P. autumnalis Muhl. ex. Ell.	...	...	f	...	...	f	...	...	...	...
P. alsodes A. Gray	s,f,d	...	f,t	...	g	d	...	...	t	...
**Dactylis glomerata* L.	s,d	...	t	...	g	d	...	...	...	...
**Holcus lanatus* L.	s,d	g	g,t	...	...	d	g,t	...	...	...
Deschampsia flexuosa (L.) Trin.	h	g	s,f,g,h,u,t	...	g	s,d	g	...	...	...
Danthonia spicata (L.) Beauv.	s	...	f,h	...	g	...	u	...	...	...
D. compressa Aust.	s,f,h	g	f,g,h,t	t	...	f	g	s	...	...
Calmagrostis canadensis (Michx.) Beauv.	...	...	f	...	...	...	...	...	...	...
C. cinnoides (Muhl.) Bart.	...	...	h	...	...	...	...	...	...	...
C. cainii Hitchc.	h	...	...	...	...	...	...	...	...	...
**Agrostis alba* L.	g	...	f,g	...	...	f	g	...	...	...
A. hiemalis (Walt.) B. S. P. var. *scabra* (Willd.) Blomquist	...	...	f,g	...	...	...	...	...	...	...
A. perennans (Walt.) Tuckerman	s,f	...	s,f	...	g	f,d	s,g	...	...	...
Agrostis borealis Hartm.	...	...	...	...	...	f	h	...	...	...
Cinna latifolia (Trev.) Griseb.	s,f,h	...	s,f	...	...	s,f	...	f	...	...
**Phleum pratense* L.	s,f,d	...	f,g,u	...	g	f,d	g	...	...	...
**Anthoxanthum odoratum* L.	g	...	...	...	...	...	...	...	t	...
Panicum depauperatum Muhl.	...	...	g	...	...	...	...	...	...	...
P. meridionale Ashe	...	...	...	u	...	...	...	...	...	...
CYPERACEAE										
Scirpus cespitosus L.	...	...	...	...	h	f	...	...	...	...
Rhynchospora capitellata (Michx.) Vahl	...	...	...	...	...	f	...	...	...	...
Carex stipata Muhl.	s,d	...	...	...	...	f	...	...	s	...
C. brunnescens (Pers.) Poir.	s,h	s,f	f,g,t	u	g	s,d	g,t	s	s,d	s
C. ruthii Mackenzie	s,g	...	f,g,t	...	g	f	...	...	...	...
C. scoparia Schk.	f,d	...	f	...	...	f,d	g,t	...	...	...
C. normalis Mackenzie	s	...	f,g,u,t	u	g	d	...	...	g	...
C. pensylvanica Lam.	f,g	...	b,t	u	g	...	...	...	...	...
C. communis Bailey	...	...	t	...	...	...	...	...	...	s,t
C. crinita Lam.	s,d	...	s,f,t	...	g	s,f	t	f	...	...

CATALOG OF VASCULAR PLANTS—*Continued*

	Smokies	Plott Balsams	Balsams	Pisgah	Craggies	Blacks	Roan	Grandfather	Whitetop	Rogers
CYPERACEAE (*continued*)										
Carex scabrata Schwein	...	...	f	...	...	...	...	...	...	...
C. gracillima Schwein	f	...	...	...	...	...	...	...	...	...
C. aestivalis M. A. Curtis	s,f	...	f,g,t	u	...	f	...	...	...	...
C. debilis Michx	s,f,g,h,d	s,f	f,g,h,u	u	g	s,f,d	g,t	s,f	s,g,d	s
C. venusta Dewy	h	...	...	...	...	...	...	...	...	...
C. granularis Muhl	...	...	u	...	...	...	...	...	...	...
C. digitalis Willd	...	...	...	u	...	...	...	...	...	...
C. laxiflora Lam	s	...	...	...	g	...	...	...	...	s
C. lurida Wahlenb	...	...	f	...	...	...	...	...	...	...
C. intumescens Rudge	s,f,g,d	...	s,f,g	...	g,u	f,d	g	f	g	s,d
ARACEAE										
Arisaema triphyllum (L.) Schott	f	s,t	s,f,g,b,t	u	u	f	g,t	s	g	s
COMMELINACEAE										
Tradescantia subaspera Ker-Gawl	t	...	g	u	...	...	...	...	...	...
JUNCACEAE										
Juncus trifidus L	...	...	...	...	h	...	...	...	...	...
J. tenuis Willd	s,f	...	g	u	...	d	g	s	...	...
J. effusus L	g	...	s,f	...	...	f	t	...	s	...
J. marginatus Rostk	g	...	...	...	...	...	...	...	...	...
J. brevicaudatus (Engelm.) Fern	g	...	f	...	...	f	t	...	...	...
Luzula acuminata Raf	s,g,b	...	f,g,u	...	u	f	...	s	...	...
L. echinata (Small) F. J. Herm	f,d	...	s,f,g,h,t	u	g	d	...	...	s,g,t	s
LILIACEAE										
Chamaelirium luteum (L.) Gray	...	...	g	...	...	...	...	...	g	...
Amianthium muscaetoxicum (Walt.) Gray	...	f,t	g	u	...	...	...	s	...	...
Stenanthium gramineum (Ker) Morong	g	...	...	t	...	...	...	...	...	...
Melanthium parviflorum (Michx.) S. Wats. (*Veratrum parviflorum* Michx.)	s,t	s,b	s,t	...	...	...	...	...	...	...
Veratrum viride Ait	s,f	...	s,f,g	...	g	s,f	g,t	s	s	s
Uvularia perfoliata L	...	t	s	...	...	...	...	...	...	...
U. pudica (Walt.) Fern	...	...	g	...	...	...	...	...	...	...
Allium cernuum Roth	...	...	g	...	...	...	...	...	...	...
A. tricoccum Ait	...	t	...	...	...	...	...	...	...	...
Lilium philadelphicum L	...	g	g	...	...	...	...	...	...	...
L. superbum L	s,f	f	f,b	u	...	f	...	...	...	...

Erythronium americanum Ker	...	...	...	...	...	...	...	...	g	...
Clintonia borealis (Ait.) Raf.	s	s,t	s	...	h	s,f	h	s	s	s
C. umbellulata (Michx.) Morong	g	t	t	...	...	...	...	...	...	...
C. spp. (sterile specimens) (*C. borealis* and *C. umbellulata*)	s,h	s	s,t	...	...	s	...	...	s	s
Smilacina racemosa (L.) Desf.	s	t	h,u,t	t	...	...	...	...	...	...
Maianthemum canadense Desf.	s	t	s,g,h,u,t	...	g	s	g,h	s	s,t	s
Streptopus roseus Michx. (including *Streptopus amplexifolius* (L.) DC.[4]	s,f	s	s,g,u	...	u	s,f	...	...	...	s
Polygonatum pubescens (Willd.) Pursh	...	...	g,b,t	...	...	...	...	...	...	...
P. biflorum (Walt.) Ell.	...	...	t	...	...	...	...	...	...	...
Medeola virginiana L.	...	t	s	...	...	...	...	...	...	...
Trillium erectum L.	s,f	s,t	s,g,u	...	u	s,f	...	...	t	s
T. grandiflorum (Michx.) Salisb.	g,t	...	...	...	...	...	...	...	...	...
T. undulatum Willd.	s,g	t	g,h,t	u	...	s	...	f	s	...
Aletris farinosa L.	...	...	g,t	u	...	...	...	...	...	...
Smilax herbacea L.	s,g,b,t	f,t	s,f,u,b,t	u	u	...	...	...	...	t
S. rotundifolia L.	f	...	g	...	...	...	...	...	...	...
S. hispida Muhl.	...	...	...	u	g	...	g	...	...	...
DIOSCOREACEAE										
Dioscorea villosa L.	...	...	u	u	...	...	...	...	...	...
AMARYLLIDACEAE										
Hypoxis hirsuta (L.) Coville	...	...	g,t	u	...	...	...	...	...	...
IRIDACEAE										
Sisyrinchium mucronatum Michx.	...	...	g,t	u	...	...	...	...	...	...
S. montanum Green	...	...	g	u	...	...	...	...	...	...
ORCHIDACEAE										
Habenaria clavellata (Michx.) Spreng.	...	...	s,f	...	...	f	t	...	...	...
Habenaria ciliaris (L.) R. Br.	g	...	...	...	...	...	...	...	...	...
H. psycodes (L.) Spreng.	s,f,u,d	f	t	u	...	s,f	...	...	...	...
Listera smallii Wieg.	...	...	s,f,g	...	h,u	...	...	...	...	...
SALICACEAE										
Salix humilis Marsh.	f	...	g,h,t	u	...	s	...	...	...	...
S. sericea Marsh.	s,f	f	f	...	...	f,d	g	f	...	...
MYRICACEAE										
Comptonia peregrina (L.) Coult.	...	...	...	t	...	...	...	...	...	...
CORYLACEAE										
Corylus cornuta Marsh.	...	...	g,u	u	...	...	...	...	...	...
Betula lutea Michx. f. (*B. alleghaniensis* Britt.)	s,f	s	s,f,u,t	u	u	s,f	s,g,t	s	s	s

[4] Absence of flowers made uncertain the separation of these two species.

CATALOG OF VASCULAR PLANTS—*Continued*

	Smokies	Plott Balsams	Balsams	Pisgah	Craggies	Blacks	Roan	Grandfather	Whitetop	Rogers
CORYLACEAE (*continued*)										
B. papyrifera var. *cordifolia* (Regel) Fern. (*B. cordifolia* Regel)	...	...	...	...	...	s,f	...	...	...	...
Alnus crispa (Ait.) Pursh	...	...	...	...	...	...	g,h	...	...	...
FAGACEAE										
Fagus grandifolia Ehrh.	s,f,t	f	g,u,b,t	u	h,u	t	g	...	s	t
Castanea dentata (Marsh.) Borkh.	s,g	...	g,u,t	u,t	...	...	...	...	...	...
Quercus borealis Michx. f. (*Q. rubra* var. *borealis* (Michx. f.) Farw.)	g,t	...	f,g,t	u	...	...	...	...	...	...
URTICACEAE										
Laportea canadensis (L.) Wedd.	s,f,t	...	b,t	...	h	...	...	...	...	...
POLYGONACEAE										
**Rumex obtusifolius* L.	s,d	...	g	...	...	...	g	...	d	...
**R. acetosella* L.	f,d	f	f,g,h,u	u	g	f,d	g	...	g	...
Polygonum punctatum Ell.	...	...	...	...	...	...	g	...	...	...
P. sagittatum L.	...	...	...	...	...	...	t	...	...	...
P. cilinode Michx.	s,f	...	f,b	...	h	s,f	...	...	...	s
PHYTOLACCACEAE										
Phytolacca americana L.	...	f	...	...	...	...	...	...	...	...
PORTULACACEAE										
Claytonia caroliniana Michx.	...	...	...	...	...	...	...	...	g	s
CARYOPHYLLACEAE										
Paronychia argyrocoma (Michx.) Nutt.	...	...	h,u	u	...	...	...	f,t	...	...
Arenaria groenlandica (Retz.) Spreng.	...	...	...	...	...	...	g	...	...	...
**Stellaria media* (L.) Cyrillo	...	...	...	...	...	...	g	...	...	...
S. pubera Michx.	...	t	...	...	...	...	...	...	...	...
**S. graminea* L.	...	...	...	...	...	...	s	...	...	...
**Cerastium vulgatum* L.	d	...	g	...	...	d	g	...	g	...
Silene virginica L.	...	g	f,g	u	...	...	g	...	...	...
S. ovata Pursh	d	...	...	...	...	...	...	...	...	...
**Saponaria officinalis* L.	...	...	...	...	...	d	...	...	...	...
RANUNCULACEAE										
Ranunculus abortivus L.	...	...	f	...	...	...	...	...	...	...
R. recurvatus Poir.	s	...	...	...	...	...	...	...	d	...
R. hispidus Michx.	...	...	t	...	...	...	...	...	...	...

R. fascicularis Muhl.	...	t	...	...	...	...	...	...	...	...
**R. acris* L.	s	...	f,g	...	...	...	...	...	...	...
**R. bulbosus* L.	...	...	...	...	...	...	...	...	g	...
Trautvetteria caroliniensis (Walt.) Vail.	s,f,d	...	s	...	g	f	s,g	f	g	...
Thalictrum clavatum DC.	s	...	t	...	g	...	t	f	...	...
T. polygamum Muhl.	s,f	...	t	...	g,u	...	...	f	...	...
Anemone virginiana L.	...	f	...	...	...	...	...	...	...	...
A. quinquefolia L.	...	t	f,g,b	...	...	...	...	...	s,g,t	s
Clematis virginiana L.	...	...	...	...	...	...	t	...	...	...
C. viorna L.	...	...	g,u,t	u	...	...	...	...	...	...
Aquilegia canadensis L.	g	g	g,t	u	...	...	...	...	g	...
Aconitum uncinatum L.	s,f	...	...	...	...	...	...	...	...	...
Cimicifuga americana Michx.	s,f	...	s,g,t	...	...	f	...	...	...	...
Actaea alba (L.) Mill.	g	t	t	...	...	...	...	...	...	...
BERBERIDACEAE										
Podophyllum peltatum L.	...	...	g,u,t	...	...	...	...	...	g	...
Diphylleia cymosa Michx.	s	...	t	...	...	...	...	...	...	...
Caulophyllum thalictroides (L.) Michx.	...	...	t	...	...	...	...	...	...	...
LAURACEAE										
Sassafras albidum (Nutt.) Nees	...	...	...	t	...	...	...	...	...	...
CRUCIFERAE										
**Lepidium campestre* (L.) R. Br.	...	...	...	...	...	...	...	...	g	...
**Capsella bursa-pastoris* (L.) Medic.	...	...	...	...	...	...	...	...	g,d	...
**Barbarea vulgaris* R. Br.	s,d	...	...	...	...	d	...	...	g,d	...
Cardamine clematitis Shuttlw.	f	...	...	...	...	...	...	f	s,t	s
C. pensylvanica Muhl.	...	...	...	...	...	...	...	...	s	...
Arabis laevigata (Muhl.) Poir.	f	t	g,b	...	...	...	...	...	...	...
DROSERACEAE										
Drosera rotundifolia L.	g	...	...	...	...	...	...	...	...	...
CRASSULACEAE										
Sedum telephioides Michx.	...	...	...	...	h	...	...	f	...	...
SAXIFRAGACEAE										
Saxifraga michauxii Britt.	s,f,h,d	s	s,f,g,h	...	g	s,f	g,h	s	t	...
Tiarella cordifolia L.	...	...	s,f,u	...	u	f	g,t	...	s,t	s
Heuchera villosa Michx.	s,f	...	g,h,u	t	h	s	g,h	s	...	...
H. americana L.	...	...	t	...	...	...	...	...	...	...
Parnassia asarifolia Vent.	s	...	...	...	...	f	...	...	...	...
Hydrangea arborescens L.	s,f,d	f	s,f,g,u,t	...	h	f	...	...	t	...
Ribes rotundifolium Michx.	s,f,h,t	s,f	s,f,g,h,u,b,t	...	h	s,f	g,h	f	t	s
R. glandulosum Grauer	s,f	s,t	s	...	u	s,f	h	s,f	s,t	s

CATALOG OF VASCULAR PLANTS—*Continued*

	Smokies	Plott Balsams	Balsams	Pisgah	Craggies	Blacks	Roan	Gandfather	Whitetop	Rogers
ROSACEAE										
Physocarpus opulifolius (L.) Maxim	...	...	...	...	h	...	...	...	...	...
Aruncus dioicus (Walt.) Fern	t	...	...	...	...	...	...	...	...	...
Gillenia trifoliata (L.) Moench	...	...	t	...	...	...	...	...	...	...
Aronia arbutifolia (L.) Ell	...	...	t	u	...	...	...	...	...	...
A. melanocarpa (Michx.) Ell	f	f	s,f,g,h,u,t	u	u	s,f	g	s	...	...
Sorbus americana Marsh	s,h	s	s,f,g,h,u	u	u	s,f	g,h	s,t	s	s
Amelanchier laevis Wieg	f,g,t	f	f,g,h,t	u	h	f	g	...	t	s
Crataegus punctata Jacq	...	...	...	...	h	...	g	...	...	t
Crataegus sp. (largely *C. macrosperma* Ashe)	g,t	f	s,g,h,t	u	u	...	g	...	...	...
Fragaria virginiana Duchesne	d	g	f,g,t	u	g	...	g	...	g	...
Potentilla tridentata Ait	...	...	g,h	u	g,h	...	g	...	g	...
**Potentilla recta* L	d	...	...	...	...	...	...	...	...	...
Potentilla monspelienses L	d	...	g	...	...	d	g	...	...	...
P. canadensis L	g,d	g	f,g,h,t	...	g	d	g,t	...	g	t
Geum radiatum Michx	h	...	...	...	...	...	g,h	f	...	...
G. geniculatum Michx	...	...	...	...	...	...	...	s	...	...
Rubus odoratus L	...	...	g	u	...	...	...	...	...	...
R. idaeus L. var. *canadensis* Richards	s,f	s,f	...	...	h	s,f,d	...	...	...	...
R. canadensis L	s,f,h,t	s,f	s,f,g,h,u	u	u	s,f	g,h	s	s	s
Agromonia gryposepala Wallr	...	...	g,t	...	...	...	...	...	...	...
A. parviflora Ait	...	...	...	u	...	...	...	...	...	...
Prunus pensylvanica L. f	s,f,h	s,f	f,g,h,u	u	u	s,f	s,g	s	...	s
P. serotina Egrh	f	f	g,b	...	...	...	...	...	s	...
LEGUMINOSAE										
**Trifolium pratense* L	f,d	...	f,u	...	g	...	g	...	...	...
**T. repens* L	f,d	...	f,g,t	...	g	d	g	...	...	...
**T. hybridum* L	...	...	...	...	...	d	...	...	...	...
**T. dubium* Sibth	...	...	...	...	...	d	...	...	...	...
**Melilotus alba* Desr	d	...	...	...	...	...	...	...	...	...
Robinia pseudoacacia L	...	...	f,g,t	...	...	...	...	...	...	...
Robinia hispida L	...	...	h,g	u	...	...	...	...	...	...
Vicia caroliniana Walt	...	t	g	...	...	...	...	...	...	...
Lathyrus venosus Muhl	...	...	t	...	...	...	...	...	...	...

OXALIDACEAE										
Oxalis acetosella L. (*O. montana* Raf.)	s,g,h	s,f	s	...	h	s,f	h	s	s	s
O. stricta L.	...	...	...	...	...	...	g	...	...	...
GERANIACEAE										
Geranium maculatum L.	g	...	g,u,t	...	...	...	...	...	...	...
**Erodium cicutarium* (L.) L'Her	...	...	...	...	...	...	...	...	g	...
AQUIFOLIACEAE										
Ilex montana T. & G.	s,f	f,t	s,g,h,t	u	u	s	...	...	s	s
ACERACEAE										
Acer spicatum Lam.	s,f	s,f	s,f,g,h,u,b	u	u	s,f	...	t	s,t	s
A. pensylvanicum L.	s,f,t	...	s,g,u	t	...	f	g	...	s	...
A. saccharum Marsh.	f,t	s	s	...	...	f	...	...	g	...
A. rubrum L.	f,t	...	s,f,g,h	...	...	f	g	s	...	...
HIPPOCASTANACEAE										
Aesculus octandra Marsh.	f,t	f	s,g,b,t	...	...	...	g	...	t	...
BALSAMINACEAE										
Impatiens pallida Nutt.	s,h,d	...	s,f	...	h	s,f	s	s	d	s
I. capensis Meerb.	s,f	...	...	...	...	...	...	...	...	...
TILIACEAE										
Tilia americana L.	...	...	u	...	...	...	...	...	...	...
GUTTIFERAE										
Hypericum buckleyi Curtis	...	...	f,g,u	u	...	...	...	...	...	...
H. prolificum L.	...	...	...	...	...	f	...	...	...	...
**H. perforatum* L.	...	...	g	...	...	...	...	...	...	...
H. mitchellianum Rydb.	...	...	f,g	u	...	f	g	s	...	...
H. graveolens Buckl.	s,f,t	...	f,g,h	...	g	s,f	s	...	...	...
H. densiflorum Pursh	...	...	g,h	...	g	...	...	...	...	...
H. mutilum L.	g	...	f	...	...	...	...	...	...	...
H. canadense L.	...	...	...	...	...	d	t	...	...	...
VIOLACEAE										
Viola pedata L.	...	...	g	u	...	...	...	...	...	...
V. cucullata Ait.	f,g	t	s,f,g	...	...	s	g,t	...	s,g,t	s
V. papilionacea Pursh	s,b	...	b	...	h	...	...	...	...	...
V. sagittata Ait.	...	...	g	...	...	...	...	...	...	...
V. pallens (Banks) Brainerd	s	...	...	...	...	...	g	...	...	...
V. incognita Brainerd	...	f	...	...	...	...	...	...	...	...
V. blanda Willd.	s,h	...	f,g	...	g,u	s,f	g	f	f,t	s
V. primulifolia L.	...	...	g	...	...	...	...	...	...	...
V. rotundifolia Michx.	...	...	s	...	...	...	...	...	...	...
V. cucullata X *sagittata* Brainerd	...	...	...	...	...	...	...	...	g	...

CATALOG OF VASCULAR PLANTS—*Continued*

	Smokies	Plott Balsams	Balsams	Pisgah	Craggies	Blacks	Roan	Grandfather	Whitetop	Rogers
ONAGRACEAE										
Epilobium angustifolium L.	...	...	...	...	...	f	...	...	...	...
Oenothera biennis L.	...	...	...	...	...	d	...	...	...	...
O. tetragona Roth.	t	g	f,g,t	u	...	...	...	...	...	...
Circaea alpina L.	s,f	...	s,f,g	...	...	...	g	s	d	...
ARALIACEAE										
Aralia nudicaulis L.	...	f	h,u,t	u	h	...	...	...	...	...
UMBELLIFERAE										
Sanicula marilandica L.	...	...	g,u,t	...	...	...	...	...	...	...
Osmorhiza claytoni (Michx.) Clarke	...	...	...	...	...	...	...	...	d	...
Zizia aptera (Gray) Fern.	t	...	t	...	...	...	...	...	...	...
Z. trifoliata (Michx.) Fern.	...	t	...	u	...	...	...	...	...	...
Ligusticum canadense (L.) Britt.	...	f,t	g,u,t	...	...	...	...	...	...	...
Thaspium barbinode (Michx.) Nutt.	...	f	g,u,b,t	u	...	...	...	...	...	...
Angelica venenosa (Greenway) Fern.	...	...	g,u	u	...	...	...	...	...	...
A. triquinata Michx. (*A. curtisii* Buckl.)	s,f,h	f	f,g,h,t	u	u	s,f	g,h	s	...	...
Oxypolis rigidior (L.) C. & R.	...	...	f	...	...	...	...	...	...	...
Heracleum lanatum Michx.	...	...	t	...	...	...	...	...	...	...
**Daucus carota* L.	...	...	...	...	h	...	...	...	...	...
CORNACEAE										
Cornus alternifolia L. f.	s,f,d	s	s,f,g,h,u,t	u	u	f	...	...	...	s
PYROLACEAE										
Monotropa uniflora L.	s,f	...	s,f,h	...	h	s	t	...	...	...
ERICACEAE										
Rhododendron maximum L.	s,f,t	f	s,f,t	t	g	s,f	g	s,t	s	...
R. catawbiense Michx.	s,f,h,d	f,t	s,f,g,h,u,t	u	g,h,u	s,f	g,h	s,t	...	...
R. X *wellesleyanum* Waterer ex Rehder	...	...	...	...	...	f	...	...	...	...
R. carolinianum Rehder	s,h	...	f,u	u	...	...	...	...	...	...
R. calendulaceum (Michx.) Torr.	g	f,t	f,g,u,t	u	...	...	...	...	...	...
R. viscosum (L.) Torr.	...	...	g,h	u	...	...	...	...	...	...
R. arborescens (Pursh) Torr.	...	...	g,t	...	u	...	...	...	...	...
R. vaseyi Gray	...	s	...	...	...	...	...	...	...	...
Menziesia pilosa (Michx.) Juss	s,f,h	...	f,g,h,u,t	u	g,u	s	g,h	s	s	s

Leiophyllum buxifolium (Berg.) Ell. (*L. buxifolium* var. *hugeri* (Small) (Schneid.) (*L. lyoni* Sweet.)	h	...	h	...	...	...	g,h	s,t	...	...
Kalmia latifolia L.	f,g,h	t	f,g,h	t	g	f	g	...	...	...
Pieris floribunda (Pursh) B. & H.	...	h	f,g,h,u	u	...	...	...	...	...	...
Lyonia ligustrina (L.) DC.	g	...	f,g,h,u,t	u	...	...	g	...	...	...
Leucothoe editorum Fern. & Schub.	f	...	s,f	...	...	...	...	...	...	...
Epigaea repens L.	g,t	...	f,g,h	u	h	...	...	...	...	...
Gaylussacia baccata (Wang.) K. Koch	...	...	g,h	u	...	...	...	...	...	...
Vaccinium erythrocarpum Michx.	s,f,h	s	f,g,t	u	h	s,f,d	g,h	s	s	s
V. stamineum L.	...	...	g,t	u	...	...	...	...	...	...
V. stamineum var. *neglectum* (Small) Deam.	...	...	g	...	...	...	...	...	...	...
V. corymbosum L. (including *V. lamarckii* Camp, *V. simulatum* Small, and *V. constablaei* Gray)	s,f,g,h	f,t	s,f,g,h,t	u	h	s,f	g	s,t	s	...
DIAPENSIACEAE										
Galax aphylla L.	g,t	...	s,g,h,t	u	h	s,f	...	s	...	...
PRIMULACEAE										
Lysimachia quadrifolia L.	g	f	g,h,u,t	u	...	...	g	...	g	...
OLEACEAE										
Fraxinus sp.	u	...	...	t	...	...	...	...	...	...
GENTIANACEAE										
Gentiana quinquefolia L.	...	...	g	...	...	f	...	...	...	...
G. puberula Michx.	h	...	...	...	...	...	...	...	...	...
G. andrewsii Griseb.	...	...	g	...	...	f	g	...	...	...
ASCLEPIADACEAE										
Asclepias exaltata L.	...	...	g	...	...	...	...	...	...	...
CONVOLVULACEAE										
**Convolvulus sepium* L.	...	...	h	...	g,h	...	...	...	...	...
Cuscuta rostrata Shuttlew.	s	t	h	...	...	f	...	...	...	...
POLEMONIACEAE										
Phlox carolina L.	...	...	f,g	...	g	...	...	...	...	...
LABIATAE										
**Prunella vulgaris* L.	...	...	f,g	t	...	d	g	...	...	...
Stachys clingmanii Small	s,f	...	f,b,t	...	...	...	...	...	...	...
Monarda didyma L.	s,f	...	...	...	...	...	t	f	...	...
M. clinopodia L.	...	...	f	u	...	...	...	...	...	...
Blephilia hirsuta (Pursh) Benth.	t	...	...	...	...	...	...	...	...	...
Pycnanthemum montanum Michx.	...	...	g	...	...	...	...	...	...	...
SOLANACEAE										
Solanum carolinense L.	...	...	g	...	...	...	...	...	...	...

CATALOG OF VASCULAR PLANTS—*Continued*

	Smokies	Plott Balsams	Balsams	Pisgah	Craggies	Blacks	Roan	Grandfather	Whitetop	Rogers
SCROPHULARIACEAE										
**Verbascum thapsus* L.	...	...	t	...	...	...	...	...	...	...
**V. blattaria* L.	...	...	g	...	...	...	...	...	...	...
Chelone lyoni Pursh.	s,d	s	s,f,t	...	...	s,f,d	h	f	...	...
Penstemon smallii Heller	...	g	g,t	u	...	...	...	...	...	...
P. canescens (Britt.) Britt.	...	...	g	...	...	...	...	...	...	...
**Veronica serpyllifolia* L.	d	...	...	...	...	...	...	...	...	...
**V. officinalis* L.	d	...	f,g	...	g	f	g	...	g,d	...
**V. arvensis* L.	s	...	...	...	...	...	...	...	...	...
Aureolaria laevigata (Raf.) Raf. (*Gerardia laevigata* Raf.)	g	...	...	...	...	...	...	...	...	...
Castilleja coccinea (L.) Spreng.	...	...	g,t	...	...	...	...	...	...	...
Melampyrum lineare Desr.	...	...	g,h	u	...	...	...	...	...	...
Pedicularis canadensis L.	t	f,t	g,u,t	u	...	...	...	...	...	...
PLANTAGINACEAE										
**Plantago major* L.	d	...	...	...	...	...	g	...	...	...
P. rugelii Dene.	...	...	...	...	...	d	...	...	...	...
**P. lanceolata* L.	s	...	g	...	...	...	...	...	...	...
RUBIACEAE										
Galium aparine L.	d	...	...	...	...	...	...	...	...	...
G. triflorum Michx.	s	...	s,t	...	...	...	...	...	...	...
G. latifolium Michx.	...	...	g	...	...	...	...	...	...	...
Houstonia serpyllifolia Michx.	s,f,d	f	f,g,h	u	g,u	s,f	s,g,t	f	g	...
H. purpurea L.	g,t	f,g	f,g,h	u	...	...	...	...	...	...
H. longifolia Gaertn.	...	...	s,f,g,h,u,t	u	...	...	...	...	...	...
H. montana (Chickering) Small	...	...	...	...	...	...	g,h	s	...	...
CAPRIFOLIACEAE										
Diervilla lonicera Mill.	...	...	...	...	...	f	...	...	...	...
D. sessilifolia Buckl.	s,f,h,d,t	f	f,g,h,u,t	u	u	f	...	...	...	...
Viburnum alnifolium Marsh.	s,f	s	s,f,g,h,b,t	u	u	s,f	s	s	s	s
V. cassinoides L.	s,f,g	s,f,t	s,f,g,h	u	u	...	...	...	...	...
Sambucus canadensis L.	...	...	...	...	...	f	g,t	...	...	...
S. pubens Michx.	s,f,h	s,f,t	s,f,g,t	u	u	s,f	s,g	s	s	s
CAMPANULACEAE										
Specularia perfoliata (L.) A. DC.	...	...	...	u	...	...	...	...	...	...

Campanula divaricata Michx.	g	...	...	t	...	...	g	...	...	...
Lobelia spicata Lam.	...	...	g	...	...	...	...	...	...	...
COMPOSITAE										
Eupatorium rugosum Houtt.	s,f,h	s,f	f,g,h	u	h	f,d	s,g,t	s	t	s
E. rugosum var. *roanense* (Small) Fern.	...	...	...	...	...	d	...	...	...	...
E. sp.	f	...	...	...	...	...	...	...	...	...
E. purpureum L.	f	...	s	...	...	f,d	g	f	...	...
Liatris spicata (L.) Willd.	...	...	t	...	...	...	...	...	...	...
Solidago curtisii T. & G.	f	...	b	u	...	d	...	...	...	...
S. bicolor L.	g	...	...	...	...	...	...	...	...	...
S. roanensis Porter	...	...	g	...	...	...	...	...	...	...
S. erecta Pursh.	f	...	...	...	...	...	...	...	...	...
S. arguta Ait.	f	f	g,t	u	...	...	...	...	...	...
S. altissima L.	f	...	...	...	...	d	...	...	...	...
S. gigantea Ait.	...	...	...	...	h	...	...	...	...	...
S. glomerata Michx.	s,f,h	f	f,g,h,t	...	g	s,f,d	g	s	...	...
Aster chlorolepis Burgess.	s,f	t	s,f,g,h	u	g,u	s,f,d	g,t	f,	t	s
A. macrophyllus L.	...	...	f,g,h,t	...	...	...	...	...	...	...
A. lowrieanus Porter	f	...	...	...	h	f,d	...	...	...	...
A. undulatus L.	f,g	...	g	...	...	...	...	...	...	...
A. prenanthoides Muhl.	...	...	f,g	...	...	...	...	...	...	...
A. puniceus L.	...	...	...	...	...	d	...	...	...	...
A. pilosus Willd.	...	...	...	...	h	d	...	...	...	...
A. lateriflorus (L.) Britt.	f	...	...	...	...	...	...	...	...	...
A. acuminatus Michx.	s,f,h	s,f	s,f,g,h,t	...	u	s,f,d	g,h	s,	s,t	s
A. umbellatus Mill.	...	...	...	u	...	...	...	...	...	...
Erigeron philadelphicus L.	d	t	t	...	...	...	...	...	...	...
E. annuus (L.) Pers.	f,d	f	f	...	...	...	...	...	...	...
E. strigosus Muhl.	f	f	f,g	u	h	d	...	...	...	...
Sericocarpus asteroides (L.) BSP.	f,g	...	g	u	...	...	g	...	...	...
Antennaria plantaginifolia (L.) Hook.	...	...	t	...	...	...	...	...	g	...
Gnaphalium obtusifolium L.	...	...	...	...	...	f	...	...	...	...
G. purpureum L.	...	...	g	...	...	...	...	...	...	...
Ambrosia artemisiifolia L.	...	...	...	...	h	...	...	...	...	...
Parthenium integrifolium L.	...	...	g	u,t	...	...	...	...	...	...
Rudbeckia laciniata L.	s,f	g	f,g,b	...	...	d	...	f	...	...
R. hirta L.	...	...	g,t	u	...	...	...	...	...	...
Helianthus atrorubens L.	g	...	...	u	...	...	...	...	...	...

CATALOG OF VASCULAR PLANTS—*Continued*

	Smokies	Plott Balsams	Balsams	Pisgah	Craggies	Blacks	Roan	Grandfather	Whitetop	Rogers
COMPOSITAE (*continued*)										
Coreopsis pubescens Ell.	...	...	g	...	...	...	...	...	...	...
C. major var. *stellata* (Nutt.) Robins.	g	...	...	u	...	...	...	...	...	...
Bidens frondosa L.	...	...	...	...	...	d	...	...	...	...
Helenium autumnale L.	...	...	...	...	...	...	g,t	...	...	...
**Achillea millefolium* L.	d	f	f,g	u	g	...	g	...	g	...
**Chrysanthemum leucanthemum* L.	f	f	g	t	g	d	g	...	...	...
Cacalia atriplicifolia L.	t	g	g	...	...	...	g	...	...	...
Senecio smallii Britt.	f,d,t	f	g,f,t	...	...	d	...	...	...	...
S. aureus L.	...	...	...	...	...	f	g,t	...	g	...
S. rugelia A. Gray	s,f	...	...	...	...	...	...	...	...	...
**Cirsium vulgare* (Savi) Tenore	...	...	...	...	...	...	g	...	...	...
C. muticum Michx.	g	f	g	u	g	...	...	...	...	...
**Cichorium intybus* L.	d	...	...	...	...	...	...	...	...	...
Krigia biflora (Walt.) Blake	...	...	u	u	...	...	...	...	...	...
K. montana Nutt.	...	...	g,h,u	...	g	d	g	...	...	...
**Taraxacum officinale* Weber	d	...	...	...	...	...	...	...	d	...
Lactuca canadensis L.	...	f	f	...	...	d	...	...	...	...
Prenanthes cylindrica (Small) Braun	s,f,g	...	f,g,b	...	h	d	g	...	g	...
**Hieracium pilosella* L.	d	f	g	...	...	...	...	...	g	...
**H. pratense* Tausch.	d	f	f,g,u,t	u	g,h	d	g	...	g	t
**H. florentinum* All.	...	...	g,t	...	...	...	...	...	...	...
H. venosum L.	...	...	g,t	u	...	...	...	...	...	...
H. paniculatum L.	f,g	...	...	...	...	...	...	...	...	...
H. scabrum Michx.	...	...	g	...	...	...	g	...	...	...

SUMMARY

The isolated high mountain areas of the Southern Appalachians were studied. Nested quadrats were plotted and analyzed in the different plant communities. A total of 3707 specimens of vascular plants representing 391 species and varieties was collected.

The southern high mountain plant communities described are spruce-fir forest, fire cherry, grass bald, heath bald, shrub bald, beech forest, disclimax, and transition zone. The fire cherry community, the secondary succession community, is represented by the following forms: early fire cherry, fire cherry-blackberry, fire cherry-heath, heath-weed, fire cherry-weed, and fire cherry-yellow birch. The vegetation is dominated by the spruce-fir and fire cherry communities which are found in seven of the ten high mountain areas.

Seven geographical elements present in the southern high mountain flora are described as follows: Southern Appalachian species, Appalachian species, northern species extending southward in the uplands or mountains, northern species of general range near their southern limit, southern species near their northern limit, species of general range in eastern North America, and introduced species.

A summary of the taxonomic treatment of *Abies* in eastern North America is included in this study.

Range extensions are reported for *Glyceria nubigena*, and *Agrostis borealis*.

LITERATURE CITED

BILLINGS, W. D. AND A. F. MARK. 1957 Factors involved in the persistence of montane treeless balds. Ecology **38:** 140–142.

BOIVIN, B. 1948. Centurie de plantes Canadiennes. Naturaliste Canadien **75:** 202–227.

BRITTON, N. L. AND A. BROWN. 1913. An Illustrated Flora of the Northern United States, Canada and the British Possessions. Charles Scribner's Sons, New York. 3 vols.

BROOKS, A. B. 1920. West Virginia Trees. Bull. 175. Agricultural Exp. Sta. Coll. of Agric., West Va. Univ. Morgantown, W. Va. 242 pp.

BROWN, D. M. 1941. Vegetation of Roan Mountain: a phytosociological and successional study. Ecol. Monog. **11:** 61–97.

CAIN, S. A. 1930. Certain floristic affinities of the trees and shrubs of the Great Smoky Mountains and vicinity. Butler Univ. Bot. Studies **1:** 129–150.

——. 1945. A biological spectrum of the flora of the Great Smoky Mountains National Park. Butler Univ. Bot. Studies. **7:** 11–24.

CAMP, W. H. 1931. The grassy balds of the Great Smoky Mountains of Tennessee and North Carolina. Ohio Jour. Sci. **31:** 157–164.

——. 1936. On Appalachian trails. N. Y. Bot. Gard. Jour. **37:** 249–265.

CARNEY, C. B. 1955. Weather and Climate in North Carolina. Bull. 396. Agricultural Exp. Sta. N. C. State College, Raleigh, N. C.

COKER, W. C. AND H. R. TOTTEN. 1945. Trees of the Southeastern States. The Univ. of North Carolina Press, Chapel Hill, N. C.

CORE, E. L. 1934. The blister pine in West Virginia. Torreya **34:** 92–93.

CRANDALL, DOROTHY L. 1958. Ground Vegetation Patterns of the Spruce-Fir Area of the Great Smoky Mountains National Park. Ecol. Monog. **28:** 337–360.

CURTIS, M. A. 1860. Trees of North Carolina. Geological and Natural History Survey of N. C. Part III. W. W. Holden, Raleigh, N. C. 123 pp.

DAVIS, J. H. JR. 1930. Vegetation of the Black Mountains of North Carolina: an ecological study. Jour. Elisha Mitchell Sci. Soc. **45:** 291–318.

FENNEMAN, N. M. 1938. Physiography of Eastern United States. McGraw-Hill, New York. 714 pp.

FERNALD, M. L. 1909. A new variety of *Abies balsamea*. Rhodora **11:** 201–203.

——. 1931. Specific segregations and identities in some floras of eastern North America and the Old World. Rhodora **33:** 25–63.

——. 1950. Gray's Manual of Botany. 8th edn. American Book Co., New York. 1632 pp.

FERNALD, M. L. AND C. A. WEATHERBY. 1932. *Abies balsamea* (L.) Mill. forma *hudsonia* (Bosc.) comb nov. Rhodora **34:** 190–191.

FOSBERG, F. R. 1941. Observations on Virginia plants. Part I. Va. Jour. Sci. **2:** 106.

FREER, R. S. 1933. Notes on the occurrence of some unusual plants in the Va. Blue Ridge. Bartonia **15:** 9–13.

FULLING, E. H. 1936. *Abies intermedia*, the Blue Ridge fir, a new species. Castanea **1:** 91–94.

GIBSON, H. A. 1913. American Forest Trees. Hardwood Record, Chicago. 708 pp.

GLEASON, H. A. 1952. The New Britton and Brown Illustrated Flora of the Northeastern United States and Adjacent Canada. N. Y. Bot. Gard., New York. 3 vols.

GRAY, ASA. 1841. Notes on a botanical excursion to the mountains of North Carolina. Amer. Jour. Sci. and Arts **42:** 1–49.

HARSHBERGER, J. W. 1899. The Botanists of Philadelphia. T. C. Davis & Sons, Philadelphia. 457 pp.

HARSHBERGER, J. W. 1903. An ecologic study of

the flora of the mountainous North Carolina. Bot. Gaz. **36:** 241–258, 368–383.

HELLER, A. A. 1891. Notes on the flora of North Carolina. Bull. Torr. Bot. Club **18:** 186–192.

HOLMES, J. S. 1918. Forest fires in North Carolina during 1915, 1916, and 1917. N. C. Geological and Economic Survey, Edwards and Broughton Printing Co., Raleigh, N. C.

KING, P. B. AND A. STUPKA. 1950. The Great Smoky Mountains—their geology and natural history. Sci. Monthly **71:** 31–43.

LITTLE, E. L. 1953. Checklist of Native and Naturalized Trees of the United States. Agriculture Handbook No. 41. Forest Service, Washington, D. C. 472 pp.

MARK, A. F. 1958. The ecology of the southern Appalachian grass balds. Ecological Monographs **28:** 293–338.

——. 1959. The flora of the grass balds and fields of the southern Appalachian Mountains. Castanea **24:** 1–21.

MILLSPAUGH, C. F. 1892. A Preliminary Catalog of the Flora of West Virginia. Bull. of W. Va. Agricultural Exp. Sta., Morgantown, W. Va.

——. 1913. The Living Flora of West Virginia. W. Va. Geological Survey, Morgantown, W. Va.

MILLSPAUGH, C. F. AND C. W. NUTTALL. 1896. Flora of West Virginia. Field Columbian Museum Publication 9, Chicago. 276 pp.

NELSON, W. A. 1928. Geologic Map of Virginia. U. S. Geological Survey. Washington, D. C.

OOSTING, H. J. 1948. The Study of Plant Communities. W. H. Freeman and Co., San Francisco, Calif. 389 pp.

OOSTING, H. J. AND W. D. BILLINGS. 1951. A comparison of virgin spruce-fir forest in the northern and southern Appalachian system. Ecology **32:** 84–103.

RAMSEUR, G. S. 1959. A Natural Stand of *Rhododendron X wellesleyanum* Waterer ex Rehder in the southern Appalachians. Jour. Elisha Mitchell Sci. Soc. **75:** 131.

RUSSELL, N. H. 1953. The beech gaps of the Great Smoky Mountains. Ecology **34:** 366–374.

RYDBERG, P. A. 1926. Botanizing in the higher Allegheny Mountains. Jour. N. Y. Bot. Gard. **27:** 1–6.

SMALL, J. K. 1933. Manual of the Southeastern Flora. The Univ. of N. C. Press, Chapel Hill, N. C. 1554 pp.

SMALL, J. K. AND A. A. HELLER. 1892. Flora of western North Carolina and contiguous territory. Mem. Torrey Bot. Club **3:** 1–39.

STRAUSBAUGH, P. D. AND E. L. CORE. 1952. Flora of West Virginia. (Part I) West Virginia Univ. Bulletin, Morgantown, W. Va.

STUCKEY. 1958. Geologic Map of North Carolina. Dept. of Cons. and Devel. Raleigh.

WELLS, B. W. 1936a. Origin of the southern Appalachian grass balds. Science, n. s. **83:** 283.

——. 1936b. Andrews Bald: The problem of its origin. Castanea **1:** 59–62.

——. 1937. Southern Appalachian grass balds. Jour. Elisha Mitchell Sci. Soc. **53:** 1–26.

WHITTAKER, R. H. 1956. Vegetation of the Great Smoky Mountains. Ecol. Monog. **26:** 1–80.